2015

Impact and Management of the Mexican Rice Borer (Lepidoptera: Crambidae) in Bioenergy Crop Agroecosystems

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IMPACT AND MANAGEMENT OF THE MEXICAN RICE BORER (LEPIDOPTERA: CRAMBIDAE) IN BIOENERGY CROP AGROECOSYSTEMS

A Dissertation
Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the formal
requirements for the degree of
Doctor of Philosophy

in

The Department of Entomology

by
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B.S., Purdue University, 2007
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December 2015

ACKNOWLEDGMENTS

I would like to thank my major professor, Dr. T. E. Reagan, in providing me the opportunity to pursue my Ph.D. His guidance and leadership have exceeded anything I could imagine in a graduate program, and he has prepared me to be an active individual in the agricultural community.

I would like to thank Dr. Rogers Leonard for agreeing to be actively involved with my academic committee, and for assisting me during the time Dr. Reagan was on medical leave. In addition, I would like to thank him for encouraging me to pursue a career in agricultural extension at the University of Florida.

I would like to give a special thanks to my colleagues and friends, Dr. Julien Beuzelin and Blake Wilson. Their assistance along the duration of my program has been invaluable and has been influential in making me a better scientist.

I thank the remaining members of my academic committee, Drs. M. O. Way, Mike Stout, and David Blouin in providing their expertise in integrated pest management, insect-plant interactions, and experimental statistics, respectively, as well as Dr. E. William Wischusen for serving as the Dean's Representative on my committee. Your support is very much appreciated, as well as your input during my Ph.D. program.

Finally, I would like to thank Melissa Crowe for her love and support. She has been by my side through the entirety of my time in Baton Rouge, and I cannot thank her enough.

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ABSTRACT

The Mexican rice borer, *Eoreuma loftini* (Dyar) (Lepidoptera: Crambidae) is an invasive stem borer pest of sugarcane, rice, corn, and sorghum, and poses a threat to the production of dedicated bioenergy feedstocks in the U. S. Gulf Coast region. Studies were conducted to assess insect-plant interactions between *E. loftini* and bioenergy and conventional cultivars of sugarcane and sorghum, including yield response, oviposition preference, and host suitability. In addition, the efficacy of select cultural and biological control tactics to manage *E. loftini* in these crops was assessed.

Bioenergy sugarcane (energycane) and sweet sorghum exhibited reduced *E. loftini* injury; however, these crops sustained greater losses in fresh stalk weight. Negative impacts to sucrose concentration from *E. loftini* injury were greatest in energycane, high-biomass sorghum, and sweet sorghum cultivars.

Eoreuma loftini eggs per plant and eggs per oviposition event were greater on mature plants than immature plants. On a crop type basis, sweet sorghum was preferred over sugarcane and high-biomass sorghum when measuring eggs per plant. The mortality-survival ratio during the neonatal stage was greater in immature sugarcane cultivar HoCP 85-845 and high-biomass cultivar ES 5200.

The percentage of bored internodes increased with higher nitrogen (N) rates. Yields indicated that N rate was positively associated with increases in stalk weight and ethanol productivity, but not sucrose concentration. Because higher N rates were associated with increased yields, our data suggest that increases in yield from additional N outweigh decreases from additional *E. loftini* injury.

Populations of *S. invicta* reduced percent relative survival of *E. loftini* by 0.1% per increase unit increase of *S. invicta*; however, reductions in the percentage of bored internodes and adult emergence holes were not detected. Reductions in *E. loftini* injury from *S. invicta* were not detected in transects of johnsongrass.

This research showed that select cultivars of bioenergy sugarcane and sorghum can be more resistant than conventional sugarcane and sorghum, demonstrating their compatibility in the Gulf Coast region. Because bioenergy crops are less tolerant to *E. loftini* in some instances, proper management practices should be continued, including judicial fertilization and conservation of natural enemies.

CHAPTER 1: GENERAL INTRODUCTION

In 2007, the United States government passed the Energy Independence and Security Act to minimize the country's reliance on non-renewable energy sources, mandating an increase in the minimum levels of renewable fuel used in transportation fuel to 136.3 billion liters by 2022 (United States Environmental Protection Agency 2007). This increase in renewable fuel will require substantial increases in acreage devoted to the production of dedicated bioenergy feedstocks for ethanol. As of now, a majority of ethanol is derived from corn, *Zea mays* L. produced in the Midwestern United States; however, this crop has garnered negative attention due to its high input to output ratio relative to other graminaceous feedstocks (Soloman et al. 2007). Dedicated bioenergy feedstocks bred for lignocellulosic biomass, including energycane, *Saccharum* spp., high-biomass sorghum, *Sorghum bicolor* (L.) Moench, and switchgrass, *Panicum virgatum L.*, have potential to produce ethanol more efficiently as a result of higher fiber, which can be hydrolyzed into additional sugars for ethanol (Soloman et al. 2007). Of the regions within the United States, the southern United States exhibits the greatest potential for production of dedicated bioenergy feedstocks because of extensive arable land, abundant rainfall, and mild winters (English et al. 2007). The Gulf Coast region, including Louisiana and Florida, readily possess agricultural infrastructure required for production of related conventional graminaceous crops, including sugarcane, *Saccharum* spp., and grain sorghum, *Sorghum bicolor* (L.) Moench, which would reduce monetary start-up costs from the government and private sector.

Prior to initiation of large-scale production of bioenergy crops, research is needed to assess the impacts on current agroecosystems, including the relationships between pest species and bioenergy crops. One species anticipated to disrupt production of bioenergy crops is the Mexican

rice borer, *Eoreuma loftini* (Dyar) (Lepidoptera: Crambidae), a serious insect pest of closely-related crops including sugarcane, rice, *Oryza sativa* L., corn, and grain sorghum (Van Zwaluwenberg 1926, Johnson 1984, and Showler et al. 2012). Upon entering the Lower Rio Grande Valley in 1980, *E. loftini* has been the most destructive pest of sugarcane in the western Gulf Coast region (Johnson and van Leerdam 1981). Range expansion of *E. loftini* continued north and eastward through the Texas rice belt at a rate of 23 km/yr (Reay-Jones et al. 2008), and in 2008, was first reported in pheromone traps in Calcasieu Parish, Louisiana (Hummel et al. 2010), where it continues its eastward expansion into rice and sugarcane production areas (Wilson et al. 2015a). Economic losses associated with *E. loftini* injury in sugarcane are estimated to reach $220 million per year once the pest is fully established across the state (Reay-Jones et al. 2008); however, it's impact on bioenergy crops has not been examined.

Current tactics used to manage *E. loftini* in conventional cropping systems include host-plant resistance, and cultural and chemical control practices. In Louisiana, HoCP 85-845 is the resistant-standard against *E. loftini* (Wilson et al. 2015b); however, this cultivar has demonstrated a loss of resistance under heavy infestations (Reay-Jones et al. 2003). Of the sugarcane cultivars grown in the Rio Grande Valley, only TCP 87-3388 has been classified as resistant (Wilson et al. 2015b). Irrigation has been shown to decrease *E. loftini* injury in sugarcane by 2.5-fold, and when integrated with cultivar resistance and applications of tebufenozide, reduced bored internodes to <10% (Reay-Jones et al. 2005). In addition, reducing drought conditions in sugarcane limits accumulation of free amino acids, such as proline (Reay-Jones et al. 2005, 2007a), which are essential for *E. loftini* development and have been shown to increase oviposition preference in host plants (Showler and Castro 2010a, Showler et al. 2011, Showler and Moran 2014). Irrigation also limits the availability of dry leaf material, which is the

preferred oviposition site of *E. loftini* (Reay-Jones et al. 2005, 2007a, Showler and Castro 2010a, 2010b). Management of *E. loftini* weed hosts can reduce harboring sites during the winter, thus reducing populations in the spring (Beuzelin et al. 2011). Attempts to utilize biological control to manage *E. loftini* populations have met with little success, in contrast to other stem borers, such as the sugarcane borer, *Diatraea saccharalis* (F.) (Lepidoptera: Crambidae) (Meagher et al. 1998); however, the effectiveness of *Solenopsis invicta* Buren in reducing *E. loftini* infestations remains unknown.

This research project focuses on determining the impact of *E. loftini* on bioenergy sugarcane and sorghum, while assessing the efficacy of select cultural and biological control tactics in reducing *E. loftini* injury and subsequent yield losses. The first study (Chapter 3) examined the susceptibility of bioenergy and conventional cultivars of sugarcane and sorghum by subjecting plants to a range of natural and artificially established *E. loftini* infestation levels. Yield data were collected to determine losses attributed to *E. loftini* injury. To further analyze susceptibility in a controlled environment, a series of greenhouse experiments (Chapter 4) were conducted to examine *E. loftini* oviposition preference and survival on cultivars of bioenergy and conventional sugarcane and sorghum. Oviposition preference was measured using a choice-experiment, while survival was measured using a no-choice experiment. The impact of added nitrogen (N) was compared among high-biomass and sweet sorghum cultivars in a 2-yr field study (Chapter 5) to determine if current recommended N regimes are compatible in a bioenergy crop system, and how these N regimes will impact injury and population dynamics of *E. loftini*. Lastly, the effectiveness of *S. invicta* as a biological control agent of *E. loftini* was measured in both conventional and bioenergy crops using a 2-yr field study (Chapter 6).

The goal of this research project is to determine if bioenergy sugarcane and sorghum will be compatible with currently produced conventional cultivars, and whether management tactics against *E. loftini* are compatible among both groups of crops.

CHAPTER 2: LITERATURE REVIEW

2.1. Taxonomy of E. loftini

The Mexican rice borer, *Eoreuma loftini* (Dyar) (Lepidoptera: Crambidae), is a member of the family Crambidae. Dyar (1917) originally described the species as *Chilo loftini*, which was bred in Arizona from Mexican sugarcane. The species was later moved into the genus *Acigona* Hübner by Bleszynski (1967), and then into the genus *Eoreuma* Ely by Klots (1970). The genus *Eoreuma* belongs to the same tribe as *Diatraea*, which contains the economically important sugarcane borer, *Diatraea saccharalis* (F.).

2.2. Distribution of E. loftini

Early sightings of *E. loftini* were located in western Mexico in Sinaloa, Colima, and Nayarit (Van Zwaluwenburg 1926). Initial discovery of the insect within the United States occurred in Arizona by Dyar (1917), followed by reports in the Imperial Valley of California (Osborn and Phillips 1946). During the 1970's, populations of *E. loftini* had spread eastward through Mexico into Veracruz, San Luis Potosi, and Tamaulipas (Riess and Flores 1976), and then across the Rio Grande River into Texas in 1980, where it became established in commercial sugarcane (Johnson and van Leerdam 1981). Range expansion of *E. loftini* continued north and eastward through the Texas rice belt at a rate of 23 km/yr (Reay-Jones at al. 2007b). In late 2008, *E. loftini* specimens were collected in pheromone traps located in Calcasieu Parish, Louisiana, close to the Texas border (Hummel et al. 2010). This observation coincided with the estimated time of arrival into Louisiana by Reay-Jones et al. (2007b). As of 2013, *E. loftini* was found infesting both rice and sugarcane in Louisiana (Wilson et al. 2015a).

2.3. Morphology and Life Cycle of E. loftini

The eggs of *E. loftini* are globular in shape, with a yellowish color. Initial laboratory studies conducted on oviposition indicated that eggs are inserted between the leaf sheath and the stalk (Van Zwaluwenburg 1926). Experiments by van Leerdam and Johnson (1986) further demonstrated an oviposition preference toward rough, vertically oriented dead leaf blades as opposed to smooth, green leaf tissue. Reay-Jones et al. (2007a) showed a 1.8 fold increase in *E. loftini* oviposition of egg masses on drought stressed sugarcane compared to nonstressed plants and that oviposition sites were more cryptic than those found on rice. Larvae hatch from the eggs after approximately 5 d (Van Zwaluwenburg 1926). Larvae of *E. loftini* are described as having a brown to yellowish-brown head capsule and a dirty white colored body with 2 rows of longitudinal, purple markings on either side (Van Zwaluwenburg 1926, Capps 1963). In sugarcane, newly hatched larvae of *E. loftini* are found feeding predominantly in dry plant material within the bottom 80 cm of the stalk (van Leerdam et al. 1984). Larval feeding occurs in the leaf sheath during early instars, whereas later instars bore into the stalk, feeding transversely through the internodes of the plant. Transverse tunneling weakens the structural integrity of the stalk, increasing the occurrence of lodging and secondary infections from pathogens (Van Zwaluwenburg 1926). Larvae undergo five to six molts, with larval development lasting approximately 78 d at 20°C and 21 d at 32°C. Sex affects the number of stadia, with males and females having five and six molts, respectively (van Leerdam 1986).

In the lab, pupal development lasted an average of 9.32 d (127.7 dd) for males and 8.46 d (115.0 dd) for females (Spurgeon et al. 1995), which coincided with the estimates demonstrated by van Leerdam (1986). Pupal weight and fecundity have been found to be related in *E. loftini*. In an experiment conducted by Spurgeon et al. (1995), female moths of varying pupal weights

were dissected immediately following eclosion to determine potential fecundity, while other females were allowed to mate and lay eggs before dissection. In both groups, pupal weight was positively related to the number of oocytes or eggs. Pupae of *E. loftini* are similar in appearance to those of *D. saccharalis,* but are distinguishable from *D. saccharalis* pupae by noting the small tubercles on the posterior portion of the abdomen, as opposed to being present on all abdominal segments (Legaspi et al. 1997b). The adult moth has light brown forewings, each with a small dark spot located on the center (Klots 1970). The adult stage lasts approximately 7 d.

Photoperiod and temperature have been shown to affect activation and termination of diapause in *E. loftini*. On artificial diet, rates of diapause initiation range between 1–79%. The lowest incidence was detected at photophases of 14 h and temperatures at 26°C, while the highest rates were detected at photophases of 10–12 h and temperatures at 20–23°C. While the incidence of diapause was impacted more when both factors were adjusted accordingly, temperature and photoperiod can independently affect the incidence rate. Termination of diapause is affected more by photoperiod than by temperature; however, the greatest incidence of diapause termination occurs when long photophases and high temperatures are concurrent (van Leerdam 1986). In experiments testing the effects of temperature on oviposition and fecundity, van Leerdam (1986) showed no differences in mean total fecundity at temperatures between 29–32°C; however, decreased levels of fecundity were apparent at 20°C. In addition, higher rates of oviposition were detected at higher temperatures. At 32°C, females laid an average of 64 eggs per day, which decreased to 29 eggs per day at 20°C. Longevity of the adult stage in both female and male moths is shorter at higher temperatures, with females living 10 d at 20°C and 5.5 d at 32°C and males living 12.1 d at 20°C and 5.8 d at 32°C (van Leerdam 1986).

Eoreuma loftini generation duration under summer conditions in the Lower Rio Grande Valley has been reported to be 45–50 d (Browning et al. 1989). Four to six overlapping generations occur in the Lower Rio Grande Valley (Legaspi et al. 1997b), and every stage is present in the field at any given time of the year (Johnson 1985, Meagher et al. 1994, 1996). In the event of adverse temperatures in the fall and winter, *E. loftini* larvae may enter a facultative diapause (Browning and Smith 1988); however, fewer larvae will enter diapause during mild winters. Larvae have been shown to be freeze tolerant for limited durations. Browning and Smith (1988) determined larval survival to be 25% after 6 d at –5°C, and 10% after 3 d at –10°C.

2.4. Host Plants of E. loftini

Eoreuma loftini has been discovered in a wide variety of crop hosts, including sugarcane (*Saccharum officinarum* L.), rice (*Oryza sativa* L.), corn (*Zea mays* L.), sorghum [*Sorghum bicolor* (L.) Moench], and barley (*Hordeum vulgare* L.) (Dyar 1917, Van Zwaluwenburg 1926, 1950, Osborn and Phillips 1946, Johnson 1984). In addition, *E. loftini* has been collected from other graminaceous hosts including johnsongrass [*Sorghum halepense* (Pers.)], sudangrass [*Sorghum bicolor* subsp. *Drummondii* (Steud.) de Wet ex Davidse, reported as *Sorghum vulgarae* var. *sudanense* (Hitchc.)], yellow bristlegrass [*Setaria pumila* (Poir.) Roem. & Schult., reported as *Setaria lutescans* (Weigel) Hubb.], bulrush (*Scripus* sp.), canna (*Cannas* sp.), wild millet, lemongrass [*Cymbopogon citrates* (DC.) Stapf.], pampasgrass [*Cortaderia selloana* (Schult. & Schult.f.) Asch. & Graebn.], and *Echinochloa* grass, and Bermuda grass [*Cynodon dactylon* (L.) Pers.] (Van Zwaluwenburg 1926, Osborn and Phillips 1946, Johnson 1984, Browning et al. 1989). *Eoreuma loftini* has also been found infesting vaseygrass (*Paspalum urvillei* Steud.) and barnyardgrass (*Echinochloa* spp. (L.) Beauvois) (Beuzelin et al. 2011, 2013, Showler et al. 2011).

2.5. Eoreuma loftini Injury to Sugarcane

Injury to sugarcane from stem borer larval feeding on the buds and stalk include decreasing juice yields, breaking or lodging, and impairment of growth (Long and Hensley 1972, Browning et al. 1989). Injury also occurs from feeding on the leaf sheath and apical meristem, with the latter causing dead heart syndrome (Browning et al. 1989). In addition to injury and yield loss from *E. loftini*, tunneled stalks are susceptible to secondary pathogens, including red rot disease (*Colletotrichum falcatum* Went.) (Ogunwolu et al. 1991).

2.6. Host Plant Resistance to E. loftini

Following the rise of *E. loftini* as the dominant sugarcane pest in the Lower Rio Grande Valley (Meagher et al. 1994, Legaspi et al. 1999b), cultivar resistance has been an important tool in reducing *E. loftini* injury in sugarcane (Reay-Jones et al. 2003). The use of chemical (Meagher et al. 1994, Legaspi et al. 1997a) and biological control (Browning and Melton 1987) tactics in the Lower Rio Grande Valley were proven unsuccessful against *E. loftini*; however, successes in managing *D. saccharalis* using resistant cultivars (Bessin et al. 1990) pushed for the screening of *E. loftini* resistant cultivars beginning in the late 1980's (Meagher et al. 1996). Initial evaluations by Pfannensteil and Meagher (1991) determined that cultivar CP 70-321 sustained the least amount of *E. loftini* injury, significantly less than in NCo 310. In addition, cultivars TCP 83-3196 and TCP 83-3180 were among the most resistant during the second ratoon (Pfannensteil and Meagher 1991). Legaspi et al. (1999b) showed that *E. loftini* injury negatively affected yield parameters in sugarcane, causing an average of 11 and 19% bored internodes in sugarcane cultivars CP 70-321 and NCo 310, respectively, which was associated with decreases of 1.3% in sugar production per hectare and 0.6% in stalk weight for each percent bored internodes. A 2-year study examining resistance in Texas and Louisiana sugarcane cultivars determined CP 70-

321 to be the most resistant, with HoCP 85-845, a *D. saccharalis* susceptible cultivar, expressing resistance under low to moderate infestations (Reay-Jones et al. 2003). At high *E. loftini* infestations, HoCP 85-845 lost a portion of its resistance, suggesting a similar resistance mechanism against *D. saccharalis* and *E. loftini*. A relative resistance ratio developed by Wilson et al. (2015b), which incorporated both bored internodes and adult emergence holes, determined HoCP 85-845 to the be the most resistant cultivar in three out of four years of study, while HoCP 04-838 was identified as highly susceptible. Energycane cultivars L 79-1002 and Ho 02-113 were identified as *E. loftini* resistant, suggesting the potential adoption of these cultivars for production of biofuels in the Gulf Coast Region (Wilson et al. 2015b).

2.7. Cultural Control of E. loftini

Irrigation has been shown to decrease *E. loftini* injury in sugarcane by 2.5-fold, and when integrated with cultivar resistance and applications of tebufenozide, reduced bored internodes to <10% (Reay-Jones et al. 2005). In addition, reducing drought conditions in sugarcane limits accumulation of free amino acids, such as proline (Reay-Jones et al. 2005, 2007a), which are essential for *E. loftini* development and have been shown to increase oviposition preference in host plants (Showler and Castro 2010a, Showler et al. 2011, Showler and Moran 2014). Irrigation also reduces the availability of dry, folded leaf material, which is the preferred oviposition site for *E. loftini* (Reay-Jones et al. 2005, 2007a, Showler and Castro 2010a, 2010b).

Weed management is important in reducing *E. loftini* host abundance throughout the year. Perennial *S. halepense* and *P. urvillei* can act as *E. loftini* hosts throughout the entire year, with *P. urvillei* harboring up to 62% of recovered larvae (Beuzelin et al. 2011).

2.8. Biological Control of E. loftini

Since the introduction of *E. loftini* into the Texas Lower Rio Grande Valley in 1980 (Johnson and van Leerdam 1981), the need for effective biological control strategies has been present. In

the years following the introduction, a classical biological control program was implemented to collect arthropod parasitoids present in the native range of *E. loftini* (Agnew et al. 1988). Limited parasitoid establishment and impact on borer damage (Meagher et al. 1992), accompanied by a severe freeze in the Lower Rio Grande Valley in 1989 (Sauls and Rouse 1989), put an end to this initial biological control program. A total of 21 species of parasitoids were released into Lower Rio Grande Valley sugarcane from 1982 to 1997 to mitigate *E. loftini* infestations (Legaspi et al. 1997b, Meagher et al. 1998). Of these parasitoids, *Chelonus sonorensis* Cameron, *Digonogastra* (=Iphiaulax) *solitaria* Wharton and Quicke, and *Alabagrus stigma* Brullé were extracted most frequently from *E. loftini* during surveys conducted from 1982 to 1995 (Meagher et al. 1998). *C. sonorensis*, a naturally occurring parasitoid of *E. loftini* (Van Zwaluwenburg 1926), was surveyed most frequently, implying movement of the species into the Lower Rio Grande Valley in conjunction with its rice borer host (Meagher et al. 1998). This species appears to be more effective at attacking its host in rice rather than sugarcane (Van Zwaluwenburg 1926). Of the released indigenous parasitoids, only *Allorhogas pyralophagus* Marsh and *A. stigma* became established in the Lower Rio Grande Valley; however, numbers are still below levels needed for effective control of *E. loftini* (Meagher et al. 1998). In addition, morphological limitations such as ovipositor length in *A. pyralophagus* prevent direct contact to the host in wide stalk plants such as sugarcane (Melton and Browning 1986, Smith et al. 1993, Meagher 1998). Another parasitoid, *Cotesia flavipes* Cameron, which has demonstrated effective levels of suppression in the closely-related *D. saccharalis* presents itself as an unsuitable parasitoid against *E. loftini* due to the host's mechanism of packing frass into its tunnels (Smith et al. 1993). Unsuccessful attempts at selecting and establishing parasitoids against *E. loftini* emphasize the need for research on alternate biological control practices.

2.9. Chemical Control of E. loftini

Screening of insecticidal efficacy against *E. loftini* was initiated in the Lower Rio Grande Valley, with applications of monocrotophos, azinphosmethyl, and carbofuran reducing bored internodes in sugarcane (Johnson 1985). Increases in yield were detected in sugarcane treated with monocrotophos, but only under weekly applications (Meagher et al. 1994), which indicates the need for mutliple applications due to the pest's active state throughout the entire year (Legaspi et al. 1997a). Applications of cyfluthrin, lambda-cyhalothrin, or tebufenozide reduced bored internodes in sugarcane; however, differences between treated and untreated checks were not detected (Legaspi et al. 1997a, Reay-Jones et al. 2005). Timed-applications of novaluran have provided superior control and increased sugar content by 14% (Wilson et al. 2012), but consistent yield increases in the Lower Rio Grande Valley have resulted in the abandonment of insecticide use by growers to manage *E. loftini* (Legaspi et al. 1999a). Insufficient insecticidal control of *E. loftini* could result from the cryptic nature of the pest, where adults oviposit egg masses into dry, folded leaves (van Leerdam et al. 1984, van Leerdam 1986). In addition, Wilson et al. (2012) observed that up to 55% of *E. loftini* larvae tunneled inside of leaf mid-rib within 1 d of eclosion, which could offer further protection from insecticides. A review of past studies has concluded that high levels of variability may exist in determining yield loss relationships, allowing for inconsistencies among studies (Reay-Jones et al. 2005), and that insecticides should not be used alone to prevent yield losses from *E. loftini* (Legaspi et al. 1999a).

2.10. Sugarcane and Sorghum as Bioenergy Feedstocks

Bioenergy feedstocks are defined as plants produced as a source of renewable fuel, such as ethanol (United States Office of Energy Efficiency and Renewable Energy 2015). The Energy Independence and Security Act of 2007 has mandated an increase in the minimum levels of

renewable fuel used for transportation fuel to 136.3 billion liters by 2022 (United States Environmental Protection Agency 2007). Previously, starch from corn has been the primary source of biofuels in the United States; however this crop has a high input to output ratio relative to other graminaceous feedstocks (Soloman et al. 2007). In combination with the mandated minimum requirements and reduced efficiency of corn, efforts have been focused on breeding alternative bioenergy feedstocks produced for lignocellulosic biomass, such as energycane, *Saccharum* spp., high-biomass sorghum, *Sorghum bicolor* (L.) Moench, and switchgrass, *Panicum virgatum* L., which have the potential to produce ethanol more efficiently because of higher fiber content that can be hydrolyzed into additional sugars for ethanol production (Soloman et al. 2007). Enerycane cultivars are generally bred as complex hybrids of *Saccharum officinarum* L., *S. spontaneum* L., *S. barberi* Jeswiet, and *S. sinese* Roxb. Amend. Jeswiet, as is with L 79-1002 and Ho 02-113 (Bischoff et al. 2008, Hale et al. 2012). Energycane cultivars are grouped into two categories, "Type I" and "Type II" feedstocks (Tew and Cobill 2008). Type I feedstocks are characterized by having low sucrose (10–14%) and high fiber contents (14–20%), whereas Type II feedstocks have lower sucrose (< 10%) and higher fiber contents (> 20%). Traditionally, sweet sorghum has been the primary *Sorghum bicolor* inbred source for production of biofuels from its sucrose content; however, thick-stemmed, late-heading sorghum cultivars have been bred from *S. bicolor* and *S. bicolor* × *drummondii* (sudangrass) hybrids for increased suitability as dedicated bioenergy crops (Blade Energy Crops 2012). English et al. (2006) compared the economic competitiveness of bioenergy crop production across various regions of the United States and concluded that the southern United States holds the greatest potential for production because of extensive arable land, abundant rainfall, and mild winters.

In addition, Gulf Coast states (e.g, Texas, Louisiana, Florida) already possess infrastructure required for growing related conventional graminaceaous crops such as sugarcane and grain sorghum, and will require less economic inputs to establish large-scale production of bioenergy crops.

2.11. Taxonomy of S. invicta

The red imported fire ant, *Solenopsis invicta* Buren, is a member of the family Formicidae. Santschi (1916) originally described the species as *Solenopsis wagneri*, in honor of its collector E. R. Wagner. Following introduction of the species into the United States, Buren (1972) renamed the species *S. invicta*. *Solenopsis invicta* belongs in the same genus as another invasive fire ant species, *Solenopsis richteri* Forel, the black imported fire ant.

2.12. Distribution of S. invicta

Solenopsis invicta is native to the region around the Pantanal flood plain in the state of Mato Grosso, Brazil (Allen et al. 1974, Buren et al. 1974). The species has expanded farther northward into the Brazilian state of Rondônia, and southward into Argentina (Buren et al. 1974). *S. invicta* was first noted in United States in Alabama in 1942 by Wilson (1951, 1994).

2.13. Solenopsis invicta as an ecological factor in cropping systems

Solenopsis invicta is a natural enemy to pests in several cropping systems including cotton (Breene 1991, Eubanks 2001, Diaz et al. 2004), soybeans (Eubanks 2001), sugarcane (Charpentier et al. 1967, Oliver et al. 1979, Reagan 1982), and peanuts (Vogt et al. 2001).

The mutualistic relationship between *S. invicta* and aphids has ecological consequences in agricultural production. The presence of aphids in cropping systems has demonstrated increases in *S. invicta* densities in cotton (Kaplan and Eubanks 2002, Diaz et al. 2004) and tomatoes (Coppler et al. 2007), disrupting biological control efforts. Surveys of arthropod herbivores and natural enemies in cotton and soybean conducted by Eubanks (2001) indicated that *S. invicta*

negatively impacted 22 of 24 and 14 of 16 natural enemy species identified in cotton and soybean, respectively; however, negative relationships between densities of *S. invicta* and almost all herbivore taxa in both crops were detected.

Not all ant-aphid interactions have resulted in negative consequences for growers. In a study by Styrsky and Eubanks (2010), the presence of cotton aphids, *Aphis gossypii*, resulted in higher concentrations of *S. invicta* which in turn decreased beet armyworm, *Spodoptera exigua*, infestations. Over multiple sampling dates, averages of 2.7 and 4.8 *S. exigua* caterpillars were found on plants with and without cotton aphids, respectively. In addition, cotton plants with *A. gossypii* produced more bolls, seeds, and seedcotton mass. The authors concluded that since significantly higher numbers of *S. invicta* were found on aphid infested plants, ant-aphid mutualism may have an impact on *S. exigua* infestation in cotton due to predation by *S. invicta*, thus impacting plant reproduction. Other studies examined a different approach by manipulating densities of *S. invicta* as opposed to aphids. In tomatoes, Diaz et al. (2004) utilized insecticidal baits to establish inclusion and exclusion plots for ants and determine whether densities of *A. gossypii* and *S. exigua* fluctuated in response to ant presence. In exclusion plots, numbers of *A. gossypii* were significantly less than in plots where *S. invicta* were present. In turn, greater numbers of *S. exigua* eggs were present in plots where populations of *S. invicta* were suppressed.

2.14. Solenopsis invicta as an arthropod predator in sugarcane

Solenopsis invicta has been documented to have a significant impact on arthropod pest densities in sugarcane through studies involving insecticides (Long et al. 1958, Hensley et al. 1961, Charpentier et al. 1967, Negm and Hensley 1967, Reagan et al. 1972). The impact of *S. invicta* on herbivorous insects was first observed during widespread Federal-State programs to eradicate *S. invicta* (Hensley et al. 1961). Increases in sugarcane borer, *D. saccharalis*,

infestations following broad spectrum heptachlor applications in sugarcane were first reported by Long et al. (1958). Surveys conducted by Hensley et al. (1961) showed increases in the average number of bored internodes and killed stalks by *D. saccharalis* in sugarcane plots that were treated with heptachlor versus untreated plots. Average bored internodes ranged from 63% in treated plots to 42% in untreated plots, indicating an increase in damage due to the loss of predatory arthropods such as *S. invicta*. However, in a separate experiment conducted by Negm and Hensley (1969), differences in sugarcane borer larvae densities were not detected between heptachlor treated plots and untreated plots. The authors' commented that larval dispersion, a factor not included in mortality, may have impacted the analysis. In a study comparing the effects of the chlorinated hydrocarbon mirex (fire ant insecticide), and azinphosmethyl (sugarcane borer insecticide) on arthropod predator densities in sugarcane, plots treated with mirex had significantly fewer populations of red imported fire ants, carabids, crickets and staphylinids, thus leading to significantly higher infestations of sugarcane borer. Plots treated only with azinphosmethyl did not demonstrate a significant decrease in red imported fire ant densities. In mirex treated plots, an average of 45.4% of sugarcane internodes were bored, where only an average of 27% of internodes were bored in untreated plots (Reagan et al. 1972). Studies involving comparisons of *D. saccharalis* infestation in the presence and absence of predatory arthropods has not been exclusive to the utilization of insecticides for predator suppression. A study conducted by Beuzelin et al. (2009) examined the effects of the Hurricane Rita storm surge on sugarcane borer populations. In surveys conducted across sugarcane fields within and outside of the storm surge zone, populations of *S. invicta* were found to be significantly lower in storm surge fields. In conjunction with higher *S. saccharalis* infestations in fields within the storm

surge zone, the authors suggest that significantly lower *S. invicta* populations may have partially allowed for increased borer densities.

Cultural practices in sugarcane have been shown to have an impact on predation of *D. saccharalis* by *S. invicta* (Ali et al. 1984, Fuller and Reagan 1988). In annual graminaceous crops such as sorghum, cultivation practices disturb populations of *S. invicta*, thus limiting stable build-ups of populations early in the season (Ali et al. 1984). This was demonstrated in an experiment by Fuller and Reagan (1988) where predation of *D. saccharalis* was compared between sugarcane and sweet sorghum. Results showed a 4-fold and 16-fold increase in predator populations (comprised heavily of *S. invicta*) in plant and first-ratoon sugarcane when compared to populations in sweet sorghum. Greater differences in the percentage of bored internodes, survival of larvae, and adult emergence were also detected between chlordane treated and untreated first-ratoon sugarcane crop than in plant cane. It is suggested that because sugarcane is a perennial crop, pest densities are higher in successive years thus allowing for a more significant impact by *S. invicta*.

Solenopsis invicta can impact overwintering populations of *D. saccharalis*, reducing infestations the following spring. An experiment conducted by Bessin and Reagan (1993) demonstrated significant differences in the number of sugarcane deadhearts (shoots with dead growing points) between chlordane-treated and untreated plots. Plots with predator suppression from chlordane exhibited up to a 6-fold increase in deadhearts the following spring.

In addition to the immature stages, sugarcane borer eggs are also susceptible to predation by *S. invicta*. An experiment by Negm and Hensley (1969) documented a significant negative correlation between the numbers of sugarcane borer eggs and fire ants. There was also a significant increase in predation of sugarcane borer eggs by arthropod predators in sugarcane

plots left untreated by insecticides versus plots that were treated. In the authors' analysis, *S. invicta* was included in the listing of arthropod predators.

Evidence from previous studies indicates that negative correlations exist between populations of *S. invicta* and other ant species in sugarcane. Reagan et al. (1972) suggested that displacement of the other ant species could be due to the aggressive nature of *S. invicta*. In an experiment by White (1980), higher levels of *D. saccharalis* predation by *S. invicta* were coupled with a stronger negative correlation between *S. invicta* and other ant species.

CHAPTER 3: YIELD RESPONSE TO MEXICAN RICE BORER (LEPIDOPTERA: CRAMBIDAE) INJURY IN BIOENERGY AND CONVENTIONAL SUGARCANE AND SORGHUM

3.1. Introduction

With the onset of the Energy Independence and Security Act of 2007, the United States government has mandated an increase in the minimum levels of renewable fuel used in transportation fuel to 136.3 billion liters by 2022 (United States Environmental Protection Agency 2007) which will require an increase in acreage of feedstocks for production of biofuels, specifically ethanol. Most ethanol produced in the United States is derived from starch in corn, *Zea mays* L., and other grain crops grown in the Midwest that have a high input to output ratio relative to other graminaceous feedstocks (Soloman et al. 2007). Dedicated bioenergy feedstocks produced for lignocellulosic biomass, such as energycane, *Saccharum* spp., high-biomass sorghum, *Sorghum* spp., and switchgrass, *Panicum virgatum* L., have the potential to produce ethanol more efficiently because of higher fiber content, which can be hydrolyzed into additional sugars for ethanol production (Soloman et al. 2007). English et al. (2006) compared the economic competitiveness of bioenergy crop production across various regions of the United States and concluded that the southern United States holds the greatest potential for production because of extensive arable land, abundant rainfall, and mild winters. In addition, Gulf Coast states (e.g, Texas, Louisiana, Florida) already possess infrastructure required for growing related conventional graminaceaous crops such as sugarcane, *Saccharum* spp., and grain sorghum, *Sorghum bicolor* (L.) Moench, and will require fewer costs to establish large-scale production of bioenergy crops.

Before large-scale production of dedicated bioenergy crops can be implemented in the Gulf Coast region, relationships between arthropod pests and bioenergy crops should be understood.

One insect pest anticipated to threaten bioenergy crop production is the Mexican rice borer, *Eoreuma loftini* (Dyar), which feeds on closely-related graminaceous crops including sugarcane, sorghum, corn, and rice, *Oryza sativa* L. (Van Zwaluwenburg 1926, Johnson 1984, Showler et al. 2012). *Eoreuma loftini* has been the most destructive pest of sugarcane in the Lower Rio Grande Valley since entering Texas in 1980 (Johnson and van Leerdam 1981). This species has expanded its geographical range northeast through the southeast Texas rice production area (Reay-Jones et al. 2007b) and eastward into rice and sugarcane in Louisiana as of 2013 (Wilson et al. 2015a). Economic losses associated with *E. loftini* in Louisiana sugarcane may reach as high as $220 million when the insect becomes fully established in the state (Reay-Jones et al. 2008); however, the impact of this pest on the production of dedicated bioenergy crops has not been examined, hence, the objectives of this study were to evaluate susceptibility of energycane, sugarcane, high-biomass sorghum, and sweet sorghum cultivars to *E. loftini* injury, and to determine *E. loftini*-induced yield reduction.

3.2. Materials and Methods

3.2.1. Field Experiment

A 2-yr study was conducted in 2012 and 2013 at the Texas A&M AgriLife Research and Extension Center at Beaumont in Jefferson County, Texas, to examine the impact of *E. loftini* injury on yields of energycane, sugarcane, high biomass-sorghum, and sweet sorghum. The study included two energycane cultivars, L 79-1002 and Ho 02-113; two sugarcane cultivars, HoCP 04-838 (*E. loftini* susceptible standard) and HoCP 85-845 (*E. loftini* resistant standard) (LSU AgCenter 2012); two high-biomass sorghum cultivars, ES 5200 and ES 5140 (Blade Energy Crops, Thousand Oaks, California); and one sweet sorghum cultivar, M81E (MAFES Foundation Seed Stocks, Mississippi State, Mississippi). Energycane cultivars L 79-1002 and Ho 02-113 are

hybrids of *Saccharum officinarum* L., *S. spontaneum* L., *S. barberi* Jeswiet, and *S. sinese* Roxb. Amend. Jeswiet released by the Louisiana State University Agricultural Center (LSU AgCenter) and USDA-ARS Sugarcane Research Unit, respectively (Bischoff et al. 2008, Hale et al. 2012). These energycane cultivars are "Type I" sugarcane feedstocks because of their low sucrose (10–14%) and high fiber contents (14–20%) (Tew and Cobill 2008, White et al. 2011). Seedcane was obtained from the LSU AgCenter Sugar Research Station, St. Gabriel, LA. High-biomass sorghum cultivars ES 5200 and ES 5140 are *Sorghum* spp. and *Sorghum* spp. × *drummondii* (sudangrass) hybrids, respectively, bred to produce thick-stemmed, late-heading stalks suitable for dedicated bioenergy production (Blade Energy Crops 2012). Sweet sorghum cultivar M81E is a conventional *Sorghum* spp. inbred released by the USDA-ARS for production of fermentable sugar (Broadhead et al. 1981).

A randomized strip-plot block design with four blocks (one replication per block) was used in this experiment. Each block was 21.9 m long and 33.6 m wide (21 rows), and was divided into seven vertical main plots and four horizontal strips. Main plots were 21.9 m long and 4.8 m wide (three rows), and strips were 5.5 m long and 33.6 m wide (21 rows). Cultivars were randomized to main plots. Sugarcane and energycane cultivars were planted as whole stalks on 2 November 2011 at a density of two stalks per 2 m row; plant and ratoon crops were used in 2012 and 2013, respectively. High-biomass and sweet sorghum cultivars were planted on 20 April 2012 and 13 May 2013 using a hand planter (Precision Garden Seeder, Earthway, Bristol, Indiana) calibrated to deliver 210,039 seeds/ha. Cultivars were not re-randomized in 2013. Four *E. loftini* infestation levels, suppressed, natural, enhanced, and highly-enhanced, were randomized to strips each year of the study. The suppressed infestation level was established to provide an uninjured control using tebufenozide (Confirm® 2F, Gowan Company, Yuma, Arizona) applied once every other

week at a rate of 140 g ai/ha with a CO_2-pressurized backpack sprayer calibrated to deliver 96 L/ha. Insecticide applications were initiated on 22 June 2012 and 18 June 2013 and were discontinued 2 wk before harvest. Natural *E. loftini* infestations were neither suppressed nor enhanced. Enhanced and highly-enhanced *E. loftini* infestation levels were established in the field by clipping wax paper strips (5 cm long by 1 cm wide) containing viable *E. loftini* egg masses (~30–50 eggs) onto the basal leaf sheaths of plants, the site where natural oviposition often occurs (Van Leerdam 1986). Eggs were obtained from a laboratory colony at the Texas A&M AgriLife Research and Extension Center in Weslaco, Texas, which was supplemented by monthly collections of larvae and pupae from sugarcane fields located in Hidalgo County, Texas. Larvae were reared on artificial diet (Martinez et al. 1988) at 25°C, 65% RH, and at a 14:10 (L:D) photoperiod (Showler and Castro 2010b). Each subplot (main plot by strip) within a strip subjected to enhanced or highly-enhanced infestations received one or three egg masses per row every two weeks, respectively. In 2012, enhancement of *E. loftini* infestations was initiated on 6 July. In 2013, enhancement of *E. loftini* infestations was initiated on 18 June in energycane and sugarcane and 21 August in high-biomass and sweet sorghum, with delayed enhancement on sorghum because of slowed plant development early in the season from sugarcane aphid, *Melanaphis sacchari* (Zehntner) infestations. Enhancement of *E. loftini* infestations was continued for 9–12 wk and discontinued 2 wk before harvest.

3.2.2. Within-season *E. loftini* Injury Determination

Periodic sampling was conducted to monitor *E. loftini* injury throughout each growing season. Each subplot was sampled six times in 2012 (21 May, 22 June, 6 July, 17 July, 9 August, 24 August) and four times in 2013 (2 July, 7 August, 21 August, 18 September) by examining 10 randomly selected stalks and recording the number of injured internodes. Internodes were

classified as injured if feeding signs characteristic of stem borer injury including window-paning and frass in the leaf sheaths or entry holes in the stalk were present. Injured internodes were expressed as the proportion of injured to total internodes.

3.2.3. End-of-season *E. loftini* Injury and Yield Determination

Experiments were harvested on 15 October in 2012 and 27 November in 2013 to collect end-of-season *E. loftini* injury and yields. Four randomly selected stalks were collected from each row of each subplot (12 stalks collected per subplot), stripped of leaf material, and the numbers of bored internodes and numbers of total internodes were recorded. Sampled stalks were weighed to determine fresh stalk weight (kg) and then crushed using a sugarcane stalk crusher (Skyfood Equipment, Miami, Florida) to separate juice from bagasse (stalk fiber). The volume of each juice sample was recorded and 1 mL from each of the samples was analyzed using a handheld refractometer (Reichert Technologies, Depew, New York) to determine Brix (% w/w soluble solids). From the Brix reading, sucrose concentration in stalks (% w/w sucrose) from each sample was calculated using the equation:

$$\textit{Sucrose concentration} = \textit{Brix} / 1 \times 0.85 / 1.71975$$

where 1 is a factor converting Brix to soluble solid concentration in juice (% w/v) assuming a juice relative density of 1, 0.85 is the purity factor for converting juice sucrose to normal juice sucrose (Reay-Jones et al. 2005), and 1.71975 is a constant estimated from calculating the relationship between fresh stalk weight and juice volume from data collected in the experiment. Ethanol productivity from sucrose in L/ha was estimated using the equation from Vasilakoglou et al. (2011):

$$\textit{Ethanol productivity from sucrose} = \textit{sucrose concentration} \times \textit{fresh biomass} \times 6.5 \times 0.85 \times [1.00/0.79]$$

where *sucrose concentration* is the sucrose concentration in stalks (% w/w) from each sample calculated from the previous equation, *fresh biomass* is the total fresh stalk weight in metric ton/ha, 6.5 is the conversion factor of ethanol from sucrose, 0.85 is the efficiency constant from converting sucrose into ethanol, and 1.00 / 0.79 is the specific gravity of ethanol in g/mL. Because experimental stalk populations were lower than expected in density but spatially homogenous, stalk populations were standardized using published population estimates released by LSU AgCenter, USDA-ARS, and Ceres Inc., and multiplied by fresh stalk weights to determine biomass per hectare for each sample. Bagasse from each sample was weighed and subsamples were collected, weighed, and allowed to dry for ≈ 4 wk. Dry bagasse samples were weighed to determine percentage moisture loss. Total bagasse weight of each sample was multiplied by (100 – % moisture loss) to estimate dry biomass for each sample. Dry biomass weights were multiplied by a factor of 465.3, the theoretical ethanol yield in L/metric ton from bagasse (United States Department of Energy 2013), to estimate lignocellulosic ethanol productivity. Total ethanol productivity was calculated as the sum of estimated ethanol yields from sucrose and lignocellulosic material.

3.2.4. Statistical Analyses

Analyses of variance (ANOVAs) were conducted using PROC GLIMMIX (SAS Institute 2008). The Kenward-Roger method was used for calculation of error degrees of freedom. Season-long injury data were analyzed using three-way ANOVAs with cultivar, *E. loftini* infestation level, sampling date, and all associated two and three-way interactions as fixed effects. Random effects included block, block × cultivar, block × *E. loftini* infestation level, and block × cultivar × *E. loftini* infestation level. Data were analyzed separately for each year. Injury and yield data collected at harvest were analyzed using two-way ANOVAs with cultivar, *E.*

loftini infestation level, and the two-way interaction as fixed effects. Random effects included year, block(year), cultivar × block(year), *E. loftini* infestation level × block(year), and *E. loftini* infestation level × cultivar × block(year). Least square means +/- standard errors from the LSMEANS statement output (PROC GLIMMIX, SAS Institute 2008) are reported. Mean pairwise comparisons were made using the LSMEANS statement and the Tukey-Kramer adjustment ($\alpha = 0.05$).

The relationship between *E. loftini* end-of-season injury and each yield parameter (fresh stalk weight, sucrose concentration, ethanol productivity) was determined using a multiple linear regression (PROC REG, SAS Institute 2008). The explanatory variables were a continuous variable for percentage of bored internodes and binomial indicator variables for each cultivar and year:

$$Yield = \beta_0 + \beta_1 PercentBored + \beta_2 ES\ 5140 + \beta_3 M81E + \beta_4 Ho\ 02\text{-}113 + \beta_5 L\ 79\text{-}1002 + \beta_6 HoCP\ 04\text{-}838 + \beta_7 HoCP\ 85\text{-}845 + \beta_8 Year$$

where β_0 is yield for ES 5200 at 0% bored internodes (intercept); β_1 is the coefficient for the continuous variable *PercentBored* ("i.e.", slope); and β_2, β_3, β_4, β_5, β_6, β_7, and β_8 are coefficients of the indicator variables used to adjust the yield at 0% bored internodes for cultivars ES 5140, M81E, Ho 02-113, L 79-1002, HoCP 04-838, and HoCP 85-845, and year, respectively. Regression parameter estimates were also used to determine the percent yield loss per percent bored internode for each cultivar. $|\beta_1|$ (magnitude change in yield per percent bored internode) was divided by the yield at 0% bored internodes (intercept) and multiplied by 100.

3.3. Results

3.3.1. *Eoreuma loftini* Within-season Injury

Although the sugarcane borer, *Diatraea saccharalis* (F.) (Lepidoptera: Crambidae), is present in Jefferson County, Texas, all larvae collected in both years were *E. loftini* and all injury characteristic of stem borers resulted from *E. loftini* feeding. In 2012, differences were detected in the percentage of injured internodes among cultivars ($F = 8.9$; df = 6, 23.1; $P < 0.0001$), *E. loftini* infestation levels ($F = 26.6$; df = 3, 74.2; $P < 0.0001$), and sampling dates ($F = 7.2$; df = 5, 3252; $P < 0.0001$). A cultivar by sampling date interaction was also detected ($F = 3.3$; df = 27, 3235; $P < 0.0001$). Although low levels of infestations were detected in suppressed subplots on the third sampling date (6 July), injury was < 2.0% injured internodes for all cultivars. Injury in subplots with natural infestation levels fluctuated from 0.0 to 8.8 ± 1.2% injured internodes, with levels of injury on the first sampling date (21 May) not exceeding that of the final sampling date (18 September) across all cultivars excluding L 79-1002, where the percentage of injured internodes decreased from 3.3 ± 1.1 to 1.6 ± 1.2% between the first and last sampling dates, respectively. The highest percentage of injured internodes, 10.7 ± 1.4%, was recorded in L 79-1002 with enhanced infestations on the fourth sampling date (17 July).

In 2013, differences were detected in the percentage of injured internodes across infestation levels ($F = 6.7$; df = 3, 24.7; $P = 0.0018$), and sampling dates ($F = 8.2$; df = 3, 3055; $P < 0.0001$). There was limited evidence ($P < 0.1$) for differences in injury among cultivars, but a cultivar by infestation level interaction was detected ($F = 2.3$; df = 18, 24.6; $P = 0.0281$). Injury in subplots with suppressed infestations remained below 1.0% injured internodes across all cultivars and sampling dates. The percentage of injured internodes ranged from 0.0 ± 1.6% in sorghum cultivars to 7.6 ± 1.6% in L 79-1002, with minimum and maximum injury levels occurring

during the first (2 July) and final (18 September) sampling dates, respectively. By the final sampling date (18 September), enhancement of infestations increased levels of injury in Ho 02-113, HoCP 04-838, ES 5200, and ES 5140, reaching as high as 12.8 ±1.6% injured internodes in ES 5200.

Table 3.1. Statistical comparisons for selected injury and yield parameters, Jefferson County, Texas, 2012–2013.

Parameter	*F*	df	*P* > *F*
Percentage of bored internodes			
Cultivar	3.00	6,42.3	0.0156
E. loftini infestation level	36.66	3,20.9	< 0.0001
Cultivar × *E. loftini* infestation level	2.11	18,125.1	0.0090
Fresh stalk weight			
Cultivar	64.63	6,42.4	< 0.0001
E. loftini infestation level	52.35	3,20.4	< 0.0001
Cultivar × *E. loftini* infestation level	2.52	18,122.7	0.0015
Sucrose concentration			
Cultivar	34.86	6,48.1	< 0.0001
E. loftini infestation level	10.74	3,146.2	< 0.0001
Cultivar × *E. loftini* infestation level	2.14	18,146.2	0.0071
Ethanol Productivity			
Cultivar	67.12	6,45.6	< 0.0001
E. loftini infestation level	31.13	3,22.7	< 0.0001
Cultivar × *E. loftini* infestation level	1.48	18,123.3	0.1067

3.3.2. End-of-season *E. loftini* Injury and Impact on Yield

A difference in the percentage of bored internodes was detected among cultivars (Table 3.1). Percentages of bored internodes ranged from 6.2 ± 3.1% in Ho 02-113 to 12.1 ± 3.1% in HoCP 04-838. Injury in HoCP 04-838 was 1.4 times greater than in HoCP 85-845, whereas injury in ES

5140 was 1.6 times greater than in M81E. *Eoreuma loftini* infestation levels impacted bored internodes in all cultivars in both years. Applications of tebufenozide were successful in reducing injury to ≤ 1.0% bored internodes under suppressed infestations. Enhanced and highly-enhanced infestations increased the percentage of bored internodes 1.3 and 1.7-fold, respectively, relative to natural infestations. An interaction was detected between cultivar and infestation level (Table 1), as a result of inconsistent fluctuations in injury to ES 5200 and M81E in response to enhancement of *E. loftini* infestation levels. Although L 79-1002, Ho 02-113, HoCP 85-845, HoCP 04-838, and ES 5140 had ≥1.4-fold greater percentage of bored internodes when increasing from natural to enhanced infestations, injury to M81E and ES 5200 decreased 1.1 and 1.4-fold, respectively, under enhanced infestations.

Fresh stalk weight (Table 3.2) ranged from 0.55 ± 0.03 kg/stalk in HoCP 04-838 to 0.19 ± 0.03 kg/stalk in M81E. Stalk weights of HoCP 04-838 were 2.0 and 1.9 times greater than in L 79-1002 (0.27 ± 0.03 kg/stalk) and Ho 02-113 (0.29 ± 0.03 kg/stalk), respectively. Enhancement of *E. loftini* infestations decreased stalk weights across all cultivars (Table 3.2). Maximum stalk weight was achieved under suppressed infestation levels (0.48 ± 0.03 kg/stalk) and decreased 1.3-fold under natural infestations. Stalk weight in plants subjected to highly-enhanced infestations decreased 1.5-fold compared to plants under suppressed infestations. Differences in stalk weight were not observed between enhanced and highly-enhanced infestation levels. Cultivars responded differently to changes in infestation level, as noted by the cultivar by infestation interaction for stalk weight (Table 3.1). Changes in stalk weights between suppressed and natural infestations ranged from 1.2-fold in Ho 02-113 and HoCP 04-838 to 1.6-fold in M81E. In addition, stalks of HoCP 85-845, ES 5200, and ES 5140 sustained no further decreases in weight under highly-enhanced infestations.

Table 3.2. Energycane, sugarcane, high-biomass sorghum, and sweet sorghum parameter estimates (± LS means) across varying *E. loftini* infestation levels. Jefferson County, Texas, 2012–2013.

Cultivar	*E. loftini* Infestation Level	Percent Bored Internodes (± 3.5 [SE])	Fresh Weight (kg) / Stalk (± 0.04 [SE])	Sucrose Concentration (w/w) (± 0.3 [SE])	Ethanol Productivity (10^3 L ha^{-1}) (± 1.2 [SE])
Energycane L 79-1002	Suppressed	0.4 f	0.34 e–g	6.3 e–h	16.1
	Natural	6.0 b–f	0.25 f–h	5.7 h	13.4
	Enhanced	12.4 a–c	0.23 f–h	5.8 h	10.1
	Highly-Enhanced	12.2 a–d	0.24 f–h	5.9 gh	11.3
Energycane Ho 02-113	Suppressed	0.5 f	0.34 e–g	7.9 a–d	18.5
	Natural	5.2 b–f	0.29 f–h	7.8 b–e	16.1
	Enhanced	7.2 b–f	0.27 f–h	7.6 b–e	14.7
	Highly-Enhanced	11.9 a–e	0.25 f–h	7.6 b–f	13.7
Sugarcane HoCP 04-838	Suppressed	0.8 ef	0.70 a	9.4 a	9.3
	Natural	11.8 a–e	0.57 b–d	8.9 ab	7.3
	Enhanced	16.3 ab	0.48 c–e	9.1 ab	6.3
	Highly-Enhanced	19.7 a	0.46 de	9.0 ab	5.3
Sugarcane HoCP 85-845	Suppressed	1.0 d–f	0.70 ab	8.6 a–c	6.7
	Natural	5.1 c–f	0.54 cd	8.6 a–c	5.3
	Enhanced	14.4 a–c	0.44 de	8.7 a–c	4.4
	Highly-Enhanced	15.0 a–c	0.45 de	8.8 a–c	4.6
Sugarcane HoCP 85-845	Suppressed	1.0 d–f	0.70 ab	8.6 a–c	6.7
	Natural	5.1 c–f	0.54 cd	8.6 a–c	5.3
	Enhanced	14.4 a–c	0.44 de	8.7 a–c	4.4
	Highly-Enhanced	15.0 a–c	0.45 de	8.8 a–c	4.6

Table 3.2. Continued

Cultivar	*E. loftini* Infestation Level	Percent Bored Internodes (± 3.5 [SE])	Fresh Weight (kg) / Stalk (± 0.04 [SE])	Sucrose Concentration (w/w) (± 0.3 [SE])	Ethanol Productivity (10^3 L ha^{-1}) (± 1.2 [SE])
High-Biomass Sorghum ES 5140	Suppressed	0.2 f	0.34 ef	5.5 h	11.5
	Natural	9.8 a–f	0.24 f–h	5.7 h	7.9
	Enhanced	13.4 a–c	0.21 gh	5.1 h	7.3
	Highly-Enhanced	19.5 a	0.21 gh	5.0 h	6.6
Sweet Sorghum M81E	Suppressed	0.2 f	0.27 f–h	7.3 c–f	9.6
	Natural	8.8 a–f	0.17 h	6.4 d–h	6.0
	Enhanced	8.0 b–f	0.16 h	6.3 e–h	6.6
	Highly-Enhanced	10.3 a–f	0.15 h	6.3 e–h	5.0

[a] Means within the same column followed by different letters are significantly different ($P < 0.05$).

[b] Means within columns for % bored internodes, fresh weight / stalk, sucrose concentration, and ethanol productivity have the same SE.

A negative relationship between the percentage of bored internodes and stalk weight was detected across cultivars and years (F = 146.0; df = 645; P < 0.0001; R^2 = 0.6398). Each unit increase in the percentage of bored internodes resulted in a 0.005 ± 0 kg reduction in stalk weight. Reductions in stalk weight in 2012 ranged from 0.74 to 1.80% per percent bored internode, with expression of damage being highest in M81E and lowest in HoCP 04-838 and HoCP 85-845 (Fig. 3.1A). In 2013, reductions in stalk weight per percent bored internode ranged from 0.85% in HoCP 04-838 to 2.70% in M81E, consistent with results from 2012. In addition, the reduction of stalk weight per percent bored internode in HoCP 85-845 was comparable to that observed in HoCP 04-838 in 2012 and 2013.

Sucrose concentration in stalks was highest in HoCP 04-838 (9.1 ± 0.3% w/w), and was 1.5 and 1.2 times greater than in L 79-1002 and Ho 02-113, respectively. Sucrose concentration in M81E (6.6 ± 0.3% w/w) was greater than in ES 5140 (5.3 ± 0.3% w/w) (t = 3.62; df = 48.3; P = 0.0118), but not compared to ES 5200 (5.8 ± 0.3% w/w) (t = 2.12; df = 48.3; P = 0.3562). Differences in sucrose concentration were detected among *E. loftini* infestation levels (Table 3.1), despite no reductions in sucrose concentration occurring between natural (7.0 ± 0.2% w/w), enhanced (6.9 ± 0.2% w/w), and highly-enhanced infestations (6.9 ± 0.2% w/w). Across both years, minimum and maximum sucrose yields were achieved under highly-enhanced and suppressed infestation levels, respectively. Sucrose concentrations among cultivar by infestation level ranged from 5.0 ± 0.3% w/w in ES 5140 at highly-enhanced infestations to 9.4 ± 0.3%

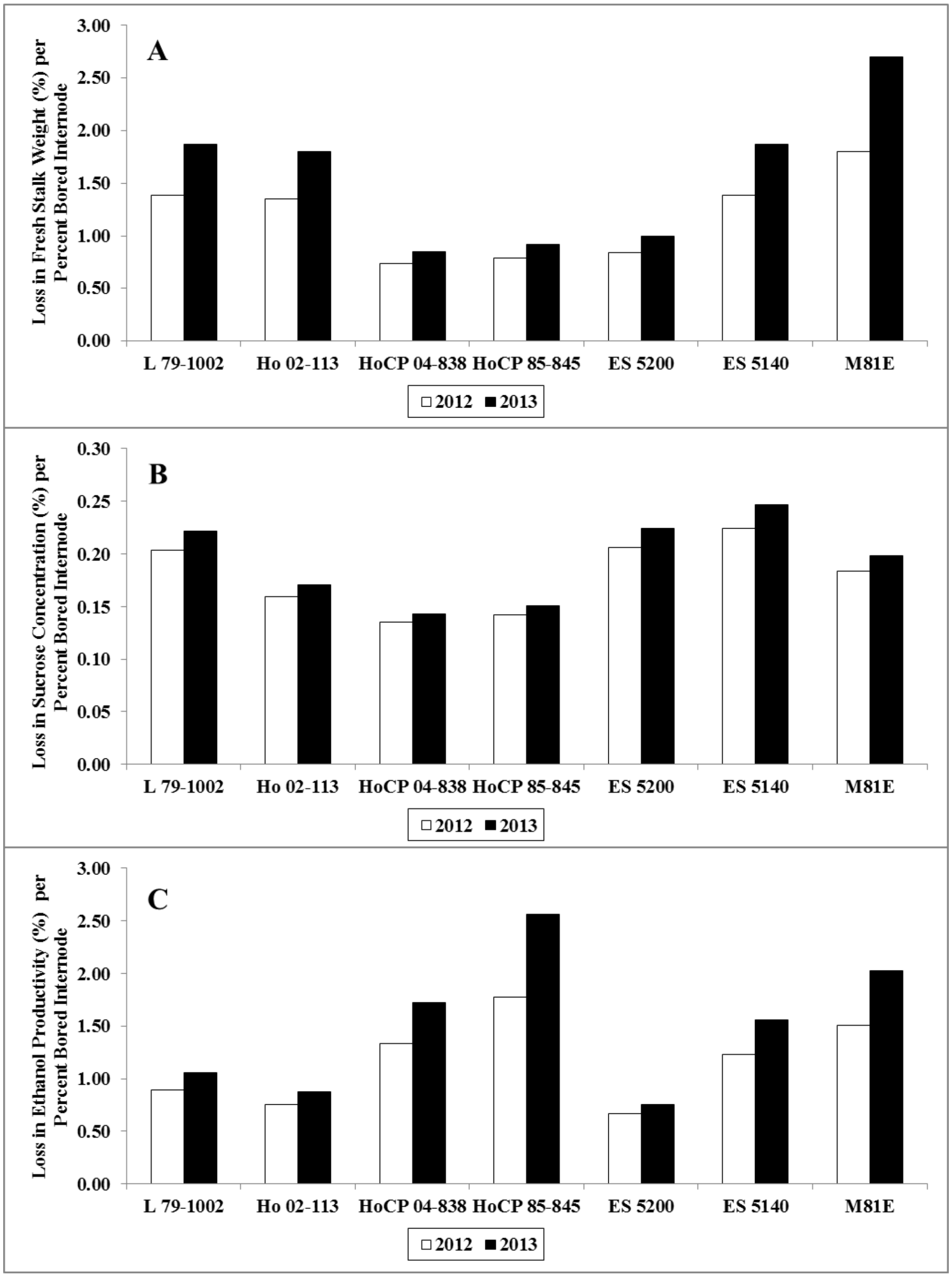

Fig. 3.1. Percent yield loss in (A) fresh stalk weight, (B) sucrose concentration, and (C) ethanol productivity per percent bored internode across seven cultivars of energycane, sugarcane, high-biomass sorghum, and sweet sorghum, estimated using multiple linear regression, Jefferson County, Texas, 2012–2013.

w/w in HoCP 04-838 at suppressed infestations. The greatest reduction in sucrose concentration occurred in M81E between suppressed and natural infestations, decreasing 1.0 ± 0.3% w/w. Sucrose concentrations remained comparable between enhanced and highly-enhanced infestations among all cultivars.

A negative relationship between the percentage of bored internodes and sucrose concentration in stalks was detected across cultivars and years ($F = 197.4$; df = 647; $P < 0.0001$; $R^2 = 0.7057$). For each unit increase in the percentage of bored internodes, sucrose concentration decreased by 0.01% ± 0.00 w/w. In 2012, reductions in sucrose ranged from 0.13 to 0.22% per percent bored internode in HoCP 04-838 and ES 5140, respectively (Fig. 3.1B). In 2013, reductions in sucrose concentration per percent bored internode ranged from 0.14 to 0.25% in HoCP 04-838 and ES 5140, respectively. Overall, sucrose concentration reductions per percent bored internode were greater in energycane and sorghum cultivars than in sugarcane cultivars. Ethanol productivity ranged from 17.5 ± 1.0 × 10^3 L/ha in ES 5200 to 5.2 ± 1.0 × 10^3 L/ha in HoCP 85-845, and ethanol productivity in ES 5200 was 1.1 and 2.4-fold greater than the most productive energycane (Ho 02-113) and sugarcane (HoCP 04-838) cultivars, respectively. Increases in *E. loftini* infestations reduced ethanol productivity 1.3, 1.4 and 1.5-fold under natural, enhanced, and highly-enhanced infestations levels, respectively.

A negative relationship between the percentage of bored internodes and ethanol productivity was detected across cultivars and years ($F = 171.0$, df = 626, $P < 0.0001$, $R^2 = 0.6821$). Each unit increase in the percentage of bored internodes resulted in a loss of 0.1 ± 0.02 × 10^3 liters of ethanol per hectare. Reductions in ethanol productivity per percent bored internode in 2012

ranged from 0.67% in ES 5200 to 1.78% in HoCP 85-845 (Fig. 3.1C). In 2013, reductions in ethanol production per percent bored internode ranged from 0.76% in ES 5200 to 2.56% in HoCP 85-845. Ethanol productivity reduction per percent bored internode was greater in sugarcane cultivars than in energycane and high-biomass cultivars.

3.4. Discussion

This study is the first to show increasing levels of *E. loftini* injury and associated yield loss in energycane and high-biomass sorghum cultivars bred as dedicated bioenergy feedstocks anticipated to be highly resistant to stem borers. As predicted, energycane cultivars were less susceptible to injury than sugarcane and high-biomass sorghum cultivars, including *E. loftini* resistant sugarcane cultivar HoCP 85-845. Plants in this study were under natural and enhanced *E. loftini* infestations. Thus, differences in injury between energycane and sugarcane cultivars were most likely associated with resistant traits affecting *E. loftini* immature performance (e.g., larval survival). Thin stalks, which average 1.40 and 1.48 cm in L 79-1002 (Bischoff et al. 2008) and Ho 02-113 (Hale et al. 2012), respectively, might convey resistance to *E. loftini* injury. However, Showler et al. (2011) and Beuzelin et al. (2013) showed that plant hosts with stalk diameter < 0.7 cm, including sudangrass (*S. bicolor* ssp. *drummondii*), johnsongrass (*Sorghum halepense* (L.) Pers.), and barnyardgrass (*Echinochloa* spp. (L.) Beauvois), are highly suitable hosts. Resistance in energycane might involve higher fiber content in L 79-1002 and Ho 02-113 than in susceptible sugarcane cultivars (Bischoff et al. 2008, Tew and Cobill 2008). High stem fiber and lignin contents, which are preferable in bioenergy feedstocks, have been associated

with negative effects on larval feeding and development on sugarcane in an African stem borer, *Eldana saccharina* Walker (Lepidoptera: Pyralidae) (Rutherford et al. 1993). Rind hardness is another characteristic which might negatively affect larval entry into the stalk (Martin et al. 1975, Ring et al. 1991).

Sugarcane cultivar HoCP 85-845, classified as *E. loftini* resistant (Reay-Jones et al. 2003, Wilson et al. 2012), expressed resistance to *E. loftini* feeding in the natural infestation treatment, but some of the cultivar's resistance was lost under heavy natural (Reay-Jones et al. 2003) and, in our study, artificial infestations. The weakening of resistance suggests an antixenosis effect, because insertion of egg masses into the leaf sheaths in our study bypass resistance mechanisms that affect oviposition preference. One resistant characteristic in HoCP 85-845 may arise from the lack of available *E. loftini* oviposition sites. Plant phenotypic characteristics or drought stress influences the availability of dry and folded leaf tissue for *E. loftini* oviposition (Reay-Jones et al. 2005, 2007a, Showler and Castro 2010a, 2010b). Analyses of free amino acid levels in HoCP 85-845 showed higher levels of free proline, which is associated with high water potential in the plant, rendering it more drought tolerant (Reay-Jones et al. 2005). In addition, nutritional or biochemical factors, including fructose and free essential amino acids, may influence oviposition preference in host plant species (Showler and Castro 2010a, Showler et al. 2011, Showler and Moran 2014).

Injury to M81E did not differ with that in HoCP 04-838 or HoCP 85-845, indicating comparable levels of susceptibility among conventional crop cultivars assessed in this study. Showler et al. (2012) compared *E. loftini* injury among corn, grain sorghum, and sugarcane under small-plot and commercial field conditions and detected no difference between injury in

sorghum and sugarcane prior to harvest. Moderate levels of injury to sorghum/sudangrass hybrid ES 5140 in our study might be attributed to higher levels of fructose, which has been associated with *E. loftini* preference in sorghum/sudangrass hybrids (Showler and Moran 2014).

This is the first study to show yield parameter reductions, including fresh stalk weight, sucrose concentration, and ethanol productivity from *E. loftini* injury in energycane and high-biomass sorghum cultivars. Although energycane cultivars were resistant to injury, losses to stalk weight and sucrose concentration corresponding with increases in injury were more evident than in conventional sugarcane cultivars. Legaspi et al. (1999b) showed that *E. loftini* injury negatively affected yield parameters in sugarcane. *Eoreuma loftini* injury causing an average of 11 and 19% bored internodes in sugarcane cultivars CP 70-321 and NCo 310, respectively, were associated with decreases of 1.3% in sugar production per hectare and 0.6% in stalk weight for each percent bored internodes (Legaspi et al 1999b), expressing similar yield reductions to those reported in this study. When left uncontrolled in southeast Texas, *E. loftini* was associated with a loss in sugar production of 502 kg per ha, or 0.5% yield loss for each percent bored internodes in cultivars LCP 85-384 and HoCP 85-845 (Reay-Jones et al. 2005). Despite moderate levels of resistance to *E. loftini* injury, sweet sorghum M81E expressed the greatest losses to stalk weight per percent bored internode. Reasons for low varietal tolerance to *E. loftini* injury in M81E might result from narrow stalk diameter where feeding would compromise stalk integrity, as documented in other sorghum cultivars (Youm et al. 1988).

Applications of tebufenozide reduced *E. loftini* injury; however differences in yield parameters between plants in suppressed and natural infestations were not always detected. Sugarcane yield (tonnage) differences associated with insecticidal control have not been observed despite reductions in *E. loftini* injury (Meagher et al.1994, Legaspi et al. 1999b, Reay-

Jones et al. 2005), resulting in the discontinuation of insecticide applications against *E. loftini* infesting sugarcane in south Texas (Legaspi et al. 1997). More recently, an increase in sugar content was observed in fields treated with novaluron timed according to recommended action thresholds (Wilson et al. 2012). High levels of variability may inherently exist in determining yield loss relationships, specifically with sugarcane, allowing for inconsistencies among studies (Reay-Jones et al. 2005). Alternatively, insecticides cannot be used as a single tactic to prevent yield losses from *E. loftini* (Legaspi et al. 1999a). While small sample sizes in this study may have been inadequate to determine precise yield estimates, each stalk sampled for injury was processed for yield determination to accurately assess the relationship between injury and yield.

In 2013, enhancement of *E. loftini* infestations were delayed until 21 August because of early season injury from severe infestations of *M. sacchari* on all high-biomass and sweet sorghum cultivars. Although *M. sacchari* has been described as a pest of sugarcane in Louisiana (White et al. 2001) and Florida (Mead 1978), severe infestations on sorghum had not been reported in the United States prior to 2013 (Villanueva et al. 2014). Lower levels of *E. loftini* injury in sorghum subplots with natural infestations could have resulted from a decrease in host preference or suitability caused by plant stress and development of black sooty mold on leaves with aphid infestations (Narayana 1975). In addition, aphid populations may have attracted the red imported fire ant, *Solenopsis invicta* Buren, which tends *M. sacchari* in sugarcane (Akbar et al. 2011). Increased *S. invicta* populations could result in increased *E. loftini* predation. The influence of aphid populations on other ecological guilds has been previously examined, revealing positive relationships between aphid populations and predation of herbivores and predators by *S. invicta* (Vinson and Scarborough 1989, Tedders et al. 1990, Styrsky and Eubanks 2010).

Yield reductions from *E. loftini* injury reported in this study note the potential threat it poses to bioenergy feedstock production in the Gulf Coast region. Because ethanol can be derived from fiber and sucrose, and higher levels of fiber confer resistance against some insects, bioenergy feedstock production was planned with limited insect pest management inputs. We observed greater ethanol yield tolerance to *E. loftini* injury in bioenergy cultivars than sugarcane and sweet sorghum cultivars, although ethanol yields can be reduced when *E. loftini* infestations are not controlled. In order to maximize ethanol yields, effective pest management practices will likely need to be implemented.

CHAPTER 4: OVIPOSITION PREFERENCE AND SURVIVAL OF AN INVASIVE STEM BORER (LEPIDOPTERA: CRAMBIDAE) IN BIOENERGY AND CONVENTIONAL SUGARCANE AND SORGHUM

4.1. Introduction

The Mexican rice borer, *Eoreuma loftini* (Dyar), is an invasive stem borer in the United States Gulf Coast region and has been documented feeding on a variety of crops including sugarcane, *Saccharum* spp., rice, *Oryza sativa* L., sorghum, *Sorghum bicolor* (L.) Moench, and corn, *Zea mays* L. (Dyar 1917, Van Zwaluwenburg 1926, Osborn and Phillips 1946, Van Zwaluwenburg 1950, Johnson 1984, Showler et al. 2012), as well as numerous weedy non-crop hosts (Van Zwaluwenburg 1926, Osborn and Phillips 1946, Johnson 1984, Browning et al. 1989, Beuzelin et al. 2011, 2013, Showler et al. 2011). Mandates from the United States government have decreed to increase renewable fuel sources for transportation (United States Environmental Protection Agency 2007). Thus, production of dedicated bioenergy crops will need to be increased, ideally in the southern United States due to present infrastructure and ideal growing conditions (English et al. 2006). Previous studies have determined that dedicated bioenergy crops, including energycane and high-biomass sorghum, are at risk of injury and subsequent yield loss resulting from *E. loftini* feeding (VanWeelden et al. 2015, Wilson et al. 2015b). High-yielding high-biomass sorghum cultivars can sustain high levels of injury from *E. loftini*, suggesting that *E. loftini* populations could build-up in these crops and increase area-wide infestations (VanWeelden et al. 2015). Because bioenergy crops will be produced in proximity to conventional crop hosts of *E. loftini*, additional knowledge of oviposition preference and suitability of dedicated bioenergy crops relative to conventional crops is needed.

Plant phenotypic characteristics are crucial aspects in the determination of host preference for *E. loftini*, importantly in the availability of dry, curled dead leaf material (Van Zwaluwenburg 1926, van Leerdam and Johnson 1984, Reay-Jones et al. 2007a, Beuzelin et al. 2013). Whether being phenotypic or induced by drought stress, numerous studies have documented that *E. loftini* exhibits a preference to oviposit on dry leaf material (Reay-Jones et al. 2007b, Showler and Castro 2010a). In addition, the pest's affinity to oviposit on drought stressed plants may be related to the presence of free amino acids (FAAs) essential for growth and development (Reay-Jones et al. 2005, 2007a, Showler and Castro 2010a, Showler et al. 2011, Showler and Castro 2010b, Showler and Moran 2014).

As *E. loftini* moves further into Louisiana (Wilson et al. 2015a), where it is estimated to cause up to $220 million in economic losses to sugarcane once fully established (Reay-Jones et al. 2008), it is important to understand the compatibility of bioenergy crops in this agroecosystem to prevent further reductions in yields. The objectives of this study were to determine oviposition preference of *E. loftini* among select cultivars of sugarcane, energycane, high-biomass sorghum, and sweet sorghum using a choice bioassay, and to estimate mortality of *E. loftini* among these cultivars using a no-choice bioassay.

4.2. Materials and Methods

4.2.1. Greenhouse Experimental Design

Two greenhouse experiments were conducted at the Texas A&M AgriLife Research and Extension Center at Beaumont, Texas to assess oviposition preference and survival of *E. loftini*. Two energycane cultivars, L 79-1002 and Ho 02-113; two conventional sugarcane cultivars, *E. loftini*-susceptible HoCP 04-838 and *E. loftini*-resistant HoCP 85-845 (Reagan et al. 2012, Wilson et al. 2015b); two high-biomass sorghum cultivars, ES 5200 and ES 5140 (Blade Energy

Crops, Thousand Oaks, California); and one sweet sorghum cultivar, M81E were selected for the study. Energycane cultivars L 79-1002 and Ho 02-113 are hybrids of *Saccharum officinarum* L., *S. spontaneum* L., *S. barberi* Jeswiet, and *S. sinense* Roxb. Amend. Jeswiet released by the Louisiana State University Agricultural Center (LSU AgCenter) and USDA-ARS Sugarcane Research Unit, respectively (Bischoff et al. 2008, Hale et al. 2012), and are classified as “Type I” sugarcane feedstocks as a result of low sucrose and high fiber (Tew and Cobill 2008, White et al. 2011). High-biomass sorghum cultivars ES 5200 and ES 5140 are *Sorghum* spp. and *Sorghum* spp. × *drummondii* (sudangrass) hybrids, respectively, bred to produce thick-stemmed, late-heading stalks suitable for dedicated bioenergy production (Blade Energy Crops 2012). Sweet sorghum cultivar M81E is a conventional *Sorghum* spp. inbred released by the USDA-ARS for production of fermentable sugar (Broadhead et al. 1981), with potential for bioenergy production (Tew et al. 2008, Erickson et al. 2012, VanWeelden et al. 2015).

Seed cane was obtained from the Texas A&M Agrilife Research and Extension Center, Beaumont, Texas and the Louisiana State Agricultural Center Sugar Research Station, St. Gabriel, Louisiana. Sugarcane was planted in the greenhouse as single nodes in 7.6 liter pots (Hummert International, Earth City, Missouri) containing a 1:2:1 mixture of sand, autoclaved potting soil, and peat moss (Premier Horticulture Inc., Quakertown, Pennsylvania), respectively, and fertilized with 350 ml of Miracle Gro water soluble 24-8-16 N-P-K (The Scotts Miracle-Gro Company, Marysville, Ohio) at 19 g/liter of water once every 3 wk. High-biomass and sweet sorghum cultivars were planted with the same potting and soil conditions at a rate of six seeds per pot. Sorghum plants were transplanted into separate pots after 4 wk of development. Plants were watered with approximately 1 liter four times per wk. Two planting dates were assigned to establish two phenological stages representing late spring and late summer stages of

development. Sugarcane and energycane cultivars were planted on 28 January and 3 April in 2013, and 10 January and 7 April in 2014. Sorghum cultivars were planted on 25 February and 24 May in 2013, and 19 March and 18 June in 2014. Prior to initiation of each experiment, plant characteristics, including height, stalk diameter at the third internode, and numbers of internodes, total leaves, and dry leaves, were recorded for each plant.

4.2.2. Oviposition Preference Experiment

An oviposition preference experiment was conducted in 2014 using a randomized block design with five replications (blocks). Greenhouse cages (blocks) measured 1.8 by 1.8 by 3 m and were constructed from 1.3 cm PVC pipe (Charlotte Pipe and Foundry Company, Cameron, Texas) and covered with 0.25 mm polyester mesh (America Home and Habitat Inc., Sealy, Texas). Seven cultivars at two phenological stages (14 host combinations) were randomly arranged into each cage 3 d prior to initiation of the experiment. *Eoreuma loftini* adults were obtained from a laboratory colony at the Texas A&M AgriLife Research and Extension Center at Weslaco, Texas, which was supplemented using larvae collected from sugarcane in the Lower Rio Grande Valley. Larvae were reared on artificial diet (Martinez et al. 1988) and maintained at 25°C, 65% RH, and at a 14:10 (L:D) photoperiod (Showler and Castro 2010b). Twenty-five male and female moths were placed into 15-liter plastic buckets and allowed to mate for 24 h prior to release. Twenty-five gravid females were released into each cage and allowed to lay eggs for 4 d. Following the oviposition period, any remaining females were removed from the cage and the numbers of eggs, oviposition events (single egg or egg mass), and eggs per oviposition event were recorded on each plant.

4.2.3. Survival Experiment

A greenhouse experiment was conducted in 2013 to assess suitability of each cultivar as a host of *E. loftini* by tracking survival of larvae across various stages of development. The experiment was arranged using a randomized block design with seven replications (blocks). As with the previous experiment, cages were designated as blocks and contained each of seven cultivars at two phenological stages (14 host combinations). *Eoreuma loftini* eggs were collected on strips of wax paper from gravid females reared at the Texas A&M AgriLife Research and Extension Center, Welsaco, TX. At initiation of the experiment, *E. loftini* egg masses (~ 100 eggs) were inserted into the basal leaf sheath of each plant, simulating a natural oviposition event (Van Leerdam 1986). Time-specific mortality was estimated to develop *E. loftini* life tables (Bellows et al. 1992). *Eoreuma loftini* mortality was recorded over 6 wk at the following stages: egg, neonate, established larva, and pupa, and survival to adulthood. The number of individuals present at the beginning and end of each stage was recorded and percent apparent mortality at each stage was calculated as:

$$(1) \qquad Apparent\ mortality = [No.\ dead\ (x) / No.\ live\ (x)] \times 100$$

where *No. dead (x)* is the number of individuals dying during stage x and *No. live (x)* is the number of individuals entering stage x. Percent real mortality was then calculated to determine the percentage of individuals dying from the original number at the start of the experiment:

$$(2) \qquad Real\ mortality = [No.\ dead\ (x) / No.\ live\ (x_0)] \times 100$$

where *No. dead (x)* is the number of individuals dying during stage x and *No. live* (x_0) is the number of individuals alive at the start of the experiment. Finally, a mortality-survival ratio was calculated at each stage:

$$(3) \qquad K(x) = [No.\ dead\ (x) / No.\ live\ (x+1)]$$

where *K(x)* is the mortality-survival ratio at stage *x*; *No. dead (x)* is the number of individuals dying during stage *x*; and *No. live (x+1)* is the number of individuals alive at the beginning of the following stage (x+1).

4.2.4. Statistical Analyses

Plant characteristics from the oviposition and survival experiments were analyzed separately. Plant height, diameter and numbers of internodes, leaves, and dry leaves were analyzed using a linear mixed model (PROC GLIMMIX, SAS Institute 2008) with host combination as a fixed effect. The random effect was block. Numbers of eggs, oviposition events, and eggs per oviposition event were analyzed using a linear mixed model (PROC GLIMMIX, SAS Institute 2008) with host combination as a fixed effect and block as a random effect. The Kenward-Roger method was used to estimate error degrees of freedom (SAS Institute 2008) and pairwise comparisons were made using LSMEANS statement (SAS Institute 2008) and Tukey’s honest significant difference (HSD) test ($\alpha = 0.05$). In addition, means between treatment groups were compared using contrasts analyzed with PROC GLIMMIX (SAS Institute 2008).

Data from the survival experiment, including percent apparent mortality, percent real mortality, mortality-survival ratio, and percent survival to adulthood were analyzed using a linear mixed model (PROC GLIMMIX, SAS Institute 2008) with host combination as a fixed effect and block as a random effect. For all univariate models, the Kenward-Roger method was used to estimate error degrees of freedom and Tukey’s HSD test was used to separate the means (SAS Institute 2008).

Table 4.1. Plant measurements on sugarcane, energycane, high-biomass sorghum, and sweet sorghum from greenhouse oviposition experiment, Beaumont, Texas, 2014.

Host Combination	Plant Height (cm)	Stalk Diameter (mm)	Total Internodes	Dry Leaves	Total Leaves
Immature					
HoCP 04-838	158.2f	11.2bc	7.0d	2.8c	8.8c
HoCP 85-845	167.6def	10.6bc	7.2d	3.0c	9.2c
L 79-1002	212.4bcde	9.0c	8.8d	3.0c	9.8c
Ho 02-113	192.8cdef	8.3c	7.4d	3.0c	9.0c
ES 5200	163.2ef	9.0c	8.6d	2.8c	10.2c
ES 5140	173.4def	9.2c	9.2d	3.2c	11.4c
M81E	157.6f	9.9bc	7.8d	3.2c	10.2c
Mature					
HoCP 04-838	369.6a	15.4a	21.0ab	15.2a	22.8a
HoCP 85-845	373.8a	13.8ab	22.4a	13.8ab	23.0a
L 79-1002	403.6a	9.0c	18.8abc	14.2ab	20.8ab
Ho 02-113	373.2a	9.8bc	17.0bc	13.2ab	19.6ab
ES 5200	245.4b	10.1bc	17.6bc	13.4ab	20.2ab
ES 5140	213.2bcd	9.9bc	15.0c	11.8ab	18.6ab
M81E	240.6cd	7.8c	16.8c	10.2b	16.6b
Type III Test of Fixed Effects	$F = 87.20$ df = 13, 52 $P<0.0001$	$F = 6.59$ df = 13, 56 $P<0.0001$	$F = 45.39$ df = 13, 56 $P<0.0001$	$F = 40.02$ df = 13, 52 $P<0.0001$	$F = 38.81$ df = 13, 52 $P<0.0001$

[a] Means followed by the same letter are not significantly different ($P < 0.05$, Tukey's HSD).

4.3. Results

4.3.1. Oviposition Preference Experiment

A range in plant characteristics was exhibited in this experiment, as noted by differences in plant height, diameter, and in the numbers of internodes, total leaves, and dry leaves among host combinations (Table 4.1). Plant height ranged from 157.6 ± 10.1 cm in immature M81E to 403.6 ± 10.1 cm in mature L 79-1002. Heights were substantially greater among all mature stages of each cultivar. Stalk diameters ranged from 7.8 ± 0.8 cm in mature M81E to 15.4 ± 0.8 cm in mature HoCP 04-838. Of the mature host combinations, M81E possessed a smaller stalk diameter in relation to its corresponding immature host combination, while stalk diameters in both stages of L 79-1002 were the same. Total internodes remained below 10 in immature host combinations, increasing to 15 to 22.4 ± 0.8 in mature hosts. The numbers of internodes were greater in all mature hosts compared to their immature counterparts. Available dry leaves were greater in mature host combinations, ranging from 10.2 to 15.2 ± 1.0 in M81E and HoCP 04-845, respectively. The ratio of dry leaves to total leaves in immature plants ranged from 0.27 in ES 5200 to 0.33 in Ho 02-113, whereas in mature plants, the ratio ranged from 0.60 in HoCP 85-845 to 0.68 in L 79-1002. In perspective, available dry leaf material was up to 2.5 times more abundant in mature plants.

Over the course of the experiment, a total of 3,521 eggs (mean: 50.3 ± 9.7 eggs per plant) and 73 oviposition events (mean: 1.0 ± 0.1 events per plant) at a mean of 40.9 ± 6.6 eggs per oviposition event were recorded across all plants. Eggs were laid exclusively on dry, curled leaves. Differences between the numbers of eggs per plant, oviposition events per plant, and number of eggs per oviposition event per plant were not detected among host combinations, although a marginal trend (0.1 > P > 0.05) among eggs per oviposition event was present (Table 4.2), with

mature plants expressing a numerically greater number of eggs per oviposition event compared to immature plants. Total eggs per plant were numerically greater in all mature host combinations with the exception of HoCP 85-845 and M81E. Increases in eggs per plant between immature and mature plants reached as high as 29.0-fold in Ho 02-113. Eggs per oviposition event increased numerically from 1.4- to 14.1-fold in mature plants; however, a decrease in eggs per plant was exhibited in mature HoCP 85-845 relative to its immature counterpart.

Based on contrasts, sweet sorghum (M81E) was preferred by *E. loftini* over cultivars of sugarcane (HoCP 04-838, HoCP 85-845) and high-biomass sorghum (ES 5200, ES 5140) as evident by a greater number of eggs per plant (Table 4.3). In addition, greater numbers of eggs were deposited per event on M81E compared to either sugarcane cultivar. Differences in egg laying were not detected between *E. loftini*-susceptible (HoCP 04-838) and resistant (HoCP 85-845) cultivars. The number of eggs on a per plant and per oviposition event basis were greater on mature plants than on immature plants.

4.3.2. Survival Experiment

Differences among plant characteristics were successfully established among host combinations (Table 4.4). Differences in plant height were detected among host combinations, ranging from 79.7 ± 13.1 cm in immature M81E to 379.7 ± 12.3 cm in mature L 79-1002. Mature plants were taller than immature, and stalk diameters were up to 1.6-fold larger in mature than in immature plants. Available dry leaf material was greater in all mature plants, with the exception of ES 5200. The ratio of dry to total leaves ranged from 0.28 in HoCP 85-845 to 0.72 in M81E at the immature stage, and from 0.56 in Ho 02-113 to 0.75 in L 79-1002 at the mature stage.

Table 4.2. Oviposition measurements from *E. loftini* on sugarcane, energycane, high-biomass sorghum, and sweet sorghum, Beaumont, Texas, 2014.

Host Combination	Eggs per Plant	Oviposition Events per Plant	Eggs per Oviposition Event
Immature			
HoCP 04-838	14.0	0.8	12.8
HoCP 85-845	48.6	1.4	34.5
L 79-1002	27.8	0.8	28.3
Ho 02-113	5.0	0.4	23.3
ES 5200	6.4	0.4	5.6
ES 5140	6.0	0.8	15.1
M81E	102.8	1.8	50.3
Mature			
HoCP 04-838	50.2	1.4	33.4
HoCP 85-845	12.8	0.6	28.1
L 79-1002	54.8	1.4	39.3
Ho 02-113	145.2	1.6	94.6
ES 5200	64.0	0.6	78.9
ES 5140	69.2	1.2	42.5
M81E	97.4	1.4	85.3
Type III Test of Fixed Effects	F = 1.59 df = 13, 52 P = 0.1184	F = 0.67 df = 13, 56 P = 0.7853	F = 2.03 df = 13, 20.9 P = 0.0718

Table 4.3. Multiple contrasts of oviposition measurements from *E. loftini* on sugarcane, energycane, high-biomass sorghum, and sweet sorghum, Beaumont, Texas, 2014.

Host Combination	Contrasts (F-values)		
	Eggs per Plant[a]	Oviposition Events per Plant[a]	Eggs per Oviposition Event[b]
Energycane versus sugarcane	1.25[d]	0.00[d]	1.72[d]
Energycane versus high-biomass sorghum	0.83[d]	0.56[d]	0.48[d]
High-biomass sorghum versus sugarcane	0.04[d]	0.56[d]	0.31[d]
High-biomass sorghum versus sweet sorghum	4.71[c]	2.97[d]	3.55[d]
HoCP 04-838 versus HoCP 85-845	0.00[d]	0.03[d]	0.17[d]
Sugarcane versus sweet sorghum	5.48[c]	1.24[d]	6.15[c]
Energycane versus sweet sorghum	2.04[d]	1.24[d]	1.55[d]
Sugarcane and energycane versus high-biomass sorghum and sweet sorghum	0.49[d]	0.00[d]	0.69[d]
Immature plants versus mature plants	4.98[c]	0.71[d]	8.69[c]

[a] df = 1, 52

[b] df = 1, 20

[c] $P \leq 0.05$

[d] $P > 0.05$

Table 4.4. Plant measurements on sugarcane, energycane, high-biomass sorghum, and sweet sorghum from greenhouse survival experiment, Beaumont, Texas, 2013.

Host Combination	Plant Height (cm)	Stalk Diameter (mm)	Total Internodes	Dry Leaves	Total Leaves
Immature					
HoCP 04-838	176.6ef	10.7cd	11.9d	6.3de	15.9de
HoCP 85-845	174.9ef	10.6cd	11.3d	4.6e	15.6de
L 79-1002	224.3cde	7.1ef	12.6d	7.0cde	16.4de
Ho 02-113	240.3bcd	9.4cde	12.4d	6.3de	16.9de
ES 5200	114.6gh	8.6cdef	7.6e	5.7de	11.6fg
ES 5140	85.4h	5.9f	5.1e	4.0e	9.3g
M81E	79.7h	6.7ef	4.5e	5.6de	7.8g
Mature					
HoCP 04-838	271.7bc	15.1ab	18.7ab	12.9b	22.1ab
HoCP 85-845	264.4bc	16.6a	18.9ab	13.4b	21.9abc
L 79-1002	379.7a	11.9bc	20.0a	18.0a	24.0a
Ho 02-113	278.9b	11.9bc	16.4bc	10.9bc	19.4bcd
ES 5200	171.5ef	8.9cdef	11.3d	9.9bcd	14.7ef
ES 5140	202.3def	9.7cde	13.7cd	11.9b	18.0cde
M81E	163.6fg	7.9def	14cd	10.4bc	16.4de
Type III Test of Fixed Effects	F = 55.60 df = 13, 77.1 P<0.0001	F = 18.53 df = 13, 83 P<0.0001	F = 46.82 df = 13, 77.1 P<0.0001	F = 33.34 df = 13, 77.1 P<0.0001	F = 23.2 df = 13, 77.1 P<0.0001

[a] Means followed by the same letter are not significantly different ($P < 0.05$, Tukey's HSD).

Age-specific mortality varied among host combinations (Table 4.5). Differences in egg mortality (neonate establishment) were detected among host combinations. Percent mortality of non-viable eggs or neonates that failed to establish ranged from 91.4 ± 1.3% in immature HoCP 85-845 to 97.9 ± 1.3% in mature L 79-1002, and mortality-survival ratios indicated between 13.4- to 53.4-fold greater rates in mortality. Apparent neonatal mortality was impacted by host combination, ranging from 14.3 ± 12.3% in mature ES 5200 to 95.1 ± 12.3% in immature Ho 02-113. While mortality was numerically greater in immature plants, differences in mortality between phenological stages were only detected in ES 5200 (6.1-fold). Real mortality occurring in the neonatal stage was greatest in immature HoCP 04-838, HoCP 85-845, and Ho 02-113, and lowest in mature ES 5140 and M81E. Survivorship through the neonatal stage occurred at a higher rate in mature plants, whereas survivorship among immature plants was only greater in M81E. The numbers of *E. loftini* to survive to established larvae were low, ranging from 0.3 ± 0.5 larvae in immature ES 5140 to 2.6 ± 0.5 larvae in mature HoCP 85-845. Differences in apparent mortality of established larvae were detected among host combinations, with no larvae surviving in immature HoCP 04-838, or either stage of Ho 02-113. Apparent mortality was lowest in immature ES 5140 and M81E. Mortality among larvae was low with respect to the starting population, ranging from 0.0 to 2.2 ± 1.2%. By the pupal stage, no *E. loftini* samples had survived in immature HoCP 04-838 or Ho 02-113, or mature L 79-1002 or Ho 02-113. Apparent mortality varied among host combinations, ranging from 0% in mature ES 5200 to 53.6 ± 15.8% in mature M81E. Total survival from egg to adulthood was <2.0% in all host combinations (Fig. 4.1), and differences between host combinations were not detected.

Table 4.5. Age-specific mortality and survival of *E. loftini* in host combinations of sugarcane, energycane, high-biomass sorghum, and sweet sorghum represented at immature and mature stages of development, Beaumont, Texas, 2013.

Stage (x)	No. Alive	No. Dead	Percent Apparent Mortality	Percent Real Mortality	Mortality-Survival Ratio
Egg					
Immature					
HoCP 04-838	72.4	66.9	92.0bc	92.0bc	13.4b
HoCP 85-845	82.6	76.1	91.4c	91.4c	13.5b
L 79-1002	72.1	67.6	93.6abc	93.6abc	22.0ab
Ho 02-113	94.7	87.9	92.0bc	92.0bc	19.3ab
ES 5200	79.4	75.3	94.6abc	94.6abc	19.3ab
ES 5140	74.0	71.0	95.9abc	95.9abc	25.5ab
M81E	64.2	62.7	97.3ab	97.3ab	44.4ab
Mature					
HoCP 04-838	91.7	88.0	95.5abc	95.5abc	38.9ab
HoCP 85-845	116.0	109.6	94.3abc	94.3abc	19.4ab
L 79-1002	98.0	95.7	97.9a	97.9a	53.1a
Ho 02-113	88.3	82.6	93.0abc	93.0abc	18.1ab
ES 5200	81.9	79.1	95.8abc	95.8abc	53.9a
ES 5140	74.6	71.9	96.0abc	96.0abc	43.6ab
M81E	73.4	70.9	96.6abc	96.6abc	32.7ab
Type III Test of Fixed Effects			$F = 3.53$ df = 13, 77 $P = 0.0002$	$F = 3.53$ df = 13, 77 $P = 0.0002$	$F = 3.69$ df = 13, 76 $P = 0.0002$

Table 4.5. Continued.

Stage (x)	No. Alive	No. Dead	Percent Apparent Mortality	Percent Real Mortality	Mortality-Survival Ratio
Neonate					
Immature					
HoCP 04-838	5.6	4.9	85.2ab	7.0ab	3.0ab
HoCP 85-845	6.4	5.7	89.7a	7.5a	4.9a
L 79-1002	4.6	3.1	76.4ab	4.8abc	1.5bc
Ho 02-113	6.9	6.4	95.1a	7.3ab	5.0a
ES 5200	4.1	3.6	86.8ab	4.7abc	3.8a
ES 5140	3.0	2.7	90.5a	3.7abc	2.0ab
M81E	1.5	1.0	75.0abc	1.9abc	0.5bc
Mature					
HoCP 04-838	3.7	1.7	43.1abc	2.3abc	1.2bc
HoCP 85-845	6.4	3.9	58.8abc	3.6abc	1.9bc
L 79-1002	2.3	1.6	55.6abc	1.5bc	0.2bc
Ho 02-113	5.7	5.0	79.0ab	6.1abc	4.5a
ES 5200	2.7	1.1	45.2abc	2.3abc	0.0c
ES 5140	2.7	1.0	46.2abc	1.3c	0.4bc
M81E	2.6	0.7	28.6bc	1.0c	0.4bc
Type III Test of Fixed Effects			F = 4.23 df = 13, 82 P<0.0001	F = 4.02 df = 13, 76.1 P<0.0001	F = 5.10 df = 13, 43 P<0.0001

Table 4.5. Continued.

Stage (x)	No. Alive	No. Dead	Percent Apparent Mortality	Percent Real Mortality	Mortality-Survival Ratio
Established Larva					
Immature					
HoCP 04-838	0.7	0.7	100.0	1.8	–
HoCP 85-845	0.7	0.4	51.7	1.2	0.0
L 79-1002	1.4	0.1	33.2	0.6	0.0
Ho 02-113	0.4	0.4	100.0	2.2	–
ES 5200	0.6	0.4	75.6	0.8	0.0
ES 5140	0.3	0.0	0.0	0.0	0.0
M81E	0.5	0.0	3.6	0.2	0.0
Mature					
HoCP 04-838	2.0	1.1	67.9	1.7	0.0
HoCP 85-845	2.6	1.9	70.1	1.6	1.0
L 79-1002	0.7	0.7	96.3	1.6	–
Ho 02-113	0.7	0.7	100.0	1.2	–
ES 5200	1.6	1.1	66.2	1.6	0.0
ES 5140	1.7	0.7	31.3	1.6	0.3
M81E	1.9	0.7	27.2	1.1	0.3
Type III Test of Fixed Effects			$F = 2.23$ df = 13, 39.4 $P = 0.0268$	$F = 0.40$ df = 13, 41.2 $P = 0.9632$	$F = 0.88$ df = 9, 13.1 $P = 0.5657$

Table 4.5. Continued.

Stage (x)	No. Alive	No. Dead	Percent Apparent Mortality	Percent Real Mortality	Mortality-Survival Ratio
Pupa					
Immature					
HoCP 04-838	0.0	0.0	–	–	–
HoCP 85-845	0.3	0.0	30.0ab	0.5	0.1
L 79-1002	1.3	0.0	27.7ab	0.5	0.0
Ho 02-113	0.0	0.0	–	–	–
ES 5200	0.1	0.0	8.2ab	0.0	0.0
ES 5140	0.3	0.0	7.1ab	0.0	0.0
M81E	0.5	0.0	27.7ab	0.5	0.0
Mature					
HoCP 04-838	0.9	0.3	–	0.9	0.5
HoCP 85-845	0.7	0.0	27.2ab	0.5	0.0
L 79-1002	0.0	0.0	–	–	–
Ho 02-113	0.0	0.0	–	–	–
ES 5200	0.4	0.0	0.0b	0.0	0.0
ES 5140	1.0	0.3	27.8ab	0.0	0.0
M81E	1.1	0.7	53.6a	1.3	0.7
Type III Test of Fixed Effects			$F = 6.62$ df = 9, 9.3 $P = 0.0044$	$F = 2.41$ df = 9, 9.9 $P = 0.0944$	$F = 38.19$ df = 1, 10.2 $P<0.0001$

[a] Means followed by the same letter are not significantly different ($P < 0.05$, Tukey's HSD).

[b] Spaces with a "–" designate host combinations with no survival at the specified stage of development.

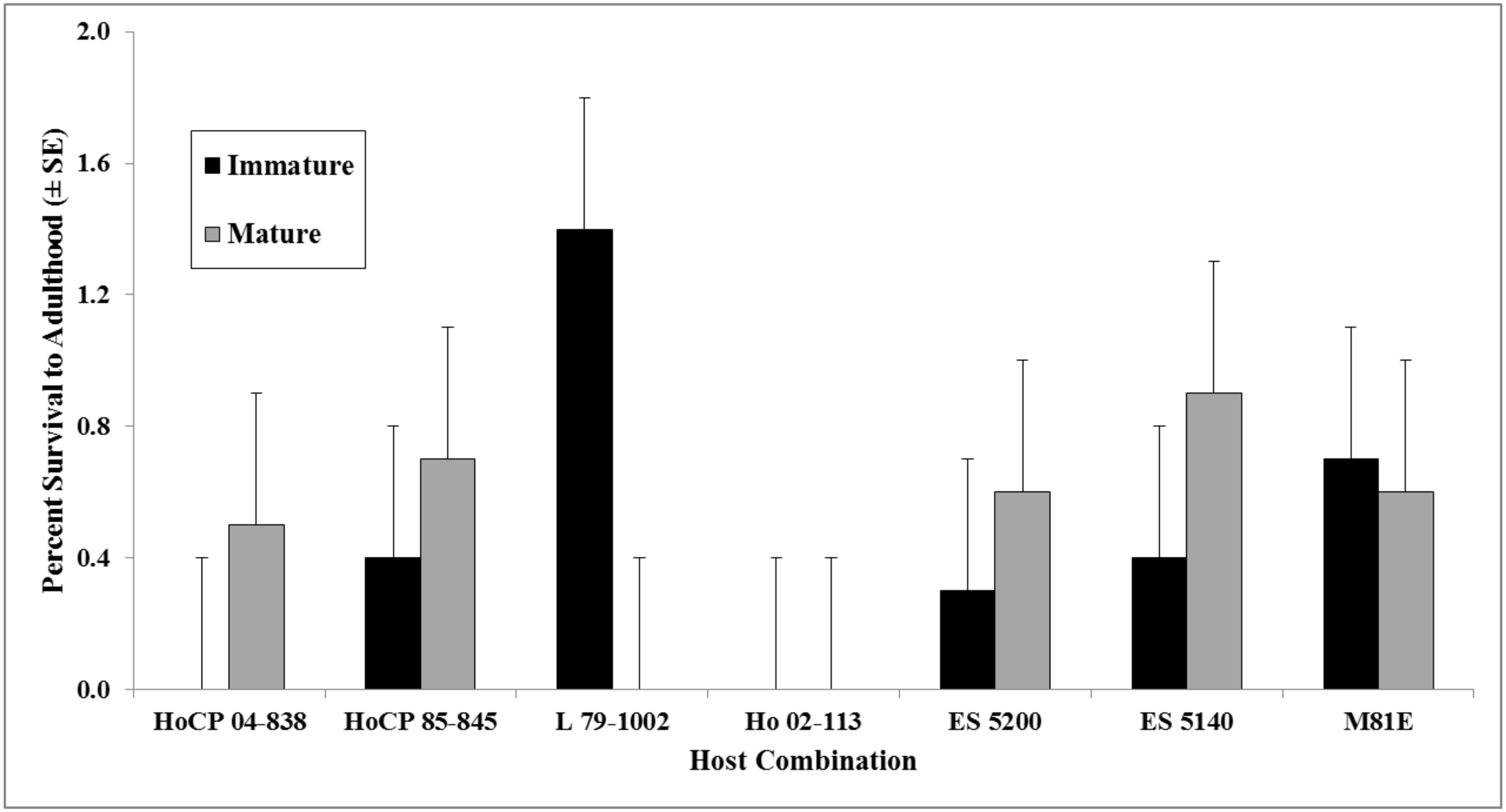

Fig. 4.1. Percentages of *E. loftini* surviving to adulthood (± LS means) by host combination, Beaumont, Texas, 2013.

4.4. Discussion

Results from these greenhouse experiments demonstrate the impacts of host type and phenological growth stage on oviposition preference and survival of *E. loftini*. While oviposition preference in terms of total numbers of eggs and oviposition events did not vary among combinations of sugarcane, energycane, high-biomass sorghum, and sweet sorghum at two phenological stages, further analyses indicated that preference is influenced by physical factors outside the established treatments. In this experiment, eggs were laid exclusively on dry leaf material on the tips, midribs, and sheaths of the leaves. *Eoreuma loftini* eggs have been observed between the leaf sheath and the stalk in sugarcane (Van Zwaluwenburg 1926), and van Leerdam and Johnson (1984) have observed that the insect prefers to oviposit eggs on rough, vertical oriented dead leaf material as opposed to smooth, green leaf material. In addition to plant phenotypic characteristics, drought stress has been associated with an increase in *E. loftini* oviposition preference resulting from greater availability of oviposition sites (Reay-Jones et al. 2005, 2007a, Showler and Castro 2010a, 2010b). While plants were provided adequate water prior to initiation of the experiment, mature plants may have exhibited symptoms of drought stress caused by increases in plant biomass or higher ambient temperatures in the greenhouse. Reay-Jones et al. (2007a) demonstrated a 1.8-fold increase in egg masses on drought stressed sugarcane compared to non-stressed plants. In our experiment, dry leaf material was more abundant in mature plants, explaining the higher numbers of eggs and eggs per oviposition event; however, this could be related more to plant height, as mature plants were taller. Resistance is likely influenced by the presence of higher levels of the FAA proline, which is associated with increased water

potential, thus rendering the plant more drought tolerant (Reay-Jones et al. 2005). In addition to sugarcane, oviposition preference of *E. loftini* is influenced by availability of dry leaf material in other hosts, including rice and non-crop graminoids (Reay-Jones et al. 2007a, Beuzelin et al. 2013). Other than phenotypic characteristics, concentrations of plant biochemicals might influence oviposition preference in host plants (Showler and Castro 2010a, Showler et al. 2011, Showler and Moran 2014).

Differences in *E. loftini* oviposition among sugarcane and sorghum cultivars were not detected in this study. Meagher et al. (1996) observed similar results where only slight differences in oviposition were detected in field, greenhouse, and laboratory trials, indicating that antixenosis is not a key factor in conferring resistance. Other studies, however, have demonstrated the opposite, where oviposition preference is influential for developing resistant cultivars. Reay-Jones et al. (2003) determined sugarcane cultivar HoCP 04-845 to be more resistant to *E. loftini* than LCP 85-384 based on percentage of bored internodes and adult emergence. In a later greenhouse experiment, LCP 85-384 was more attractive for oviposition than HoCP 85-845, indicating an antixenotic resistance mechanism most likely resulting from greater availability of dry leaf material in LCP 85-384 (Reay-Jones et al. 2007a). In our experiment, differences among *E. loftini* susceptible HoCP 04-838 and *E. loftini* resistant HoCP 85-845 werenot detectable; however, the availability of dry leaf material was nearly the same between cultivars.

On a by crop type basis, sweet sorghum was more attractive than sugarcane or high biomass-sorghum cultivars. Interestingly, more eggs were laid in immature M81E, which had less dry leaf material than its mature counterpart, suggesting that oviposition in sweet sorghum could be influenced by other plant characteristics.

Minor differences in mortality were expressed among host combinations. Neonatal mortality might be associated with lower availability of folded leaf material (Showler and Castro 2010b). Greater apparent mortality exhibited in immature Ho 02-113 compared to mature M81E might have been attributed to lower availability of dry leaf material; however, this trend was not expressed among other cultivars. Acceptance of the host plant is influenced greatly by contact chemoreception in lepidopterans (Ramaswamy 1988), and the numbers of eggs per ovipostion event can be increased or decreased depending on the suitability of the plant. Because eggs masses were distributed on plants in relatively equal numbers, higher levels of mortality could have been present on host combinations that are normally deemed unsuitable by the female moth, thus masking treatments effects. In our experiment, neonate establishment did not differ between HoCP 04-838 and HoCP 85-845, most likely due to similar quantities of available dry leaf material. Wilson et al. (2012) demonstrated a lower percentage of neonatal establishment in HoCP 85-845 compared to *E. loftini* susceptible HoCP 00-950, indicating that resistance might have been caused by greater availability of dry leaf material or leaf sheath appression (Coburn and Hensley 1972). In addition, resistance in HoCP 85-845 is suggested to be antixenotic primarily due to it susceptibility under heavy, natural *E. loftini* infestations (Reay-Jones et al. 2003) or when eggs were applied to plant leaf sheaths in the field (VanWeelden et al. 2015).

Establishment of larvae into the stalk might have been impacted by plant phenotypic characteristics, such as rind hardness (Martin et al. 1975, Ring et al. 1991). Once in the stalk, larval mortality varied greatly among host combinations. High levels of mortality

exhibited in both stages of energycane cultivar Ho 02-113 and mature L 79-1002 may have resulted from higher levels of stem fiber and lignin contents, which negatively impacted larval feeding and development in the African stem borer, *Eldana saccharina* Walker (Lepidoptera: Pyralidae) (Rutherford et al. 1993).

Survival from egg to adult was very low among host combinations, and may have prevented detection of differences in survival. Low percentages of adult survival may also have been attributed to infestations of the red imported fire ant, *Solenopsis invicta* Buren (Hymenoptera: Formicidae), which were present at times throughout the experiment. *Solenopsis invicta* has been shown to significantly reduce *D. saccharalis* infestations in sugarcane; however, its impact on *E. loftini* remains unknown.

Implementation of cultivars with antixenotic or antibiotic resistance mechanisms can be an important tool in integrated pest management (Smith 1989), and has been demonstrated with *E. loftini* in sugarcane (Legaspi et al. 1999b, Reay-Jones et al. 2003, 2005, 2007a, VanWeelden et al. 2015, Wilson et al. 2015). Limited exposure of the insect to insecticide treatments (Wilson et al. 2012), as well as little to no increase in yield when chemicals are applied (Meagher et al. 1994, Legaspi et al. 1997a, 1999b), suggest the need for using resistant cultivars in managing *E. loftini* infestations. Additional field studies should be implemented to further enhance our knowledge of *E. loftini* population dynamics in mixed cropping systems consisting of conventional and bioenergy crops. Integrating susceptible conventional or bioenergy crops, such as corn (Showler et al. 2011) or high-biomass sorghum (VanWeelden et al. 2015), will increase local

infestations, thus risking area-wide outbreaks. Proper implementation of resistant cultivars in combination with alternate management tactics will continue to be the best strategy in mitigating crop losses to *E. loftini* in mixed crop agroecosystems.

CHAPTER 5: IMPACT OF NITROGEN FERTILIZATION ON MEXICAN RICE BORER (LEPIDOPTERA: CRAMBIDAE) INJURY AND YIELD IN BIOENERGY SORGHUM

5.1. Introduction

The Mexican rice borer, *Eoreuma loftini* (Dyar), has become one of the dominant pests of graminaceous crops in Texas and Louisiana since its introduction into the Lower Rio Grande Valley in 1980 (Johnson and van Leerdam 1981, Legaspi et al. 1997a, Reay-Jones et al. 2007b, Wilson et al. 2015a). Hosts of this invasive species include sugarcane, *Saccharum* spp., rice, *Oryza sativa* L., corn, *Zea mays* L., and grain sorghum, *Sorghum bicolor* (L.) Moench (Dyar 1917, Van Zwaluwenburg 1926, Osborn and Phillips 1946, Van Zwaluwenburg 1950, Johnson 1984, Showler et al. 2012), as well as related bioenergy crops (VanWeelden et al. 2015). Recent demands in the United States for increased production of dedicated bioenergy feedstocks high in sucrose or lignocellulosic biomass (United States Environmental Protection Agency 2007), including high-biomass sorghum, *Sorghum* spp. hybrids, sweet sorghum, *Sorghum bicolor* (L.) Moench, and energycane, *Saccharum* spp., are anticipated to increase the host availability for *E. loftini*, which could impact area-wide infestations in conventional and bioenergy crops.

Current integrated pest management tactics to mitigate *E. loftini* infestations in sugarcane include judiciously timed insecticide applications (Wilson et al. 2012), irrigation (Reay-Jones et al. 2005), and host-plant resistance (Reay-Jones et al. 2003, Way et al. 2006, Wilson et al. 2015b, VanWeelden et al. 2015). However, little research has been conducted on management strategies in cultivars of sorghum produced as dedicated bioenergy feedstocks, specifically with the impact of fertilization. Current nitrogen (N) fertilization recommendations for sweet sorghum range from 45 to 90 kg/ha

in the Gulf Coast region (Viator et al. 2010), but little is known whether this regime is optimal for production of newly emerging high-biomass sorghum cultivars. In addition, the compatibility of recommended N regimes with current management strategies for *E. loftini* is unknown. Because N is essential for all biological processes and greater availability of N results in greater productivity among organisms, it is considered a limiting factor in ecosystems (Mattson 1980). Impacts on insect pest biology resulting from enhancements in available N have been documented on numerous crops, including grain sorghum (Wale et al. 2006), corn (Sétamou et al. 1995, Wale et al. 2006), sugarcane (Atkinson and Nuss 1989, Showler 2015), and wheat (*Triticum* spp. L.) (Honek 1991, Gash 2012). Thus, manipulation of N fertilization can be a useful tool in an integrated pest management strategy. Quantity of available N is linked to many plant characteristics in sugarcane, including concentrations of free amino acids and vigor (Showler 2015), which in turn can impact host preference for oviposition and larval performance of *E. loftini*. The objective of this study was to assess *E. loftini* injury and yield response across varying N fertilization regimes in high-biomass and sweet sorghum cultivars.

5.2. Materials and Methods

5.2.1. Experimental Design

A field experiment was conducted in 2013 and 2014 at the Texas A&M AgriLife Research and Extension Center at Beaumont, Texas (Jefferson County) to evaluate the impact of N fertilization on *E. loftini* injury and yield in three cultivars of sorghum used in the production of biofuels. Cultivars included two high-biomass sorghum cultivars, ES 5200 and ES 5140 (Blade Energy Crops, Thousand Oaks, California), and one sweet sorghum cultivar, M81E (MAFES Foundation Seed Stocks, Mississippi State University,

Mississippi). High-biomass sorghum cultivars ES 5200 and ES 5140 are *S. bicolor* and *S. bicolor* × *drummondii* (sudangrass) hybrids, respectively, bred to produce thick-stemmed, late maturing crops for use as dedicated bioenergy feedstocks (Blade Energy Crops 2012). Sweet sorghum cultivar, M81E, is a *S. bicolor* inbred released by the USDA-ARS U.S. Sugar Crops Field Station for production of fermentable sugar (Broadhead et al. 1981), and has potential for ethanol production (Tew et al. 2008, Erickson et al. 2012).

The experiment was arranged using a randomized block, split-plot design with four blocks (one replication per block). Each block was 22.7 m long and 25.4 m wide (24 rows). Rates of N fertilization were randomized to six-row plots (22.7 m long and 6.4 m wide) and sorghum cultivars were randomized to two-row subplots (22.7 m long and 2.1 m wide). Prior to planting, soil samples consisting of single 2.5 cm wide by 30 cm deep cores at 15 locations within the field were collected and analyzed for available N at the Louisiana State University Agricultural Center Soil Testing and Plant Laboratory, Baton Rouge, Louisiana. Soil analysis showed that available N ranged from 0.08 to 0.13% (mean: 0.10%, standard deviation: 0.02%), and available N in field plots prior to fertilization was not expected to interfere with the experimental design. High-biomass sorghum and sweet sorghum cultivars were planted using a four-row precision cone planter (Kinkaid Equipment Manufacturing, Haven, Kansas) on 10 May in 2013 and 9 May in 2014 at a rate of 210,000 seeds per hectare. Two wk after planting, urea granules were applied by hand to plots at one of four fertilization rates: 0, 45, 90, 135 kg N/ha. Nitrogen granules were applied to plots to reduce any confounding effects resulting from N mobility in the soil. The study was conducted on adjacent field sites in 2013 and 2014, and N fertilization rates and sorghum cultivars were re-randomized each year.

Plants were sampled throughout the growing season during both years to determine within- season *E. loftini* injury. Subplots were sampled on 17 July, 7 August, 4 September, and 26 September in 2013 and 17 July, 4 August, 21 August, 5 September, and 3 October in 2014. At each date, 10 plants were randomly selected in each subplot and inspected for leaf sheath feeding and bored internodes from *E. loftini*. In addition, the height and total number of internodes were recorded for each plant. Injury was expressed as the percentage of injured internodes [(internodes with leaf sheath feeding or bored internodes / total internodes) × 100].

5.2.2. *Eoreuma loftini* End-of-season Injury and Yield

Experiments were harvested on 2 October in 2013 and 24 October in 2014 to collect *E. loftini* end-of-season injury and yields. Twelve stalks were sampled from each row of each subplot (24 stalks per subplot), stripped of leaf material, and the numbers of internodes, bored internodes, and *E. loftini* adult emergence holes were recorded. Stalks were then weighed to determine fresh stalk weight (kg), and crushed using a sugarcane stalk crusher (Skyfood Equipment, Miami, Florida) to separate juice from bagasse. A 1 mL aliquot of juice from each sample was analyzed using a handheld refractometer (Reichert Technologies, Depew, New York) to determine Brix (% w/w of soluble solids). From the Brix reading, sucrose concentration in stalks (% w/w) from each sample was calculated using the model (VanWeelden et al. 2015):

$$(1)\ \textit{Sucrose concentration} = \textit{Brix} / 1 \times 0.85 / 1.72$$

where 1 is the factor converting *Brix* to soluble solid concentration in juice (% w/v) assuming a juice relative density of 1; 0.85 is the purity factor for converting juice sucrose to normal juice sucrose (Reay-Jones et al. 2005); and 1.72 is a constant estimated

from calculating the relationship between fresh stalk weight and juice volume from data collected in the experiment. Bagasse from each sample was weighed, and a sub-sample of bagasse was removed, weighed, and dried for two wk to remove moisture content. Dry weights of samples were used to estimate percent moisture remaining in the bagasse. Estimation of ethanol productivity (liter/ha) was determined to be the sum of ethanol outputs from both sucrose and lignocellulosic biomass. Predicted ethanol output from sucrose was calculated using the model (Vasilakoglou et al. 2011):

(2) $$\textit{Predicted sucrose ethanol output} = \textit{sucrose concentration} \times \textit{fresh biomass} \times 6.5 \times 0.85 \times 1.27$$

where *sucrose concentration* is calculated using model (1) for each sample; *fresh biomass* is the total fresh stalk weight in Mg/ha; 6.5 is the conversion factor of ethanol from sucrose; 0.85 is the efficiency constant from converting sucrose into ethanol; and 1.27 is the specific gravity of ethanol in g/mL. Because stands were low but spatially homogenous, stalk populations were standardized using published stand counts (Blade Energy Crops 2012) to estimate fresh biomass per hectare. Dry bagasse weight (following adjustment for moisture remaining after crushing) from each sample was multiplied by a factor of 465.3, the theoretical ethanol yield in liter/metric ton from bagasse (Unites States Department of Energy 2013) to determine lignocellulosic ethanol productivity. Predicted ethanol outputs from sucrose and lignocellulosic biomass were summed to estimate total ethanol productivity of each sample.

5.2.3. Statistical Analyses

Data were analyzed separately by year. Within-season *E. loftini* injury data for each subplot were analyzed using a linear mixed model (PROC GLIMMIX) (SAS Institute

2008) with N fertilization rate, cultivar, and sampling date, along with all two and three-way interactions, as fixed effects. Random effects included block, block × N fertilization rate, and block × N fertilization rate × cultivar. A multivariate analysis was conducted using PROC GLM (SAS Institute 2008) with a MANOVA statement including all injury (percentage of bored internodes, no. adult emergence holes per stalk) and yield parameters (fresh stalk weight, sucrose concentration, ethanol productivity) because these response variables were collected from the same observation units (i.e., stalk samples). Fixed effects included N fertilization rate, cultivar, and the N fertilization rate × cultivar interaction. Random effects included block, block × N fertilization rate, and block × N fertilization rate × cultivar. Subsequently, univariate linear mixed models with the same fixed and random effects as the multivariate linear mixed model were conducted to independently compare percentage of bored internodes, no. adult emergence holes per stalk, fresh stalk weight, sucrose concentration, and ethanol productivity. For all univariate models, the Kenward-Roger method was used to estimate the error degrees of freedom (PROC GLIMMIX) (SAS Institute 2008). Least square means ± standard errors from the LSMEANS statement output (PROC GLIMMIX, SAS Institute 2008) were reported. Pairwise comparisons were made using LSMEANS statement (SAS Institute 2008) and adjusted with Tukey's honest significant difference (HSD) test ($\alpha = 0.05$).

Simple linear regressions were conducted using PROC REG (SAS Institute 2008) to determine the relationships between N fertilization (x) and the percentage of bored internodes (y). In addition, regressions were conducted between percentage of bored internodes (x) and yield (stalk weight, sucrose concentration, ethanol productivity) (y).

Because the effect the cultivar was not significant (*P* > 0.05) in predicting the relationship between N fertilization and the percentage of bored internodes, data were pooled across all cultivars.

5.3. Results

5.3.1. *Eoreuma loftini* Within-season Injury

In 2013, within-season percentage of *E. loftini* injured internodes remained below 2.0% across all sampling dates, ranging from 0.0% on 17 July to 1.4% on 26 September. However, differences were detected (*F* = 17.64; df = 3, 781.5; *P* < 0.0001), with injury recorded on 26 September greater than injury on 17 July (0.0% injured internodes: *t* = 6.78; df = 783.1; *P* <0.0001), 7 August (0.2% injured internodes: *t* = 5.82; df = 783.1; *P* <0.0001), and 4 September (0.3% injured internodes: *t* = 5.00; *df* = 786.3; *P* <0.0001). The percentage of injured internodes generally increased with N rate (*F* = 3.67; df = 3, 27.6; *P* = 0.0241), ranging from 0.28% at 0 kg N/ha to 0.92% at 135 kg N/ha. A sampling date by N rate interaction was detected (*F* = 3.18; df = 9, 783.3; *P* = 0.0009). The percentage of injured internodes for 17 July remained at 0.0% across all N rates, while injury at later sampling dates increased with added N, reaching percentages of injured internodes as high as 0.6% on 4 September and 2.9% on 26 September. Despite the percentage of injured internodes remaining low throughout the growing season in 2014, differences in the within-season percentage of injured internodes were detected among sampling dates (*F* = 6.78; df = 783.1; *P* <0.0001), peaking late in the season on 5 September at 0.4% injured internodes.

5.3.2 *Eoreuma loftini* End-of-season Injury and Yields

5.3.2.1. 2013 Field Experiment

Multivariate analysis of end-of-season *E. loftini* injury and yield in 2013 showed that at least one injury (percentage of bored internodes, no. adult emergence holes) or yield (fresh stalk weight, sucrose concentration, ethanol productivity) parameter changed with N rate (Wilks' Lambda = 0.1736; F = 3.77; df = 15, 63.9; P <0.0001) and sorghum cultivar (Wilks' Lambda = 0.0004; F = 20.44; df = 4, 10; P = 0.0052). The effect of N was generally consistent across cultivar, by the absence of an interaction (Wilks' Lambda = 0.3026; F = 1.09; df = 30, 94; P = 0.3646). Higher N rates were associated with increases in the percentage of bored internodes (Table 5.1; Fig. 5.1a). In absence of added N, the percentage of bored internodes averaged 2.9% across all cultivars, increasing to 3.7, 5.0, and 8.4% at rates of 45, 90, and 135 kg N/ha, respectively. The percentage of bored internodes varied by cultivar across all N rates (Table 5.1), with greater levels of injury in ES 5140 (5.8%) than in M81E (4.1%), but not in ES 5200 (5.1%). Although no difference in emergence per stalk was detected between N rates of 0 and 45 kg/ha, emergence per stalk increased 7.4-fold when N was increased from 45 to 135 kg/ha (t = 7.83; df = 27; P <0.0001) and 3.1-fold when N was increased from 90 to 135 kg/ha (t = 6.09; df = 27; P <0.0001) (Fig. 5.1c). *Eoreuma loftini* adult emergence per stalk was greatest in ES 5200 (0.31), followed by ES 5140 (0.21) and M81E (0.09). Despite no interaction in the multivariate analysis, the univariate analysis detected an N rate by cultivar interaction for emergence holes per stalk (Table 5.1).

Table 5.1. Statistical comparisons of *E. loftini* injury and sorghum yield parameters from univariate two-way ANOVAs. Beaumont, Texas, 2013–2014.

Parameter	2013			2014		
	F	df	*P* > *F*	*F*	df	*P* > *F*
Percentage of Bored Internodes						
N Rate	19.69	3,81.0	< 0.0001	9.86	3,33.0	< 0.0001
Cultivar	3.48	2,81.0	0.0356	1.87	2,33.0	0.1705
N Rate × Cultivar	1.08	6,81.0	0.3832	1.38	6,33.0	0.2507
Adult Emergence						
N Rate	27.19	3,27.0	< 0.0001	1.45	3,81.0	0.2340
Cultivar	5.75	2,6.0	0.0404	1.20	2,81.0	0.3056
N Rate × Cultivar	2.89	6,27.0	0.0261	1.13	6,81.0	0.3531
Fresh Stalk Weight						
N Rate	5.27	3,27.0	0.0054	3.18	3,33.0	0.0367
Cultivar	44.25	2,9.0	< 0.0001	1.29	2,33.0	0.2887
N Rate × Cultivar	1.15	6,27.0	0.3636	1.55	6,33.0	0.1941
Sucrose Concentration						
N Rate	0.19	3,32.9	0.9025	0.78	3,33.0	0.5142
Cultivar	30.49	2,32.9	< 0.0001	12.70	2,33.0	< 0.0001
N Rate × Cultivar	1.73	6,32.9	0.1462	2.45	6,33.0	0.0451
Ethanol Productivity						
N Rate	26.53	3,26.5	0.0150	5.53	3,33.0	0.0034
Cultivar	30.42	2,8.9	0.0001	0.38	2,33.0	0.6862
N Rate × Cultivar	1.22	6,26.5	0.3289	2.04	6,33.0	0.0885

In 2013, increased N had a positive impact on fresh stalk weight across all cultivars (Tables 5.1 and 5.2), ranging from 0.22 kg/stalk at 0 kg N/ha to 0.34 kg/stalk at 135 kg N/ha. Pairwise comparisons failed to detect differences in stalk weight between plots subjected to 0 and 45 kg N/ha, or 90 and 135 kg N/ha. However, stalk weights at 135 kg N/ha were 1.5 and 1.4-fold greater than at 0 (0.22 kg/stalk: t = 3.83; df = 26.7; P = 0.0036) and 45 kg N/ha (0.25 kg/stalk: t = 2.81; df = 27.3; P = 0.0428), respectively. Stalk weight varied by cultivar (Table 5.1), with that

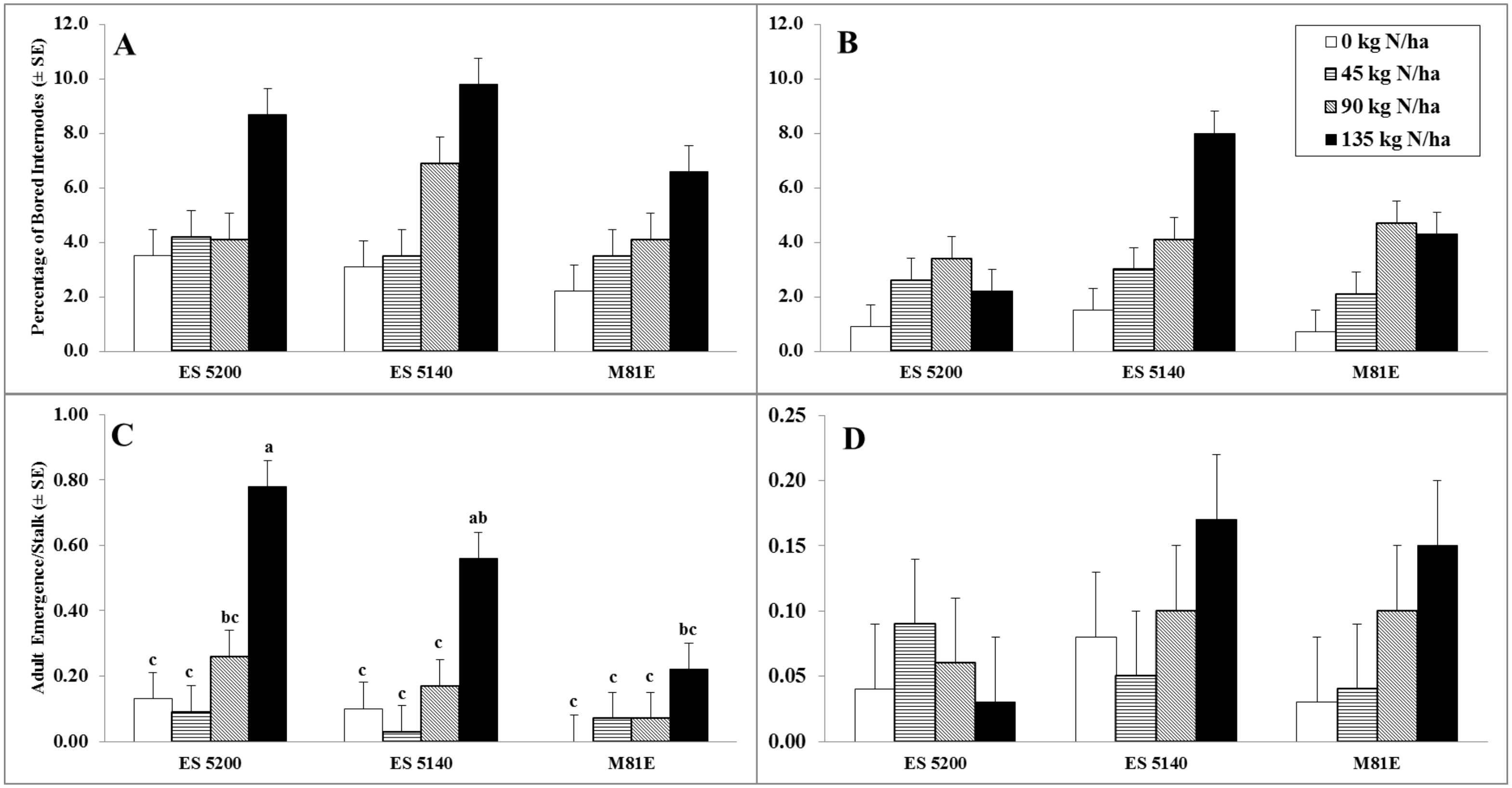

Fig. 5.1. *Eoreuma loftini* injury in high-biomass and sweet sorghum cultivars at four N fertilization rates. Percentage of bored internodes in (A) 2013 and (B) 2014. Number of adult emergence holes per stalk in (C) 2013 and (D) 2014, Beaumont, Texas. Differences in adult emergence / stalk were not detected between treatments in 2014.

of ES 5200 (0.52 kg/stalk) 2.6 and 5.2-fold greater than that of ES 5140 (0.20 kg/stalk: *t* = 6.90; df = 9.0; *P* = 0.0002) and M81E (0.10 kg/stalk: *t* = 9.00; df = 9.0; *P* <0.0001), respectively. No difference in stalk weight was detected between ES 5140 and M81E. Sucrose concentration across all cultivars was not impacted by N rate, but varied by cultivar, being 4.9% in ES 5140, 5.7% in ES 5200, and 6.7% in M81E across all N rates (Table 5.1). A positive response to N was detected for ethanol productivity (Tables 5.1 and 5.2) and ranged from 12.2 × 10^3 liter/ha at 0 kg N/ha to 18.9 × 10^3 liter/ha at 135 kg N/ha. The greatest increases in ethanol yields were observed between 90 and 135 kg N/ha (+ 4.8 × 10^3 liter/ha), whereas ethanol yield remained unchanged between 0 and 45 kg N/ha. Ethanol productivity also varied by cultivar (Table 5.1), with ES 5200 (27.4 × 10^3 liter/ha) yielding 2.6 and 4.9-fold more ethanol than in ES 5140 (10.4 × 10^3 liter/ha: *t* = 5.79; df = 8.8; *P* = 0.0007) and M81E (5.5 × 10^3 liter/ha: *t* = 7.42; df = 8.9; *P* = 0.0001), respectively.

Results from regression from 2013 detected a positive relationship between N rate and the percentage of bored internodes (*F* = 47.77; df = 95; *P* < 0.0001) (Fig. 5.2a) across all cultivars. An increase in N by 1 kg/ha corresponded to an increase of 0.04 ± 0.01 in the percentage of bored internodes. Associations between the percentage of bored internodes and fresh stalk weight, sucrose concentration, and ethanol productivity were not detected (Fig 5.2b–d).

5.3.2.2. 2014 Field Experiment

Multivariate analysis of end-of-season data in 2014 showed that at least one of the injury or yield parameters changed with N rate (Wilks' Lambda = 0.2313; *F* = 2.98; *df* = 15, 63.9; *P* = 0.0012) and cultivar (Wilks' Lambda = 0.0012; *F* = 11.39; *df* = 4, 10; *P* = 0.0158). The effect of N was similar to data from 2013, as shown by the absence of an interaction (Wilks' Lambda =

Table 5.2. Yield estimates (± LS means) in high-biomass and sweet sorghum at varying nitrogen fertilization rates, Beaumont, Texas, 2013–2014.

Cultivar	N Rate (kg/ha)	2013		
		Fresh Weight (kg) per Stalk (± 0.05 [SE])	Sucrose Concentration (± 0.4 [SE])	Ethanol Productivity (10^3 liter/ha) (± SE)
High-biomass Sorghum ES 5200	0	0.42	5.4	23.2 ± 3.0
	45	0.49	5.7	23.6 ± 3.0
	90	0.54	5.7	27.0 ± 3.1
	135	0.63	6.1	35.6 ± 3.0
High-biomass Sorghum ES 5140	0	0.18	4.7	10.2 ± 3.0
	45	0.16	4.8	8.4 ± 3.0
	90	0.17	4.7	8.3 ± 3.0
	135	0.28	5.5	14.6 ± 3.1
Sweet Sorghum M81E	0	0.06	7.0	3.2 ± 3.0
	45	0.10	6.7	5.5 ± 3.0
	90	0.12	6.8	7.0 ± 3.0
	135	0.17	6.1	6.4 ± 3.1

Table 5.2. Continued.

Cultivar	N Rate (kg/ha)	2014 Fresh Weight (kg) per Stalk (± 0.03 [SE])	Sucrose Concentration (± 0.3 [SE])	Ethanol Productivity (10^3 liter/ha) (± 1.5 [SE])
High-biomass Sorghum ES 5200	0	0.11	5.1 ab	4.9
	45	0.15	4.9 ab	6.8
	90	0.16	5.2 ab	7.6
	135	0.16	5.2 ab	8.0
High-biomass Sorghum ES 5140	0	0.16	3.6 b	5.8
	45	0.13	3.7 b	5.0
	90	0.18	4.2 ab	7.2
	135	0.19	4.4 ab	7.9
Sweet Sorghum M81E	0	0.11	5.6 a	4.6
	45	0.19	4.6 ab	8.0
	90	0.15	4.7 ab	5.9
	135	0.20	3.9 b	6.9

[1]Means followed by the same letter are not significantly different ($P < 0.05$, Tukey's HSD).

[2]Means within columns for fresh weight per stalk (2013, 2014), sucrose concentration (2013, 2014), and ethanol productivity (2014) have the same SE.

0.2245; *F* = 1.42; df = 30, 94; *P* = 0.1041). The percentage of bored internodes varied among N rates (Table 5.1, Fig. 5.1b). Similarly with data from 2013, the percentage of bored internodes increased with increasing rates of N, ranging from 1.2% at 0 kg N/ha to 3.9% at 135 kg N/ha. Differences in the percentage of bored internodes were not detected among cultivars. Despite a 2.2-fold increase in *E. loftini* adult emergence per stalk between 0 and 135 kg N/ha, variations in emergence per stalk among N rates or cultivars were not detected (Table 5.1, Fig. 5.1d).

In 2014, fresh stalk weights were lowest at 0 kg N/ha, increasing 1.4-fold at 135 kg N/ha, although differences in stalk weights were not detected between 0, 45, 90 kg N/ha. Consistent with 2013, sucrose concentration varied among cultivars but not N rates (Table 5.1). Sucrose concentration of ES 5140 (4.0%) was less than that of ES 5200 (5.1%: *t* = -4.97; df = 33; *P* <0.0001) and M81E (4.7%: *t* = -3.21; df = 33; *P* = 0.0080). The greatest sucrose concentrations were detected at 90 kg N/ha for ES 5200 and 135 kg N/ha for ES 5140; however, sucrose concentration in M81E was negatively impacted by increasing N, decreasing 1.4-fold at 135 kg N/ha when compared to yields at 0 kg N/ha (Table 5.2). Ethanol productivity, though numerically less than in 2013, had a positive response to N (Table 5.1), ranging from 5.1 × 10^3 liter/ha at 0 kg N/ha to 7.6 × 10^3 liter/ha at 135 kg N/ha across all cultivars. Ethanol yields increased 1.3-fold between 0 and 45 kg N/ha, but did not change after increasing N to 90 kg/ha. Increasing N to 135 kg/ha increased ethanol productivity 1.5-fold when compared to plants under the 0 kg N/ha regime.

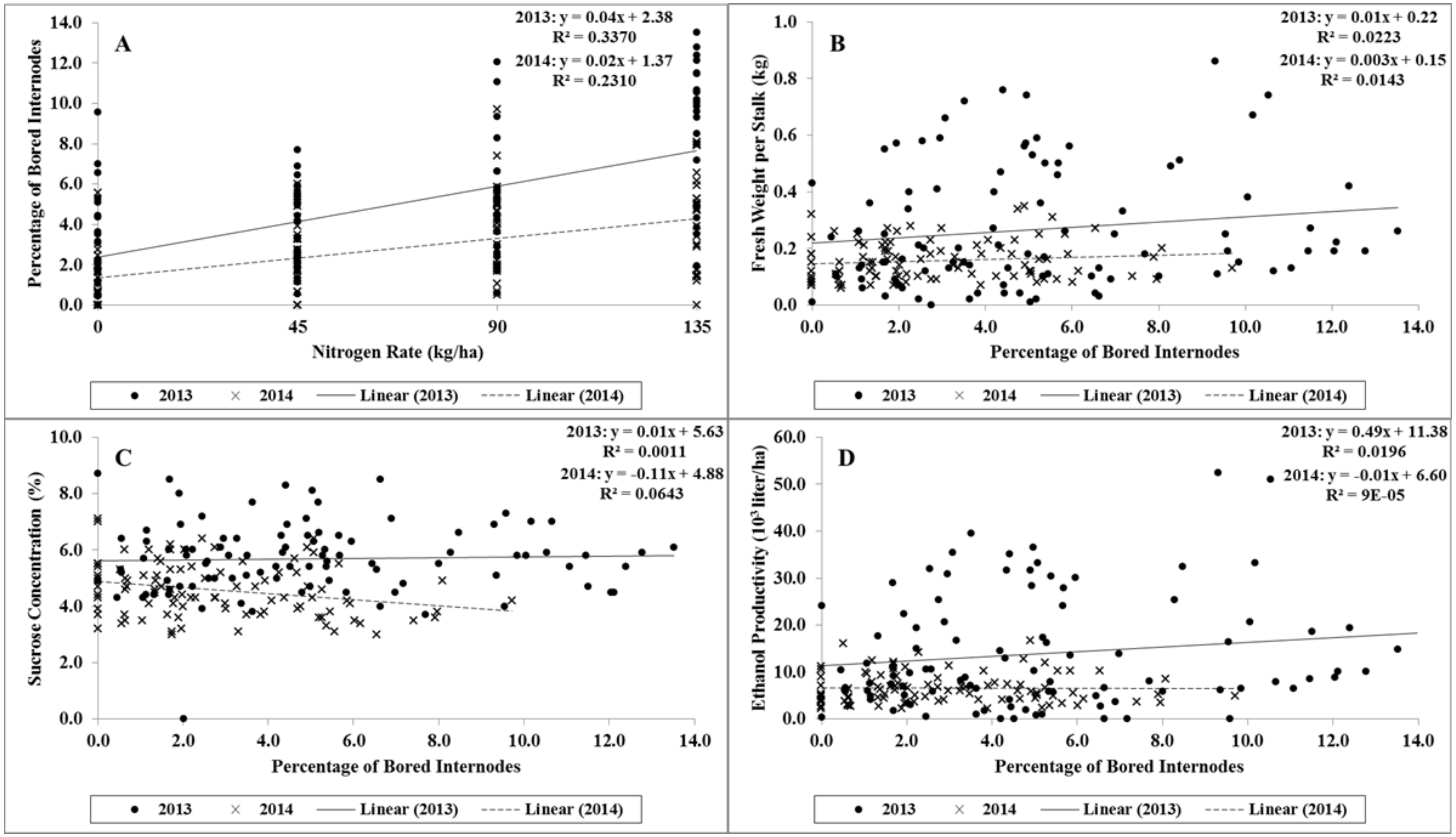

Fig. 5.2. Simple linear regression estimating relationships among N rate, *E. loftini* injury, and yield, Beaumont, Texas, 2013–2014. Regressions include (A) N rate vs percentage of bored internodes, (B) percentage of bored internodes vs fresh weight per stalk, (C) percentage of bored internodes vs sucrose concentration, and (D) percentage of bored internodes vs ethanol productivity. Data from 2013 and 2014 were analyzed separately.

Results from regression in 2014 detected a positive relationship between N fertilization rate and the percentage of bored internodes ($F = 28.23$; df = 95; $P < 0.0001$) (Fig. 5.2a) across all cultivars. An increase in N by 1 kg/ha corresponded to an increase of 0.02 ± 0.004 in the percentage of bored internodes. In addition, a negative relationship was detected between the percentage of bored internodes and sucrose concentration ($F = 6.46$; df = 95; $P = 0.0127$) (Fig. 5.2c), but not fresh stalk weight or ethanol productivity (Fig. 5.2b and Fig. 5.2d). Sucrose concentration decreased by 0.1 ± 0.04% w/w for every unit increase in the percentage of bored internodes.

5.3. Discussion

Nitrogen fertilization had a direct impact on *E. loftini* infesting sorghum cultivars bred as bioenergy feedstocks. The association between increased levels of *E. loftini* injury and increased N fertilization documented in this study is consistent with Showler (2015), where high-rate applications of compost increased the percentage of *E. loftini* bored internodes in sugarcane. Increases in applied N in sugarcane have also been associated with greater infestation levels and survival of the African sugarcane stalk borer, *Eldana saccharina* Walker (Lepidoptera: Pyralidae) (Atkinson and Nuss 1989). In addition, associations between stem borer infestations and N fertilization have been documented for *Chilo partellus* (Swinhoe) (Lepidoptera: Crambidae) and *Busseola fusca* (Fuller) (Lepidoptera: Noctuidae) in grain sorghum (Van den Berg and Van Rensburg 1991, Addo-Bedaiko and Thanguane 2012) and corn (Arshad et al. 2013).

The association between N fertilization and *E. loftini* injury and adult emergence could result from the association between N fertilization and host-plant nutritional quality, specifically free amino-acids (Showler and Moran 2014, Showler 2015). Increases in free-amino acids essential

for insect growth and development (Nation 2002) could have increased host preference for oviposition in *E. loftini* females, thus increasing injury. An additional environmental factor that might increase host preference and subsequent injury, as demonstrated with *E. loftini* in sugarcane, is drought stress, which has been associated with increased concentrations of free amino acids (Reay-Jones et al. 2005, Showler and Castro 2010a). Fields used in this study were not irrigated, which could have increased *E. loftini* infestations through enhancement of nutrients. Furthermore, drought stress would also increase the occurrence of dry and folded leaf tissue, which is known to be a preferred site for *E. loftini* oviposition, and has been associated with higher concentrations of free amino acids (Reay-Jones et al. 2005, 2007a, Showler and Castro 2010a, 2010b). Recorded rainfall from May through October was ≈432 mm in 2013 and ≈838 mm in 2014 (National Weather Service 2015), indicating that higher infestations observed in 2013 could have been due to lower rainfall.

Elevated numbers of *E. loftini* emergence holes in response to N fertilization in 2013 indicates that N can impact moth production, thus having the potential to influence area-wide populations. This same association has been demonstrated in sugarcane (Showler 2015). Because *E. loftini* has the ability to infest numerous crop and non-crop hosts (Showler at al. 2011, 2012, Beuzelin et al. 2011, Showler and Reagan 2012), minimizing moth production is key in reducing area-wide impacts. The lack of a detectable increase in adult emergence in 2014 may have been caused by reduced pest pressure that year, evident from lower levels of injury in our study and lower *E. loftini* pheromone trap catches across east Texas in 2014 compared to 2013 (Way et al. 2013, 2014).

Reductions in yield might have occurred from increased *E. loftini* injury under higher N rate; however, this damage was likely masked by increased plant growth. Although, *E. loftini* injury is capable of reducing yields in high-biomass and sweet sorghum (VanWeelden et al. 2015), our results suggest N fertilization exerts a greater influence on yield. The reduction of sucrose concentration in 2014 from *E. loftini* injury indicates reductions in sucrose concentration are less likely to be off-set by increased N fertilization rate as sugar content in sorghum is not as heavily impacted by N (Erickson et al. 2012), especially in non-irrigated environments (Han et al. 2012) such as those in this study. The positive association between N rate and stalk biomass demonstrated in this study is consistent with results from previous studies (Erickson et al. 2012, Han et al. 2012), although this trend is not always linear. Under non-irrigated conditions, production of biomass may increase at the expense of sugar (Han et al. 2012), which may explain discrepancies between stalk weight and sucrose concentration relative to N rate. Although stalk samples collected for yield analysis were relatively small and may have not been adequate to determine precise yield estimates, each stalk sampled for injury was processed for yield determination to accurately assess the relationship between injury and yield.

The high biomass and moderate concentrations of sucrose exhibited in ES 5200 give this cultivar the greatest potential for production of ethanol. Results in 2013 demonstrated that even with no added N, ES 5200 was estimated to produce more ethanol than ES 5140 or M81E under high N rates, justifying ES 5200 as a candidate for low-input biofuel production. In addition, production of ES 5200 under low to moderate N fertilization rates will reduce infestation and subsequent production of *E. loftini* adults, lessening the impact of bioenergy crops in conventional cropping systems.

Assessment of sorghum yield losses associated with *E. loftini* was may have been partially impacted by outbreaks of the sugarcane aphid, *Melanaphis sacchari* (Zehntner) (Hemiptera: Aphididae), which occurred during both years of the study (Brewer 2013). *Melanaphis sacchari* has been reported as a pest of grain sorghum in Asia and Africa (Blackman and Eastop 2000) and sugarcane in Florida and Louisiana (Mead 1979, White et al. 2001); however, severe infestations on grain sorghum had not been reported in the United States prior to 2013 (Villanueva et al. 2014). Infestations of *M. sacchari* on high-biomass and sweet sorghum cultivars have been reported by VanWeelden et al. (VanWeelden et al. 2015), and likely had a negative impact on ethanol productivity in all cultivars. In both years of the this study, *M. sacchari* infestations were observed in early summer through the time of harvest, and although multiple applications of flonicamid (Carbine 50 WG, FMC Corporation, Philadelphia, Pennsylvania) reduced infestations for a short period, plants exhibited signs of aphid feeding throughout the growing seasons. Rates of N fertilizer have been directly related to aphid abundance, as exhibited with greenbug, *Schizaphis graminum* (Rondani), on grain sorghum (Archer et al. 1982); however, further studies will need to be conducted to determine whether this trend applies to *M. sacchari* on bioenergy sorghum.

Current N fertilization recommendations for sweet sorghum by the Louisiana State Agricultural Center range from 45 to 90 kg/ha (Viator et al. 2010); however, estimates as high as 90 to 110 kg/ha have been recommended for optimal use in production of bioenergy crops (Erickson et al. 2012). Additional costs of increasing N applications from 90 kg/ha to the maximum rate examined in the study (135 kg/ha) would average $55/ha (Deliberto et al. 2015), which would allow for greater ethanol yields from lignocellusic biomass but little or no

additional yields from sucrose. Results from this study suggest N recommendations of 45 to 90 kg/ha would allow for a balance of higher yields and lower *E. loftini* injury and moth production, which in turn, would increase the compatibility of bioenergy crops in conventional cropping systems in the Gulf Coast region by reducing area-wide impacts on *E. loftini*.

CHAPTER 6: INTEGRATING HOST PLANT RESISTANCE AND BIOLOGICAL CONTROL TO REDUCE MEXICAN RICE BORER (LEPIDOPTERA: CRAMBIDAE) INFESTATIONS IN GULF COAST AGROECOSYSTEMS

6.1. Introduction

The Mexican rice borer, *Eoreuma loftini* (Dyar) (Lepidoptera: Crambidae), has been a serious pest of sugarcane, *Saccharum* spp., rice, *Oryza sativa* L., corn, *Zea mays* L., and sorghum, *Sorghum bicolor* (L.) Moench, in the Gulf Coast region since the insect was first observed in the Lower Rio Grande Valley in 1980 (Van Zwaluwenburg 1926; Johnson and van Leerdam 1981; Johnson 1984; Showler et al. 2012). In addition to feeding on conventional graminaceous crops, *E. loftini* is also a potential threat to graminaceous bioenergy feedstocks by its ability to reduce ethanol yields (VanWeelden et al. 2015). Because of the cryptic nature of *E. loftini* larvae, insecticide applications were found to be ineffective and uneconomical, and as a result, their use in Texas sugarcane was abandoned (Meagher et al. 1994). Using resistant sugarcane cultivars has demonstrated success in reducing *E. loftini* injury and adult production (Meagher et al. 1996; Reay-Jones et al. 2003, 2005; Wilson et al. 2015a), and has shown compatibility with other pest management tactics including irrigation (Reay-Jones et al. 2005). However, integration of host plant resistance with other lower input management strategies, such as conservation biological control of a highly abundant species, could further reduce infestations of this invasive pest. Addressing the need for additional management strategies would provide growers with more options in reducing pest infestations, especially as the range of *E. loftini* continues to expand through rice and sugarcane production regions in Louisiana (Wilson et al. 2015b), which is expected to cause heavy economic losses (Reay-Jones et al. 2008).

Attempts to utilize biological control to manage *E. loftini* populations have had little success, in contrast to other stem borers, such as the sugarcane borer, *Diatraea saccharalis* (F.) (Lepidoptera: Crambidae) (Meagher et al. 1998). The parasitic wasp, *Cotesia flavipes* (Cameron) (Hymenoptera: Braconidae), has been attributed to controlling *D. saccharalis* populations in the Lower Rio Grande Valley of Texas, but has been ineffective for control of *E. loftini* (Meagher et al. 1998), mainly due to the stem borer's behavior of packing frass into its tunnels (Smith et al. 1993). Unsuccessful attempts at selecting and establishing parasitoids for control of *E. loftini* emphasize the need for additional research on alternate biological control agents. In addition to suppression by parasitic species, generalist predators such as the red imported fire ant, *Solenopsis invicta* Buren (Hymenoptera: Formicidae), have exhibited successful control of *D. saccharalis* (Long et al. 1958; Hensley et al. 1961; Charpentier et al. 1967; Negm and Hensley 1967; Reagan et al. 1972); however, little is known regarding the impact of *S. invicta* on *E. loftini*. An advantage of using *S. invicta* as a biological control agent is that the insect is already present in the southern United States (Wilson 1951, 1994), which encompasses all major sugarcane production areas in the contiguous United States, and would not require extensive introduction and establishment as required with parasitoids. If utilization of resistant cultivars along with conservation of the ever-present *S. invicta* as a biological control agent, can be achieved to reduce *E. loftini* infestations, more effective and economical means of management tactics can be implemented throughout the growing season to further protect crops. The first objective of this study was to assess the integration of resistant cultivars and conservation of *S. invicta* as a natural enemy to reduce *E. loftini* infestations in mixed cropping systems

consisting of conventional and bioenergy sugarcane and sorghum cultivars. The second objective was to assess the effectiveness of *S. invicta* in reducing infestations of *E. loftini* in weedy, non-crop habitats adjacent to commercial rice fields.

6.2. Materials and Methods

6.2.1. Host Plant Resistance and Predation Experiment

A 2-yr field experiment was conducted in 2012 and 2013 at the Texas A&M AgriLife Research and Extension Center in Beaumont, Texas (Jefferson County) to determine the impacts of host plant resistance and biological control by *S. invicta* in reducing infestations of *E. loftini* in a mixed cropping system consisting of sugarcane, energycane, high-biomass sorghum, and sweet sorghum. Seven cultivars were selected for the experiment; two energycane cultivars, L 79-1002 and Ho 02-113, two conventional sugarcane cultivars, HoCP 04-838 (*E. loftini*-susceptible standard) and HoCP 85-845 (*E. loftini*-resistant standard) (LSU AgCenter 2012), two high-biomass sorghum cultivars, ES 5200 and ES 5140 (Blade Energy Crops, Thousand Oaks, California), and one sweet sorghum cultivar, M81E (MAFES Foundation Seed Stocks, Mississippi State, Mississippi). Energycane cultivars L 79-1002 and Ho 02-113 were released by the Louisiana State University Agricultural Center and USDA-ARS Sugarcane Research Unit, respectively, as dedicated feedstocks for production of ethanol (Bischoff et al. 2008, Hale et al. 2012). High-biomass sorghum cultivars ES 5200 and ES 5140 are *Sorghum* spp. and *Sorghum* spp. × *drummondii* (sudangrass) hybrids, respectively, bred for production of ethanol from cellulosic biomass (Blade Energy Crops 2012). Sweet sorghum cultivar M81E was released by the USDA-ARS for production of fermentable sugar (Broadhead et al. 1981) yet has potential for production of ethanol (Tew et al. 2008; Erickson et al. 2012, VanWeelden et al. 2015).

The experiment was arranged using a randomized complete block design with three blocks (replications). Blocks were divided among two adjacent experimental fields. Two blocks were 43.8 m long and 33.6 m wide (21 rows) (field 1), while the third block was 36 m long and 8 m wide (field 2). Blocks in fields 1 and 2 were divided into two main plots measuring 21.9 m long and 33.6 m wide (21 rows), and 18 m long and 8 m wide (five rows), respectively. *Solenopsis invicta* treatments (unsuppressed and suppressed) were assigned to plots, and the suppression treatment was established using biweekly applications of an insecticide granule bait containing hydramethylnon and S-methoprene (Extinguish Plus®, Wellmark International, Shaumburg, Illinois). Plots in fields 1 and 2 were divided into subplots measuring 21.9 m long and 4.8 m wide (three rows), and 3.6 m long and 1.6 m wide (one row), respectively. Cultivars were randomized to subplots. Sugarcane and energycane cultivars were planted as whole stalks on 26 Oct 2011 and 2 Nov 2011 at a density of 2 stalks per 2 m row and were ratooned in 2013. Sorghum cultivars were planted on 20 Apr 2012 and 13 May 2013 using a hand planter (Precision Garden Seeder, Earthway, Bristol, Indiana) calibrated to deliver 210,000 seeds per hectare (Blade Energy Crops 2012).

Pitfall trapping was used to monitor *S. invicta* populations throughout the growing season by placing one trap into the center of each subplot. Traps were constructed from glass Mason jars (Ball Corporation, Broomfield, Colorado) filled with 350 mL of ethylene-glycol and 5 mL of dish soap (Soft Soap, Colgate-Palmolive, New York City, New York). Jars were imbedded into the soil and covered with metal sheets 3 cm above the trap to prevent overflow from rainwater. The contents of each trap were collected biweekly and returned to the lab, and samples of *S. invicta* were identified and counted to determine population densities within each plot. Fields were harvested on 15 October in 2012 and 27 November in 2013 to record injury attributed to *E.*

loftini feeding. At harvest, 12 stalks were randomly collected from each subplot, stripped of leaf material, and the numbers of internodes, *E. loftini* bored internodes, and *E. loftini* adult emergence holes were recorded from each sample. *Eoreuma loftini* injury was represented as a percentage of bored internodes (no. bored internodes / no. total internodes). Relative survival of *E. loftini* from stalk entry to adulthood was calculated using the equation from Bessin et al. (1990):

Relative survival = no. adult emergence holes / no. bored internodes

6.2.2. *Eoreuma loftini* Predation in Non-Crop Habitats

A 2-yr field experiment was conducted in 2011 and 2012 to assess the effectiveness of *S. invicta* as a biological control agent of *E. loftini* in uncultivated field margins and to determine if conservation of *S. invicta* is useful in reducing pest populations that could infest nearby crops. The experiment was conducted at two commercial rice farms in Jefferson County (30.059° N, 94.279° W) and Chambers County (29.027° N, 94.544° W), Texas. At each farm, sampling for *E. loftini* was conducted within uncultivated field margins adjacent to actively producing rice fields. Three margins per field were selected based on the predominance of the perennial grass, johnsongrass (*Sorghum halepense* (L.) Pers.), which is a known non-crop host of *E. loftini* and is capable of harboring borers throughout the year (Osborn & Phillips 1946; Johnson 1984; Beuzelin et al. 2011). Within each margin, a 44 m long transect was flagged off and then divided into two, 22 m plots. *Solenopsis invicta* population levels (unsuppressed and suppressed) were randomized to plots, with *S. invicta* suppressed plots being established using biweekly applications of an insecticide granule bait containing hydramethylnon and S-methoprene. *Solenopsis invicta* populations were monitored from May to November using two pitfall traps per plot, which were placed 8 m from the right or left extremity of each plot, totaling four pitfall

traps per transect. *Eoreuma loftini* infestations were surveyed on 24 August and November 17 in 2011 and September 17 and December 3 in 2012 using quadrat sampling. On each date, a single 1 m^2 quadrat was randomly selected in each plot and all johnsongrass tillers were cut, bagged, and returned to the lab and the numbers of *S. halepense* tillers and *E. loftini* entry holes were recorded from each sample. Percentage of injured tillers per sample was calculated by the number of *E. loftini* entry holes / number of tillers.

6.2.3. Data Analyses

Data from both years of the host plant resistance and predation experiment were analyzed together. *Eoreuma loftini* injury data (percentage of bored internodes, number of adult emergence holes per stalk, percent relative survival) were analyzed using a two-way analysis of variance (ANOVA) (PROC GLIMMIX, SAS Institute 2008) with *S. invicta* treatment, cultivar, and the two-way interaction as fixed effects. Random effects were year, block (year), and cultivar × block (year). The Kenward-Roger method was used for calculation of error degrees of freedom. In addition, injury data were analyzed using a one-way analysis of covariance (ANCOVA) (PROC MIXED, SAS Institute 2008) with weekly *S. invicta* trap catch (continuous variable) and cultivar (categorical variable) as fixed effects. A homogenous covariable model, which excluded the weekly *S. invicta* trap catch × cultivar interaction term, was used because the preliminary ANCOVA model including the interaction term and using a “Type I” test of fixed effects did not detect the need to estimate a regression coefficient for each cultivar. Mean pairwise comparisons were conducted using an LSMEANS statement (SAS Institute 2008) and means were separated using Tukey’s honest significant difference (HSD) test ($\alpha = 0.05$).

Data collected from the non-crop habitat experiment (weekly *S. invicta* trap catch, tiller density, injury per quadrat, injury per tiller) were analyzed using a one-way ANOVA (PROC GLIMMIX, SAS Institute 2008) with *S. invicta* treatment as a fixed effect. Random effects included year, farm, year × farm, transect (year × farm), *S. invicta* treatment × transect (year × farm), and date × *S. invicta* treatment × transect (year × farm). The Kenward-Roger method was used for calculation of error degrees of freedom. In addition, a simple linear regression was conducted using PROC REG (SAS Institute 2008) to determine the relationship between weekly *S. invicta* trap catch (x) and *E. loftini* injury per quadrat (y).

6.3. Results

6.3.1. Host Plant Resistance and Predation Experiment

Pitfall trapping revealed that *S. invicta* was present both years and represented the dominant natural enemy with > 80% of trap catches. In addition, biweekly infestation counts indicated that ≥ 95% of stem borers detected were *E. loftini*, with *D. saccharalis* representing remaining infestations. Insecticide baits successfully reduced *S. invicta* populations 3.4-fold; however, trap catches only reached 40.6 (± 3.3) ants per week in unsuppressed plots (Table 6.1). While the percentage of bored internodes was not impacted by *S. invicta* suppression, *E. loftini* adult emergence per stalk increased 1.6-fold when *S. invicta* populations were suppressed (Table 6.1).

Results from the ANCOVA demonstrated a relationship between cultivar (independent variable) and the percentage of bored internodes; however, weekly *S. invicta* trap catch (covariate) was not correlated to injury (Table 6.2). Injury was highest in high-biomass sorghum cultivars ES 5200 and ES 5140 and lowest in energycane cultivar Ho 02-113 and *E. loftini*-resistant sugarcane cultivar HoCP 85-845 (Table 6.2). Differences in *E. loftini* adult emergence

Table 6.1. Comparison of *E. loftini* injury, adult emergence, and relative survival under unsuppressed and suppressed populations of *S. invicta* in cultivars of sugarcane, energycane, high-biomass sorghum, and sweet sorghum, Beaumont, Texas, 2011–2012.

Parameter	*S. invicta* Trap Catch per Week	Percentage of Bored Internodes	Adult Emergence per Stalk	Percent Relative Survival
S. invicta Treatment	*F* = 38.19 df = 1, 10.2 *P*<.0001	*F* = 1.94 df = 1, 64 *P* = 0.1690	*F* = 6.21 df = 1, 64 *P* = 0.0153	*F* = 0.48 df = 1, 65 *P* = 0.4890
Cultivar	*F* = 0.64 df = 6, 59.4 *P* = 0.6956	*F* = 5.91 df = 6, 64 *P*<.0001	*F* = 10.48 df = 6, 64 *P*<.0001	*F* = 5.12 df = 6, 65 *P* = 0.0002
S. invicta Treatment × Cultivar	*F* = 0.64 df = 6, 59.4 *P* = 0.7011	*F* = 0.48 df = 6, 64 *P* = 0.8181	*F* = 0.65 df = 6, 64 *P* = 0.6887	*F* = 0.29 df = 6, 65 *P* = 0.9383

holes per stalk were detected among cultivars (Table 6.2). Emergence per stalk was greatest in ES 5200 and *E. loftini*-susceptible sugarcane cultivar HoCP 04-838, with a 3-fold increase in emergence per stalk present in HoCP 04-838 compared to HoCP 85-845. In contrast to the analysis of variance, the number of adult emergence holes was not dependent on *S. invicta* trap catch. Differences in *E. loftini* percent relative survival were detected among cultivars, and a negative relationship between *E. loftini* relative survival and *S. invicta* trap catch was detected (Table 6.2, Fig. 6.1). In the absence of *S. invicta*, *E. loftini* percent relative survival ranged from 13.3% in Ho 02-113 to 41.8% in HoCP 04-838. Both energycane cultivars expressed lower levels of *E. loftini* relative survival, while survival increased at least 2.6-fold in conventional sugarcane cultivars. Among high-biomass sorghum cultivars, *E. loftini* relative survival in the absence of predation ranged from 20.4% in ES 5140 to 31.9% in ES 5200. In the presence of *S. invicta*, relative survival ranged from 9.5 to 38.0% in Ho 02-113 and HoCP 04-838, respectively (Table 6.2). Analysis of covariance estimated that a unit increase in *S. invicta* trap catch corresponded to a decrease of 0.1 in the percent relative survival of *E. loftini*, which in turn

Table 6.2. *Eoreuma loftini* injury and survival in sugarcane, energycane, high-biomass sorghum, and sweet sorghum as impacted by cultivar and *S. invicta* trap catch per week, Jefferson County, Texas, 2012 and 2013.

Crop Type	Cultivar	Percentage of Bored Internodes (± SE)	No. Adult Emergence Holes / Stalk (± SE)	Percent Relative Survival (± SE)
Sugarcane	HoCP 04-838	11.7 (± 1.8)	0.72 (± 0.10)	38.0 (± 4.4)
	HoCP 85-845	5.2 (± 1.8)	0.24 (± 0.10)	31.0 (± 4.3)
Energycane	L 79-1002	6.7 (± 1.8)	0.10 (± 0.10)	11.0 (± 4.4)
	Ho 02-113	5.6 (± 1.8)	0.09 (± 0.10)	9.5 (± 4.4)
High-biomass Sorghum	ES 5200	14.5 (± 1.9)	0.80 (± 0.10)	28.0 (± 4.6)
	ES 5140	12.1 (± 2.0)	0.36 (± 0.10)	16.6 (± 4.8)
Sweet Sorghum	M81E	11.5 (± 2.0)	0.33 (± 0.10)	18.7 (± 4.8)
Type III Test of Fixed Effects	Cultivar	F = 3.94 df = 6, 71 P = 0.0018	F = 7.69 df = 6, 71 P<0.0001	F = 5.97 df = 6, 71 P<0.0001
	S. invicta Trap Catch	F = 0.03 df = 1, 71 P = 0.8812	F = 2.29 df = 1, 71 P = 0.1346	F = 4.06 df = 1, 71 P = 0.0478

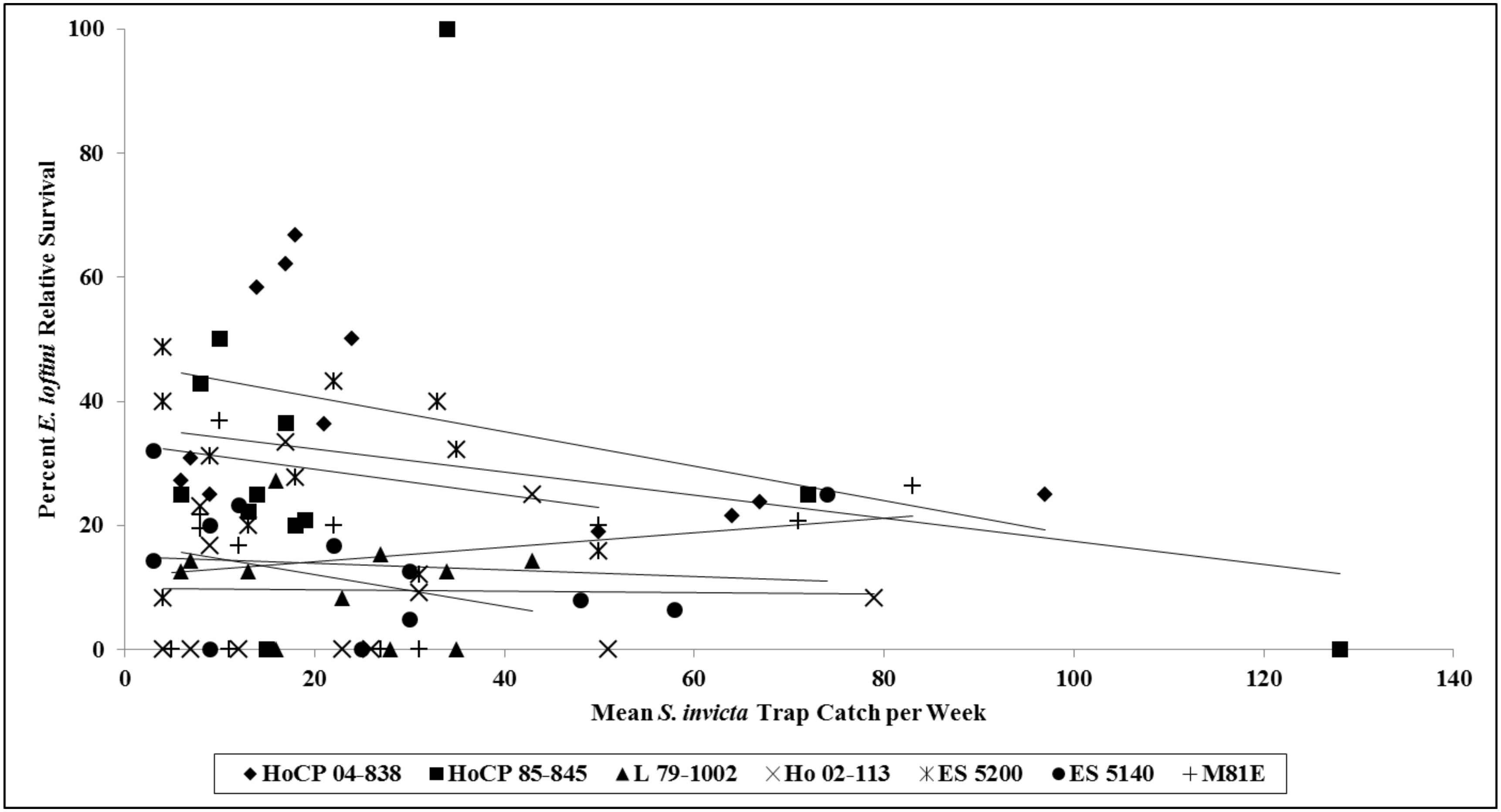

Fig. 6.1. Relationship between weekly *S. invicta* pitfall trap catch and percent *E. loftini* relative survival by cultivar, Beaumont, Texas, 2012–2013.

would equate to a percent decrease in relative survival as low as 0.3% in HoCP 04-838 and as high as 1.1% in Ho 02-113 per unit increase in *S. invicta* trap catch. For sorghum cultivars, a unit increase in *S. invicta* trap catch would decrease relative survival by 0.45, 0.70, and 0.63% in ES 5200, ES 5140, and M81E, respectively (Fig. 6.1).

6.3.2. *Eoreuma loftini* Predation in Non-Crop Habitats

Transects adjacent to rice farms represented non-crop habitats consisting primarily of *S. halepense*, a year-around host of *E. loftini* (Beuzelin et al. 2011). Other non-crop hosts present in lower densities within each transect included vaseygrass (*Paspalum urvillei* Steud.) and

Table 6.3. Comparison of *E. loftini* injury under unsuppressed and suppressed populations of *S. invicta* within *S. halepense* transects adjacent to rice fields, Jefferson and Chambers Counties, Texas, 2011 and 2012.

S. invicta Treatment	*S. invicta* Trap Catch / Week (± SE)	Tillers per m^2 (± SE)	Total Injury (± SE)	Injury per Tiller (± SE)
Unsuppressed	46.5 (± 19.8)	53.2 (± 4.1)	4.6 (± 1.4)	0.09 (± 0.03)
Suppressed	57.0 (± 19.8)	55.4 (± 4.0)	7.2 (± 1.4)	0.14 (± 0.03)
Type III Test of Fixed Effects	$F = 0.34$ df = 1, 20 $P = 0.5673$	$F = 0.20$ df = 1, 34.1 $P = 0.6565$	$F = 2.67$ df = 1, 92 $P = 0.1054$	$F = 1.87$ df = 1, 45.3 $P = 0.1786$

barnyardgrass (*Echinochloa* spp. (L.) Beauvois), which are confirmed non-crop hosts of *E. loftini* (Beuzelin et al. 2011). Insecticidal baits were unable to suppress *S. invicta* populations, as demonstrated by the lack of difference between unsuppressed and suppressed plots (Table 6.3). The number of tillers collected per sample did not differ between *S. invicta* suppressed and unsuppressed subplots, indicating equal availability of plant material for harboring *E. loftini* among treatments. Despite up to a 1.6-fold numerical decrease in *E. loftini* injury to *S. halepense* when populations of *S. invicta* were unsuppressed, differences in injury could not be detected

(Table 6.3). Consistent with results from the analysis of variance, *E. loftini* injury per quadrat was not dependent on *S. invicta* trap catch (F = 0.01; df = 1, 94; P = 0.9139; R^2 = 0.0001) (Fig. 6.2), further demonstrating the lack of evidence in the ability of *S. invicta* in reducing *E. loftini* infestations in non-crop habitats consisting of johnsongrass.

6.4. Discussion

Results from this study demonstrate the effectiveness of utilizing a combination of host plant resistance and biological control to reduce *E. loftini* infestations in cropping systems consisting of conventional and bioenergy cultivars of sugarcane and sorghum. Of the cultivars assessed in this study, energycane cultivars generally expressed the lowest levels of *E. loftini* preference (percent bored internodes) and suitability (number of adult emergence holes per stalk) when compared to sugarcane, high-biomass sorghum, and sweet sorghum cultivars. In addition, survival of initial infesting borers (relative survival) was also low, indicating that these cultivars serve as good candidates for large-scale production due to their resistance and ability to reduce moth production, thus limiting the risk of negative area-wide impacts from *E. loftini* infestations.

Relative survival can be a useful tool in measuring the proportion of individuals infesting sugarcane that reach adulthood, which in turn, has the ability to infest other crops (Bessin et al. 1990). Previous studies have compared various *E. loftini* injury parameters, including percentage of bored internodes, adult emergence per stalk, and relative survival, on conventional and bioenergy cultivars of sugarcane and sorghum (VanWeelden et al. 2015, Wilson et al. 2015b) and have determined that energycane cultivars generally have lower host preference and suitability when compared to conventional sugarcane cultivars. One mechanism that may reduce suitability could be smaller stalk diameter, which averages 1.40 cm in L 79-1002 (Bischoff et al. 2008) and 1.48 cm in Ho 02-113 (Hale et al. 2012), when compared to other cultivars examined

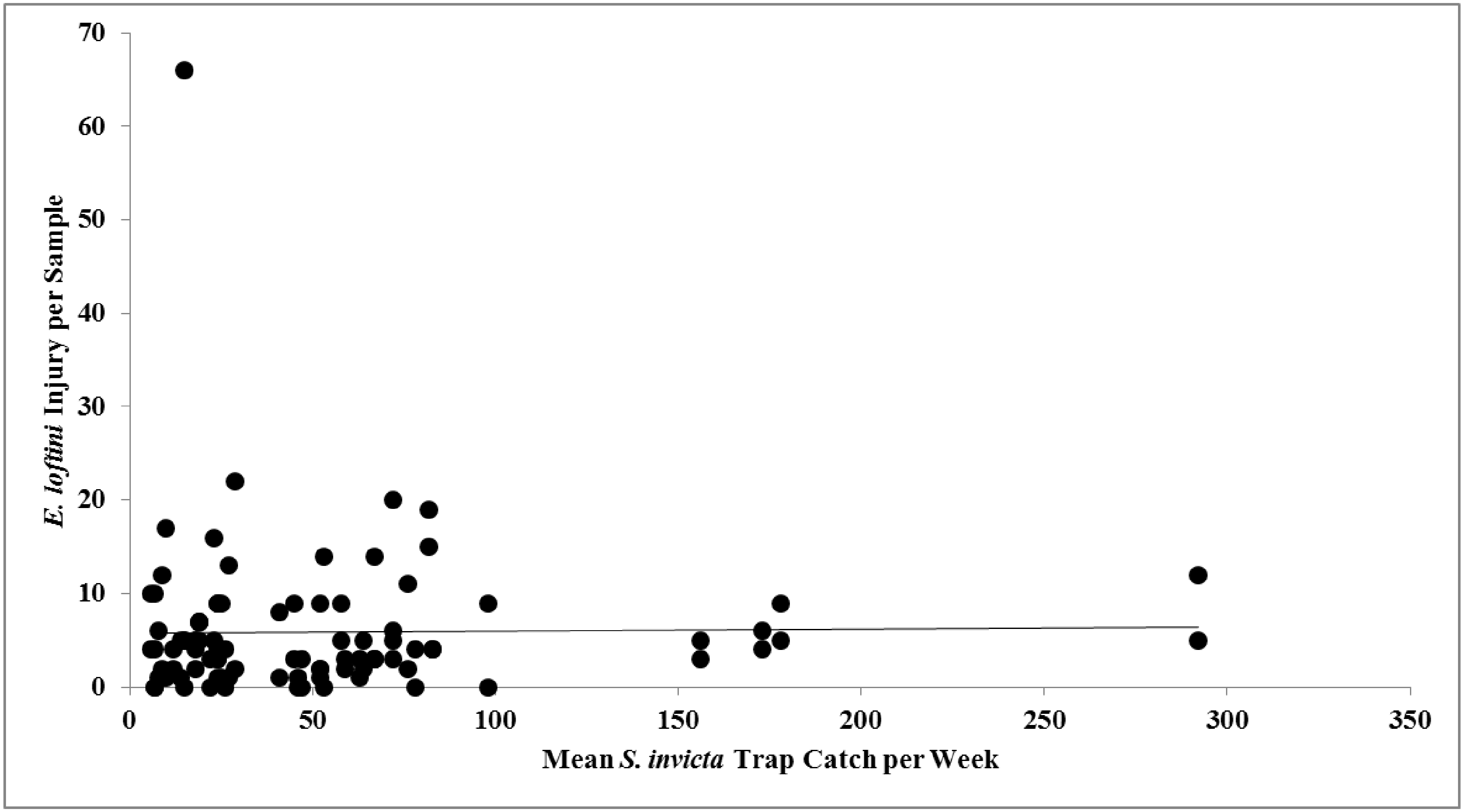

Fig. 6.2. Relationship between weekly *S. invicta* pitfall trap catch and *E. loftini* injury per 1 m^2 quadrat of *S. halpense*, Jefferson and Chambers Counties, Texas, 2011–2012.

in this study. Although plants with stalk diameters < 0.7 cm can act as suitable hosts of *E. loftini* (Showler et al. 2011; Beuzelin et al. 2013), it is possible that planting these cultivars in close proximity to cultivars with thicker stalks could have further decreased the susceptibility of the thin-stalked cultivars. Higher fiber content present in L 79-1002 and Ho 02-113 compared to other sugarcane cultivars could also act as a mechanism for reduced suitability (Bischoff et al. 2008; Tew and Cobill 2008). Breeding feedstocks for production of biofuels requires greater levels of stem fiber and lignin, and have shown negative effects on larval feeding and development of the African stem borer, *Eldana saccharina* Walker (Lepidoptera: Pyralidae), in sugarcane (Rutherford et al. 1993). Greater fiber may also increase rind hardness, which can impact the larval ability to enter the stalk (Martin et al. 1975; Ring et al. 1991).

While natural enemies, such as *S. invicta*, have been documented to have significant impacts on arthropod pests in sugarcane (Long et al. 1958; Hensley et al. 1961; Charpentier et al. 1967; Negm and Hensley 1967; Reagan et al. 1972; Reagan 1986; Showler and Reagan 1987; Bessin and Reagan 1993; Beuzelin et al. 2009), the impact of predaceous natural enemies on *E. loftini* infestations has not been examined. Since initial detection of *E. loftini* into the Lower Rio Grande Valley of Texas in 1980 (Johnson 1981), biological control programs have been assessed, including a classical biological control program which was implemented to collect parasitoids present in the native range of *E. loftini* (Agnew et al. 1988); however, minimal establishment of parasitoids into introduced areas was reported (Meagher et al. 1992), putting an end to further efforts. Of the non-indigenous parasitoids released, only *Allorhogas pyralophagus* Marsh (Hymenoptera: Braconidae) and *Alabagrus stigma* Brullé (Hymenoptera: Braconidae) became established in the Lower Rio Grande Valley, but populations were below densities needed for effective control of *E. loftini* (Meagher et al. 1998). The use of generalist natural

enemies, such as *S. invicta*, can be more effective in mitigating *E. loftini* infestations for two reasons; (1) they are already present in the environment and do not require extensive introduction efforts, and (2) natural enemies such as *S. invicta* are able to decrease infestations of other related insects due to their polyphagous nature, allowing for a wider range of management applications. Since first detection of *S. invicta* in the United States in 1942 (Wilson 1951, 1994), this invasive insect has spread throughout the country, with its range now encompassing all sugarcane production regions in the contiguous United States. Conserving *S. invicta* populations within cropping systems can reduce pest populations without any direct input from the grower. In addition, the generalist predatory behavior of *S. invicta* will allow for suppression of other insect pests in sugarcane and sorghum, without having to rely on multiple, specialist parasitic species.

Although there is potential in utilizing *S. invicta* as a biological control agent to reduce *E. loftini* infestations in cropping systems, results from this study showed that the effectiveness of *S. invicta* was reduced or even non-present in weedy habitats consisting of non-crop hosts of *E. loftini*. Selection of weedy transects was based on the prevalence of *S. halepense*, a perennial weed host of *E. loftini* (Osborn & Phillips 1946; Johnson 1984; Beuzelin et al. 2011), but transects also consisted of other graminoids including *P. urvillei* and *Echinochloa* spp., all of which are confirmed hosts of *E. loftini* (Beuzelin et al. 2011). Factors that may have led to the lack of any detectable impact on *E. loftini* by *S. invicta* include lower population densities of *S. invicta*, a greater abundance of alternative food sources, and the failure to suppress *S. invicta*. Ali et al. (1984) compared predation efficacy of *S. invicta* among weedy and non-weedy sugarcane habitats, and concluded that *S. invicta* prey capture was lower in weedy habitats due to predator satiation. In addition, Ali and Reagan (1985) concluded that while *S. invicta* was more abundant in weedy sugarcane habitats, foraging was greater in weed-free habitats. *Sorghum halepense* and

E. loftini densities did not differ between unsuppressed and suppressed subplots, indicating uniformity among subplots. Because differences were not detected in injury between *S. invicta* suppression levels, and densities of *S. halepense* and *E. loftini* did not differ, it is presumed in this study that *S. invicta* is not as effective of a biological control agent in non-crop habitats consisting of johnsongrass.

Benefits from reduced infestations of *E. loftini* through the use of resistant cultivars and natural enemies can have positive impacts on yields. VanWeelden et al. (2015) reported yield losses attributed to *E. loftini* feeding of 0.01% w/w for sucrose concentration and 133.8 liters of ethanol per hectare for predicted ethanol yields per unit increase in the percentage of bored internodes. Based on results from this study, replacing *E. loftini*-susceptible cultivar HoCP 04-838 with *E. loftini*-resistant sugarcane cultivar HoCP 85-845 can mitigate reductions to sucrose yields by up to 0.07% w/w and ethanol yields by up to 869.7 L/ha.

Integrating host plant resistance and conservation of natural enemies has the potential to reduce baseline *E. loftini* infestations prior to initiation of other management practices during the growing season. While not an effective biological control agent in non-crop habitats, *S. invicta* has exhibits potential in reducing survival of *E. loftini* in a cropping system consisting of conventional and bioenergy cultivars of sugarcane and sorghum. Synchronization of resistant cultivars and conservation of *S. invicta* to mitigate infestations of *E. loftini* provides an additional, environmentally friendly option for management of this invasive pest in the Gulf Coast region.

CHAPTER 7: SUMMARY

The Mexican rice borer, *Eoreuma loftini* (Dyar) (Lepidoptera: Crambidae) is a serious pest of sugarcane, *Saccharum* spp., rice, *Oriza sativa* L., corn, *Zea mays* L., and sorghum, *Sorghum bicolor* (L.) Moench (Van Zwaluwenberg 1926, Johnson 1984, and Showler et al. 2012). *Eoreuma loftini* was first detected in the Lower Rio Grande Valley in 1980 (Johnson and van Leerdam 1981), where it continued to expand its range north and eastward through the Texas rice belt at a rate of 23km/yr (Reay-Jones et al. 2008). In 2008, initial detection of *E. loftini* in Louisiana occurred in a pheromone trap in Calcasieu Parish (Hummel et al. 2010), and by 2013, infestations of the stem borer were observed in rice and sugarcane (Wilson et al. 2015a). Once established throughout the state, monetary losses from *E. loftini* infestations in sugarcane are expected to reach $220 million per year (Reay-Jones et al. 2008). With the passing of the Energy Independence and Security Act in the United States in 2007, increases in the acreage of dedicated bioenergy crops will be required to reach the demand for minimum levels of renewable fuel (U. S. Environmental Protection Agency 2007). Because many bioenergy crops are closely related to host plants of *E. loftini*, research is needed to determine the impact of this pest on bioenergy crops. The susceptibility of select bioenergy crop cultivars to *E. loftini* injury and the efficacy of management practices in reducing infestations were examined.

A field experiment was conducted to assess the susceptibility of sugarcane, energycane, *Saccharum* spp., high-biomass sorghum, *Sorghum* spp., and sweet sorghum, *Sorghum* spp., cultivars to *E. loftini* infestations, and to measure subsequent yield losses from *E. loftini* injury. Seven cultivars were subjected to four natural and artificially established *E. loftini* infestations levels. Energycane and sweet sorghum exhibited reduced *E. loftini* injury; however, these crops, along with high-biomass sorghum, sustained greater losses in fresh stalk weight. Negative

impacts to sucrose concentration from *E. loftini* injury were greatest in energycane, high-biomass sorghum, and sweet sorghum cultivars. Even under heavy *E. loftini* infestations, energycane and high-biomass sorghum were estimated to produce more ethanol than all other cultivars under suppressed infestations. This study demonstrated that energycane and high-biomass sorghum hold the greatest potential as dedicated bioenergy crops for production of ethanol in the Gulf Coast region, but that *E. loftini* management practices should be continued to mitigate yield losses.

To further analyze the susceptibility crop cultivars to *E. loftini*, two greenhouse experiments were conducted to measure oviposition preference and survival of *E. loftini* on cultivars of bioenergy and conventional sugarcane and sorghum represented at two phenological stages of development. Oviposition preference was measured by releasing gravid female moths into cages containing each cultivar, and recording the numbers of eggs and oviposition events. Survival of *E. loftini* was measured by pinning viable eggs to the leaf sheaths of each plant, and recording survival and mortality at each insect development stage. Mature plants possessed greater availability of dry leaf material compared to immature plants, and all *E. loftini* eggs were observed exclusively on dry leaf material. Oviposition did not vary among host combinations based on cultivar and crop phenological stage; however eggs per plant and eggs per oviposition event were greater on mature plants than immature plants. On a crop type basis, sweet sorghum was preferred over sugarcane and high-biomass sorghum when measuring eggs per plant. The number of eggs per oviposition event was also greater on sweet sorghum than on sugarcane. In the survival experiment, survival from egg to adult did not vary among host combinations, with $<2.0\%$ of *E. loftini* larvae surviving to adulthood. Neonates failing to establish on plants was 13.4-to 53.4-fold greater than successful establishment. The mortality-survival ratio during the

neonatal stage was greater in immature sugarcane cultivar HoCP 85-845 and high biomass cultivar ES 5200 relative to each cultivar's mature stage; however remained constant among other host combinations. Results from this study suggest that plant physical characteristics could play a more important in host selection, but further evaluations will be needed to quantify other characteristics that play a part in host suitability.

To examine the compatibility of current recommended fertilization regimes, a field experiment was conducted to assess the impact of nitrogen (N) fertilization on *E. loftini* injury and subsequent yield loss in high-biomass and sweet sorghum cultivars. Two cultivars of high-biomass sorghum and one cultivar of sweet sorghum were subject to four fertilization regimes ranging from 0 to 135 kg N/ha, and injury and yield were recorded at the end of the season. The percentage of bored internodes increased with higher N rates. Yields indicated that N rate was positively associated with increases in stalk weight and ethanol productivity, but not sucrose concentration. Because higher N rates were associated with increased yields despite having greater levels of *E. loftini* injury, our data suggests that increases in yield from additional N outweigh decreases from additional *E. loftini* injury. Results from this study revealed that fertilization rates maintained between the recommended rate of 45 and 90 kg N/ha minimize risks of negative area-wide impacts from increased production of *E. loftini* adults, while still allowing for optimum yields.

To address the lack of data addressing *Solenopsis invicta* Buren as a biological control agent of *E. loftini*, a field experiment was conducted to measure the impact of *S. invicta* in reducing populations of *E. loftini* in conventional and bioenergy sugarcane and sorghum cultivars. Populations of *S. invicta* were estimated using pitfall trapping, and data were regressed against *E. loftini* injury and adult emergence data collected from cultivars with varying levels of

resistance to *E. loftini*. Resistant cultivars reduced percent relative survival of *E. loftini* by up to 4-fold in sugarcane and 1.7-fold in sorghum. Populations of *S. invicta* further percent reduced relative survival of *E. loftini* by 0.1% per increase unit increase of *S. invicta*; however, reductions in the percentage of bored internodes and adult emergence holes due to the presence *S. invicta* were not detected. An additional field experiment assessed the efficacy of *S. invicta* in reducing *E. loftini* injury in non-crop hosts. Reductions in *E. loftini* injury and densities from *S. invicta* were not detected in transects of johnsongrass (*Sorghum halepense* (L.) Persoon), indicating that current management of non-crop hosts should be continued to reduce infestations in adjacent crops. Results from these experiments suggest that a combination of resistant cultivars and conservation of *S. invicta* has the potential to reduce baseline infestations of *E. loftini*, reducing additional inputs needed to mitigate infestations throughout the growing season.

This research project showed that select cultivars of bioenergy sugarcane and sorghum are more resistant than their conventional counterparts, and incorporating them into a conventional crop agroecosystem such as Louisiana should not result in any major shifts in area-wide *E. loftini* populations. While these bioenergy cultivars can be more resistant to injury, yields may be impacted more per unit injury, and proper management practices should be continued. Current N fertilization recommendations for sorghum should be maintained for high-biomass and sweet sorghum in order to prevent increases in area-wide populations, and while the impact of *S. invicta* as a biological control agent is not as substantial with *E. loftini* as compared with other stem borers, conservation of these natural enemies will aid in reducing baseline infestations.

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APPENDIX A: LETTER OF PERMISSION FOR CHAPTER 3

Hi Matt,

Thank you for your request. On behalf of the Entomological Society of America, I grant you permission to use the publication listed below as a chapter in your PhD dissertation.

VanWeelden, M. T., B. E. Wilson, J. M. Beuzelin, T. E. Reagan, and M. O. Way. 2015.Yield response to Mexican rice borer (Lepidoptera: Crambidae) injury in bioenergy and conventional sugarcane and sorghum. J. Econ. Entomol. DOI: 10.1093/jee/tov190.

Best regards,
Joshua Lancette
Manager of Publications
Entomological Society of America

APPENDIX B: SAS PROGRAMS FOR CHAPTER 3

“Within-season Injury 2012”

```
ods rtf file="rtf_file.rtf";
data Infestation2012;
input date$ variety$ infestation$ rep$ stalk$ height internodes feedingsigns bored white yellow chinch mealy armyworm larvae;
injury = (feedingsigns / internodes);
cards;
```

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1	1002 0	2 0	I	8	28	7	0	0	0	0	0	0

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2	8380	20	II	8	45	6	0	0	0	0	0	0
2	8380	20	II	9	42	9	0	0	0	0	0	0
2	8380	20	II	10	51	7	0	0	0	0	0	0
2	8450	20	II	1	65	9	0	0	0	0	0	0
2	8450	20	II	2	61	8	0	0	0	0	0	0
2	8450	20	II	3	63	6	0	0	0	0	0	0
2	8450	20	II	4	66	8	0	0	0	0	0	0
2	8450	20	II	5	68	8	0	0	0	0	0	0
2	8450	20	II	6	67	7	0	0	0	0	0	0
2	8450	20	II	7	64	7	1	0	0	0	0	0
2	8450	20	II	8	66	7	0	0	0	0	0	0

2	8450	20	II	9	61	8	0	0	0	0	0	0
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2	1130	20	II	1	53	6	0	0	0	0	0	0
2	1130	20	II	2	90	6	0	0	0	0	0	0
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2	1130	20	II	4	85	8	0	0	0	0	0	0
2	1130	20	II	5	54	5	0	0	0	0	0	0
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2	1130	20	II	7	59	6	0	0	0	0	0	0
2	1130	20	II	8	79	7	1	0	0	0	0	0
2	1130	20	II	9	89	8	0	0	0	0	0	0
2	1130	20	II	10	85	7	2	0	0	0	0	0
2	10020	20	II	1	77	6	2	0	0	0	0	0
2	10020	20	II	2	89	8	0	0	0	0	0	0
2	10020	20	II	3	74	6	0	0	0	0	0	0
2	10020	20	II	4	89	7	2	1	0	0	0	0
2	10020	20	II	5	89	9	1	0	0	0	0	0
2	10020	20	II	6	93	8	3	1	0	0	0	0
2	10020	20	II	7	64	5	0	0	0	0	0	0
2	10020	20	II	8	90	8	0	0	0	0	0	0
2	10020	20	II	9	91	6	2	0	0	0	0	0
2	10020	20	II	10	80	9	0	0	0	0	0	0
2	52000	20	II	1	48	7	0	0	0	0	0	0

2	52000	20	II	2	44	7	0	0	0	0	0	0
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2	52000	20	II	7	42	8	0	0	0	0	0	0
2	52000	20	II	8	42	8	0	0	0	0	0	0
2	52000	20	II	9	43	6	0	0	0	0	0	0
2	52000	20	II	10	52	7	0	0	0	0	0	0
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2	51400	20	II	8	42	6	0	0	0	0	0	0
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2	M81E0	20	II	1	41	6	0	0	0	0	0	0
2	M81E0	20	II	2	32	6	0	0	0	0	0	0
2	M81E0	20	II	3	40	6	0	0	0	0	0	0
2	M81E1	20	II	4	37	7	0	0	0	0	0	0

2	M81E0	20	II	5	37	6	0	0	0	0	0	0
2	M81E0	20	II	6	42	5	0	0	0	0	0	0
2	M81E0	20	II	7	20	6	0	0	0	0	0	0
2	M81E0	20	II	8	44	5	0	0	0	0	0	0
2	M81E0	20	II	9	39	6	0	0	0	0	0	0
2	M81E0	20	II	10	45	6	0	0	0	0	0	0
2	52000	20	III	1	46	8	0	0	0	0	0	0
2	52000	20	III	2	54	8	0	0	0	0	0	0
2	52000	20	III	3	60	7	0	0	0	0	0	0
2	52000	20	III	4	54	8	0	0	0	0	0	0
2	52000	20	III	5	44	9	0	0	0	0	0	0
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2	52000	20	III	7	51	8	0	0	0	0	0	0
2	52000	20	III	8	42	7	0	0	0	0	0	0
2	52001	20	III	9	54	7	0	0	0	0	0	0
2	52000	20	III	10	50	7	0	0	0	0	0	0
2	M81E0	20	III	1	46	5	0	0	0	0	0	0
2	M81E0	20	III	2	57	6	0	0	0	0	0	0
2	M81E0	20	III	3	52	8	0	0	0	0	0	0
2	M81E0	20	III	4	45	9	0	0	0	0	0	0
2	M81E0	20	III	5	47	5	0	0	0	0	0	0
2	M81E2	20	III	6	50	6	0	0	0	0	0	0
2	M81E1	20	III	7	52	7	0	0	0	0	0	0

2	M81E0	20	III	8	36	6	0	0	0	0	0	0
2	M81E0	20	III	9	53	6	0	0	0	0	0	0
2	M81E0	20	III	10	31	5	0	0	0	0	0	0
2	51400	20	III	1	28	8	0	0	0	0	0	0
2	51400	20	III	2	49	8	0	0	0	0	0	0
2	51400	20	III	3	48	10	0	0	0	0	0	0
2	51400	20	III	4	45	7	0	0	0	0	0	0
2	51400	20	III	5	52	7	0	0	0	0	0	0
2	51400	20	III	6	47	6	0	0	0	0	0	0
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2	8450	20	III	3	47	6	0	0	0	0	0	0
2	8450	20	III	4	40	6	0	0	0	0	0	0
2	8450	20	III	5	52	8	0	0	0	0	0	0
2	8450	20	III	6	42	6	0	0	0	0	0	0
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2	8450	20	III	8	75	7	0	0	0	0	0	0
2	8450	20	III	9	57	7	0	0	0	0	0	0
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2	8380	20	III	1	63	8	0	0	0	0	0	0
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2	8380	20	III	3	50	7	0	0	0	0	0	0
2	8380	20	III	4	46	6	0	0	0	0	0	0
2	8380	20	III	5	30	5	0	0	0	0	0	0
2	8380	20	III	6	70	8	0	0	0	0	0	0
2	8380	20	III	7	56	6	0	0	0	0	0	0
2	8380	20	III	8	45	9	0	0	0	0	0	0
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2	1130	20	III	3	82	7	0	0	0	0	0	0
2	1130	20	III	4	77	7	0	0	0	0	0	0
2	1130	20	III	5	79	7	0	0	0	0	0	0
2	1130	20	III	6	77	7	0	0	0	0	0	0
2	1130	20	III	7	78	7	0	0	0	0	0	0
2	1130	20	III	8	68	7	0	0	0	0	0	0
2	1130	20	III	9	81	8	0	0	0	0	0	0
2	1130	20	III	10	97	8	0	0	0	0	0	0
2	10020	20	III	1	64	5	0	0	0	0	0	0
2	10020	20	III	2	56	6	0	0	0	0	0	0
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2	10020	20	III	4	66	7	0	0	0	0	0	0
2	10020	20	III	5	64	6	0	0	0	0	0	0
2	10020	20	III	6	72	7	1	0	0	0	0	0
2	10020	20	III	7	67	8	0	0	0	0	0	0
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2	10020	20	III	9	82	7	0	0	0	0	0	0
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2	1130	20	IV	1	79	7	1	0	0	0	0	0
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2	1130	20	IV	3	97	9	0	0	0	0	0	0
2	1130	20	IV	4	83	7	0	0	0	0	0	0
2	1130	20	IV	5	92	10	0	0	0	0	0	0
2	1130	20	IV	6	96	10	1	0	0	0	0	0
2	1130	20	IV	7	74	6	0	0	0	0	0	0
2	1130	20	IV	8	87	8	0	0	0	0	0	0
2	1130	20	IV	9	81	8	0	0	0	0	0	0
2	1130	20	IV	10	92	7	1	0	0	0	0	0
2	8380	20	IV	1	47	6	0	0	0	0	0	0
2	8380	20	IV	2	47	7	0	0	0	0	0	0
2	8380	20	IV	3	47	9	0	0	0	0	0	0
2	8380	20	IV	4	55	6	0	0	0	0	0	0
2	8380	20	IV	5	42	7	0	0	0	0	0	0
2	8380	20	IV	6	65	7	0	0	0	0	0	0

2	8380	20	IV	7	47	6	0	0	0	0	0	0
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2	8380	20	IV	9	57	9	1	0	0	0	0	0
2	8380	20	IV	10	67	7	0	0	0	0	0	0
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2	10020	20	IV	3	101	7	3	0	0	0	0	0
2	10020	20	IV	4	81	7	0	0	0	0	0	0
2	10020	20	IV	5	81	6	0	0	0	0	0	0
2	10020	20	IV	6	80	6	3	2	0	0	0	0
2	10020	20	IV	7	61	6	0	0	0	0	0	0
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2	10020	20	IV	9	67	7	0	0	0	0	0	0
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2	8450	20	IV	2	45	6	0	0	0	0	0	0
2	8450	20	IV	3	62	10	0	0	0	0	0	0
2	8450	20	IV	4	59	8	0	0	0	0	0	0
2	8450	20	IV	5	56	7	0	0	0	0	0	0
2	8450	20	IV	6	53	7	0	0	0	0	0	0
2	8450	20	IV	7	61	8	0	0	0	0	0	0
2	8450	20	IV	8	59	8	0	0	0	0	0	0
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2	52000	20	IV	2	42	6	0	0	0	0	0	0
2	52000	20	IV	3	72	8	0	0	0	0	0	0
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2	52000	20	IV	8	61	8	0	0	0	0	2	0
2	52000	20	IV	9	51	7	0	0	0	0	0	0
2	52000	20	IV	10	64	7	0	0	0	0	0	0
2	M81E0	20	IV	1	45	6	0	0	0	0	0	0
2	M81E0	20	IV	2	53	8	0	0	0	0	0	0
2	M81E0	20	IV	3	56	7	0	0	0	0	0	0
2	M81E0	20	IV	4	57	7	0	0	0	0	0	0
2	M81E1	20	IV	5	42	5	0	0	0	0	0	0
2	M81E0	20	IV	6	61	7	0	0	0	0	0	0
2	M81E0	20	IV	7	55	9	0	0	0	0	0	0
2	M81E0	20	IV	8	61	6	0	0	0	0	0	0
2	M81E2	20	IV	9	57	6	0	0	0	0	0	0
2	M81E0	20	IV	10	47	6	0	0	0	0	0	0
2	51400	20	IV	1	49	7	0	0	0	0	0	0
2	51400	20	IV	2	53	7	0	0	0	0	0	0

2	51400	20	IV	3	33	6	0	0	0	0	0	0
2	51400	20	IV	4	58	8	0	0	0	0	0	0
2	51400	20	IV	5	60	8	0	0	0	0	0	0
2	51400	20	IV	6	67	9	1	0	0	0	0	0
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2	51400	20	IV	8	36	7	0	0	0	0	0	0
2	51400	20	IV	9	62	7	0	0	0	0	0	0
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3	1130	10	I	1	102	8	0	0	0	0	0	0
3	1130	10	I	2	75	5	0	0	0	0	0	0
3	1130	10	I	3	101	7	0	0	0	0	0	0
3	1130	10	I	4	101	7	0	0	0	0	0	0
3	1130	10	I	5	93	7	0	0	0	0	0	0
3	1130	10	I	6	104	8	0	0	0	0	0	0
3	1130	10	I	7	91	5	0	0	0	0	0	0
3	1130	10	I	8	64	4	1	0	0	0	0	0
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3	1130	20	I	1	64	5	0	0	0	0	0	0
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3	1130	20	I	3	77	6	0	0	0	0	0	0
3	1130	20	I	4	100	5	0	0	0	0	0	0
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3	1130	20	I	6	72	5	1	0	0	0	0	0
3	1130	20	I	7	96	8	0	0	0	0	0	0
3	1130	20	I	8	61	5	0	0	0	0	0	0
3	1130	20	I	9	61	5	0	0	0	0	0	0
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3	8380	10	I	1	70	7	0	0	0	0	0	0
3	8380	10	I	2	63	8	0	0	0	0	0	0
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3	8380	10	I	4	110	11	0	0	0	0	0	0
3	8380	10	I	5	76	6	0	0	0	0	0	0
3	8380	10	I	6	75	6	0	0	0	0	0	0
3	8380	10	I	7	62	6	0	0	0	0	0	0
3	8380	10	I	8	108	10	0	0	0	0	0	0
3	8380	10	I	9	94	10	0	0	0	0	0	0
3	8380	10	I	10	71	9	0	0	0	0	0	0
3	8380	20	I	1	77	6	0	0	0	0	0	0
3	8380	20	I	2	87	9	0	0	0	0	0	0
3	8380	20	I	3	56	7	0	0	0	0	0	0
3	8380	20	I	4	108	10	1	0	0	0	0	0
3	8380	20	I	5	60	5	0	0	0	0	0	0
3	8380	20	I	6	82	7	0	0	0	0	0	0
3	8380	20	I	7	62	6	0	0	0	0	0	0
3	8380	20	I	8	76	7	0	0	0	0	0	0

3	8380	20	I	9	82	7	1	0	0	0	0	0
3	8380	20	I	10	78	7	2	0	0	0	0	0
3	M81E0	10	I	1	56	6	0	0	0	0	0	0
3	M81E0	10	I	2	57	7	0	0	0	0	0	0
3	M81E0	10	I	3	92	6	0	0	0	0	0	0
3	M81E0	10	I	4	66	7	0	0	0	0	0	0
3	M81E0	10	I	5	91	8	0	0	0	0	0	0
3	M81E0	10	I	6	68	6	0	0	0	0	0	0
3	M81E0	10	I	7	111	8	0	0	0	0	0	0
3	M81E0	10	I	8	92	8	0	0	0	0	0	0
3	M81E0	10	I	9	69	8	0	0	0	0	0	0
3	M81E0	10	I	10	95	8	0	0	0	0	0	0
3	M81E0	20	I	1	80	7	0	0	0	0	0	0
3	M81E0	20	I	2	49	7	0	0	0	0	0	0
3	M81E0	20	I	3	95	8	0	0	0	0	0	0
3	M81E0	20	I	4	74	9	0	0	0	0	0	0
3	M81E0	20	I	5	63	5	0	0	0	0	0	0
3	M81E0	20	I	6	60	6	0	0	0	0	0	0
3	M81E0	20	I	7	54	5	0	0	0	0	0	0
3	M81E0	20	I	8	75	7	0	0	0	0	0	0
3	M81E0	20	I	9	63	6	0	0	0	0	0	0
3	M81E0	20	I	10	62	6	2	0	0	0	0	0
3	52000	10	I	1	72	8	0	0	0	0	0	0

3	52000	10	I	2	54	6	0	0	0	0	0	0
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3	52000	10	I	4	61	8	0	0	0	0	0	0
3	52000	10	I	5	57	7	0	0	0	0	0	0
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3	52000	10	I	7	70	5	0	0	0	0	0	0
3	52000	10	I	8	79	10	0	0	0	0	0	0
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3	52000	20	I	1	54	7	0	0	0	0	0	0
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3	52000	20	I	3	49	7	0	0	0	0	0	0
3	52000	20	I	4	56	8	0	0	0	0	0	0
3	52000	20	I	5	46	6	0	0	0	0	0	0
3	52000	20	I	6	50	6	0	0	0	0	0	0
3	52000	20	I	7	73	11	0	0	0	0	0	0
3	52000	20	I	8	50	6	0	0	0	0	0	0
3	52000	20	I	9	50	5	0	0	0	0	0	0
3	52000	20	I	10	59	8	0	0	0	0	0	0
3	10020	10	I	1	92	6	0	0	0	0	0	0
3	10020	10	I	2	110	9	0	0	0	0	0	0
3	10020	10	I	3	93	9	2	0	0	0	0	0
3	10020	10	I	4	87	7	1	0	0	0	0	0

3	10020	10	I	5	130	4	0	0	0	0	0	0
3	10020	10	I	6	98	7	0	0	0	0	0	0
3	10020	10	I	7	71	5	0	0	0	0	0	0
3	10020	10	I	8	98	7	0	0	0	0	0	0
3	10020	10	I	9	99	8	0	0	0	0	0	0
3	10020	10	I	10	87	4	1	0	0	0	0	0
3	10020	20	I	1	90	7	0	0	0	0	0	0
3	10020	20	I	2	100	7	0	0	0	0	0	0
3	10020	20	I	3	84	6	1	0	0	0	0	0
3	10020	20	I	4	94	6	0	0	0	0	0	0
3	10020	20	I	5	96	7	0	0	0	0	0	0
3	10020	20	I	6	64	6	0	0	0	0	0	0
3	10020	20	I	7	88	8	1	0	0	0	0	0
3	10020	20	I	8	68	4	1	0	0	0	0	0
3	10020	20	I	9	70	6	0	0	0	0	0	0
3	10020	20	I	10	100	5	0	0	0	0	0	0
3	51400	10	I	1	60	8	0	0	0	0	0	0
3	51400	10	I	2	54	7	0	0	0	0	0	0
3	51400	10	I	3	52	7	0	0	0	0	0	0
3	51400	10	I	4	57	9	0	0	0	0	0	0
3	51400	10	I	5	52	9	0	0	0	0	0	0
3	51400	10	I	6	67	9	0	0	0	0	0	0
3	51400	10	I	7	50	7	0	0	0	0	0	0

3	51400	10	I	8	50	8	0	0	0	0	0	0
3	51400	10	I	9	71	8	0	0	0	0	0	0
3	51400	10	I	10	58	8	0	0	0	0	0	0
3	51400	20	I	1	67	9	0	0	0	0	0	0
3	51400	20	I	2	57	7	0	0	0	0	0	0
3	51400	20	I	3	64	9	0	0	0	0	0	0
3	51400	20	I	4	53	8	0	0	0	0	0	0
3	51400	20	I	5	72	9	0	0	0	0	0	0
3	51400	20	I	6	54	6	0	0	0	0	0	0
3	51400	20	I	7	59	8	0	0	0	0	0	0
3	51400	20	I	8	67	8	0	0	0	0	0	0
3	51400	20	I	9	72	8	0	0	0	0	0	0
3	51400	20	I	10	63	7	0	0	0	0	0	0
3	8450	10	I	1	69	9	0	0	0	0	0	0
3	8450	10	I	2	70	6	0	0	0	0	0	0
3	8450	10	I	3	74	9	0	0	0	0	0	0
3	8450	10	I	4	80	8	0	0	0	0	0	0
3	8450	10	I	5	83	9	0	0	0	0	0	0
3	8450	10	I	6	81	9	0	0	0	0	0	0
3	8450	10	I	7	66	7	0	0	0	0	0	0
3	8450	10	I	8	74	7	0	0	0	0	0	0
3	8450	10	I	9	72	10	0	0	0	0	0	0
3	8450	10	I	10	81	8	0	0	0	0	0	0

3	8450	20	I	1	64	7	0	0	0	0	0	0
3	8450	20	I	2	55	7	0	0	0	0	0	0
3	8450	20	I	3	51	5	0	0	0	0	0	0
3	8450	20	I	4	74	8	1	1	0	0	0	0
3	8450	20	I	5	71	8	0	0	0	0	0	0
3	8450	20	I	6	51	7	0	0	0	0	0	0
3	8450	20	I	7	81	8	1	1	0	0	0	0
3	8450	20	I	8	90	10	0	0	0	0	0	0
3	8450	20	I	9	63	7	1	1	0	0	0	0
3	8450	20	I	10	64	6	0	0	0	0	0	0
3	8380	20	II	1	58	6	0	0	0	0	0	0
3	8380	20	II	2	62	7	0	0	0	0	0	0
3	8380	20	II	3	45	5	1	1	0	0	0	0
3	8380	20	II	4	81	8	0	0	0	0	0	0
3	8380	20	II	5	68	6	0	0	0	0	0	0
3	8380	20	II	6	72	7	0	0	0	0	0	0
3	8380	20	II	7	54	5	0	0	0	0	0	0
3	8380	20	II	8	63	7	0	0	0	0	0	0
3	8380	20	II	9	79	10	1	0	0	0	0	0
3	8380	20	II	10	79	6	0	0	0	0	0	0
3	8380	10	II	1	64	6	0	0	0	0	0	0
3	8380	10	II	2	50	6	0	0	0	0	0	0
3	8380	10	II	3	68	8	0	0	0	0	0	0

3	8380	10	II	4	77	7	0	0	0	0	0	0
3	8380	10	II	5	50	5	0	0	0	0	0	0
3	8380	10	II	6	64	6	0	0	0	0	0	0
3	8380	10	II	7	64	6	0	0	0	0	0	0
3	8380	10	II	8	71	8	0	0	0	0	0	0
3	8380	10	II	9	53	4	0	0	0	0	0	0
3	8380	10	II	10	74	7	1	0	0	0	0	0
3	52000	10	II	1	70	6	0	0	0	0	0	0
3	52000	10	II	2	63	6	0	0	0	0	0	0
3	52000	10	II	3	75	8	0	0	0	0	0	0
3	52000	10	II	4	61	6	0	0	0	0	0	0
3	52000	10	II	5	67	6	0	0	0	0	0	0
3	52000	10	II	6	62	8	0	0	0	0	0	0
3	52000	10	II	7	64	5	0	0	0	0	0	0
3	52000	10	II	8	48	4	0	0	0	0	0	0
3	52000	10	II	9	63	6	0	0	0	0	0	0
3	52000	10	II	10	79	8	0	0	0	0	0	0
3	52000	20	II	1	77	6	0	0	0	0	0	0
3	52000	20	II	2	54	8	0	0	0	0	0	0
3	52000	20	II	3	58	6	0	0	0	0	0	0
3	52000	20	II	4	55	7	0	0	0	0	0	0
3	52000	20	II	5	72	7	0	0	0	0	0	0
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3	52000	20	II	7	76	7	0	0	0	0	0	0
3	52000	20	II	8	62	6	0	0	0	0	0	0
3	52000	20	II	9	70	6	0	0	0	0	0	0
3	52000	20	II	10	71	11	1	0	0	0	0	0
3	51400	20	II	1	70	6	0	0	0	0	0	0
3	51400	20	II	2	69	8	0	0	0	0	0	0
3	51400	20	II	3	68	9	0	0	0	0	0	0
3	51400	20	II	4	66	6	0	0	0	0	0	0
3	51400	20	II	5	62	5	0	0	0	0	0	0
3	51400	20	II	6	64	6	0	0	0	0	0	0
3	51400	20	II	7	46	4	1	0	0	0	0	0
3	51400	20	II	8	55	6	0	0	0	0	0	0
3	51400	20	II	9	67	7	0	0	0	0	0	0
3	51400	20	II	10	81	10	1	0	0	0	0	0
3	51400	10	II	1	70	7	0	0	0	0	0	0
3	51400	10	II	2	70	5	0	0	0	0	0	0
3	51400	10	II	3	89	8	0	0	0	0	0	0
3	51400	10	II	4	98	8	0	0	0	0	0	0
3	51400	10	II	5	60	6	0	0	0	0	0	0
3	51400	10	II	6	74	6	0	0	0	0	0	0
3	51400	10	II	7	89	8	0	0	0	0	0	0
3	51400	10	II	8	51	5	0	0	0	0	0	0
3	51400	10	II	9	60	7	0	0	0	0	0	0

3	51400	10	II	10	78	9	0	0	0	0	0	0
3	8450	20	II	1	71	5	0	0	0	0	0	0
3	8450	20	II	2	74	7	0	0	0	0	0	0
3	8450	20	II	3	74	6	0	0	0	0	0	0
3	8450	20	II	4	78	7	0	0	0	0	0	0
3	8450	20	II	5	73	6	0	0	0	0	0	0
3	8450	20	II	6	84	8	0	0	0	0	0	0
3	8450	20	II	7	70	7	0	0	0	0	0	0
3	8450	20	II	8	60	5	0	0	0	0	0	0
3	8450	20	II	9	94	11	0	0	0	0	2	0
3	8450	20	II	10	67	6	0	0	0	0	0	0
3	8450	10	II	1	70	6	0	0	0	0	0	0
3	8450	10	II	2	50	5	0	0	0	0	0	0
3	8450	10	II	3	79	6	0	0	0	0	0	0
3	8450	10	II	4	60	4	0	0	0	0	0	0
3	8450	10	II	5	78	9	1	0	0	0	0	0
3	8450	10	II	6	74	6	0	0	0	0	0	0
3	8450	10	II	7	107	12	0	0	0	0	0	0
3	8450	10	II	8	89	10	0	0	0	0	0	0
3	8450	10	II	9	86	6	0	0	0	0	0	0
3	8450	10	II	10	68	8	0	0	0	0	0	0
3	1130	10	II	1	97	9	0	0	0	0	0	0
3	1130	10	II	2	82	5	0	0	0	0	0	0

3	1130	10	II	3	82	6	0	0	0	0	0	0
3	1130	10	II	4	102	9	0	0	0	0	0	0
3	1130	10	II	5	89	7	0	0	0	0	0	0
3	1130	10	II	6	71	7	0	0	0	0	0	0
3	1130	10	II	7	100	6	1	0	0	0	0	0
3	1130	10	II	8	101	9	0	0	0	0	0	0
3	1130	10	II	9	95	8	0	0	0	0	0	0
3	1130	10	II	10	61	4	0	0	0	0	0	0
3	1130	20	II	1	87	6	0	0	0	0	0	0
3	1130	20	II	2	96	8	0	0	0	0	0	0
3	1130	20	II	3	97	7	1	0	0	0	0	0
3	1130	20	II	4	105	8	0	0	0	0	0	0
3	1130	20	II	5	67	5	0	0	0	0	0	0
3	1130	20	II	6	101	7	0	0	0	0	0	0
3	1130	20	II	7	79	7	0	0	0	0	2	0
3	1130	20	II	8	90	7	0	0	0	0	0	0
3	1130	20	II	9	85	8	2	0	0	0	0	0
3	1130	20	II	10	100	7	1	0	0	0	0	0
3	10020	20	II	1	50	6	0	0	0	0	0	0
3	10020	20	II	2	64	11	3	0	0	0	0	0
3	10020	20	II	3	78	5	0	0	0	0	0	0
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3	10020	20	II	6	76	4	0	0	0	0	0	0
3	10020	20	II	7	74	4	0	0	0	0	0	0
3	10020	20	II	8	102	9	0	0	0	0	0	0
3	10020	20	II	9	83	6	0	0	0	0	0	0
3	10020	20	II	10	90	6	1	0	0	0	0	0
3	10020	10	II	1	100	6	0	0	0	0	0	0
3	10020	10	II	2	83	5	0	0	0	0	0	0
3	10020	10	II	3	93	6	0	0	0	0	0	0
3	10020	10	II	4	67	4	0	0	0	0	0	0
3	10020	10	II	5	65	6	0	0	0	0	0	0
3	10020	10	II	6	115	9	1	0	0	0	0	0
3	10020	10	II	7	78	5	0	0	0	0	0	0
3	10020	10	II	8	97	7	1	0	0	0	0	0
3	10020	10	II	9	109	7	0	0	0	0	0	0
3	10020	10	II	10	63	4	0	0	0	0	0	0
3	M81E0	10	II	1	43	4	0	0	0	0	0	0
3	M81E0	10	II	2	77	6	0	0	0	0	0	0
3	M81E0	10	II	3	65	7	0	0	0	0	0	0
3	M81E0	10	II	4	650	6	0	0	0	0	0	0
3	M81E0	10	II	5	77	7	0	0	0	0	0	0
3	M81E0	10	II	6	60	4	0	0	0	0	0	0
3	M81E0	10	II	7	74	7	0	0	0	0	0	0
3	M81E0	10	II	8	64	6	0	0	0	0	0	0

3	M81E0	10	II	9	52	5	0	0	0	0	0	0
3	M81E0	10	II	10	52	4	0	0	0	0	0	0
3	M81E0	20	II	1	62	6	0	0	0	0	0	0
3	M81E0	20	II	2	54	3	0	0	0	0	0	0
3	M81E0	20	II	3	59	5	0	0	0	0	0	0
3	M81E0	20	II	4	45	4	0	0	0	0	0	0
3	M81E0	20	II	5	43	4	0	0	0	0	0	0
3	M81E0	20	II	6	62	5	0	0	0	0	0	0
3	M81E0	20	II	7	63	6	0	0	0	0	0	0
3	M81E0	20	II	8	54	4	1	1	0	0	0	0
3	M81E0	20	II	9	53	4	0	0	0	0	0	0
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3	1130	20	III	1	98	9	0	0	0	0	0	0
3	1130	20	III	2	91	7	0	0	0	0	0	0
3	1130	20	III	3	69	5	0	0	0	0	0	0
3	1130	20	III	4	71	8	0	0	0	0	0	0
3	1130	20	III	5	98	7	0	0	0	0	0	0
3	1130	20	III	6	60	5	0	0	0	0	0	0
3	1130	20	III	7	86	7	0	0	0	0	0	0
3	1130	20	III	8	101	8	3	0	0	0	0	0
3	1130	20	III	9	60	4	0	0	0	0	0	0
3	1130	20	III	10	47	10	0	0	0	0	0	0
3	1130	10	III	1	80	6	0	0	0	0	0	0

3	1130	10	III	2	126	9	1	0	0	0	0	0
3	1130	10	III	3	127	7	0	0	0	0	0	0
3	1130	10	III	4	89	6	0	0	0	0	0	0
3	1130	10	III	5	93	6	0	0	0	0	0	0
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3	1130	10	III	7	92	10	0	0	0	0	0	0
3	1130	10	III	8	85	6	0	0	0	0	0	0
3	1130	10	III	9	93	7	1	0	0	0	0	0
3	1130	10	III	10	107	9	0	0	0	0	0	0
3	M81E0	20	III	1	86	8	0	0	0	0	0	0
3	M81E0	20	III	2	92	6	0	0	0	0	0	0
3	M81E0	20	III	3	61	6	0	0	0	0	0	0
3	M81E0	20	III	4	68	6	0	0	0	0	0	0
3	M81E0	20	III	5	80	5	0	0	0	0	0	0
3	M81E0	20	III	6	82	5	0	0	0	0	0	0
3	M81E0	20	III	7	61	5	0	0	0	0	0	0
3	M81E0	20	III	8	60	5	0	0	0	0	0	0
3	M81E0	20	III	9	80	4	1	0	0	0	0	0
3	M81E0	20	III	10	78	6	1	0	0	0	0	0
3	M81E0	10	III	1	82	5	0	0	0	0	0	0
3	M81E0	10	III	2	62	5	0	0	0	0	0	0
3	M81E0	10	III	3	61	6	0	0	0	0	0	0
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3	M81E0	10	III	5	81	5	0	0	0	0	0	0
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3	M81E0	10	III	7	65	4	0	0	0	0	0	0
3	M81E0	10	III	8	67	6	0	0	0	0	0	0
3	M81E0	10	III	9	71	6	0	0	0	0	0	0
3	M81E0	10	III	10	68	7	0	0	0	0	0	0
3	10020	20	III	1	65	5	0	0	0	0	0	0
3	10020	20	III	2	64	4	0	0	0	0	0	0
3	10020	20	III	3	112	7	1	0	0	0	0	0
3	10020	20	III	4	110	8	1	0	0	0	0	0
3	10020	20	III	5	44	4	0	0	0	0	0	0
3	10020	20	III	6	90	5	1	0	0	0	0	0
3	10020	20	III	7	63	6	0	0	0	0	0	0
3	10020	20	III	8	119	9	1	0	0	0	0	0
3	10020	20	III	9	52	4	0	0	0	0	0	0
3	10020	20	III	10	95	5	1	0	0	0	0	0
3	10020	10	III	1	92	6	0	0	0	0	0	0
3	10020	10	III	2	67	5	0	0	0	0	0	0
3	10020	10	III	3	72	5	0	0	0	0	0	0
3	10020	10	III	4	90	5	2	0	0	0	0	0
3	10020	10	III	5	83	7	0	0	0	0	0	0
3	10020	10	III	6	134	9	0	0	0	0	0	0
3	10020	10	III	7	129	6	0	0	0	0	0	0

3	10020	10	III	8	157	5	0	0	0	0	0	0
3	10020	10	III	9	187	5	0	0	0	0	0	0
3	10020	10	III	10	140	8	0	0	0	0	0	0
3	51400	10	III	1	80	5	0	0	0	0	0	0
3	51400	10	III	2	47	8	0	0	0	0	0	0
3	51400	10	III	3	85	6	0	0	0	0	0	0
3	51400	10	III	4	91	8	0	0	0	0	0	0
3	51400	10	III	5	85	7	0	0	0	0	0	0
3	51400	10	III	6	78	8	0	0	0	0	0	0
3	51400	10	III	7	93	8	0	0	0	0	0	0
3	51400	10	III	8	53	5	0	0	0	0	0	0
3	51400	10	III	9	90	9	0	0	0	0	0	0
3	51400	10	III	10	87	8	0	0	0	0	0	0
3	51400	20	III	1	88	9	0	0	0	0	0	0
3	51400	20	III	2	74	9	0	0	0	0	0	0
3	51400	20	III	3	62	5	0	0	0	0	0	0
3	51400	20	III	4	80	6	0	0	0	0	0	0
3	51400	20	III	5	83	8	0	0	0	0	0	0
3	51400	20	III	6	77	6	0	0	0	0	0	0
3	51400	20	III	7	74	8	0	0	0	0	0	0
3	51400	20	III	8	82	7	0	0	0	0	0	0
3	51400	20	III	9	80	9	0	0	0	0	0	0
3	51400	20	III	10	84	7	0	0	0	0	0	0

3	52000	10	III	1	77	7	0	0	0	0	0	0
3	52000	10	III	2	95	9	0	0	0	0	0	0
3	52000	10	III	3	80	7	0	0	0	0	0	0
3	52000	10	III	4	58	7	0	0	0	0	0	0
3	52000	10	III	5	103	10	0	0	0	0	0	0
3	52000	10	III	6	79	7	0	0	0	0	0	0
3	52000	10	III	7	90	7	0	0	0	0	0	0
3	52000	10	III	8	76	6	0	0	0	0	0	0
3	52000	10	III	9	81	8	0	0	0	0	0	0
3	52000	10	III	10	95	7	0	0	0	0	0	0
3	52000	20	III	1	80	6	0	0	0	0	0	0
3	52000	20	III	2	103	10	0	0	0	0	0	0
3	52000	20	III	3	74	8	0	0	0	0	0	0
3	52000	20	III	4	54	8	0	0	0	0	0	0
3	52000	20	III	5	92	8	0	0	0	0	0	0
3	52000	20	III	6	70	7	0	0	0	0	0	0
3	52000	20	III	7	52	7	0	0	0	0	0	0
3	52000	20	III	8	63	6	0	0	0	0	0	0
3	52000	21 EMER mrb	III	9	63	6	2	2	0	0	0	0
3	52000	20	III	10	89	8	0	0	0	0	0	0
3	8380	20	III	1	31	5	0	0	0	0	0	0
3	8380	20	III	2	23	3	0	0	0	0	0	0
3	8380	20	III	3	35	4	0	0	0	0	0	0

3	8380	20	III	4	40	5	0	0	0	0	0	0
3	8380	20	III	5	43	5	0	0	0	0	0	0
3	8380	20	III	6	31	5	0	0	0	0	0	0
3	8380	20	III	7	68	6	0	0	0	0	0	0
3	8380	20	III	8	64	6	0	0	0	0	0	0
3	8380	20	III	9	70	6	0	0	0	0	0	0
3	8380	20	III	10	66	8	0	0	0	0	0	0
3	8380	10	III	1	45	5	0	0	0	0	0	0
3	8380	10	III	2	54	5	0	0	0	0	0	0
3	8380	10	III	3	52	4	0	0	0	0	0	0
3	8380	10	III	4	54	5	0	0	0	0	0	0
3	8380	10	III	5	55	5	0	0	0	0	0	0
3	8380	10	III	6	46	4	0	0	0	0	0	0
3	8380	10	III	7	31	4	0	0	0	0	0	0
3	8380	10	III	8	56	8	0	0	0	0	0	0
3	8380	10	III	9	82	6	0	0	0	0	0	0
3	8380	10	III	10	34	5	0	0	0	0	0	0
3	8450	10	III	1	56	5	0	0	0	0	0	0
3	8450	10	III	2	81	10	0	0	0	0	0	0
3	8450	10	III	3	59	8	0	0	0	0	0	0
3	8450	10	III	4	59	7	0	0	0	0	0	0
3	8450	10	III	5	50	5	0	0	0	0	0	0
3	8450	10	III	6	61	7	0	0	0	0	0	0

3	8450	10	III	7	48	6	0	0	0	0	0	0
3	8450	10	III	8	57	8	0	0	0	0	0	0
3	8450	10	III	9	44	4	0	0	0	0	0	0
3	8450	10	III	10	54	6	0	0	0	0	0	0
3	8450	20	III	1	50	5	0	0	0	0	0	0
3	8450	20	III	2	59	8	0	0	0	0	0	0
3	8450	20	III	3	63	8	0	0	0	0	0	0
3	8450	20	III	4	72	6	0	0	0	0	0	0
3	8450	20	III	5	62	6	0	0	0	0	0	0
3	8450	20	III	6	53	5	0	0	0	0	0	0
3	8450	20	III	7	56	5	0	0	0	0	0	0
3	8450	20	III	8	53	5	0	0	0	0	0	0
3	8450	20	III	9	51	7	0	0	0	0	0	0
3	8450	20	III	10	87	7	0	0	0	0	0	0
3	51400	10	IV	1	101	10	0	0	0	0	0	0
3	51400	10	IV	2	90	5	0	0	0	0	0	0
3	51400	10	IV	3	106	6	0	0	0	0	0	0
3	51401	10	IV	4	110	6	0	0	0	0	0	0
3	51400	10	IV	5	113	10	0	0	0	0	0	0
3	51400	10	IV	6	105	7	0	0	0	0	0	0
3	51400	10	IV	7	85	6	0	0	0	0	0	0
3	51400	10	IV	8	112	8	0	0	0	0	0	0
3	51400	10	IV	9	120	7	0	0	0	0	0	0

3	51400	10	IV	10	96	6	0	0	0	0	0	0
3	51400	20	IV	1	106	7	0	0	0	0	0	0
3	51400	20	IV	2	78	7	0	0	0	0	0	0
3	51400	20	IV	3	110	7	0	0	0	0	0	0
3	51400	20	IV	4	99	7	0	0	0	0	0	0
3	51400	20	IV	5	98	6	0	0	0	0	0	0
3	51400	20	IV	6	103	9	0	0	0	0	0	0
3	51400	20	IV	7	96	7	1	1	0	0	0	0
3	51400	20	IV	8	90	7	0	0	0	0	0	0
3	51400	20	IV	9	96	8	0	0	0	0	0	0
3	51400	20	IV	10	83	8	0	0	0	0	0	0
3	8450	20	IV	1	85	10	0	0	0	0	0	0
3	8450	20	IV	2	83	6	0	0	0	0	0	0
3	8450	20	IV	3	65	6	0	0	0	0	0	0
3	8450	20	IV	4	94	10	0	0	0	0	0	0
3	8450	20	IV	5	76	6	0	0	0	0	0	0
3	8450	20	IV	6	85	8	3	0	0	0	0	0
3	8450	20	IV	7	84	7	1	0	0	0	0	0
3	8450	20	IV	8	74	7	0	0	0	0	0	0
3	8450	20	IV	9	60	5	0	0	0	0	0	0
3	8450	20	IV	10	90	7	0	0	0	0	0	0
3	8450	10	IV	1	106	6	0	0	0	0	0	0
3	8450	10	IV	2	100	7	0	0	0	0	0	0

3	8450	10	IV	3	100	6	0	0	0	0	0	0
3	8450	10	IV	4	103	8	1	0	0	0	0	0
3	8450	10	IV	5	86	6	1	0	0	0	0	0
3	8450	10	IV	6	90	5	0	0	0	0	0	0
3	8450	10	IV	7	59	5	0	0	0	0	0	0
3	8450	10	IV	8	103	13	0	0	0	0	0	0
3	8450	10	IV	9	86	6	0	0	0	0	0	0
3	8450	10	IV	10	90	6	0	0	0	0	0	0
3	M81E0	10	IV	1	105	6	0	0	0	0	0	0
3	M81E0	10	IV	2	106	8	0	0	0	0	0	0
3	M81E0	10	IV	3	100	6	0	0	0	0	0	0
3	M81E1	10	IV	4	97	8	0	0	0	0	0	0
3	M81E0	10	IV	5	104	6	0	0	0	0	0	0
3	M81E0	10	IV	6	103	5	0	0	0	0	0	0
3	M81E0	10	IV	7	98	6	0	0	0	0	0	0
3	M81E0	10	IV	8	123	10	0	0	0	0	0	0
3	M81E0	10	IV	9	100	6	0	0	0	0	0	0
3	M81E0	10	IV	10	130	7	0	0	0	0	0	0
3	M81E0	20	IV	1	109	7	0	0	0	0	0	0
3	M81E0	20	IV	2	100	5	0	0	0	0	0	0
3	M81E0	20	IV	3	87	6	0	0	0	0	0	0
3	M81E0	20	IV	4	100	5	0	0	0	0	0	0
3	M81E0	20	IV	5	95	6	0	0	0	0	0	0

3	M81E0	20	IV	6	92	6	0	0	0	0	1	0
3	M81E0	20	IV	7	87	8	0	0	0	0	0	0
3	M81E0	20	IV	8	85	4	0	0	0	0	0	0
3	M81E0	20	IV	9	99	7	0	0	0	0	0	0
3	M81E0	20	IV	10	80	5	0	0	0	0	0	0
3	10020	20	IV	1	105	6	1	0	0	0	0	0
3	10020	20	IV	2	92	6	0	0	0	0	0	0
3	10020	20	IV	3	100	5	0	0	0	0	0	0
3	10020	20	IV	4	86	8	1	1	0	0	0	0
3	10020	20	IV	5	100	6	0	0	0	0	0	0
3	10020	20	IV	6	104	6	1	0	0	0	0	0
3	10020	20	IV	7	126	8	0	0	0	0	0	0
3	10020	20	IV	8	122	6	0	0	0	0	0	0
3	10020	20	IV	9	91	5	0	0	0	0	0	0
3	10020	20	IV	10	80	5	3	0	0	0	0	0
3	10020	10	IV	1	110	8	0	0	0	0	0	0
3	10020	10	IV	2	115	7	1	0	0	0	0	0
3	10020	10	IV	3	83	5	0	0	0	0	0	0
3	10020	10	IV	4	153	8	2	0	0	0	0	0
3	10020	10	IV	5	98	6	0	0	0	0	0	0
3	10020	10	IV	6	157	10	0	0	0	0	0	0
3	10020	10	IV	7	95	5	0	0	0	0	0	0
3	10020	10	IV	8	124	7	0	0	0	0	0	0

3	10020	10	IV	9	107	7	0	0	0	0	0	0
3	10020	10	IV	10	120	6	1	0	0	0	0	0
3	52000	20	IV	1	100	8	1	0	0	0	0	0
3	52000	20	IV	2	91	7	0	0	0	0	0	0
3	52000	20	IV	3	70	4	0	0	0	0	0	0
3	52000	20	IV	4	110	6	0	0	0	0	0	0
3	52000	20	IV	5	82	8	0	0	0	0	0	0
3	52000	20	IV	6	100	6	0	0	0	0	0	0
3	52000	20	IV	7	105	9	0	0	0	0	0	0
3	52000	20	IV	8	105	7	0	0	0	0	0	0
3	52000	20	IV	9	102	7	0	0	0	0	0	0
3	52000	20	IV	10	130	8	0	0	0	0	0	0
3	52000	10	IV	1	104	7	0	0	0	0	0	0
3	52000	10	IV	2	130	6	0	0	0	0	0	0
3	52000	11 I IN SHEATH	IV	3	105	7	1	0	0	0	0	0
3	52000	10	IV	4	120	8	0	0	0	0	0	0
3	52000	10	IV	5	157	10	0	0	0	0	0	0
3	52000	10	IV	6	120	8	0	0	0	0	0	0
3	52000	10	IV	7	125	8	0	0	0	0	0	0
3	52000	10	IV	8	117	8	0	0	0	0	0	0
3	52000	10	IV	9	130	9	0	0	0	0	0	0
3	52000	10	IV	10	125	8	0	0	0	0	0	0
4	8450	40	I	1	76	8	0	0	0	0	0	0

4	8450	40	I	2	86	9	0	0	0	0	0	0
4	8450	40	I	3	61	8	2	0	0	0	0	0
4	8450	40	I	4	97	9	0	0	0	0	0	0
4	8450	40	I	5	64	7	1	0	0	0	0	0
4	8450	40	I	6	81	10	0	0	0	0	0	0
4	8450	40	I	7	84	8	0	0	0	0	0	0
4	8450	40	I	8	58	8	1	0	0	0	0	0
4	8450	10	I	1	58	7	0	0	0	0	0	0
4	8450	10	I	2	91	8	0	0	0	0	0	0
4	8450	10	I	3	79	9	0	0	0	0	0	0
4	8450	10	I	4	76	6	0	0	0	0	0	0
4	8450	10	I	5	86	7	0	0	0	0	0	0
4	8450	10	I	6	112	9	0	0	0	0	0	0
4	8450	10	I	7	91	8	0	0	0	0	0	0
4	8450	10	I	8	91	9	0	0	0	0	0	0
4	8450	30	I	1	74	8	2	2	0	0	0	0
4	8450	30	I	2	76	8	0	0	0	0	0	0
4	8450	30	I	3	97	11	0	0	0	0	0	0
4	8450	30	I	4	76	7	0	0	0	0	0	0
4	8450	30	I	5	112	8	0	0	0	0	0	0
4	8450	30	I	6	86	9	0	0	0	0	0	0
4	8450	30	I	7	112	11	1	1	0	0	0	0
4	8450	30	I	8	79	7	1	1	0	0	0	0

4	8450	20	I	1	76	7	0	0	0	0	0	0
4	8450	20	I	2	99	8	0	0	0	0	0	0
4	8450	20	I	3	58	9	0	0	0	0	0	0
4	8450	20	I	4	79	7	0	0	0	0	0	0
4	8450	20	I	5	94	7	0	0	0	0	0	0
4	8450	20	I	6	91	12	0	0	0	0	0	0
4	8450	20	I	7	89	8	0	0	0	0	0	0
4	8450	20	I	8	66	7	0	0	0	0	0	0
4	8380	40	I	1	94	9	0	0	0	0	0	0
4	8380	40	I	2	112	14	0	0	0	0	0	0
4	8380	40	I	3	152	14	0	0	0	0	0	0
4	8380	40	I	4	99	10	0	0	0	0	0	0
4	8380	40	I	5	104	14	0	0	0	0	0	0
4	8380	40	I	6	124	11	0	0	0	0	0	0
4	8380	40	I	7	137	12	2	0	0	0	0	0
4	8380	40	I	8	76	6	0	0	0	0	0	0
4	8380	10	I	1	119	10	0	0	0	0	0	0
4	8380	10	I	2	119	11	0	0	0	0	0	0
4	8380	10	I	3	117	9	0	0	0	0	0	0
4	8380	10	I	4	109	8	0	0	0	0	0	0
4	8380	10	I	5	97	9	0	0	0	0	0	0
4	8380	10	I	6	112	10	0	0	0	0	0	0
4	8380	10	I	7	69	7	0	0	0	0	0	0

4	8380	10	I	8	112	12	0	0	0	0	0	0
4	8380	30	I	1	97	1	0	0	0	0	0	0
4	8380	30	I	2	48	5	0	0	0	0	0	0
4	8380	30	I	3	89	11	1	1	0	0	0	0
4	8380	30	I	4	79	8	0	0	0	0	0	0
4	8380	30	I	5	94	8	0	0	0	0	0	0
4	8380	30	I	6	71	8	0	0	0	0	0	0
4	8380	30	I	7	61	6	2	0	0	0	0	0
4	8380	30	I	8	61	4	0	0	0	0	0	0
4	8380	20	I	1	51	6	0	0	0	0	0	0
4	8380	20	I	2	66	6	0	0	0	0	0	0
4	8380	20	I	3	104	6	0	0	0	0	0	0
4	8380	20	I	4	124	11	4	1	0	0	0	0
4	8380	20	I	5	99	9	2	0	0	0	0	0
4	8380	20	I	6	89	7	0	0	0	0	0	0
4	8380	20	I	7	91	7	0	0	0	0	0	0
4	8380	20	I	8	91	8	0	0	0	0	0	0
4	51400	40	I	1	124	10	0	0	0	0	0	0
4	51400	40	I	2	117	12	0	0	0	0	10	0
4	51400	40	I	3	99	9	0	0	0	0	0	0
4	51400	40	I	4	119	11	0	0	0	0	0	0
4	51400	40	I	5	130	11	0	0	0	0	0	0
4	51400	40	I	6	94	9	0	0	0	0	0	0

4	51400	40	I	7	114	10	0	0	0	0	1	0
4	51400	40	I	8	94	10	0	0	0	0	10	0
4	51400	10	I	1	109	9	0	0	0	0	0	0
4	51400	10	I	2	81	8	0	0	0	0	0	0
4	51400	10	I	3	89	9	0	0	0	0	0	0
4	51400	10	I	4	99	8	0	0	0	0	0	0
4	51400	10	I	5	81	9	0	0	0	0	0	0
4	51400	10	I	6	81	9	0	0	0	0	0	0
4	51400	10	I	7	84	7	0	0	0	0	0	0
4	51400	10	I	8	91	10	0	0	0	0	0	0
4	51400	30	I	1	71	7	0	0	0	0	0	0
4	51400	30	I	2	97	8	0	0	0	0	0	0
4	51400	30	I	3	71	8	0	0	0	0	0	0
4	51400	30	I	4	97	9	0	0	0	0	0	0
4	51400	30	I	5	76	7	0	0	0	0	0	0
4	51400	30	I	6	56	8	0	0	0	0	0	0
4	51400	30	I	7	86	10	1	0	0	0	0	0
4	51400	30	I	8	66	7	1	0	0	0	0	0
4	51400	20	I	1	71	7	0	0	0	0	0	0
4	51400	21	I	2	94	10	1	0	0	0	0	0
4	51400	22	I	3	94	9	0	0	0	0	0	0
4	51400	20	I	4	104	10	0	0	0	0	0	0
4	51400	21	I	5	86	8	0	0	0	0	0	0

4	51400	20	I	6	81	11	0	0	0	0	0	0
4	51400	21	I	7	91	9	0	0	0	0	0	0
4	51400	20	I	8	84	7	0	0	0	0	0	0
4	10020	40	I	1	132	10	2	0	0	0	0	0
4	10020	40	I	2	127	9	0	0	0	0	0	0
4	10020	40	I	3	140	8	0	0	0	0	0	0
4	10020	40	I	4	122	10	0	0	0	0	0	0
4	10020	40	I	5	107	6	0	0	0	0	0	0
4	10020	40	I	6	145	9	0	0	0	0	0	0
4	10020	40	I	7	142	8	0	0	0	0	0	0
4	10020	40	I	8	137	8	3	2	0	0	0	0
4	10020	10	I	1	119	9	0	0	0	0	0	0
4	10020	10	I	2	107	9	0	0	0	0	0	0
4	10020	10	I	3	122	9	0	0	0	0	0	0
4	10020	10	I	4	124	9	0	0	0	0	0	0
4	10020	10	I	5	132	8	0	0	0	0	0	0
4	10020	10	I	6	117	7	0	0	0	0	0	0
4	10020	10	I	7	127	9	0	0	0	0	0	0
4	10020	10	I	8	122	7	0	0	0	0	0	0
4	10020	30	I	1	114	7	1	1	0	0	0	0
4	10020	30	I	2	99	6	0	0	0	0	0	0
4	10020	30	I	3	117	8	0	0	0	0	0	0
4	10020	30	I	4	124	8	0	0	0	0	0	0

4	10020	30	I	5	117	8	2	2	0	0	0	0
4	10020	30	I	6	91	6	0	0	0	0	0	0
4	10020	30	I	7	119	8	0	0	0	0	0	0
4	10020	30	I	8	91	7	1	0	0	0	0	0
4	10020	20	I	1	94	8	1	1	0	0	0	0
4	10020	20	I	2	81	7	0	0	0	0	0	0
4	10020	20	I	3	74	7	0	0	0	0	0	0
4	10020	20	I	4	66	6	0	0	0	0	0	0
4	10020	20	I	5	84	6	1	0	0	0	0	0
4	10020	20	I	6	130	9	0	0	0	0	0	0
4	10020	20	I	7	81	6	0	0	0	0	0	0
4	10020	20	I	8	122	8	0	0	0	0	0	0
4	52000	40	I	1	135	10	0	0	0	0	0	0
4	52000	40	I	2	163	11	0	0	0	0	0	0
4	52000	41 II mrb	I	3	117	10	2	1	0	0	0	0
4	52000	40	I	4	137	10	0	0	0	0	2	0
4	52000	40	I	5	163	12	3	1	0	0	0	0
4	52000	40	I	6	124	10	0	0	0	0	0	0
4	52000	40	I	7	86	8	0	0	0	0	0	0
4	52000	40	I	8	124	9	0	0	0	0	0	0
4	52000	10	I	1	89	9	0	0	0	0	0	0
4	52000	10	I	2	97	11	0	0	0	0	0	0
4	52000	10	I	3	109	12	0	0	0	0	0	0

4	52000	10	I	4	86	9	0	0	0	0	0	0
4	52000	10	I	5	91	10	0	0	0	0	0	0
4	52000	10	I	6	56	8	0	0	0	0	0	0
4	52000	10	I	7	114	10	0	0	0	0	0	0
4	52000	10	I	8	94	8	0	0	0	0	0	0
4	52000	30	I	1	94	9	0	0	0	0	7	0
4	52000	30	I	2	99	10	0	0	0	0	0	0
4	52000	30	I	3	38	9	0	0	0	0	0	0
4	52000	30	I	4	76	9	1	0	0	0	0	0
4	52000	30	I	5	74	7	0	0	0	0	0	0
4	52000	30	I	6	86	12	0	0	0	0	0	0
4	52000	30	I	7	99	10	0	0	0	0	0	0
4	52000	30	I	8	76	8	0	0	0	0	0	0
4	52000	20	I	1	71	9	0	0	0	0	7	0
4	52003	20	I	2	74	8	0	0	0	0	1	0
4	52000	20	I	3	69	8	0	0	0	0	0	0
4	52000	20	I	4	71	8	3	0	0	0	0	0
4	52000	20	I	5	76	8	0	0	0	0	0	0
4	52000	20	I	6	91	8	0	0	0	0	0	0
4	52000	20	I	7	104	11	0	0	0	0	0	0
4	52000	20	I	8	76	9	1	1	0	0	0	0
4	M81E0	40	I	1	91	5	0	0	0	0	0	0
4	M81E0	40	I	2	152	9	2	0	0	0	0	0

4	M81E0	40	I	3	142	9	3	1	0	0	0	0
4	M81E0	40	I	4	119	9	1	0	0	0	7	0
4	M81E0	40	I	5	119	6	0	0	0	0	0	0
4	M81E0	40	I	6	142	10	0	0	0	0	0	0
4	M81E0	40	I	7	94	6	0	0	0	0	0	0
4	M81E0	40	I	8	119	7	1	0	0	0	0	0
4	M81E0	10	I	1	89	8	2	0	0	0	0	0
4	M81E0	10	I	2	104	9	0	0	0	0	0	0
4	M81E0	10	I	3	117	8	0	0	0	0	0	0
4	M81E0	10	I	4	89	7	0	0	0	0	0	0
4	M81E0	10	I	5	97	8	0	0	0	0	0	0
4	M81E0	10	I	6	91	7	0	0	0	0	0	0
4	M81E0	10	I	7	94	8	0	0	0	0	0	0
4	M81E0	10	I	8	124	9	0	0	0	0	0	0
4	M81E0	30	I	1	76	6	0	0	0	0	0	0
4	M81E0	30	I	2	66	7	0	0	0	0	0	0
4	M81E0	30	I	3	81	6	0	0	0	0	0	0
4	M81E0	30	I	4	91	10	0	0	0	0	0	0
4	M81E0	30	I	5	79	5	0	0	0	0	0	0
4	M81E0	30	I	6	86	6	0	0	0	0	0	0
4	M81E0	30	I	7	86	7	0	0	0	0	0	0
4	M81E0	30	I	8	84	6	0	0	0	0	0	0
4	M81E0	20	I	1	91	5	2	2	0	0	0	0

4	M81E0	20	I	2	99	7	0	0	0	0	0	0
4	M81E0	20	I	3	127	9	2	2	0	0	0	0
4	M81E0	20	I	4	91	6	0	0	0	0	0	0
4	M81E0	20	I	5	137	8	0	0	0	0	0	0
4	M81E1	20	I	6	81	6	0	0	0	0	0	0
4	M81E0	20	I	7	107	8	0	0	0	0	2	0
4	M81E0	20	I	8	84	6	0	0	0	0	0	0
4	1130	40	I	1	97	7	0	0	0	0	0	0
4	1130	40	I	2	89	5	2	0	0	0	0	0
4	1130	40	I	3	117	7	0	0	0	0	0	0
4	1130	40	I	4	104	6	0	0	0	0	0	0
4	1130	40	I	5	127	9	0	0	0	0	0	0
4	1130	40	I	6	140	10	0	0	0	0	0	0
4	1130	40	I	7	81	6	0	0	0	0	0	0
4	1130	40	I	8	117	10	0	0	0	0	0	0
4	1130	10	I	1	94	7	0	0	0	0	0	0
4	1130	10	I	2	84	5	0	0	0	0	0	0
4	1130	10	I	3	102	8	0	0	0	0	0	0
4	1130	10	I	4	61	5	0	0	0	0	0	0
4	1130	10	I	5	86	6	0	0	0	0	0	0
4	1130	10	I	6	99	6	0	0	0	0	0	0
4	1130	10	I	7	84	6	0	0	0	0	0	0
4	1130	10	I	8	97	7	0	0	0	0	0	0

4	1130	30	I	1	130	8	1	0	0	0	0	0
4	1130	30	I	2	66	4	0	0	0	0	0	0
4	1130	30	I	3	91	8	0	0	0	0	0	0
4	1130	30	I	4	122	10	1	0	0	0	0	0
4	1130	30	I	5	69	5	0	0	0	0	0	0
4	1130	30	I	6	86	6	3	0	0	0	0	0
4	1130	30	I	7	91	8	0	0	0	0	0	0
4	1130	30	I	8	137	7	0	0	0	0	0	0
4	1130	20	I	1	38	3	0	0	0	0	0	0
4	1130	20	I	2	142	11	3	1	0	0	0	0
4	1130	20	I	3	94	6	0	0	0	0	0	0
4	1130	20	I	4	130	10	0	0	0	0	0	0
4	1130	20	I	5	81	6	1	0	0	0	0	0
4	1130	20	I	6	147	12	1	0	0	0	0	0
4	1130	20	I	7	119	6	0	0	0	0	0	0
4	1130	20	I	8	119	8	1	0	0	0	0	0
4	10020	30	II	1	117	9	5	0	0	0	0	0
4	10020	30	II	2	112	6	0	0	0	0	0	0
4	10020	30	II	3	91	6	0	0	0	0	0	0
4	10020	30	II	4	89	7	3	3	0	0	0	0
4	10020	30	II	5	127	8	1	0	0	0	0	0
4	10020	30	II	6	122	8	0	0	0	0	0	0
4	10020	30	II	7	114	8	4	2	0	0	0	0

4	10020	30	II	8	64	5	1	0	0	0	0	0
4	10020	40	II	1	127	8	0	0	0	0	0	0
4	10020	40	II	2	97	6	0	0	0	0	0	0
4	10020	40	II	3	112	6	1	0	0	0	0	0
4	10020	40	II	4	109	6	0	0	0	0	0	0
4	10020	40	II	5	122	7	0	0	0	0	0	0
4	10020	40	II	6	107	7	0	0	0	0	0	0
4	10020	40	II	7	142	8	1	1	0	0	0	0
4	10020	40	II	8	137	9	3	0	0	0	0	0
4	10020	20	II	1	99	7	0	0	0	0	0	0
4	10020	20	II	2	91	7	0	0	0	0	0	0
4	10020	20	II	3	127	98	3	3	0	0	0	0
4	10020	20	II	4	142	12	0	0	0	0	0	0
4	10020	20	II	5	127	8	0	0	0	0	0	0
4	10020	20	II	6	112	7	0	0	0	0	0	0
4	10020	20	II	7	84	5	0	0	0	0	0	0
4	10020	20	II	8	127	8	0	0	0	0	0	0
4	10020	10	II	1	109	8	0	0	0	0	0	0
4	10020	10	II	2	119	7	0	0	0	0	0	0
4	10020	10	II	3	127	10	0	0	0	0	0	0
4	10020	10	II	4	114	8	0	0	0	0	0	0
4	10020	10	II	5	109	9	0	0	0	0	0	0
4	10020	10	II	6	99	6	0	0	0	0	0	0

4	10020	10	II	7	114	7	0	0	0	0	0	0
4	10020	10	II	8	119	8	0	0	0	0	0	0
4	M81E0	30	II	1	53	6	0	0	0	0	0	0
4	M81E0	30	II	2	81	6	0	0	0	0	0	0
4	M81E0	30	II	3	56	3	0	0	0	0	0	0
4	M81E0	30	II	4	69	5	0	0	0	0	0	0
4	M81E0	30	II	5	64	6	0	0	0	0	0	0
4	M81E0	30	II	6	66	4	0	0	0	0	0	0
4	M81E0	30	II	7	56	6	0	0	0	0	0	0
4	M81E0	30	II	8	66	6	0	0	0	0	1	0
4	M81E0	40	II	1	66	7	0	0	0	0	0	0
4	M81E1	40	II	2	58	4	0	0	0	0	0	0
4	M81E0	40	II	3	76	5	0	0	0	0	0	0
4	M81E0	40	II	4	69	6	0	0	0	0	0	0
4	M81E0	40	II	5	76	6	0	0	0	0	0	0
4	M81E0	40	II	6	86	7	0	0	0	0	0	0
4	M81E0	40	II	7	64	6	0	0	0	0	0	0
4	M81E0	40	II	8	58	5	1	0	0	0	0	0
4	M81E0	20	II	1	81	6	0	0	0	0	0	0
4	M81E0	20	II	2	91	6	0	0	0	0	0	0
4	M81E0	20	II	3	117	7	0	0	0	0	0	0
4	M81E0	20	II	4	71	6	0	0	0	0	0	0
4	M81E0	20	II	5	91	6	0	0	0	0	0	0

4	M81E0	20	II	6	69	6	0	0	0	0	1	0
4	M81E0	20	II	7	97	7	0	0	0	0	0	0
4	M81E0	20	II	8	91	7	0	0	0	0	0	0
4	M81E0	10	II	1	109	8	0	0	0	0	0	0
4	M81E0	10	II	2	66	5	0	0	0	0	0	0
4	M81E0	10	II	3	86	5	0	0	0	0	0	0
4	M81E0	10	II	4	112	7	0	0	0	0	0	0
4	M81E0	10	II	5	117	8	0	0	0	0	0	0
4	M81E0	10	II	6	137	8	0	0	0	0	0	0
4	M81E0	10	II	7	89	6	0	0	0	0	0	0
4	M81E0	10	II	8	89	7	0	0	0	0	0	0
4	51400	10	II	1	94	6	0	0	0	0	0	0
4	51400	10	II	2	97	7	0	0	0	0	0	0
4	51400	10	II	3	91	6	0	0	0	0	0	0
4	51400	10	II	4	89	6	0	0	0	0	0	0
4	51400	10	II	5	97	11	0	0	0	0	0	0
4	51400	10	II	6	117	5	0	0	0	0	0	0
4	51400	10	II	7	91	7	0	0	0	0	0	0
4	51400	10	II	8	124	8	0	0	0	0	0	0
4	51400	20	II	1	99	7	0	0	0	0	0	0
4	51400	20	II	2	124	10	0	0	0	0	0	0
4	51400	20	II	3	127	11	0	0	0	0	0	0
4	51400	20	II	4	102	8	0	0	0	0	0	0

4	51400	20	II	5	91	8	0	0	0	0	0	0
4	51400	20	II	6	94	8	0	0	0	0	4	0
4	51400	20	II	7	122	9	0	0	0	0	0	0
4	51400	20	II	8	102	8	0	0	0	0	0	0
4	51400	40	II	1	99	7	0	0	0	0	0	0
4	51400	40	II	2	114	11	1	0	0	0	0	0
4	51400	40	II	3	119	9	0	0	0	0	0	0
4	51400	40	II	4	99	13	0	0	0	0	0	0
4	51400	40	II	5	94	8	0	0	0	0	0	0
4	51400	40	II	6	79	8	0	0	0	0	0	0
4	51400	40	II	7	109	12	0	0	0	0	0	0
4	51400	40	II	8	124	10	0	0	0	0	0	0
4	51400	30	II	1	107	7	0	0	0	0	0	0
4	51400	30	II	2	86	7	0	0	0	0	0	0
4	51400	30	II	3	71	5	0	0	0	0	2	0
4	51400	30	II	4	94	6	0	0	0	0	1	0
4	51400	30	II	5	104	11	0	0	0	0	0	0
4	51400	30	II	6	79	9	0	0	0	0	0	0
4	51400	30	II	7	79	8	0	0	0	0	0	0
4	51400	30	II	8	79	8	0	0	0	0	0	0
4	1130	30	II	1	104	10	1	0	0	0	0	0
4	1130	30	II	2	109	8	1	0	0	0	0	0
4	1130	30	II	3	94	8	0	0	0	0	0	0

4	1130	30	II	4	76	6	1	1	0	0	0	0
4	1130	30	II	5	107	10	1	0	0	0	0	0
4	1130	30	II	6	119	8	0	0	0	0	0	0
4	1130	30	II	7	76	7	2	0	0	0	0	0
4	1130	30	II	8	152	9	0	0	0	0	0	0
4	1130	40	II	1	104	7	0	0	0	0	0	0
4	1130	40	II	2	117	9	2	0	0	0	0	0
4	1130	40	II	3	117	7	0	0	0	0	0	0
4	1130	40	II	4	124	10	0	0	0	0	0	0
4	1130	40	II	5	107	8	1	0	0	0	0	0
4	1130	40	II	6	124	8	0	0	0	0	0	0
4	1130	40	II	7	119	9	2	0	0	0	0	0
4	1130	40	II	8	127	7	0	0	0	0	0	0
4	1130	20	II	1	130	9	0	0	0	0	0	0
4	1130	20	II	2	122	7	0	0	0	0	0	0
4	1130	20	II	3	124	8	0	0	0	0	0	0
4	1130	20	II	4	89	6	0	0	0	0	0	0
4	1130	20	II	5	117	8	0	0	0	0	0	0
4	1130	20	II	6	91	6	0	0	0	0	0	0
4	1130	20	II	7	127	7	2	0	0	0	0	0
4	1130	20	II	8	109	8	0	0	0	0	0	0
4	1130	10	II	1	112	8	0	0	0	0	0	0
4	1130	10	II	2	119	6	0	0	0	0	0	0

4	1130	10	II	3	79	6	0	0	0	0	0	0
4	1130	10	II	4	114	10	0	0	0	0	0	0
4	1130	10	II	5	117	9	0	0	0	0	0	0
4	1130	10	II	6	99	8	0	0	0	0	0	0
4	1130	10	II	7	97	6	0	0	0	0	0	0
4	1130	10	II	8	97	7	0	0	0	0	0	0
4	8450	10	II	1	86	6	0	0	0	0	0	0
4	8450	10	II	2	71	6	0	0	0	0	0	0
4	8450	10	II	3	97	9	0	0	0	0	0	0
4	8450	10	II	4	127	8	0	0	0	0	0	0
4	8450	10	II	5	94	8	0	0	0	0	0	0
4	8450	10	II	6	107	9	0	0	0	0	0	0
4	8450	10	II	7	114	9	0	0	0	0	0	0
4	8450	10	II	8	104	8	0	0	0	0	0	0
4	8450	20	II	1	91	8	0	0	0	0	0	0
4	8450	20	II	2	104	8	0	0	0	0	0	0
4	8450	20	II	3	64	9	0	0	0	0	0	0
4	8450	20	II	4	94	12	0	0	0	0	0	0
4	8450	20	II	5	122	10	0	0	0	0	0	0
4	8450	20	II	6	119	11	0	0	0	0	0	0
4	8450	20	II	7	102	7	0	0	0	0	1	0
4	8450	20	II	8	99	7	1	1	0	0	0	0
4	8450	40	II	1	99	9	0	0	0	0	0	0

4	8450	40	II	2	97	8	0	0	0	0	0	0
4	8450	40	II	3	94	7	0	0	0	0	0	0
4	8450	40	II	4	89	8	0	0	0	0	0	0
4	8450	40	II	5	91	6	0	0	0	0	0	0
4	8450	40	II	6	99	7	2	0	0	0	0	0
4	8450	40	II	7	107	8	0	0	0	0	0	0
4	8450	40	II	8	117	9	0	0	0	0	0	0
4	8450	30	II	1	76	5	0	0	0	0	0	0
4	8450	30	II	2	94	8	1	0	0	0	0	0
4	8450	30	II	3	76	8	0	0	0	0	0	0
4	8450	30	II	4	76	6	0	0	0	0	0	0
4	8450	30	II	5	76	6	0	0	0	0	0	0
4	8450	30	II	6	76	6	1	0	0	0	0	0
4	8450	30	II	7	74	6	0	0	0	0	0	0
4	8450	30	II	8	97	6	0	0	0	0	0	0
4	52000	30	II	1	107	11	0	0	0	0	0	0
4	52000	30	II	2	107	11	0	0	0	0	12	0
4	52000	30	II	3	89	11	0	0	0	0	0	0
4	52000	30	II	4	94	10	0	0	0	0	0	0
4	52000	30	II	5	66	8	0	0	0	0	0	0
4	52000	30	II	6	107	9	0	0	0	0	0	0
4	52000	30	II	7	97	7	0	0	0	0	0	0
4	52000	30	II	8	112	11	0	0	0	0	2	0

4	52000	40	II	1	89	8	0	0	0	0	0	0
4	52000	40	II	2	97	7	0	0	0	0	0	0
4	52000	40	II	3	124	7	0	0	0	0	0	0
4	52000	40	II	4	89	9	0	0	0	0	0	0
4	52000	40	II	5	89	7	0	0	0	0	0	0
4	52000	40	II	6	114	10	0	0	0	0	0	0
4	52000	40	II	7	91	8	0	0	0	0	0	0
4	52000	40	II	8	99	8	0	0	0	0	10	0
4	52000	20	II	1	76	8	0	0	0	0	0	0
4	52000	20	II	2	94	8	0	0	0	0	3	0
4	52000	20	II	3	89	7	0	0	0	0	0	0
4	52000	20	II	4	89	7	0	0	0	0	0	0
4	52000	20	II	5	81	6	0	0	0	0	0	0
4	52000	20	II	6	97	7	0	0	0	0	2	0
4	52000	20	II	7	89	7	1	1	0	0	0	0
4	52000	20	II	8	97	7	0	0	0	0	0	0
4	52000	10	II	1	89	8	0	0	0	0	0	0
4	52000	10	II	2	91	11	0	0	0	0	0	0
4	52000	10	II	3	84	7	0	0	0	0	0	0
4	52000	10	II	4	97	8	0	0	0	0	0	0
4	52000	10	II	5	94	6	0	0	0	0	0	0
4	52000	10	II	6	89	8	0	0	0	0	0	0
4	52000	10	II	7	97	9	0	0	0	0	0	0

4	52000	10	II	8	94	7	0	0	0	0	0	0
4	8380	10	II	1	74	7	0	0	0	0	0	0
4	8380	10	II	2	89	8	0	0	0	0	0	0
4	8380	10	II	3	86	8	0	0	0	0	0	0
4	8380	10	II	4	84	9	0	0	0	0	0	0
4	8380	10	II	5	86	10	0	0	0	0	0	0
4	8380	10	II	6	94	7	1	0	0	0	0	0
4	8380	10	II	7	71	6	0	0	0	0	0	0
4	8380	10	II	8	74	6	0	0	0	0	0	0
4	8380	20	II	1	69	7	0	0	0	0	0	0
4	8381	20	II	2	91	9	1	0	0	0	0	0
4	8380	20	II	3	79	9	0	0	0	0	0	0
4	8380	20	II	4	79	9	0	0	0	0	0	0
4	8380	20	II	5	86	8	1	0	0	0	0	0
4	8380	20	II	6	69	6	1	1	0	0	0	0
4	8380	20	II	7	56	7	0	0	0	0	0	0
4	8380	20	II	8	71	7	0	0	0	0	0	0
4	8380	40	II	1	79	9	0	0	0	0	0	0
4	8380	40	II	2	89	11	0	0	0	0	0	0
4	8380	40	II	3	84	10	1	0	0	0	0	0
4	8380	40	II	4	99	10	0	0	0	0	0	0
4	8380	40	II	5	102	10	0	0	0	0	0	0
4	8380	40	II	6	74	8	2	2	0	0	0	0

4	8380	40	II	7	74	8	0	0	0	0	0	0
4	8380	40	II	8	94	8	0	0	0	0	0	0
4	8380	30	II	1	89	9	0	0	0	0	0	0
4	8380	30	II	2	76	7	0	0	0	0	0	0
4	8380	30	II	3	86	7	0	0	0	0	0	0
4	8380	30	II	4	84	7	0	0	0	0	0	0
4	8380	30	II	5	71	8	0	0	0	0	0	0
4	8380	30	II	6	74	7	1	1	0	0	0	0
4	8380	30	II	7	81	8	0	0	0	0	0	0
4	8380	30	II	8	74	7	0	0	0	0	0	0
4	10020	20	III	1	45	10	0	0	0	0	0	0
4	10020	20	III	2	97	6	0	0	0	0	0	0
4	10020	20	III	3	117	9	4	0	0	0	0	0
4	10020	20	III	4	112	6	0	0	0	0	0	0
4	10020	20	III	5	104	6	0	0	0	0	0	0
4	10020	20	III	6	94	8	0	0	0	0	0	0
4	10020	20	III	7	137	8	1	0	0	0	0	0
4	10020	20	III	8	107	7	0	0	0	0	0	0
4	10020	30	III	1	107	7	1	1	0	0	0	0
4	10020	30	III	2	109	9	0	0	0	0	0	0
4	10020	30	III	3	107	9	0	0	0	0	0	0
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4	10020	30	III	6	114	8	0	0	0	0	0	0
4	10020	30	III	7	124	7	0	0	0	0	0	0
4	10020	30	III	8	117	11	0	0	0	0	0	0
4	10020	10	III	1	81	10	0	0	0	0	0	0
4	10020	10	III	2	122	10	0	0	0	0	0	0
4	10020	10	III	3	91	6	0	0	0	0	0	0
4	10020	10	III	4	109	6	0	0	0	0	0	0
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4	10020	10	III	6	127	10	0	0	0	0	0	0
4	10020	10	III	7	107	7	0	0	0	0	0	0
4	10020	10	III	8	152	8	1	0	0	0	0	0
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4	10020	40	III	2	89	8	0	0	0	0	0	0
4	10020	40	III	3	135	12	4	2	0	0	0	0
4	10020	40	III	4	132	8	0	0	0	0	0	0
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4	10020	40	III	6	137	8	0	0	0	0	0	0
4	10020	40	III	7	142	8	0	0	0	0	0	0
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4	51400	40	III	1	114	8	1	0	0	0	0	0
4	51400	40	III	2	104	8	0	0	0	0	0	0
4	51400	40	III	3	99	9	0	0	0	0	0	0
4	51400	40	III	4	99	7	0	0	0	0	0	0

4	51400	40	III	5	99	8	0	0	0	0	5	0
4	51400	40	III	6	117	9	0	0	0	0	0	0
4	51400	40	III	7	89	7	0	0	0	0	0	0
4	51400	40	III	8	112	10	0	0	0	0	0	0
4	51400	10	III	1	119	10	0	0	0	0	0	0
4	51400	10	III	2	127	9	0	0	0	0	0	0
4	51400	10	III	3	135	10	0	0	0	0	0	0
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4	51400	10	III	6	137	7	0	0	0	0	0	0
4	51400	10	III	7	132	10	0	0	0	0	0	0
4	51400	10	III	8	94	8	0	0	0	0	0	0
4	51400	30	III	1	109	8	0	0	0	0	0	0
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4	51400	30	III	4	97	9	0	0	0	0	0	0
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4	51400	30	III	7	114	8	0	0	0	0	0	0
4	51400	30	III	8	127	3	0	0	0	0	0	0
4	51400	20	III	1	102	8	0	0	0	0	0	0
4	51400	20	III	2	104	9	0	0	0	0	0	0
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4	51400	20	III	6	124	10	0	0	0	0	0	0
4	51400	20	III	7	109	10	0	0	0	0	0	0
4	51400	20	III	8	127	8	0	0	0	0	0	0
4	M81E0	20	III	1	89	6	0	0	0	0	0	0
4	M81E0	20	III	2	102	8	0	0	0	0	0	0
4	M81E0	20	III	3	104	7	0	0	0	0	0	0
4	M81E0	20	III	4	97	5	0	0	0	0	0	0
4	M81E0	20	III	5	109	8	0	0	0	0	0	0
4	M81E0	20	III	6	97	7	0	0	0	0	0	0
4	M81E0	20	III	7	119	5	0	0	0	0	0	0
4	M81E0	20	III	8	91	8	0	0	0	0	0	0
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4	M81E0	30	III	2	109	7	0	0	0	0	0	0
4	M81E0	30	III	3	124	8	0	0	0	0	0	0
4	M81E0	30	III	4	127	6	0	0	0	0	0	0
4	M81E0	30	III	5	107	6	0	0	0	0	0	0
4	M81E0	30	III	6	89	6	0	0	0	0	0	0
4	M81E0	30	III	7	107	6	0	0	0	0	0	0
4	M81E0	30	III	8	102	8	0	0	0	0	1	0
4	M81E0	10	III	1	94	5	0	0	0	0	0	0
4	M81E0	10	III	2	114	7	2	0	0	0	0	0

4	M81E0	10	III	3	117	8	0	0	0	0	0	0
4	M81E0	10	III	4	130	9	0	0	0	0	0	0
4	M81E0	10	III	5	107	7	0	0	0	0	0	0
4	M81E0	10	III	6	104	7	0	0	0	0	0	0
4	M81E0	10	III	7	99	7	0	0	0	0	0	0
4	M81E0	10	III	8	104	7	0	0	0	0	0	0
4	M81E0	40	III	1	107	7	0	0	0	0	0	0
4	M81E0	40	III	2	89	8	0	0	0	0	0	0
4	M81E1	40	III	3	104	8	0	0	0	0	0	0
4	M81E0	40	III	4	91	6	0	0	0	0	0	0
4	M81E0	40	III	5	107	7	0	0	0	0	0	0
4	M81E0	40	III	6	91	6	0	0	0	0	0	0
4	M81E0	40	III	7	107	6	0	0	0	0	0	0
4	M81E0	40	III	8	104	7	0	0	0	0	0	0
4	8380	40	III	1	102	11	0	0	0	0	0	0
4	8380	40	III	2	84	16	0	0	0	0	0	0
4	8380	40	III	3	89	7	0	0	0	0	0	0
4	8380	40	III	4	76	6	0	0	0	0	0	0
4	8380	40	III	5	66	7	1	0	0	0	0	0
4	8380	40	III	6	76	6	0	0	0	0	0	0
4	8380	40	III	7	89	8	1	0	0	0	0	0
4	8380	40	III	8	89	6	0	0	0	0	0	0
4	8380	10	III	1	94	8	0	0	0	0	0	0

4	8380	10	III	2	91	7	0	0	0	0	0	0
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4	8380	10	III	4	76	7	0	0	0	0	0	0
4	8380	10	III	5	74	7	0	0	0	0	0	0
4	8380	10	III	6	89	7	0	0	0	0	0	0
4	8380	10	III	7	107	10	0	0	0	0	0	0
4	8380	10	III	8	74	8	0	0	0	0	0	0
4	8380	30	III	1	89	8	0	0	0	0	0	0
4	8380	30	III	2	56	6	0	0	0	0	0	0
4	8380	30	III	3	76	7	0	0	0	0	0	0
4	8380	30	III	4	56	6	0	0	0	0	0	0
4	8380	30	III	5	61	6	0	0	0	0	0	0
4	8380	30	III	6	89	8	0	0	0	0	0	0
4	8380	30	III	7	69	7	0	0	0	0	0	0
4	8380	30	III	8	81	9	0	0	0	0	0	0
4	8380	20	III	1	79	8	0	0	0	0	0	0
4	8380	20	III	2	69	8	0	0	0	0	0	0
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4	8380	20	III	4	89	9	0	0	0	0	0	0
4	8380	20	III	5	86	7	0	0	0	0	0	0
4	8380	20	III	6	74	7	0	0	0	0	0	0
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4	8450	20	III	1	81	8	0	0	0	0	0	0
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4	8450	20	III	3	86	8	0	0	0	0	0	0
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4	8450	30	III	3	74	7	0	0	0	0	0	0
4	8450	30	III	4	79	8	0	0	0	0	0	0
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4	8450	10	III	1	71	6	0	0	0	0	0	0
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4	8450	40	III	6	81	7	0	0	0	0	0	0
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4	8450	40	III	8	76	8	0	0	0	0	0	0
4	52000	40	III	1	137	9	0	0	0	0	0	0
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4	52000	40	III	7	130	9	0	0	0	0	0	0
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4	52000	10	III	2	127	11	0	0	0	0	0	0
4	52000	10	III	3	117	8	0	0	0	0	0	0
4	52000	10	III	4	94	7	0	0	0	0	0	0
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4	52000	30	III	1	109	7	0	0	0	0	0	0
4	52000	30	III	2	117	10	1	0	0	0	0	0
4	52000	30	III	3	122	9	0	0	0	0	0	0
4	52000	30	III	4	91	11	0	0	0	0	0	0
4	52000	32 I IN SHEATH	III	5	130	8	2	0	0	0	0	0
4	52000	30	III	6	102	7	0	0	0	0	0	0
4	52003	30	III	7	84	8	0	0	0	0	0	0
4	52000	30	III	8	102	8	0	0	0	0	0	0
4	52000	20	III	1	89	5	0	0	0	0	0	0
4	52000	20	III	2	104	9	0	0	0	0	0	0
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4	1130	20	III	3	109	4	0	0	0	0	0	0
4	1130	20	III	4	84	6	1	0	0	0	0	0
4	1130	20	III	5	81	5	0	0	0	0	0	0

4	1130	20	III	6	102	8	1	0	0	0	0	0
4	1130	20	III	7	109	4	0	0	0	0	0	0
4	1130	20	III	8	79	6	1	1	0	0	0	0
4	1130	30	III	1	107	7	0	0	0	0	0	0
4	1130	30	III	2	112	6	0	0	0	0	0	0
4	1130	30	III	3	112	7	0	0	0	0	0	0
4	1130	30	III	4	81	5	1	1	0	0	0	0
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4	1130	10	III	4	132	7	0	0	0	0	0	0
4	1130	10	III	5	119	10	3	0	0	0	0	0
4	1130	10	III	6	89	4	0	0	0	0	0	0
4	1130	10	III	7	142	9	0	0	0	0	0	0
4	1130	10	III	8	132	9	0	0	0	0	0	0
4	1130	40	III	1	112	7	0	0	0	0	0	0
4	1130	40	III	2	119	9	0	0	0	0	0	0
4	1130	40	III	3	81	6	0	0	0	0	0	0
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4	1130	40	III	5	119	8	0	0	0	0	0	0
4	1130	40	III	6	109	8	0	0	0	0	0	0
4	1130	40	III	7	94	6	0	0	0	0	0	0
4	1130	40	III	8	145	7	1	0	0	0	0	0
5	8450	40	I	1	117	11	0	0	0	0	0	0
5	8450	40	I	2	107	14	0	0	0	0	0	0
5	8450	40	I	3	142	14	3	3	0	0	0	0
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5	8450	40	I	5	91	14	0	0	0	0	0	0
5	8450	40	I	6	114	11	2	2	0	0	0	0
5	8450	40	I	7	119	10	0	0	0	0	0	0
5	8450	40	I	8	142	13	2	2	0	0	0	0
5	8450	10	I	1	137	13	0	0	0	0	0	0
5	8450	10	I	2	117	14	0	0	0	0	0	0
5	8450	10	I	3	112	10	0	0	0	0	0	0
5	8450	10	I	4	122	16	0	0	0	0	0	0
5	8450	10	I	5	86	8	0	0	0	0	0	0
5	8450	10	I	6	140	14	0	0	0	0	0	0
5	8450	10	I	7	117	14	0	0	0	0	0	0
5	8450	10	I	8	107	14	0	0	0	0	0	0
5	8450	30	I	1	119	12	0	0	0	0	0	0
5	8450	30	I	2	102	12	0	0	0	0	0	0
5	8450	30	I	3	109	15	0	0	0	0	0	0

5	8450	30	I	4	117	13	0	0	0	0	0	0
5	8450	30	I	5	122	13	0	0	0	0	0	0
5	8450	30	I	6	109	13	0	0	0	0	0	0
5	8450	30	I	7	89	10	0	0	0	0	0	0
5	8450	30	I	8	145	13	0	0	0	0	0	0
5	8450	20	I	1	94	10	0	0	0	0	0	0
5	8450	20	I	2	94	10	0	0	0	0	0	0
5	8450	20	I	3	97	8	0	0	0	0	0	0
5	8450	20	I	4	119	11	0	0	0	0	0	0
5	8450	20	I	5	112	12	0	0	0	0	0	0
5	8450	20	I	6	107	7	0	0	0	0	0	0
5	8450	20	I	7	140	9	0	0	0	0	0	0
5	8450	20	I	8	97	13	0	0	0	0	0	0
5	10020	30	I	1	188	13	0	0	0	0	0	0
5	10020	30	I	2	127	8	0	0	0	0	0	0
5	10020	30	I	3	150	11	0	0	0	0	0	0
5	10020	30	I	4	137	10	0	0	0	0	0	0
5	10020	30	I	5	147	10	0	0	0	0	0	0
5	10020	30	I	6	132	11	0	0	0	0	0	0
5	10020	30	I	7	145	10	0	0	0	0	0	0
5	10020	30	I	8	117	8	0	0	0	0	0	0
5	10020	20	I	1	112	63	0	0	0	0	0	0
5	10020	20	I	2	117	8	1	1	0	0	0	0

5	10020	20	I	3	124	10	0	0	0	0	0	0
5	10020	20	I	4	137	10	0	0	0	0	0	0
5	10020	20	I	5	122	9	1	1	0	0	0	0
5	10020	20	I	6	119	6	0	0	0	0	0	0
5	10020	20	I	7	107	8	0	0	0	0	0	0
5	10020	20	I	8	142	8	0	0	0	0	0	0
5	10020	40	I	1	140	8	0	0	0	0	0	0
5	10020	40	I	2	175	11	0	0	0	0	0	0
5	10020	40	I	3	173	15	0	0	0	0	0	0
5	10020	40	I	4	91	6	0	0	0	0	0	0
5	10020	40	I	5	183	10	0	0	0	0	0	0
5	10020	40	I	6	173	11	1	1	0	0	0	2
5	10020	40	I	7	208	14	2	2	0	0	0	0
5	10020	40	I	8	150	8	0	0	0	0	0	0
5	10020	10	I	1	137	10	0	0	0	0	0	0
5	10020	10	I	2	142	9	0	0	0	0	0	0
5	10020	10	I	3	152	8	0	0	0	0	0	0
5	10020	10	I	4	185	12	0	0	0	0	0	0
5	10020	10	I	5	122	7	0	0	0	0	0	0
5	10020	10	I	6	142	12	0	0	0	0	0	0
5	10020	10	I	7	142	9	0	0	0	0	0	0
5	10020	10	I	8	157	11	0	0	0	0	0	0
5	52000	10	I	1	157	12	0	0	0	0	0	0

5	52000	10	I	2	160	12	0	0	0	0	0	0
5	52000	10	I	3	117	12	0	0	0	0	10	0
5	52000	10	I	4	142	13	0	0	0	0	0	0
5	52000	10	I	5	135	12	0	0	0	0	0	0
5	52000	10	I	6	173	10	0	0	0	0	0	0
5	52000	10	I	7	155	13	2	2	0	0	0	0
5	52000	10	I	8	97	12	0	0	0	0	3	0
5	52000	40	I	1	135	11	0	0	0	0	4	0
5	52001	40	I	2	183	13	0	0	0	0	0	0
5	52000	40	I	3	9	8	0	0	0	0	0	0
5	52000	40	I	4	173	16	1	1	0	0	0	0
5	52000	40	I	5	170	12	0	0	0	0	3	0
5	52000	40	I	6	178	12	1	1	0	0	2	0
5	52000	40	I	7	142	11	4	3	0	0	0	0
5	52000	40	I	8	198	11	0	0	0	0	3	0
5	52000	20	I	1	124	10	1	1	0	0	5	0
5	52000	20	I	2	142	11	0	0	0	0	0	0
5	52000	20	I	3	117	12	1	1	0	0	0	0
5	52000	20	I	4	132	8	0	0	0	0	0	0
5	52000	20	I	5	127	12	0	0	0	0	0	0
5	52000	20	I	6	140	10	1	1	0	0	0	0
5	52002	20	I	7	117	12	0	0	0	0	0	0
5	52000	20	I	8	114	8	0	0	0	0	0	0

5	52001	30	I	1	157	14	0	0	0	0	0	0
5	52000	30	I	2	140	15	0	0	0	0	0	0
5	52000	30	I	3	130	12	0	0	0	0	0	0
5	52000	30	I	4	130	11	0	0	0	0	0	0
5	52000	30	I	5	117	10	0	0	0	0	10	0
5	52000	30	I	6	127	10	0	0	0	0	20	0
5	52001	30	I	7	137	12	1	1	0	0	5	0
5	52000	30	I	8	127	12	0	0	0	0	15	0
5	8380	30	I	1	132	13	0	0	0	0	0	0
5	8380	30	I	2	155	15	0	0	0	0	0	0
5	8380	30	I	3	168	15	0	0	0	0	0	0
5	8380	30	I	4	127	10	0	0	0	0	0	0
5	8380	30	I	5	130	7	0	0	0	0	0	0
5	8380	30	I	6	150	14	0	0	0	0	0	0
5	8380	30	I	7	157	13	1	0	0	0	0	0
5	8380	30	I	8	160	18	2	2	0	0	0	0
5	8380	20	I	1	122	13	1	0	0	0	0	0
5	8380	20	I	2	155	13	0	0	0	0	0	0
5	8380	20	I	3	147	15	0	0	0	0	0	0
5	8380	20	I	4	145	8	0	0	0	0	0	0
5	8380	20	I	5	150	18	0	0	0	0	0	0
5	8380	20	I	6	150	14	0	0	0	0	0	0
5	8380	20	I	7	142	15	0	0	0	0	0	0

5	8380	20	I	8	132	11	0	0	0	0	0	0
5	8380	40	I	1	124	9	0	0	0	0	0	0
5	8380	40	I	2	135	13	0	0	0	0	0	0
5	8380	40	I	3	178	16	0	0	0	0	0	2
5	8380	40	I	4	137	11	0	0	0	0	0	0
5	8380	40	I	5	157	12	1	0	0	0	0	0
5	8380	40	I	6	157	14	0	0	0	0	0	0
5	8380	40	I	7	183	15	0	0	0	0	0	0
5	8380	40	I	8	170	14	0	0	0	0	0	0
5	8380	10	I	1	127	10	0	0	0	0	0	0
5	8380	10	I	2	173	16	0	0	0	0	0	0
5	8380	10	I	3	157	15	0	0	0	0	0	0
5	8380	10	I	4	160	18	0	0	0	0	0	0
5	8380	10	I	5	150	7	0	0	0	0	0	0
5	8380	10	I	6	147	13	0	0	0	0	0	0
5	8380	10	I	7	147	9	0	0	0	0	0	0
5	8380	10	I	8	142	12	0	0	0	0	0	0
5	M81E0	10	I	1	117	9	0	0	0	0	0	0
5	M81E0	10	I	2	157	12	0	0	0	0	0	0
5	M81E0	10	I	3	178	12	0	0	0	0	0	0
5	M81E0	10	I	4	173	14	0	0	0	0	0	0
5	M81E0	10	I	5	142	8	0	0	0	0	0	0
5	M81E0	10	I	6	165	11	0	0	0	0	0	0

5	M81E0	10	I	7	188	15	0	0	0	0	0	0
5	M81E0	10	I	8	203	14	0	0	0	0	0	0
5	M81E0	40	I	1	203	14	0	0	0	0	0	0
5	M81E0	40	I	2	203	14	0	0	0	0	0	0
5	M81E0	40	I	3	234	13	1	1	0	0	0	0
5	M81E0	40	I	4	234	14	0	0	0	0	0	0
5	M81E0	40	I	5	183	10	0	0	0	0	0	0
5	M81E0	40	I	6	163	10	0	0	0	0	0	0
5	M81E0	40	I	7	185	17	3	2	0	0	0	0
5	M81E1	40	I	8	150	9	0	0	0	0	0	0
5	M81E0	20	I	1	147	12	0	0	0	0	1	0
5	M81E0	20	I	2	152	10	0	0	0	0	0	0
5	M81E0	20	I	3	178	15	1	1	0	0	5	0
5	M81E0	20	I	4	124	8	1	1	0	0	0	0
5	M81E0	20	I	5	160	13	0	0	0	0	0	0
5	M81E0	20	I	6	203	14	0	0	0	0	0	0
5	M81E0	20	I	7	157	12	2	1	0	0	0	0
5	M81E0	20	I	8	137	10	0	0	0	0	0	0
5	M81E0	30	I	1	155	12	0	0	0	0	0	0
5	M81E0	30	I	2	117	8	0	0	0	0	0	0
5	M81E0	30	I	3	142	8	1	1	0	0	0	0
5	M81E0	30	I	4	142	12	1	1	0	0	0	0
5	M81E0	30	I	5	117	8	0	0	0	0	0	0

5	M81E0	30	I	6	130	11	0	0	0	0	0	0
5	M81E0	30	I	7	122	9	0	0	0	0	0	0
5	M81E0	30	I	8	198	11	0	0	0	0	0	0
5	1130	30	I	1	140	9	0	0	0	0	0	0
5	1130	30	I	2	127	9	2	0	0	0	0	0
5	1130	30	I	3	140	10	0	0	0	0	0	0
5	1130	30	I	4	155	11	0	0	0	0	0	0
5	1130	30	I	5	127	10	1	0	0	0	0	0
5	1130	30	I	6	142	9	4	3	0	0	0	0
5	1130	30	I	7	135	8	0	0	0	0	0	0
5	1130	30	I	8	135	10	0	0	0	0	0	0
5	1130	20	I	1	117	9	0	0	0	0	0	0
5	1130	20	I	2	102	10	0	0	0	0	0	0
5	1130	20	I	3	147	13	1	0	0	0	10	0
5	1130	20	I	4	132	10	0	0	0	0	0	0
5	1130	20	I	5	102	7	0	0	0	0	0	0
5	1130	20	I	6	74	12	0	0	0	0	0	0
5	1130	20	I	7	147	11	0	0	0	0	1	0
5	1130	20	I	8	107	12	0	0	0	0	0	0
5	1130	40	I	1	122	9	0	0	0	0	0	0
5	1130	40	I	2	173	13	0	0	0	0	0	0
5	1130	40	I	3	122	11	0	0	0	0	0	0
5	1130	40	I	4	168	14	0	0	0	0	0	0

5	1130	40	I	5	145	11	0	0	0	0	0	0
5	1130	40	I	6	112	6	2	1	0	0	0	0
5	1130	40	I	7	175	12	0	0	0	0	0	0
5	1130	40	I	8	74	7	0	0	0	0	0	0
5	1130	10	I	1	157	12	1	1	0	0	0	0
5	1130	10	I	2	140	11	0	0	0	0	0	0
5	1130	10	I	3	157	12	0	0	0	0	0	0
5	1130	10	I	4	142	12	0	0	0	0	0	0
5	1130	10	I	5	127	13	0	0	0	0	0	0
5	1130	10	I	6	102	5	0	0	0	0	0	0
5	1130	10	I	7	130	8	0	0	0	0	0	0
5	1130	10	I	8	135	10	0	0	0	0	0	0
5	51400	20	I	1	127	12	0	0	0	0	0	0
5	51400	20	I	2	137	8	0	0	0	0	0	0
5	51400	20	I	3	117	15	0	0	0	0	0	0
5	51400	20	I	4	142	13	0	0	0	0	0	0
5	51400	20	I	5	140	15	0	0	0	0	0	0
5	51400	20	I	6	137	10	0	0	0	0	0	0
5	51400	20	I	7	137	14	0	0	0	0	0	0
5	51400	20	I	8	142	14	0	0	0	0	0	0
5	51400	30	I	1	142	15	0	0	0	0	0	0
5	51400	30	I	2	107	14	0	0	0	0	0	0
5	51400	30	I	3	117	12	0	0	0	0	0	0

5	51400	30	I	4	152	14	0	0	0	0	0	0
5	51400	30	I	5	99	8	0	0	0	0	0	0
5	51400	30	I	6	99	8	0	0	0	0	0	0
5	51400	30	I	7	142	11	0	0	0	0	0	0
5	51400	30	I	8	140	12	0	0	0	0	0	0
5	51400	10	I	1	140	14	0	0	0	0	0	0
5	51400	10	I	2	137	13	0	0	0	0	0	0
5	51400	10	I	3	145	15	0	0	0	0	0	0
5	51400	10	I	4	140	10	0	0	0	0	0	0
5	51400	10	I	5	137	12	0	0	0	0	0	0
5	51400	10	I	6	147	12	0	0	0	0	0	0
5	51400	10	I	7	160	13	0	0	0	0	0	0
5	51400	10	I	8	142	10	0	0	0	0	0	0
5	51400	40	I	1	127	10	0	0	0	0	0	0
5	51400	40	I	2	157	15	0	0	0	0	0	0
5	51400	40	I	3	173	14	0	0	0	0	0	0
5	51400	40	I	4	183	15	0	0	0	0	0	0
5	51400	40	I	5	147	10	0	0	0	0	0	0
5	51400	40	I	6	163	10	0	0	0	0	0	0
5	51400	40	I	7	173	12	0	0	0	0	0	0
5	51400	40	I	8	157	12	0	0	0	0	0	0
5	8380	20	II	1	84	8	0	0	0	0	0	0
5	8380	20	II	2	91	7	0	0	0	0	0	0

5	8380	20	II	3	127	10	0	0	0	0	0	0
5	8380	20	II	4	112	9	0	0	0	0	0	0
5	8380	20	II	5	107	14	0	0	0	0	0	0
5	8380	20	II	6	58	7	0	0	0	0	0	0
5	8380	20	II	7	99	7	1	0	0	0	0	0
5	8380	20	II	8	114	10	1	1	0	0	0	0
5	8380	10	II	1	102	11	0	0	0	0	0	0
5	8380	10	II	2	142	10	0	0	0	0	0	0
5	8380	10	II	3	104	11	0	0	0	0	0	0
5	8380	10	II	4	99	10	0	0	0	0	0	0
5	8380	10	II	5	127	12	0	0	0	0	0	0
5	8380	10	II	6	97	10	0	0	0	0	0	0
5	8380	10	II	7	114	9	0	0	0	0	0	0
5	8380	10	II	8	132	14	0	0	0	0	0	0
5	8380	30	II	1	91	8	0	0	0	0	0	0
5	8380	30	II	2	76	7	0	0	0	0	0	0
5	8380	30	II	3	132	11	1	1	0	0	0	0
5	8380	30	II	4	127	12	0	0	0	0	0	0
5	8380	30	II	5	145	8	0	0	0	0	0	0
5	8380	30	II	6	112	10	0	0	0	0	0	0
5	8380	30	II	7	147	7	0	0	0	0	0	0
5	8380	30	II	8	107	8	2	2	0	0	0	0
5	8380	40	II	1	117	9	0	0	0	0	0	0

5	8380	40	II	2	127	11	0	0	0	0	0	0
5	8380	40	II	3	142	10	0	0	0	0	0	0
5	8380	40	II	4	135	11	0	0	0	0	0	0
5	8380	40	II	5	127	11	0	0	0	0	0	0
5	8380	40	II	6	122	16	0	0	0	0	0	0
5	8380	40	II	7	89	6	0	0	0	0	0	0
5	8380	40	II	8	122	12	1	1	0	0	0	0
5	52000	40	II	1	152	12	0	0	0	0	0	0
5	52000	40	II	2	135	13	1	1	0	0	0	0
5	52000	40	II	3	147	132	0	0	0	0	0	0
5	52000	41 I	II	4	152	13	2	2	0	0	2	0
5	52000	40	II	5	137	12	0	0	0	0	0	0
5	52000	40	II	6	142	10	2	2	0	0	1	0
5	52000	40	II	7	97	7	0	0	0	0	0	0
5	52000	40	II	8	155	14	0	0	0	0	0	0
5	52001	30	II	1	178	16	0	0	0	0	0	0
5	52000	30	II	2	157	15	1	0	0	0	0	0
5	52000	30	II	3	160	13	0	0	0	0	0	0
5	52000	30	II	4	173	10	0	0	0	0	0	0
5	52000	30	II	5	122	11	0	0	0	0	25	0
5	52000	30	II	6	157	12	1	0	0	0	0	0
5	52000	30	II	7	152	12	0	0	0	0	30	0
5	52000	30	II	8	127	11	0	0	0	0	0	0

5	52000	10	II	1	117	12	0	0	0	0	0	0
5	52000	10	II	2	127	10	0	0	0	0	0	0
5	52000	10	II	3	127	13	0	0	0	0	0	0
5	52000	10	II	4	117	9	0	0	0	0	0	0
5	52000	10	II	5	140	16	0	0	0	0	0	0
5	52000	10	II	6	117	13	0	0	0	0	0	0
5	52000	10	II	7	137	10	0	0	0	0	2	0
5	52000	10	II	8	155	15	0	0	0	0	0	0
5	52000	20	II	1	132	12	1	1	0	0	0	0
5	52000	20	II	2	130	12	0	0	0	0	0	0
5	52000	20	II	3	137	11	0	0	0	0	1	0
5	52000	20	II	4	132	12	0	0	0	0	0	0
5	52000	20	II	5	117	10	0	0	0	0	15	0
5	52000	20	II	6	127	9	0	0	0	0	0	0
5	52000	20	II	7	140	11	1	0	0	0	0	0
5	52000	20	II	8	142	12	0	0	0	0	0	0
5	8450	20	II	1	102	12	0	0	0	0	0	0
5	8450	20	II	2	91	5	0	0	0	0	0	0
5	8450	20	II	3	122	12	0	0	0	0	0	0
5	8450	20	II	4	147	12	0	0	0	0	0	0
5	8450	20	II	5	127	10	0	0	0	0	0	0
5	8450	20	II	6	142	11	0	0	0	0	0	0
5	8450	20	II	7	112	8	1	0	0	0	0	0

5	8450	20	II	8	132	13	0	0	0	0	0	0
5	8450	10	II	1	107	9	0	0	0	0	0	0
5	8450	10	II	2	155	10	0	0	0	0	0	0
5	8450	10	II	3	117	12	0	0	0	0	0	0
5	8450	10	II	4	150	12	0	0	0	0	0	0
5	8450	10	II	5	127	7	0	0	0	0	0	0
5	8450	10	II	6	142	13	1	0	0	0	0	0
5	8450	10	II	7	109	13	0	0	0	0	0	0
5	8450	10	II	8	122	14	0	0	0	0	0	0
5	8450	30	II	1	117	10	0	0	0	0	0	0
5	8450	30	II	2	117	13	0	0	0	0	0	0
5	8450	30	II	3	142	13	1	0	0	0	0	0
5	8450	30	II	4	91	8	0	0	0	0	0	0
5	8450	30	II	5	137	12	0	0	0	0	0	0
5	8450	30	II	6	81	8	3	2	0	0	0	0
5	8450	30	II	7	142	13	1	0	0	0	0	0
5	8450	30	II	8	117	11	0	0	0	0	0	0
5	8450	40	II	1	165	13	1	0	0	0	0	0
5	8450	40	II	2	114	9	0	0	0	0	0	0
5	8450	40	II	3	99	7	0	0	0	0	0	0
5	8450	40	II	4	117	11	2	2	0	0	0	0
5	8450	40	II	5	142	12	0	0	0	0	0	0
5	8450	40	II	6	145	12	0	0	0	0	0	0

5	8450	40	II	7	152	6	2	1	0	0	0	0
5	8450	40	II	8	135	12	1	0	0	0	0	0
5	1130	40	II	1	163	10	0	0	0	0	0	0
5	1130	40	II	2	160	11	3	2	0	0	0	0
5	1130	40	II	3	142	11	0	0	0	0	0	0
5	1130	40	II	4	147	11	1	0	0	0	0	0
5	1130	40	II	5	124	7	0	0	0	0	0	0
5	1130	40	II	6	142	9	0	0	0	0	0	0
5	1130	40	II	7	155	13	2	0	0	0	0	0
5	1130	40	II	8	135	8	1	1	0	0	0	0
5	1130	30	II	1	91	7	0	0	0	0	0	0
5	1130	30	II	2	173	9	0	0	0	0	0	0
5	1130	30	II	3	114	10	0	0	0	0	0	0
5	1130	30	II	4	94	5	0	0	0	0	0	0
5	1130	30	II	5	122	11	0	0	0	0	0	0
5	1130	30	II	6	142	11	1	0	0	0	0	0
5	1130	30	II	7	145	11	1	0	0	0	0	0
5	1130	30	II	8	137	9	1	1	0	0	0	0
5	1130	10	II	1	150	12	1	0	0	0	0	0
5	1130	10	II	2	147	13	0	0	0	0	0	0
5	1130	10	II	3	145	10	0	0	0	0	0	0
5	1130	10	II	4	152	9	0	0	0	0	0	0
5	1130	10	II	5	132	4	0	0	0	0	0	0

5	1130	10	II	6	112	6	0	0	0	0	0	0
5	1130	10	II	7	142	11	0	0	0	0	0	0
5	1130	10	II	8	137	8	0	0	0	0	0	0
5	1130	20	II	1	132	7	0	0	0	0	0	0
5	1130	20	II	2	145	11	0	0	0	0	0	0
5	1130	20	II	3	127	7	0	0	0	0	0	0
5	1130	20	II	4	114	7	0	0	0	0	0	0
5	1130	20	II	5	117	5	0	0	0	0	0	0
5	1130	20	II	6	145	10	1	1	0	0	0	0
5	1130	20	II	7	157	13	2	1	0	0	0	0
5	1130	20	II	8	157	10	2	0	0	0	0	0
5	51400	20	II	1	140	12	0	0	0	0	0	0
5	51400	20	II	2	155	12	2	0	0	0	3	0
5	51400	20	II	3	142	11	0	0	0	0	0	0
5	51400	20	II	4	175	13	0	0	0	0	0	0
5	51400	20	II	5	168	11	0	0	0	0	0	0
5	51400	20	II	6	135	10	0	0	0	0	0	0
5	51400	20	II	7	155	11	0	0	0	0	0	0
5	51400	20	II	8	188	10	0	0	0	0	0	0
5	51400	10	II	1	142	11	0	0	0	0	0	0
5	51400	10	II	2	145	10	0	0	0	0	0	0
5	51400	10	II	3	155	10	0	0	0	0	0	0
5	51400	10	II	4	150	12	0	0	0	0	0	0

5	51400	10	II	5	173	14	0	0	0	0	0	0
5	51400	10	II	6	145	13	0	0	0	0	0	0
5	51400	10	II	7	165	13	0	0	0	0	0	0
5	51400	10	II	8	150	9	0	0	0	0	0	0
5	51400	30	II	1	124	10	0	0	0	0	0	0
5	51400	30	II	2	142	13	0	0	0	0	1	0
5	51400	30	II	3	99	15	0	0	0	0	2	0
5	51400	30	II	4	130	11	0	0	0	0	0	0
5	51400	30	II	5	124	8	0	0	0	0	0	0
5	51400	30	II	6	142	5	0	0	0	0	0	0
5	51400	30	II	7	122	10	0	0	0	0	1	0
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5	51400	40	II	1	124	10	0	0	0	0	0	0
5	51400	40	II	2	124	13	0	0	0	0	0	0
5	51400	40	II	3	163	14	0	0	0	0	0	0
5	51400	40	II	4	152	12	0	0	0	0	0	0
5	51400	40	II	5	135	12	0	0	0	0	0	0
5	51400	40	II	6	132	10	0	0	0	0	0	0
5	51400	40	II	7	150	13	0	0	0	0	2	0
5	51400	40	II	8	147	12	0	0	0	0	0	0
5	M81E0	10	II	1	145	8	0	0	0	0	0	0
5	M81E0	10	II	2	132	11	0	0	0	0	0	0
5	M81E0	10	II	3	97	5	0	0	0	0	0	0

5	M81E0	10	II	4	145	9	0	0	0	0	0	0
5	M81E0	10	II	5	211	12	0	0	0	0	0	0
5	M81E0	10	II	6	208	14	0	0	0	0	0	0
5	M81E0	10	II	7	173	13	0	0	0	0	0	0
5	M81E0	10	II	8	183	16	0	0	0	0	0	0
5	M81E0	20	II	1	132	8/	0	0	0	0	0	0
5	M81E0	20	II	2	142	10	0	0	0	0	0	0
5	M81E0	20	II	3	147	14	0	0	0	0	0	0
5	M81E0	20	II	4	142	10	0	0	0	0	0	0
5	M81E0	20	II	5	117	7	0	0	0	0	0	0
5	M81E0	20	II	6	198	14	1	0	0	0	0	0
5	M81E0	20	II	7	117	13	0	0	0	0	0	0
5	M81E0	20	II	8	183	12	1	0	0	0	0	0
5	M81E0	40	II	1	122	8	0	0	0	0	0	0
5	M81E0	40	II	2	183	11	0	0	0	0	0	0
5	M81E0	40	II	3	130	14	0	0	0	0	0	0
5	M81E0	40	II	4	147	11	1	0	0	0	2	0
5	M81E0	40	II	5	147	8	0	0	0	0	0	0
5	M81E0	40	II	6	119	8	0	0	0	0	0	0
5	M81E0	40	II	7	130	8	0	0	0	0	0	0
5	M81E0	40	II	8	117	10	1	1	0	0	0	0
5	M81E0	30	II	1	132	11	2	2	0	0	0	0
5	M81E0	30	II	2	109	9	0	0	0	0	0	0

5	M81E0	30	II	3	157	13	1	0	0	0	0	0
5	M81E0	30	II	4	104	7	0	0	0	0	0	0
5	M81E0	30	II	5	122	9	0	0	0	0	0	0
5	M81E0	30	II	6	117	10	1	0	0	0	0	0
5	M81E0	30	II	7	127	13	0	0	0	0	0	0
5	M81E0	30	II	8	132	10	1	1	0	0	0	0
5	10020	20	II	1	117	12	0	0	0	0	0	0
5	10020	20	II	2	119	10	4	4	0	0	0	0
5	10020	20	II	3	152	12	0	0	0	0	0	0
5	10020	20	II	4	173	10	0	0	0	0	0	0
5	10020	20	II	5	137	11	0	0	0	0	0	0
5	10020	20	II	6	142	10	0	0	0	0	0	0
5	10020	20	II	7	114	6	0	0	0	0	0	0
5	10020	20	II	8	170	10	0	0	0	0	0	0
5	10020	10	II	1	145	9	0	0	0	0	0	0
5	10020	10	II	2	145	10	0	0	0	0	0	0
5	10020	10	II	3	114	7	0	0	0	0	0	0
5	10020	10	II	4	137	12	0	0	0	0	0	0
5	10020	10	II	5	119	8	0	0	0	0	0	0
5	10020	10	II	6	140	11	0	0	0	0	0	0
5	10020	10	II	7	130	10	0	0	0	0	0	0
5	10020	10	II	8	173	12	0	0	0	0	0	0
5	10020	30	II	1	1468	10	0	0	0	0	0	0

5	10020	30	II	2	124	10	2	2	0	0	0	0
5	10020	30	II	3	157	11	1	1	0	0	0	0
5	10020	30	II	4	140	10	0	0	0	0	0	0
5	10020	30	II	5	117	6	0	0	0	0	0	0
5	10020	30	II	6	150	12	0	0	0	0	0	0
5	10020	30	II	7	142	10	0	0	0	0	0	0
5	10020	30	II	8	183	13	2	2	0	0	0	0
5	10020	40	II	1	147	11	0	0	0	0	0	0
5	10020	40	II	2	147	9	0	0	0	1	0	0
5	10020	40	II	3	183	13	0	0	0	0	0	0
5	10020	40	II	4	94	8	0	0	0	0	0	0
5	10020	40	II	5	152	9	0	0	0	0	0	0
5	10020	40	II	6	137	10	0	0	0	0	0	0
5	10020	40	II	7	140	10	1	1	0	0	0	0
5	10020	40	II	8	147	9	0	0	0	0	0	3
5	1130	20	III	1	140	9	1	0	0	0	0	0
5	1130	20	III	2	135	8	0	0	0	0	0	0
5	1130	20	III	3	140	8	0	0	0	0	0	0
5	1130	20	III	4	145	11	0	0	0	0	0	0
5	1130	20	III	5	94	6	0	0	0	0	0	0
5	1130	20	III	6	130	78	0	0	0	0	0	0
5	1130	20	III	7	132	11	2	1	0	0	0	0
5	1130	20	III	8	130	7	0	0	0	0	0	0

5	1130	30	III	1	155	11	0	0	0	0	0	0
5	1130	30	III	2	107	8	1	0	0	0	0	0
5	1130	30	III	3	91	5	0	0	0	0	0	0
5	1130	30	III	4	140	9	0	0	0	0	0	0
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5	1130	30	III	6	102	8	0	0	0	0	0	0
5	1130	30	III	7	127	8	0	0	0	0	0	0
5	1130	30	III	8	142	8	0	0	0	0	0	0
5	1130	10	III	1	155	8	0	0	0	0	0	0
5	1130	10	III	2	124	7	0	0	0	0	0	0
5	1130	10	III	3	107	7	0	0	0	0	0	0
5	1130	10	III	4	145	9	0	0	0	0	0	0
5	1130	10	III	5	145	8	0	0	0	0	0	0
5	1130	10	III	6	91	4	0	0	0	0	0	0
5	1130	10	III	7	163	12	0	0	0	0	0	0
5	1130	10	III	8	130	10	0	0	0	0	0	0
5	1130	40	III	1	165	11	0	0	0	0	0	0
5	1130	40	III	2	175	12	0	0	0	0	0	0
5	1130	40	III	3	135	13	1	1	0	0	0	0
5	1130	40	III	4	163	13	0	0	0	0	0	0
5	1130	40	III	5	168	10	1	1	0	0	0	0
5	1130	40	III	6	168	7	0	0	0	0	0	0
5	1130	40	III	7	132	12	2	0	0	0	0	0

5	1130	40	III	8	150	10	0	0	0	0	0	0
5	52000	40	III	1	170	13	0	0	0	0	0	0
5	52000	40	III	2	178	13	0	0	0	0	1	0
5	52000	40	III	3	183	11	0	0	0	0	0	0
5	52000	40	III	4	226	14	0	0	0	0	0	0
5	52000	40	III	5	135	12	1	1	0	0	0	0
5	52000	40	III	6	142	12	0	0	0	0	0	0
5	52000	40	III	7	208	12	0	0	0	0	1	0
5	52000	40	III	8	183	12	0	0	0	0	0	0
5	52000	10	III	1	135	10	0	0	0	0	0	0
5	52000	10	III	2	183	13	0	0	0	0	0	0
5	52000	10	III	3	150	16	0	0	0	0	0	0
5	52000	10	III	4	152	14	0	0	0	0	0	0
5	52000	10	III	5	150	11	0	0	0	0	0	0
5	52000	10	III	6	127	9	0	0	0	0	0	0
5	52000	10	III	7	160	8	0	0	0	0	0	0
5	52000	10	III	8	160	14	0	0	0	0	0	0
5	52000	30	III	1	152	11	0	0	0	0	0	0
5	52000	30	III	2	132	15	0	0	0	0	0	0
5	52000	30	III	3	163	14	0	0	0	0	0	0
5	52000	30	III	4	140	12	0	0	0	0	0	0
5	52000	30	III	5	206	10	0	0	0	0	0	0
5	52000	30	III	6	198	14	1	0	0	0	3	0

5	52000	30	III	7	155	12	0	0	0	0	0	0
5	52000	30	III	8	135	13	0	0	0	0	0	0
5	52000	20	III	1	168	11	0	0	0	0	0	0
5	52000	20	III	2	119	9	0	0	0	0	0	0
5	52000	20	III	3	117	11	0	0	0	0	0	0
5	52000	20	III	4	137	12	1	1	0	0	5	0
5	52000	20	III	5	147	10	0	0	0	0	0	0
5	52000	20	III	6	175	11	0	0	0	0	0	0
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5	52000	20	III	8	170	12	0	0	0	0	0	0
5	8450	20	III	1	66	9	0	0	0	0	0	0
5	8450	20	III	2	74	5	0	0	0	0	0	0
5	8450	20	III	3	102	11	0	0	0	0	0	0
5	8450	20	III	4	112	13	0	0	0	0	0	0
5	8450	20	III	5	119	9	0	0	0	0	0	0
5	8450	20	III	6	124	7	0	0	0	0	0	0
5	8450	20	III	7	119	11	0	0	0	0	0	0
5	8450	20	III	8	81	8	1	1	0	0	0	0
5	8450	30	III	1	66	9	0	0	0	0	0	0
5	8450	30	III	2	79	5	0	0	0	0	0	0
5	8450	30	III	3	122	13	0	0	0	0	0	0
5	8450	30	III	4	66	7	0	0	0	0	0	0
5	8450	30	III	5	122	10	0	0	0	0	0	0

5	8450	30	III	6	104	9	1	0	0	0	0	0
5	8450	30	III	7	99	11	0	0	0	0	0	0
5	8450	30	III	8	91	8	0	0	0	0	0	0
5	8450	10	III	1	102	7	0	0	0	0	0	0
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5	8450	10	III	3	117	12	0	0	0	0	0	0
5	8450	10	III	4	89	9	0	0	0	0	0	0
5	8450	10	III	5	130	11	0	0	0	0	0	0
5	8450	10	III	6	145	10	0	0	0	0	0	0
5	8450	10	III	7	99	11	0	0	0	0	0	0
5	8450	10	III	8	94	9	0	0	0	0	0	0
5	8450	40	III	1	86	12	0	0	0	0	0	0
5	8450	40	III	2	71	6	0	0	0	0	0	0
5	8450	40	III	3	94	8	0	0	0	0	0	0
5	8450	40	III	4	102	11	0	0	0	0	0	0
5	8450	40	III	5	114	13	0	0	0	0	0	0
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5	8450	40	III	7	64	7	0	0	0	0	0	0
5	8450	40	III	8	94	7	0	0	0	0	0	0
5	8380	40	III	1	91	6	0	0	0	0	0	0
5	8380	40	III	2	112	9	0	0	0	0	0	0
5	8380	40	III	3	132	10	0	0	0	0	0	0
5	8380	40	III	4	145	12	2	0	0	0	0	0

5	8380	40	III	5	117	10	0	0	0	0	0	0
5	8380	40	III	6	112	6	0	0	0	0	0	0
5	8380	40	III	7	119	10	1	0	0	0	0	0
5	8380	40	III	8	163	14	2	0	0	0	0	0
5	8380	10	III	1	86	78	0	0	0	0	0	0
5	8380	10	III	2	127	9	0	0	0	0	0	0
5	8380	10	III	3	102	12	0	0	0	0	0	0
5	8380	10	III	4	112	8	0	0	0	0	0	0
5	8380	10	III	5	140	12	0	0	0	0	0	0
5	8380	10	III	6	132	12	0	0	0	0	0	0
5	8380	10	III	7	91	10	0	0	0	0	0	0
5	8380	10	III	8	132	11	0	0	0	0	0	0
5	8380	30	III	1	91	11	0	0	0	0	0	0
5	8380	30	III	2	86	4	0	0	0	0	0	0
5	8380	30	III	3	135	12	0	0	0	0	0	0
5	8380	30	III	4	109	10	0	0	0	0	0	0
5	8380	30	III	5	114	10	0	0	0	0	0	0
5	8380	30	III	6	94	11	0	0	0	0	0	0
5	8380	30	III	7	74	4	0	0	0	0	0	0
5	8380	30	III	8	132	15	4	4	0	0	0	0
5	8380	20	III	1	112	10	0	0	0	0	0	0
5	8380	20	III	2	89	10	0	0	0	0	0	0
5	8380	20	III	3	119	11	0	0	0	0	0	0

5	8380	20	III	4	145	10	0	0	0	0	0	0
5	8380	20	III	5	89	6	0	0	0	0	0	0
5	8380	20	III	6	127	11	0	0	0	0	0	0
5	8380	20	III	7	97	10	0	0	0	0	0	0
5	8380	20	III	8	124	10	0	0	0	0	0	0
5	M81E0	20	III	1	145	10	0	0	0	0	0	0
5	M81E0	20	III	2	155	11	0	0	0	0	0	0
5	M81E0	20	III	3	203	16	0	0	0	0	0	0
5	M81E0	20	III	4	183	13	1	0	0	0	0	0
5	M81E0	20	III	5	168	10	0	0	0	0	0	0
5	M81E0	20	III	6	168	12	0	0	0	0	0	0
5	M81E0	20	III	7	168	12	0	0	0	0	0	0
5	M81E0	20	III	8	165	11	0	0	0	0	0	0
5	M81E0	30	III	1	135	11	0	0	0	0	0	0
5	M81E0	30	III	2	157	11	0	0	0	0	0	0
5	M81E0	30	III	3	130	10	2	1	0	0	0	0
5	M81E0	30	III	4	140	11	0	0	0	0	0	0
5	M81E0	30	III	5	142	10	1	1	0	0	0	0
5	M81E0	30	III	6	117	9	3	2	0	0	0	0
5	M81E0	30	III	7	132	10	0	0	0	0	0	0
5	M81E0	30	III	8	163	12	0	0	0	0	0	0
5	M81E0	10	III	1	140	11	0	0	0	0	0	0
5	M81E0	10	III	2	185	14	0	0	0	0	0	0

5	M81E0	10	III	3	185	8	0	0	0	0	0	0
5	M81E0	10	III	4	112	7	0	0	0	0	0	0
5	M81E0	10	III	5	160	12	0	0	0	0	0	0
5	M81E0	10	III	6	132	11	0	0	0	0	0	0
5	M81E0	10	III	7	165	13	0	0	0	0	0	0
5	M81E0	10	III	8	117	9	0	0	0	0	0	0
5	M81E0	40	III	1	124	6	0	0	0	0	0	0
5	M81E0	40	III	2	150	11	0	0	0	0	0	0
5	M81E0	40	III	3	183	11	0	0	0	0	0	0
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5	M81E0	40	III	5	150	11	0	0	0	0	0	0
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5	M81E0	40	III	7	132	10	1	1	0	0	0	0
5	M81E0	40	III	8	203	16	0	0	0	0	0	0
5	51400	40	III	1	140	12	1	1	0	0	0	0
5	51400	40	III	2	132	7	0	0	0	0	0	0
5	51400	40	III	3	119	8	0	0	0	0	0	0
5	51400	40	III	4	157	12	0	0	0	0	0	0
5	51400	40	III	5	152	10	0	0	0	0	0	0
5	51400	40	III	6	137	10	0	0	0	0	0	0
5	51400	40	III	7	135	11	2	2	0	0	0	0
5	51400	40	III	8	142	9	0	0	0	0	0	0
5	51400	10	III	1	175	12	0	0	0	0	0	0

5	51400	10	III	2	107	7	0	0	0	0	0	0
5	51400	10	III	3	163	12	0	0	0	0	0	0
5	51400	10	III	4	185	14	0	0	0	0	0	0
5	51400	10	III	5	173	13	0	0	0	0	0	0
5	51400	10	III	6	137	8	0	0	0	0	0	0
5	51400	10	III	7	193	16	0	0	0	0	0	0
5	51400	10	III	8	142	11	0	0	0	0	0	0
5	51400	30	III	1	117	7	0	0	0	0	0	0
5	51400	30	III	2	168	13	2	1	0	0	4	0
5	51400	30	III	3	188	16	0	0	0	0	0	0
5	51400	30	III	4	142	10	1	0	0	0	0	0
5	51400	30	III	5	145	11	1	0	0	0	0	0
5	51400	30	III	6	178	16	3	2	0	0	0	0
5	51400	30	III	7	183	11	1	0	0	0	0	0
5	51400	30	III	8	150	9	0	0	0	0	0	0
5	51400	20	III	1	175	15	0	0	0	0	0	0
5	51400	20	III	2	157	10	1	1	0	0	1	0
5	51400	20	III	3	152	11	0	0	0	0	0	0
5	51400	20	III	4	140	13	0	0	0	0	0	0
5	51400	20	III	5	165	15	5	5	0	0	0	0
5	51400	20	III	6	127	8	0	0	0	0	0	0
5	51400	20	III	7	142	12	0	0	0	0	0	0
5	51400	20	III	8	183	16	0	0	0	0	0	0

5	10020	20	III	1	178	15	0	0	0	0	0	0
5	10020	20	III	2	117	5	0	0	0	0	0	0
5	10020	20	III	3	137	7	0	0	0	0	0	0
5	10020	20	III	4	107	7	0	0	0	0	0	0
5	10020	20	III	5	147	12	0	0	0	0	0	0
5	10020	20	III	6	130	7	0	0	0	0	0	0
5	10020	20	III	7	152	12	0	0	0	0	0	0
5	10020	20	III	8	147	11	0	0	0	0	0	0
5	10020	30	III	1	117	10	0	0	0	0	0	0
5	10020	30	III	2	127	10	0	0	0	0	0	0
5	10020	30	III	3	137	11	0	0	0	0	0	0
5	10020	30	III	4	152	7	0	0	0	0	0	0
5	10020	30	III	5	102	7	0	0	0	0	0	0
5	10020	30	III	6	117	6	0	0	0	0	0	0
5	10020	30	III	7	152	10	0	0	0	0	0	0
5	10020	30	III	8	142	11	0	0	0	0	0	0
5	10020	10	III	1	130	6	0	0	0	0	0	0
5	10020	10	III	2	175	15	0	0	0	0	0	0
5	10020	10	III	3	150	11	0	0	0	0	0	0
5	10020	10	III	4	175	14	0	0	0	0	0	0
5	10020	10	III	5	157	10	0	0	0	0	0	0
5	10020	10	III	6	152	12	0	0	0	0	0	0
5	10020	10	III	7	142	10	0	0	0	0	0	0

5	10020	10	III	8	97	4	0	0	0	0	0	0
5	10020	40	III	1	102	7	0	0	0	0	0	0
5	10020	40	III	2	122	7	0	0	0	0	0	0
5	10020	40	III	3	127	6	0	0	0	0	0	0
5	10020	40	III	4	150	10	1	1	0	0	0	0
5	10020	40	III	5	157	11	0	0	0	0	0	0
5	10020	40	III	6	66	6	0	0	0	0	0	0
5	10020	40	III	7	168	10	0	0	0	0	0	0
5	10020	40	III	8	157	10	1	0	0	0	0	0
5	8380	40	IV	1	152	12	0	0	0	0	0	0
5	8380	40	IV	2	91	8	0	0	0	0	0	0
5	8380	40	IV	3	127	11	0	0	0	0	0	0
5	8380	40	IV	4	140	12	0	0	0	0	0	0
5	8380	40	IV	5	145	13	0	0	0	0	0	0
5	8380	40	IV	6	157	8	0	0	0	0	0	0
5	8380	40	IV	7	127	10	0	0	0	0	0	0
5	8380	40	IV	8	157	11	1	1	0	0	0	0
5	8380	30	IV	1	99	8	0	0	0	0	0	0
5	8380	30	IV	2	109	13	0	0	0	0	0	0
5	8380	30	IV	3	132	13	0	0	0	0	0	0
5	8380	30	IV	4	145	10	1	0	0	0	0	0
5	8380	30	IV	5	122	9	0	0	0	0	0	0
5	8380	30	IV	6	109	8	1	0	0	0	0	0

5	8380	30	IV	7	142	15	0	0	0	0	0	0
5	8380	30	IV	8	142	12	4	1	0	0	0	0
5	8380	20	IV	1	102	10	0	0	0	0	0	0
5	8380	20	IV	2	142	8	0	0	0	0	0	0
5	8380	20	IV	3	147	13	0	0	0	0	0	0
5	8380	20	IV	4	132	12	0	0	0	0	0	0
5	8380	20	IV	5	135	10	0	0	0	0	0	0
5	8380	20	IV	6	142	14	5	2	0	0	0	0
5	8380	20	IV	7	91	8	0	0	0	0	0	0
5	8380	20	IV	8	142	12	1	1	0	0	0	0
5	8380	10	IV	1	142	9	0	0	0	0	0	0
5	8380	10	IV	2	168	14	0	0	0	0	0	0
5	8380	10	IV	3	91	12	0	0	0	0	0	0
5	8380	10	IV	4	127	13	0	0	0	0	0	0
5	8380	10	IV	5	168	12	0	0	0	0	0	0
5	8380	10	IV	6	124	6	0	0	0	0	0	0
5	8380	10	IV	7	155	13	0	0	0	0	0	0
5	8380	10	IV	8	145	11	0	0	0	0	0	0
5	1130	10	IV	1	155	12	0	0	0	0	0	0
5	1130	10	IV	2	152	8	0	0	0	0	0	0
5	1130	10	IV	3	150	10	0	0	0	0	0	0
5	1130	10	IV	4	140	8	0	0	0	0	0	0
5	1130	10	IV	5	157	11	0	0	0	0	0	0

5	1130	10	IV	6	163	13	0	0	0	0	0	0
5	1130	10	IV	7	147	10	0	0	0	0	0	0
5	1130	10	IV	8	150	9	0	0	0	0	0	0
5	1130	20	IV	1	157	8	0	0	0	0	0	0
5	1130	20	IV	2	91	6	0	0	0	0	0	0
5	1130	20	IV	3	175	15	1	0	0	0	0	0
5	1130	20	IV	4	122	5	0	0	0	0	0	0
5	1130	20	IV	5	178	12	0	0	0	0	0	0
5	1130	20	IV	6	142	11	1	0	0	0	0	0
5	1130	20	IV	7	170	12	0	0	0	0	0	0
5	1130	20	IV	8	104	8	2	2	0	0	0	0
5	1130	30	IV	1	140	12	0	0	0	0	0	0
5	1130	30	IV	2	127	6	0	0	0	0	0	0
5	1130	30	IV	3	117	8	0	0	0	0	0	0
5	1130	30	IV	4	137	9	0	0	0	0	0	0
5	1130	30	IV	5	183	10	0	0	0	0	0	0
5	1130	30	IV	6	168	12	2	0	0	0	0	0
5	1130	30	IV	7	152	9	0	0	0	0	0	0
5	1130	30	IV	8	152	4	0	0	0	0	0	0
5	1130	40	IV	1	155	11	0	0	0	0	0	0
5	1130	40	IV	2	102	6	0	0	0	0	0	0
5	1130	40	IV	3	140	12	2	2	0	0	0	0
5	1130	40	IV	4	152	12	0	0	0	0	0	0

5	1130	40	IV	5	102	7	0	0	0	0	0	0
5	1130	40	IV	6	127	4	0	0	0	0	0	0
5	1130	40	IV	7	150	10	1	1	0	0	0	0
5	1130	40	IV	8	124	8	2	2	0	0	0	0
5	8450	40	IV	1	117	12	1	1	0	0	0	0
5	8450	40	IV	2	79	5	0	0	0	0	0	0
5	8450	40	IV	3	109	9	0	0	0	0	0	0
5	8450	40	IV	4	124	10	0	0	0	0	0	0
5	8450	40	IV	5	107	7	0	0	0	0	0	0
5	8450	40	IV	6	155	8	0	0	0	0	0	0
5	8450	40	IV	7	122	10	0	0	0	0	0	0
5	8450	40	IV	8	117	11	3	2	0	0	0	0
5	8450	30	IV	1	104	8	0	0	0	0	0	0
5	8450	30	IV	2	150	8	0	0	0	0	0	0
5	8450	30	IV	3	150	11	3	3	0	0	0	0
5	8450	30	IV	4	140	10	0	0	0	0	0	0
5	8450	30	IV	5	147	11	0	0	0	0	0	0
5	8450	30	IV	6	132	6	0	0	0	0	0	0
5	8450	30	IV	7	155	15	2	0	0	0	0	0
5	8450	30	IV	8	124	12	1	0	0	0	0	0
5	8450	20	IV	1	99	9	0	0	0	0	0	0
5	8450	20	IV	2	102	8	0	0	0	0	0	0
5	8450	20	IV	3	150	9	2	2	0	0	0	0

5	8450	20	IV	4	140	10	0	0	0	0	0	0
5	8450	20	IV	5	142	9	1	0	0	0	0	0
5	8450	20	IV	6	91	9	0	0	0	0	0	0
5	8450	20	IV	7	89	10	0	0	0	0	0	0
5	8450	20	IV	8	124	11	3	2	0	0	0	0
5	8450	10	IV	1	145	9	0	0	0	0	0	0
5	8450	10	IV	2	155	10	0	0	0	0	0	0
5	8450	10	IV	3	152	11	1	1	0	0	0	0
5	8450	10	IV	4	117	8	0	0	0	0	0	0
5	8450	10	IV	5	145	11	0	0	0	0	0	0
5	8450	10	IV	6	130	9	0	0	0	0	0	0
5	8450	10	IV	7	142	10	0	0	0	0	0	0
5	8450	10	IV	8	122	6	0	0	0	0	0	0
5	51400	10	IV	1	127	8	0	0	0	0	0	0
5	51400	10	IV	2	180	17	0	0	0	0	0	0
5	51400	10	IV	3	157	11	1	0	0	0	0	0
5	51400	10	IV	4	157	10	0	0	0	0	0	0
5	51400	10	IV	5	147	11	0	0	0	0	0	0
5	51400	10	IV	6	208	18	0	0	0	0	0	0
5	51400	10	IV	7	155	13	0	0	0	0	0	0
5	51400	10	IV	8	183	11	0	0	0	0	0	0
5	51400	20	IV	1	140	10	0	0	0	0	0	0
5	51400	20	IV	2	89	5	0	0	0	0	0	0

5	51400	20	IV	3	168	16	0	0	0	0	0	0
5	51400	20	IV	4	244	15	0	0	0	0	3	0
5	51400	20	IV	5	168	13	0	0	0	0	0	0
5	51400	22 I MRB	IV	6	168	13	4	4	0	0	0	0
5	51400	20	IV	7	157	12	0	0	0	0	0	0
5	51400	20	IV	8	185	15	3	3	0	0	0	0
5	51400	30	IV	1	152	8	0	0	0	0	0	0
5	51400	30	IV	2	142	11	1	0	0	0	0	0
5	51400	30	IV	3	165	14	1	0	0	0	0	0
5	51400	30	IV	4	147	10	0	0	0	0	0	0
5	51400	30	IV	5	147	10	0	0	0	0	0	0
5	51400	30	IV	6	183	13	0	0	0	0	0	0
5	51400	30	IV	7	147	13	0	0	0	0	0	0
5	51400	30	IV	8	152	11	1	1	0	0	0	0
5	51400	40	IV	1	183	13	0	0	0	0	0	0
5	51400	40	IV	2	163	12	0	0	0	0	0	0
5	51400	40	IV	3	102	5	0	0	0	0	0	0
5	51400	40	IV	4	165	10	0	0	0	0	0	0
5	51400	40	IV	5	183	10	3	3	0	0	0	0
5	51400	40	IV	6	173	12	5	5	0	0	0	0
5	51400	40	IV	7	183	13	0	0	0	0	0	0
5	51400	40	IV	8	183	11	0	0	0	0	0	0
5	10020	40	IV	1	142	13	0	0	0	0	0	0

5	10020	40	IV	2	170	13	1	0	0	0	0	0
5	10020	40	IV	3	155	9	1	0	0	0	0	0
5	10020	40	IV	4	170	13	0	0	0	0	0	0
5	10020	40	IV	5	152	7	0	0	0	0	0	0
5	10020	40	IV	6	178	8	0	0	0	0	0	0
5	10020	40	IV	7	185	14	0	0	0	0	0	0
5	10020	40	IV	8	137	9	0	0	0	0	0	0
5	10020	30	IV	1	119	8	0	0	0	0	0	0
5	10020	30	IV	2	168	10	5	5	0	0	0	0
5	10020	30	IV	3	145	10	0	0	0	0	0	0
5	10020	30	IV	4	183	11	0	0	0	0	0	0
5	10020	30	IV	5	137	5	0	0	0	0	0	0
5	10020	30	IV	6	188	11	0	0	0	0	0	0
5	10020	30	IV	7	175	12	0	0	0	0	0	0
5	10020	30	IV	8	152	9	0	0	0	0	0	0
5	10020	21 I MRB	IV	1	173	11	5	5	0	0	0	0
5	10020	20	IV	2	173	12	3	0	0	0	0	0
5	10020	20	IV	3	183	13	0	0	0	0	0	0
5	10020	20	IV	4	157	10	0	0	0	0	0	0
5	10020	20	IV	5	178	11	0	0	0	0	0	0
5	10020	20	IV	6	170	11	2	2	0	0	0	0
5	10020	20	IV	7	188	13	1	0	0	0	0	0
5	10020	20	IV	8	180	12	0	0	0	0	0	0

5	10020	10	IV	1	150	10	0	0	0	0	0	0
5	10020	10	IV	2	178	7	0	0	0	0	0	0
5	10020	10	IV	3	185	12	0	0	0	0	0	0
5	10020	10	IV	4	163	9	0	0	0	0	0	0
5	10020	10	IV	5	183	12	0	0	0	0	0	0
5	10020	10	IV	6	163	10	0	0	0	0	0	0
5	10020	10	IV	7	188	10	0	0	0	0	0	0
5	10020	10	IV	8	180	14	0	0	0	0	0	0
5	M81E0	10	IV	1	208	14	0	0	0	0	0	0
5	M81E0	10	IV	2	229	16	0	0	0	0	0	0
5	M81E0	10	IV	3	163	12	0	0	0	0	0	0
5	M81E0	10	IV	4	203	12	0	0	0	0	0	0
5	M81E0	10	IV	5	208	13	0	0	0	0	0	0
5	M81E0	10	IV	6	198	13	0	0	0	0	0	0
5	M81E0	10	IV	7	203	13	0	0	0	0	0	0
5	M81E0	10	IV	8	193	14	0	0	0	0	0	0
5	M81E0	20	IV	1	183	13	2	2	0	0	0	0
5	M81E0	20	IV	2	163	12	0	0	0	0	0	0
5	M81E0	20	IV	3	216	15	3	2	0	0	0	0
5	M81E0	20	IV	4	180	11	2	1	0	0	0	0
5	M81E0	20	IV	5	175	11	0	0	0	0	0	0
5	M81E0	20	IV	6	180	11	1	0	0	0	0	0
5	M81E0	20	IV	7	211	13	1	0	0	0	0	0

5	M81E0	20	IV	8	191	13	0	0	0	0	0	0
5	M81E0	30	IV	1	135	12	0	0	0	0	0	0
5	M81E0	30	IV	2	208	14	1	1	0	0	0	0
5	M81E0	30	IV	3	178	12	0	0	0	0	0	0
5	M81E0	30	IV	4	213	13	3	2	0	0	0	0
5	M81E0	30	IV	5	175	10	0	0	0	0	0	0
5	M81E0	30	IV	6	135	10	0	0	0	0	0	0
5	M81E0	30	IV	7	234	17	3	3	0	0	5	0
5	M81E0	30	IV	8	170	11	0	0	0	0	0	0
5	M81E0	40	IV	1	150	12	0	0	0	0	0	0
5	M81E0	40	IV	2	173	13	1	1	0	0	0	0
5	M81E0	40	IV	3	69	10	0	0	0	0	0	0
5	M81E0	40	IV	4	147	8	2	0	0	0	0	0
5	M81E0	40	IV	5	147	8	1	0	0	0	0	0
5	M81E0	40	IV	6	142	11	0	0	0	0	0	0
5	M81E0	40	IV	7	188	15	0	0	0	0	0	0
5	M81E0	40	IV	8	165	13	0	0	0	0	0	0
5	52000	40	IV	1	191	13	0	0	0	0	0	0
5	52000	40	IV	2	163	13	1	1	0	0	0	0
5	52000	40	IV	3	183	14	0	0	0	0	0	0
5	52000	40	IV	4	185	17	1	0	0	0	0	0
5	52000	40	IV	5	188	12	1	0	0	0	0	0
5	52000	40	IV	6	150	11	0	0	0	0	0	0

5	52000	40	IV	7	183	13	0	0	0	0	0	0
5	52000	40	IV	8	196	14	0	0	0	0	0	0
5	52000	30	IV	1	168	13	0	0	0	0	0	0
5	52000	30	IV	2	193	17	0	0	0	0	0	0
5	52000	30	IV	3	165	14	1	1	0	0	0	0
5	52000	30	IV	4	188	13	0	0	0	0	0	0
5	52000	31 II MRB	IV	5	155	12	4	2	0	0	0	0
5	52000	30	IV	6	140	12	0	0	0	0	0	0
5	52000	30	IV	7	142	12	0	0	0	0	0	0
5	52000	30	IV	8	173	12	0	0	0	0	0	0
5	52000	20	IV	1	203	20	0	0	0	0	0	0
5	52000	20	IV	2	183	14	0	0	0	0	0	0
5	52000	20	IV	3	185	14	0	0	0	0	0	0
5	52000	20	IV	4	211	15	0	0	0	0	0	0
5	52000	20	IV	5	183	15	0	0	0	0	0	0
5	52000	20	IV	6	168	12	1	1	0	0	0	0
5	52000	20	IV	7	1803	13	1	0	0	0	0	0
5	52000	20	IV	8	198	14	2	1	0	0	0	0
5	52000	10	IV	1	193	14	0	0	0	0	0	0
5	52000	10	IV	2	198	13	0	0	0	0	0	0
5	52000	10	IV	3	178	8	0	0	0	0	0	0
5	52000	10	IV	4	180	13	0	0	0	0	0	0
5	52000	10	IV	5	140	10	0	0	0	0	0	0

5	52000	10	IV	6	188	11	0	0	0	0	0	0
5	52000	10	IV	7	203	13	0	0	0	0	0	0
5	52000	10	IV	8	183	14	0	0	0	0	0	0
6	10020	40	I	1	224	13	0	0	0	0	0	0
6	10020	40	I	2	183	7	0	0	0	0	0	0
6	10020	40	I	3	165	7	0	0	0	0	0	0
6	10020	40	I	4	185	12	0	0	0	0	0	0
6	10020	40	I	5	196	12	0	0	0	0	0	0
6	10020	40	I	6	191	12	0	0	0	0	0	0
6	10020	40	I	7	168	13	1	1	0	0	0	0
6	10020	40	I	8	185	9	0	0	0	0	0	0
6	10020	10	I	1	193	9	0	0	0	0	0	0
6	10020	10	I	2	183	9	0	0	0	0	0	0
6	10020	10	I	3	132	6	0	0	0	0	0	0
6	10020	10	I	4	152	9	0	0	0	0	1	0
6	10020	10	I	5	157	7	0	0	0	0	0	0
6	10020	10	I	6	180	12	0	0	0	0	0	0
6	10020	10	I	7	173	8	0	0	0	0	0	0
6	10020	10	I	8	142	7	0	0	0	0	0	0
6	10020	30	I	1	157	9	0	0	0	0	0	0
6	10020	30	I	2	99	5	0	0	0	0	0	0
6	10020	30	I	3	117	9	0	0	0	0	0	0
6	10020	30	I	4	142	11	2	1	0	0	0	0

6	10020	30	I	5	132	8	0	0	0	0	0	0
6	10020	30	I	6	173	13	0	0	0	0	0	0
6	10020	30	I	7	165	10	1	0	0	0	0	0
6	10020	30	I	8	152	8	1	1	0	0	0	0
6	10020	20	I	1	127	9	1	0	0	0	0	0
6	10020	20	I	2	147	9	0	0	0	0	0	0
6	10020	20	I	3	142	9	0	0	0	0	0	0
6	10020	20	I	4	102	8	0	0	0	0	0	0
6	10020	20	I	5	132	6	0	0	0	0	0	0
6	10020	20	I	6	124	4	0	0	0	0	0	0
6	10020	20	I	7	124	8	0	0	0	0	0	0
6	10020	20	I	8	127	8	0	0	0	0	0	0
6	51400	20	I	1	142	11	0	0	0	0	1	0
6	51400	20	I	2	163	17	0	0	0	0	0	0
6	51400	20	I	3	150	8	0	0	0	0	0	0
6	51400	20	I	4	142	14	0	0	0	0	0	0
6	51400	21 I MRB	I	5	183	13	1	1	0	0	0	0
6	51400	20	I	6	170	17	0	0	0	0	0	0
6	51400	20	I	7	137	11	0	0	0	0	1	0
6	51400	20	I	8	157	10	0	0	0	0	2	0
6	51400	30	I	1	107	8	0	0	0	0	0	0
6	51400	30	I	2	152	11	0	0	0	0	3	0
6	51400	30	I	3	130	10	0	0	0	0	0	0

6	51400	30	I	4	152	12	0	0	0	0	0	0
6	51400	30	I	5	102	10	1	1	0	0	0	0
6	51400	30	I	6	157	15	0	0	0	0	0	0
6	51400	30	I	7	163	15	0	0	0	0	2	0
6	51400	30	I	8	163	17	0	0	0	0	3	0
6	51400	10	I	1	150	16	0	0	0	0	3	0
6	51400	10	I	2	150	13	0	0	0	0	3	2
6	51400	10	I	3	165	12	0	0	0	0	3	0
6	51400	10	I	4	157	11	0	0	0	0	3	0
6	51400	10	I	5	152	10	0	0	0	0	3	1
6	51400	10	I	6	142	11	0	0	0	0	3	0
6	51400	10	I	7	124	10	0	0	0	0	3	0
6	51400	10	I	8	157	15	1	0	0	0	3	1
6	51400	40	I	1	183	12	0	0	0	0	3	0
6	51400	40	I	2	193	12	0	0	0	0	3	0
6	51400	40	I	3	168	12	0	0	0	0	3	0
6	51400	40	I	4	183	16	0	0	0	0	3	5
6	51400	40	I	5	178	13	0	0	0	0	3	0
6	51400	40	I	6	155	13	1	1	0	0	3	0
6	51400	40	I	7	231	13	0	0	0	0	3	0
6	51400	40	I	8	208	16	1	0	0	0	3	1
6	8450	30	I	1	127	10	0	0	0	0	0	0
6	8450	30	I	2	109	9	0	0	0	0	0	0

6	8450	30	I	3	152	17	0	0	0	0	0	0
6	8450	30	I	4	135	11	0	0	0	0	0	0
6	8450	30	I	5	114	12	3	0	0	0	0	0
6	8450	30	I	6	76	7	0	0	0	0	0	0
6	8450	30	I	7	152	17	0	0	0	0	0	0
6	8450	30	I	8	130	9	0	0	0	0	0	0
6	8450	20	I	1	142	12	0	0	0	0	0	0
6	8450	20	I	2	132	13	0	0	0	0	0	0
6	8450	20	I	3	130	10	0	0	0	0	0	0
6	8450	20	I	4	117	10	0	0	0	0	0	0
6	8450	20	I	5	112	13	0	0	0	0	0	0
6	8450	2 1 III MRB	I	6	142	14	1	1	0	0	0	0
6	8450	20	I	7	152	14	0	0	0	0	0	0
6	8450	20	I	8	140	10	0	0	0	0	0	0
6	8450	40	I	1	76	9	0	0	0	0	0	0
6	8450	40	I	2	112	15	1	1	0	0	0	0
6	8450	40	I	3	114	8	0	0	0	0	0	0
6	8450	40	I	4	117	11	0	0	0	0	0	0
6	8450	40	I	5	112	6	1	0	0	0	0	0
6	8450	40	I	6	132	6	0	0	0	0	0	0
6	8450	40	I	7	89	8	0	0	0	0	0	0
6	8450	40	I	8	117	11	0	0	0	0	0	0
6	8450	10	I	1	86	9	0	0	0	0	0	0

6	8450	10	I	2	142	10	0	0	0	0	0	0
6	8450	10	I	3	127	15	0	0	0	0	0	0
6	8450	10	I	4	137	14	0	0	0	0	0	0
6	8450	10	I	5	102	7	0	0	0	0	0	0
6	8450	10	I	6	124	10	0	0	0	0	0	0
6	8450	10	I	7	142	11	0	0	0	0	0	0
6	8450	10	I	8	137	12	0	0	0	0	0	0
6	8380	40	I	1	193	15	0	0	0	0	0	0
6	8380	40	I	2	201	17	0	0	0	0	0	0
6	8380	40	I	3	175	19	0	0	0	0	0	0
6	8380	40	I	4	178	16	0	0	0	0	0	0
6	8380	40	I	5	183	14	0	0	0	0	0	0
6	8380	40	I	6	173	12	1	1	0	0	0	0
6	8380	40	I	7	168	14	0	0	0	0	0	0
6	8380	40	I	8	193	17	0	0	0	0	0	0
6	8380	10	I	1	175	14	0	0	0	0	0	0
6	8380	10	I	2	142	12	0	0	0	0	0	0
6	8380	10	I	3	183	16	0	0	0	0	0	0
6	8380	10	I	4	180	15	0	0	0	0	0	0
6	8380	10	I	5	142	14	0	0	0	0	0	0
6	8380	10	I	6	173	13	0	0	0	0	0	0
6	8380	10	I	7	140	10	0	0	0	0	0	0
6	8380	10	I	8	180	18	0	0	0	0	0	0

6	8380	30	I	1	132	9	0	0	0	0	0	0
6	8380	30	I	2	157	14	0	0	0	0	0	0
6	8380	30	I	3	152	15	0	0	0	0	0	0
6	8380	30	I	4	175	15	0	0	0	0	0	0
6	8380	30	I	5	173	17	0	0	1	0	0	0
6	8380	30	I	6	183	13	0	0	2	0	0	0
6	8380	30	I	7	168	13	0	0	0	0	0	0
6	8380	30	I	8	160	16	0	0	0	0	0	0
6	8380	20	I	1	132	9	0	0	0	0	0	0
6	8380	20	I	2	122	13	0	0	0	0	0	0
6	8380	20	I	3	168	19	0	0	0	0	0	0
6	8380	20	I	4	142	14	0	0	0	0	0	0
6	8380	20	I	5	142	16	0	0	0	0	0	0
6	8380	20	I	6	157	15	2	1	0	0	0	0
6	8380	20	I	7	165	15	0	0	0	0	0	0
6	8380	20	I	8	142	9	0	0	0	0	0	0
6	M81E0	10	I	1	208	12	0	0	0	0	0	0
6	M81E0	10	I	2	221	12	0	0	0	0	0	0
6	M81E0	10	I	3	234	16	0	0	0	0	0	0
6	M81E0	10	I	4	239	11	0	0	0	0	0	0
6	M81E0	10	I	5	203	12	0	0	0	0	0	0
6	M81E0	10	I	6	244	14	0	0	0	0	0	0
6	M81E0	10	I	7	229	15	0	0	0	0	1	0

6	M81E0	10	I	8	234	15	1	0	0	0	0	0
6	M81E0	40	I	1	234	13	0	0	0	0	3	0
6	M81E0	40	I	2	188	13	0	0	0	0	0	0
6	M81E0	40	I	3	213	10	0	0	0	0	1	0
6	M81E0	40	I	4	274	15	0	0	0	0	5	0
6	M81E0	40	I	5	269	13	0	0	0	0	0	0
6	M81E0	40	I	6	229	13	0	0	0	0	0	0
6	M81E0	40	I	7	221	15	0	0	0	0	0	0
6	M81E0	40	I	8	234	13	0	0	0	0	0	0
6	M81E0	20	I	1	137	9	0	0	0	0	0	0
6	M81E0	20	I	2	137	11	0	0	0	0	15	0
6	M81E0	20	I	3	231	16	0	0	0	0	2	0
6	M81E0	20	I	4	165	12	0	0	0	0	0	0
6	M81E0	20	I	5	183	14	0	0	0	0	20	0
6	M81E0	20	I	6	127	4	0	0	0	0	20	0
6	M81E0	20	I	7	183	14	0	0	0	0	0	0
6	M81E0	20	I	8	142	10	0	0	0	0	0	0
6	M81E0	30	I	1	236	12	0	0	0	0	0	0
6	M81E0	30	I	2	188	11	0	0	0	0	0	0
6	M81E0	30	I	3	193	13	0	0	0	0	0	0
6	M81E0	30	I	4	175	9	0	0	0	0	0	0
6	M81E0	30	I	5	244	16	1	0	0	0	3	0
6	M81E0	30	I	6	208	16	0	0	0	0	0	0

6	M81E0	30	I	7	206	12	0	0	0	0	0	0
6	M81E0	30	I	8	208	15	0	0	0	0	0	0
6	52000	10	I	1	152	12	0	0	0	0	20	0
6	52000	10	I	2	147	16	0	0	0	0	0	0
6	52000	10	I	3	127	11	0	0	0	0	7	0
6	52000	10	I	4	175	14	0	0	0	0	15	0
6	52000	10	I	5	142	13	0	0	0	0	7	0
6	52000	10	I	6	132	13	0	0	0	0	0	0
6	52000	10	I	7	132	11	0	0	0	0	12	0
6	52000	10	I	8	114	11	0	0	0	0	0	0
6	52000	40	I	1	132	14	0	0	0	0	30	0
6	52000	40	I	2	183	15	2	2	0	0	0	0
6	52000	40	I	3	183	14	0	0	0	0	0	0
6	52000	40	I	4	130	12	0	0	0	0	6	0
6	52000	40	I	5	183	13	2	2	0	0	2	0
6	52000	40	I	6	183	11	0	0	0	0	5	0
6	52000	40	I	7	193	15	5	3	0	0	6	0
6	52000	40	I	8	193	15	0	0	0	0	1	0
6	52000	20	I	1	132	12	0	0	0	0	10	0
6	52000	20	I	2	122	15	1	0	0	0	0	0
6	52000	20	I	3	147	15	0	0	0	0	0	0
6	52000	20	I	4	127	15	0	0	0	0	50	0
6	52000	20	I	5	102	6	2	2	0	0	10	0

6	52000	20	I	6	89	9	1	0	0	0	2	0
6	52000	20	I	7	145	14	0	0	0	0	100	0
6	52000	20	I	8	132	8	0	0	0	0	8	0
6	52000	30	I	1	127	11	1	0	0	0	13	0
6	52000	30	I	2	117	11	0	0	0	0	30	0
6	52000	30	I	3	127	10	0	0	0	0	2	0
6	52000	30	I	4	152	13	0	0	0	0	5	0
6	52000	30	I	5	132	11	0	0	0	0	0	0
6	52000	30	I	6	117	10	0	0	0	0	20	0
6	52000	30	I	7	130	14	0	0	0	0	20	0
6	52000	30	I	8	157	14	0	0	0	0	0	0
6	1130	30	I	1	165	13	0	0	0	0	0	0
6	1130	30	I	2	97	6	0	0	0	0	0	0
6	1130	30	I	3	168	7	0	0	0	0	0	0
6	1130	30	I	4	168	13	0	0	0	0	0	0
6	1130	30	I	5	142	7	0	0	0	0	0	0
6	1130	30	I	6	135	10	0	0	0	0	0	0
6	1130	30	I	7	137	8	0	0	0	0	0	0
6	1130	30	I	8	142	9	0	0	0	0	0	0
6	1130	20	I	1	124	8	1	0	0	0	0	0
6	1130	20	I	2	145	8	0	0	0	0	1	0
6	1130	20	I	3	142	11	0	0	0	0	0	0
6	1130	20	I	4	140	10	0	0	0	0	0	0

6	1130	20	I	5	104	6	0	0	0	0	0	0
6	1130	20	I	6	132	10	0	0	0	0	0	0
6	1130	20	I	7	145	14	0	0	0	0	0	0
6	1130	20	I	8	117	7	0	0	0	0	0	0
6	1130	40	I	1	157	13	0	0	0	0	0	0
6	1130	40	I	2	142	13	0	0	0	0	0	0
6	1130	40	I	3	183	12	0	0	0	0	0	0
6	1130	40	I	4	173	14	0	0	0	0	0	0
6	1130	40	I	5	157	12	0	0	0	0	0	0
6	1130	40	I	6	147	12	0	0	0	0	0	0
6	1130	40	I	7	145	8	0	0	0	0	0	0
6	1130	40	I	8	127	11	0	0	0	0	0	0
6	1130	10	I	1	157	9	0	0	0	0	0	0
6	1130	10	I	2	168	10	0	0	0	0	0	0
6	1130	10	I	3	142	9	0	0	0	0	0	0
6	1130	10	I	4	147	10	0	0	0	0	0	0
6	1130	10	I	5	152	10	0	0	0	0	0	0
6	1130	10	I	6	175	12	0	0	0	0	0	0
6	1130	10	I	7	168	14	0	0	0	0	0	0
6	1130	10	I	8	142	8	0	0	0	0	0	0
6	1130	30	II	1	150	9	0	0	0	0	0	0
6	1130	30	II	2	157	13	0	0	0	0	0	0
6	1130	30	II	3	168	13	0	0	0	0	0	0

6	1130	30	II	4	157	8	1	0	0	0	0	0
6	1130	30	II	5	178	14	0	0	0	0	0	0
6	1130	30	II	6	132	7	0	0	0	0	0	0
6	1130	30	II	7	147	8	0	0	0	0	0	0
6	1130	30	II	8	168	14	0	0	0	0	0	0
6	1130	20	II	1	132	9	0	0	0	0	0	0
6	1130	20	II	2	132	9	0	0	0	0	0	0
6	1130	20	II	3	142	9	0	0	0	0	0	0
6	1130	20	II	4	160	10	0	0	0	0	0	0
6	1130	20	II	5	132	10	1	1	0	0	0	0
6	1130	20	II	6	102	6	0	0	0	0	0	0
6	1130	20	II	7	157	11	0	0	0	0	0	0
6	1130	20	II	8	147	10	1	0	0	0	0	0
6	1130	40	II	1	145	6	0	0	0	0	0	0
6	1130	40	II	2	142	11	0	0	0	0	0	0
6	1130	40	II	3	183	15	0	0	0	0	0	0
6	1130	40	II	4	142	14	0	0	0	0	0	0
6	1130	40	II	5	152	9	0	0	0	0	0	0
6	1130	40	II	6	160	10	0	0	0	0	0	0
6	1130	40	II	7	132	9	0	0	0	0	0	0
6	1130	40	II	8	183	14	0	0	0	0	0	0
6	1130	10	II	1	152	11	0	0	0	0	0	0
6	1130	10	II	2	147	11	0	0	0	0	0	0

6	1130	10	II	3	89	5	0	0	0	0	0	0
6	1130	10	II	4	168	14	1	1	0	0	0	0
6	1130	10	II	5	140	8	0	0	0	0	0	0
6	1130	10	II	6	150	12	0	0	0	0	0	0
6	1130	10	II	7	175	13	0	0	0	0	0	0
6	1130	10	II	8	145	8	0	0	0	0	0	0
6	52000	40	II	1	97	11	0	0	0	0	0	0
6	52000	40	II	2	127	12	0	0	0	0	1	0
6	52000	40	II	3	193	18	0	0	0	0	50	0
6	52000	42	II	4	150	12	2	2	0	0	0	0
6	52000	40	II	5	124	14	0	0	0	0	3	0
6	52001	40	II	6	117	9	0	0	0	0	3	0
6	52000	40	II	7	183	17	0	0	0	0	10	0
6	52000	40	II	8	155	13	0	0	0	0	6	0
6	52000	30	II	1	147	16	0	0	0	0	1	0
6	52000	30	II	2	142	10	0	0	0	0	0	0
6	52000	30	II	3	142	13	0	0	0	0	20	0
6	52000	30	II	4	152	12	0	0	0	0	20	0
6	52000	30	II	5	173	12	0	0	0	0	3	0
6	52000	30	II	6	147	12	0	0	0	0	0	0
6	52000	30	II	7	165	17	1	1	0	0	0	0
6	52000	30	II	8	160	15	0	0	0	0	10	0
6	52000	10	II	1	142	13	0	0	0	0	2	0

6	52000	10	II	2	145	13	0	0	0	0	0	0
6	52000	10	II	3	127	11	0	0	0	0	0	0
6	52000	10	II	4	142	9	0	0	0	0	0	0
6	52000	10	II	5	132	15	0	0	0	0	0	0
6	52000	10	II	6	193	14	0	0	0	0	0	0
6	52000	10	II	7	132	16	0	0	0	0	20	0
6	52000	10	II	8	89	10	0	0	0	0	0	0
6	52000	20	II	1	147	11	0	0	0	0	0	0
6	52000	20	II	2	124	12	0	0	0	0	10	0
6	52000	20	II	3	117	15	0	0	0	0	0	0
6	52000	20	II	4	183	19	0	0	0	0	40	0
6	52000	20	II	5	132	9	0	0	0	0	0	0
6	52000	20	II	6	117	13	0	0	0	0	3	0
6	52000	20	II	7	155	12	0	0	0	0	0	0
6	52000	20	II	8	124	12	0	0	0	0	1	0
6	M81E0	40	II	1	178	10	0	0	0	0	0	0
6	M81E0	40	II	2	188	11	0	0	0	0	0	0
6	M81E0	40	II	3	234	13	0	0	0	0	0	0
6	M81E0	40	II	4	183	10	0	0	0	0	0	0
6	M81E0	40	II	5	178	11	0	0	0	0	0	0
6	M81E0	40	II	6	142	8	0	0	0	0	0	0
6	M81E0	40	II	7	201	8	0	0	0	0	0	0
6	M81E0	40	II	8	193	12	1	0	0	0	0	0

6	M81E0	30	II	1	127	8	0	0	0	0	0	0
6	M81E0	30	II	2	147	6	0	0	0	0	0	0
6	M81E0	30	II	3	127	6	0	0	0	0	0	0
6	M81E0	30	II	4	157	9	0	0	0	0	0	0
6	M81E0	30	II	5	178	14	0	0	0	0	0	0
6	M81E0	30	II	6	107	9	0	0	0	0	0	0
6	M81E0	30	II	7	117	7	0	0	0	0	0	0
6	M81E0	30	II	8	114	6	0	0	0	0	0	0
6	M81E0	10	II	1	122	8	0	0	0	0	0	0
6	M81E0	10	II	2	193	13	0	0	0	0	0	0
6	M81E0	10	II	3	191	8	0	0	0	0	0	0
6	M81E0	10	II	4	193	9	0	0	0	0	0	0
6	M81E0	10	II	5	208	11	0	0	0	0	0	0
6	M81E0	10	II	6	124	6	0	0	0	0	0	0
6	M81E0	10	II	7	193	9	0	0	0	0	0	0
6	M81E0	10	II	8	183	12	0	0	0	0	0	0
6	M81E0	20	II	1	218	14	0	0	0	0	0	0
6	M81E0	20	II	2	188	12	0	0	0	0	0	0
6	M81E0	20	II	3	170	8	0	0	0	0	0	0
6	M81E0	20	II	4	193	9	0	0	0	0	0	0
6	M81E0	20	II	5	183	12	0	0	0	0	0	0
6	M81E0	20	II	6	145	10	0	0	0	0	0	0
6	M81E0	20	II	7	201	13	2	0	0	0	0	0

6	M81E0	20	II	8	175	10	0	0	0	0	0	0
6	51400	20	II	1	140	10	0	0	0	0	1	0
6	51400	20	II	2	142	12	0	0	0	0	0	0
6	51400	20	II	3	183	13	0	0	0	0	2	0
6	51400	20	II	4	188	12	0	0	0	0	1	0
6	51400	20	II	5	203	15	0	0	0	0	0	0
6	51400	20	II	6	142	8	0	0	0	0	0	0
6	51400	20	II	7	157	9	0	0	0	0	0	0
6	51400	20	II	8	208	12	0	0	0	0	0	0
6	51400	10	II	1	145	10	0	0	0	0	0	0
6	51400	10	II	2	193	12	0	0	0	0	0	0
6	51400	10	II	3	203	12	0	0	0	0	0	0
6	51400	10	II	4	168	13	0	0	0	0	0	0
6	51400	10	II	5	157	13	0	0	0	0	0	0
6	51400	10	II	6	155	12	0	0	0	0	0	0
6	51400	10	II	7	163	12	0	0	0	0	0	0
6	51400	10	II	8	168	11	0	0	0	0	0	0
6	51400	30	II	1	137	11	0	0	0	0	12	0
6	51400	30	II	2	152	12	0	0	0	0	0	0
6	51400	30	II	3	165	10	0	0	0	0	0	0
6	51400	30	II	4	107	9	0	0	0	0	5	0
6	51400	30	II	5	183	14	0	0	0	0	0	0
6	51400	30	II	6	142	10	0	0	0	0	1	0

6	51400	30	II	7	84	10	0	0	0	0	0	0
6	51400	30	II	8	150	11	0	0	0	0	0	0
6	51400	40	II	1	147	11	0	0	0	0	3	0
6	51400	40	II	2	173	12	2	2	0	0	0	0
6	51400	40	II	3	132	9	0	0	0	0	0	0
6	51400	40	II	4	165	6	0	0	0	0	0	0
6	51400	40	II	5	198	15	0	0	0	0	0	0
6	51400	40	II	6	188	13	0	0	0	0	0	0
6	51400	40	II	7	183	14	3	3	0	0	0	0
6	51400	40	II	8	150	9	0	0	0	0	0	0
6	10020	20	II	1	180	11	0	0	0	0	0	0
6	10020	20	II	2	173	12	4	4	0	0	0	0
6	10020	20	II	3	107	6	0	0	0	0	0	0
6	10020	20	II	4	168	9	0	0	0	0	0	0
6	10020	20	II	5	140	6	0	0	0	0	0	0
6	10020	20	II	6	193	12	1	0	0	0	0	0
6	10020	20	II	7	178	8	0	0	0	0	0	0
6	10020	20	II	8	168	12	0	0	0	0	0	0
6	10020	10	II	1	150	9	0	0	0	0	0	0
6	10020	10	II	2	193	13	0	0	0	0	0	0
6	10020	10	II	3	203	11	0	0	0	0	0	0
6	10020	10	II	4	124	8	0	0	0	0	0	0
6	10020	10	II	5	142	11	0	0	0	0	0	0

6	10020	10	II	6	201	10	0	0	0	0	0	0
6	10020	10	II	7	145	7	0	0	0	0	0	0
6	10020	10	II	8	193	12	0	0	0	0	0	0
6	10020	30	II	1	168	8	0	0	0	0	0	0
6	10020	30	II	2	163	9	0	0	0	0	0	0
6	10020	30	II	3	191	12	0	0	0	0	0	0
6	10020	30	II	4	147	8	0	0	0	0	0	0
6	10020	30	II	5	193	13	0	0	0	0	0	0
6	10020	30	II	6	117	10	0	0	0	0	0	0
6	10020	30	II	7	160	9	0	0	0	0	0	0
6	10020	30	II	8	206	10	3	3	0	0	0	0
6	10020	40	II	1	147	11	0	0	0	0	0	0
6	10020	40	II	2	180	8	0	0	0	0	0	0
6	10020	40	II	3	185	12	0	0	0	0	0	0
6	10020	40	II	4	185	10	1	0	0	0	0	0
6	10020	40	II	5	163	8	0	0	0	0	0	0
6	10020	40	II	6	132	8	0	0	0	0	0	0
6	10020	40	II	7	180	12	0	0	0	0	0	0
6	10020	40	II	8	152	10	0	0	0	0	0	0
6	8380	40	II	1	102	11	0	0	0	0	0	0
6	8380	40	II	2	142	12	0	0	0	0	0	0
6	8380	40	II	3	135	15	0	0	0	0	0	0
6	8380	40	II	4	132	12	0	0	0	0	0	0

6	8380	40	II	5	122	15	0	0	0	0	0	0
6	8380	40	II	6	102	10	0	0	0	0	0	0
6	8380	40	II	7	117	13	0	0	0	0	0	0
6	8380	40	II	8	127	9	0	0	0	0	0	0
6	8380	30	II	1	122	9	0	0	0	0	0	0
6	8380	30	II	2	122	12	0	0	0	0	0	0
6	8380	30	II	3	102	9	0	0	0	0	0	0
6	8380	30	II	4	124	10	0	0	0	0	0	0
6	8380	30	II	5	142	13	0	0	0	0	0	0
6	8380	30	II	6	142	16	0	0	0	0	0	0
6	8380	30	II	7	130	9	0	0	0	0	0	0
6	8380	30	II	8	89	8	0	0	0	0	0	0
6	8380	10	II	1	147	14	0	0	0	0	0	0
6	8380	10	II	2	142	9	0	0	0	0	0	0
6	8380	10	II	3	135	14	0	0	0	0	0	0
6	8380	10	II	4	142	14	0	0	0	0	0	0
6	8380	10	II	5	124	15	0	0	0	0	0	0
6	8380	10	II	6	124	12	2	1	0	0	0	0
6	8380	10	II	7	127	13	0	0	0	0	0	0
6	8380	10	II	8	168	12	2	2	0	0	0	0
6	8380	20	II	1	102	14	0	0	0	0	0	0
6	8380	20	II	2	119	10	0	0	0	0	0	0
6	8380	20	II	3	122	15	0	0	0	0	0	0

6	8380	20	II	4	152	15	0	0	0	0	0	0
6	8380	20	II	5	127	11	0	0	0	0	0	0
6	8380	20	II	6	147	15	0	0	0	0	0	0
6	8380	20	II	7	132	9	0	0	0	0	0	0
6	8380	20	II	8	117	5	0	0	0	0	0	0
6	8450	40	II	1	147	13	0	0	0	0	0	0
6	8450	40	II	2	109	8	0	0	0	0	0	0
6	8450	40	II	3	142	14	0	0	0	0	0	0
6	8450	40	II	4	157	14	0	0	0	0	0	0
6	8450	40	II	5	107	5	0	0	0	0	0	0
6	8450	40	II	6	124	12	0	0	0	0	0	0
6	8450	40	II	7	155	14	0	0	0	0	0	0
6	8450	40	II	8	119	9	0	0	0	0	0	0
6	8450	30	II	1	122	9	0	0	0	0	0	0
6	8450	30	II	2	145	12	0	0	0	0	0	0
6	8450	30	II	3	122	9	0	0	0	0	0	0
6	8450	30	II	4	145	12	0	0	0	0	0	0
6	8450	30	II	5	142	14	0	0	0	0	0	0
6	8450	30	II	6	124	7	0	0	0	0	0	0
6	8450	30	II	7	107	10	0	0	0	0	0	0
6	8450	30	II	8	130	12	0	0	0	0	0	0
6	8450	10	II	1	145	13	0	0	0	0	0	0
6	8450	10	II	2	122	10	0	0	0	0	0	0

6	8450	10	II	3	135	18	0	0	0	0	0	0
6	8450	10	II	4	142	14	0	0	0	0	0	0
6	8450	10	II	5	137	10	0	0	0	0	0	0
6	8450	10	II	6	122	11	0	0	0	0	0	0
6	8450	10	II	7	117	8	2	2	0	0	0	0
6	8450	10	II	8	157	14	1	0	0	0	0	0
6	8450	20	II	1	150	13	0	0	0	0	0	0
6	8450	20	II	2	132	12	0	0	0	0	0	0
6	8450	20	II	3	142	11	0	0	0	0	0	0
6	8450	20	II	4	142	12	4	4	0	0	0	0
6	8450	20	II	5	145	14	0	0	0	0	0	0
6	8450	20	II	6	157	13	3	2	0	0	0	0
6	8450	20	II	7	142	11	0	0	0	0	0	0
6	8450	20	II	8	130	12	2	1	0	0	0	0
6	M81E0	10	III	1	135	17	0	0	0	0	0	0
6	M81E0	10	III	2	117	10	0	0	0	0	0	0
6	M81E0	10	III	3	130	9	0	0	0	0	0	0
6	M81E0	10	III	4	188	11	0	0	0	0	0	0
6	M81E0	10	III	5	147	13	0	0	0	0	0	0
6	M81E0	10	III	6	145	8	0	0	0	0	0	0
6	M81E0	10	III	7	145	14	0	0	0	0	0	0
6	M81E0	10	III	8	114	10	0	0	0	0	0	0
6	M81E0	40	III	1	114	11	0	0	0	0	1	0

6	M81E0	40	III	2	127	8	0	0	0	0	0	0
6	M81E0	40	III	3	152	11	0	0	0	0	0	0
6	M81E0	40	III	4	173	15	0	0	0	0	0	0
6	M81E0	40	III	5	249	15	0	0	0	0	5	0
6	M81E0	40	III	6	216	15	0	0	0	0	0	0
6	M81E0	40	III	7	117	10	0	0	0	0	0	0
6	M81E0	40	III	8	132	16	0	0	0	0	0	0
6	M81E0	20	III	1	168	12	0	0	0	0	0	0
6	M81E0	20	III	2	160	13	0	0	0	0	0	0
6	M81E0	20	III	3	188	12	0	0	0	0	0	0
6	M81E0	20	III	4	244	15	0	0	0	0	0	0
6	M81E0	20	III	5	203	11	0	0	0	0	0	0
6	M81E0	20	III	6	145	9	0	0	0	0	0	0
6	M81E0	20	III	7	216	9	1	0	0	0	0	0
6	M81E0	20	III	8	163	12	0	0	0	0	0	0
6	M81E0	30	III	1	142	14	0	0	0	0	0	0
6	M81E0	30	III	2	165	11	0	0	0	0	0	0
6	M81E0	30	III	3	218	12	0	0	0	0	0	0
6	M81E0	30	III	4	155	8	0	0	0	0	0	0
6	M81E0	30	III	5	137	13	0	0	0	0	0	0
6	M81E0	30	III	6	145	10	0	0	0	0	0	0
6	M81E0	30	III	7	145	9	0	0	0	0	0	0
6	M81E0	30	III	8	145	12	0	0	0	0	0	0

6	51400	40	III	1	135	9	1	0	0	0	0	0
6	51400	40	III	2	119	10	0	0	0	0	0	0
6	51400	40	III	3	122	8	0	0	0	0	0	0
6	51400	40	III	4	135	10	0	0	0	0	2	0
6	51400	40	III	5	124	8	0	0	0	0	0	0
6	51400	40	III	6	142	13	0	0	0	0	1	0
6	51400	40	III	7	145	11	0	0	0	0	0	0
6	51400	40	III	8	132	14	1	0	0	0	0	0
6	51400	10	III	1	168	17	0	0	0	0	0	0
6	51400	10	III	2	183	14	0	0	0	0	0	0
6	51400	10	III	3	170	13	0	0	0	0	0	0
6	51400	10	III	4	170	14	0	0	0	0	0	0
6	51400	10	III	5	157	12	0	0	0	0	0	0
6	51400	10	III	6	183	10	0	0	0	0	0	0
6	51400	10	III	7	168	12	0	0	0	0	0	0
6	51400	10	III	8	132	9	0	0	0	0	0	0
6	51400	30	III	1	150	17	1	0	0	0	0	0
6	51400	30	III	2	132	8	0	0	0	0	0	0
6	51400	30	III	3	193	14	0	0	0	0	0	0
6	51400	30	III	4	183	6	0	0	0	0	0	0
6	51400	30	III	5	180	11	0	0	0	0	0	0
6	51400	30	III	6	130	8	0	0	0	0	9	0
6	51400	30	III	7	249	16	0	0	0	0	0	0

6	51400	30	III	8	152	10	0	0	0	0	10	0
6	51400	20	III	1	168	12	0	0	0	0	0	0
6	51400	20	III	2	170	14	1	0	0	0	6	0
6	51400	20	III	3	183	14	0	0	0	0	0	0
6	51400	20	III	4	175	15	0	0	0	0	2	0
6	51400	20	III	5	168	11	0	0	0	0	0	0
6	51400	20	III	6	160	15	1	0	0	0	0	0
6	51400	20	III	7	165	12	0	0	0	0	2	0
6	51400	20	III	8	183	14	0	0	0	0	0	0
6	1130	10	III	1	137	9	1	0	0	0	0	0
6	1130	10	III	2	165	12	0	0	0	0	0	0
6	1130	10	III	3	193	13	1	0	0	0	0	0
6	1130	10	III	4	193	15	0	0	0	0	0	0
6	1130	10	III	5	173	11	0	0	0	0	0	0
6	1130	10	III	6	165	9	0	0	0	0	0	0
6	1130	10	III	7	137	12	0	0	0	0	0	0
6	1130	10	III	8	163	11	0	0	0	0	0	0
6	1130	40	III	1	170	12	0	0	0	0	0	0
6	1130	40	III	2	175	13	0	0	0	0	0	0
6	1130	40	III	3	173	13	0	0	0	0	0	0
6	1130	40	III	4	175	12	0	0	0	0	0	0
6	1130	40	III	5	178	11	0	0	0	0	0	0
6	1130	40	III	6	140	9	0	0	0	0	0	0

6	1130	40	III	7	168	8	0	0	0	0	0	0
6	1130	40	III	8	132	9	0	0	0	0	0	0
6	1130	20	III	1	124	8	0	0	0	0	0	0
6	1130	20	III	2	99	7	0	0	0	0	0	0
6	1130	20	III	3	109	9	0	0	0	0	0	0
6	1130	20	III	4	130	10	0	0	0	0	0	0
6	1130	20	III	5	130	8	0	0	0	0	0	0
6	1130	20	III	6	165	10	1	0	0	0	0	0
6	1130	20	III	7	152	12	3	0	0	0	0	0
6	1130	20	III	8	107	8	0	0	0	0	0	0
6	1130	30	III	1	142	12	1	0	0	0	0	0
6	1130	30	III	2	130	11	0	0	0	0	0	0
6	1130	30	III	3	152	12	0	0	0	0	0	0
6	1130	30	III	4	140	11	0	0	0	0	0	0
6	1130	30	III	5	107	12	1	0	0	0	0	0
6	1130	30	III	6	157	11	0	0	0	0	0	0
6	1130	30	III	7	165	11	0	0	0	0	0	0
6	1130	30	III	8	152	12	0	0	0	0	0	0
6	8380	40	III	1	127	8	0	0	0	0	0	0
6	8380	40	III	2	132	11	0	0	0	0	0	0
6	8380	40	III	3	147	13	0	0	0	0	0	0
6	8380	40	III	4	135	8	0	0	0	0	0	0
6	8380	40	III	5	147	14	0	0	0	0	0	0

6	8380	40	III	6	147	13	0	0	0	0	0	0
6	8380	40	III	7	152	15	0	0	0	0	0	0
6	8380	40	III	8	132	9	1	1	0	0	0	0
6	8380	10	III	1	124	13	0	0	0	0	0	0
6	8380	10	III	2	122	8	0	0	0	0	0	0
6	8380	10	III	3	183	14	0	0	0	0	0	0
6	8380	10	III	4	132	11	0	0	0	0	0	0
6	8380	10	III	5	135	15	0	0	0	0	0	0
6	8380	10	III	6	152	13	0	0	0	0	0	0
6	8380	10	III	7	155	14	0	0	0	0	0	0
6	8380	10	III	8	124	10	1	0	0	0	0	0
6	8380	30	III	1	137	11	0	0	0	0	0	0
6	8380	30	III	2	107	6	0	0	0	0	0	0
6	8380	30	III	3	137	12	0	0	0	0	0	0
6	8380	30	III	4	112	10	0	0	0	0	0	0
6	8380	30	III	5	150	12	0	0	0	0	0	0
6	8380	30	III	6	137	12	0	0	0	0	0	0
6	8380	30	III	7	130	9	0	0	0	0	0	0
6	8380	30	III	8	130	13	0	0	0	0	0	0
6	8380	20	III	1	122	8	0	0	0	0	0	0
6	8380	20	III	2	127	11	1	0	0	0	0	0
6	8380	20	III	3	157	12	0	0	0	0	0	0
6	8380	20	III	4	157	13	0	0	0	0	0	0

6	8380	20	III	5	142	7	1	0	0	0	0	0
6	8380	20	III	6	137	11	0	0	0	0	0	0
6	8380	20	III	7	152	13	0	0	0	0	0	0
6	8380	20	III	8	140	11	0	0	0	0	0	0
6	8450	10	III	1	140	11	0	0	0	0	0	0
6	8450	10	III	2	150	12	0	0	0	0	0	0
6	8450	10	III	3	135	10	0	0	0	0	0	0
6	8450	10	III	4	137	14	0	0	0	0	0	0
6	8450	10	III	5	91	7	0	0	0	0	0	0
6	8450	10	III	6	157	11	0	0	0	0	0	0
6	8450	10	III	7	117	10	0	0	0	0	0	0
6	8450	10	III	8	135	8	0	0	0	0	0	0
6	8450	40	III	1	94	8	1	0	0	0	0	0
6	8450	40	III	2	104	18	0	0	0	0	0	0
6	8450	40	III	3	102	9	1	0	0	0	0	0
6	8450	40	III	4	119	13	0	0	0	0	0	0
6	8450	40	III	5	117	9	0	0	0	0	0	0
6	8450	40	III	6	94	8	0	0	0	0	0	0
6	8450	40	III	7	94	7	0	0	0	0	0	0
6	8450	40	III	8	107	9	0	0	0	0	0	0
6	8450	20	III	1	86	7	1	0	0	0	0	0
6	8450	20	III	2	86	6	0	0	0	0	0	0
6	8450	20	III	3	107	12	0	0	0	0	0	0

6	8450	20	III	4	122	9	0	0	0	0	0	0
6	8450	20	III	5	71	9	0	0	0	0	1	0
6	8450	20	III	6	114	9	0	0	0	0	0	0
6	8450	20	III	7	94	8	0	0	0	0	0	0
6	8450	20	III	8	107	9	0	0	0	0	0	0
6	8450	30	III	1	86	8	0	0	0	0	0	0
6	8450	30	III	2	104	11	0	0	0	0	0	0
6	8450	30	III	3	135	11	0	0	0	0	0	0
6	8450	30	III	4	127	10	0	0	0	0	0	0
6	8450	30	III	5	109	7	0	0	0	0	0	0
6	8450	30	III	6	81	7	1	0	0	0	0	0
6	8450	30	III	7	132	9	0	0	0	0	0	0
6	8450	30	III	8	137	11	0	0	0	0	0	0
6	52000	40	III	1	203	14	0	0	0	0	0	0
6	52000	40	III	2	178	14	0	0	0	0	0	0
6	52000	40	III	3	183	18	3	3	0	0	0	0
6	52000	40	III	4	173	12	2	1	0	0	0	0
6	52000	40	III	5	229	15	0	0	0	0	0	0
6	52000	40	III	6	178	12	1	0	0	0	0	0
6	52000	40	III	7	168	11	0	0	0	0	0	0
6	52000	40	III	8	249	14	2	1	0	0	0	0
6	52000	10	III	1	147	11	0	0	0	0	0	0
6	52000	10	III	2	160	13	0	0	0	0	0	0

6	52000	10	III	3	183	17	0	0	0	0	0	0
6	52000	10	III	4	206	15	0	0	0	0	0	0
6	52000	10	III	5	198	11	0	0	0	0	0	0
6	52000	10	III	6	157	16	0	0	0	0	0	0
6	52000	10	III	7	183	16	0	0	0	0	0	0
6	52000	10	III	8	183	15	0	0	0	0	0	0
6	52000	30	III	1	163	11	1	1	0	0	0	0
6	52000	30	III	2	213	16	0	0	0	0	0	0
6	52000	30	III	3	206	13	0	0	0	0	5	0
6	52000	30	III	4	198	18	0	0	0	0	0	0
6	52000	30	III	5	168	11	0	0	0	0	0	0
6	52000	30	III	6	155	11	0	0	0	0	0	0
6	52000	30	III	7	175	11	0	0	0	0	0	0
6	52000	30	III	8	185	11	0	0	0	0	4	0
6	52000	20	III	1	175	13	0	0	0	0	2	0
6	52000	20	III	2	168	11	0	0	0	0	0	0
6	52000	20	III	3	152	18	0	0	0	0	0	0
6	52000	20	III	4	135	12	0	0	0	0	0	0
6	52000	20	III	5	183	11	0	0	0	0	0	0
6	52000	20	III	6	183	14	0	0	0	0	0	0
6	52000	20	III	7	135	11	1	1	0	0	0	0
6	52000	20	III	8	152	15	0	0	0	0	0	0
6	10020	10	III	1	124	6	0	0	0	0	0	0

6	10020	10	III	2	137	5	0	0	0	0	0	0
6	10020	10	III	3	137	8	0	0	0	0	0	0
6	10020	10	III	4	183	10	0	0	0	0	0	0
6	10020	10	III	5	213	11	0	0	0	0	0	0
6	10020	10	III	6	193	12	0	0	0	0	0	0
6	10020	10	III	7	132	6	0	0	0	0	0	0
6	10020	10	III	8	178	11	0	0	0	0	0	0
6	10020	40	III	1	122	8	0	0	0	0	0	0
6	10020	40	III	2	178	10	0	0	0	0	0	0
6	10020	40	III	3	206	12	2	2	0	0	0	0
6	10020	40	III	4	193	11	0	0	0	0	0	0
6	10020	40	III	5	175	10	0	0	0	0	0	0
6	10020	40	III	6	193	12	0	0	0	0	0	0
6	10020	40	III	7	147	6	0	0	0	0	0	0
6	10020	40	III	8	165	10	0	0	0	0	0	0
6	10020	20	III	1	152	9	0	0	0	0	0	0
6	10020	20	III	2	122	8	0	0	0	0	0	0
6	10020	20	III	3	145	7	0	0	0	0	0	0
6	10020	20	III	4	180	11	0	0	0	0	0	0
6	10020	20	III	5	175	7	0	0	0	0	0	0
6	10020	20	III	6	180	12	0	0	0	0	0	0
6	10020	20	III	7	165	7	0	0	0	0	0	0
6	10020	20	III	8	183	12	0	0	0	0	0	0

6	10020	30	III	1	140	6	1	0	0	0	0	0
6	10020	30	III	2	107	5	0	0	0	0	0	0
6	10020	30	III	3	178	9	0	0	0	0	0	0
6	10020	30	III	4	165	13	0	0	0	0	0	0
6	10020	30	III	5	173	12	0	0	0	0	0	0
6	10020	30	III	6	152	7	0	0	0	0	0	0
6	10020	30	III	7	178	9	1	0	0	0	0	0
6	10020	30	III	8	183	13	0	0	0	0	0	0
6	8380	20	IV	1	76	5	0	0	0	0	0	0
6	8380	20	IV	2	117	12	0	0	0	0	0	0
6	8380	20	IV	3	168	12	3	0	0	0	0	0
6	8380	20	IV	4	147	15	0	0	0	0	0	0
6	8380	20	IV	5	152	9	0	0	0	0	0	0
6	8380	20	IV	6	102	9	0	0	0	0	0	0
6	8380	20	IV	7	178	19	0	0	0	0	0	0
6	8380	20	IV	8	165	13	0	0	0	0	0	0
6	8380	10	IV	1	142	11	0	0	0	0	0	0
6	8380	10	IV	2	130	8	0	0	0	0	0	0
6	8380	10	IV	3	130	9	0	0	0	0	0	0
6	8380	10	IV	4	147	15	0	0	0	0	0	0
6	8380	10	IV	5	165	11	0	0	0	0	0	0
6	8380	10	IV	6	81	15	0	0	0	0	0	0
6	8380	10	IV	7	191	13	0	0	0	0	0	0

6	8380	10	IV	8	127	11	0	0	0	0	0	0
6	8380	40	IV	1	127	8	1	1	0	0	0	0
6	8380	40	IV	2	117	10	0	0	0	0	0	0
6	8380	40	IV	3	157	9	2	2	0	0	0	0
6	8380	40	IV	4	140	9	0	0	0	0	0	0
6	8380	40	IV	5	157	9	0	0	0	0	0	0
6	8380	40	IV	6	155	12	0	0	0	0	0	0
6	8380	40	IV	7	132	9	0	0	0	0	0	0
6	8380	40	IV	8	132	14	0	0	0	0	0	0
6	8380	30	IV	1	114	8	0	0	0	0	0	0
6	8380	30	IV	2	114	7	0	0	0	0	0	0
6	8380	30	IV	3	165	13	4	4	0	0	0	0
6	8380	30	IV	4	130	12	0	0	0	0	0	0
6	8380	30	IV	5	188	19	0	0	0	0	0	0
6	8380	30	IV	6	124	8	0	0	0	0	0	0
6	8380	30	IV	7	165	9	0	0	0	0	0	0
6	8380	30	IV	8	147	17	0	0	0	0	0	0
6	1130	30	IV	1	145	8	0	0	0	0	0	0
6	1130	30	IV	2	145	8	0	0	0	0	0	0
6	1130	30	IV	3	150	8	0	0	0	0	0	0
6	1130	30	IV	4	183	10	0	0	0	0	0	0
6	1130	30	IV	5	178	13	0	0	0	0	0	0
6	1130	30	IV	6	180	12	0	0	0	0	0	0

6	1130	30	IV	7	185	8	0	0	0	0	0	0
6	1130	30	IV	8	180	10	0	0	0	0	0	0
6	1130	40	IV	1	145	12	0	0	0	0	0	0
6	1130	40	IV	2	142	10	0	0	0	0	0	0
6	1130	40	IV	3	132	7	1	1	0	0	0	0
6	1130	40	IV	4	170	12	0	0	0	0	0	0
6	1130	40	IV	5	124	6	0	0	0	0	0	0
6	1130	40	IV	6	178	12	0	0	0	0	0	0
6	1130	40	IV	7	127	7	0	0	0	0	0	0
6	1130	40	IV	8	109	8	1	1	0	0	0	0
6	1130	10	IV	1	178	10	0	0	0	0	0	0
6	1130	10	IV	2	132	10	0	0	0	0	0	0
6	1130	10	IV	3	188	11	0	0	0	0	0	0
6	1130	10	IV	4	165	7	0	0	0	0	0	0
6	1130	10	IV	5	183	8	0	0	0	0	0	0
6	1130	10	IV	6	178	10	0	0	0	0	0	0
6	1130	10	IV	7	142	10	0	0	0	0	0	0
6	1130	10	IV	8	188	11	0	0	0	0	0	0
6	1130	20	IV	1	218	12	0	0	0	0	0	0
6	1130	20	IV	2	193	11	0	0	0	0	0	0
6	1130	20	IV	3	188	12	0	0	0	0	0	0
6	1130	20	IV	4	102	6	0	0	0	0	0	0
6	1130	20	IV	5	206	9	0	0	0	0	0	0

6	1130	20	IV	6	185	11	0	0	0	0	0	0
6	1130	20	IV	7	191	13	0	0	0	0	0	0
6	1130	20	IV	8	178	9	0	0	0	0	0	0
6	8450	20	IV	1	132	8	0	0	0	0	0	0
6	8450	20	IV	2	91	8	0	0	0	0	0	0
6	8450	20	IV	3	147	11	0	0	0	0	0	0
6	8450	20	IV	4	140	11	0	0	0	0	0	0
6	8450	20	IV	5	168	13	0	0	0	0	0	0
6	8450	20	IV	6	147	12	0	0	0	0	0	0
6	8450	20	IV	7	117	9	0	0	0	0	0	0
6	8450	20	IV	8	178	13	0	0	0	0	0	0
6	8450	10	IV	1	117	10	0	0	0	0	0	0
6	8450	10	IV	2	142	10	0	0	0	0	0	0
6	8450	10	IV	3	147	10	0	0	0	0	0	0
6	8450	10	IV	4	142	13	0	0	0	0	0	0
6	8450	10	IV	5	160	8	0	0	0	0	0	0
6	8450	10	IV	6	140	10	0	0	0	0	0	0
6	8450	10	IV	7	137	14	0	0	0	0	0	0
6	8450	10	IV	8	142	11	0	0	0	0	1	0
6	8450	40	IV	1	104	7	0	0	0	0	0	0
6	8450	40	IV	2	119	8	0	0	0	0	0	0
6	8450	40	IV	3	142	13	3	2	0	0	0	0
6	8450	40	IV	4	119	11	0	0	0	0	0	0

6	8450	40	IV	5	122	9	0	0	0	0	0	0
6	8450	40	IV	6	86	7	0	0	0	0	0	0
6	8450	40	IV	7	86	8	0	0	0	0	0	0
6	8450	40	IV	8	142	9	0	0	0	0	0	0
6	8450	30	IV	1	130	8	0	0	0	0	0	0
6	8450	30	IV	2	147	13	3	3	0	0	0	0
6	8450	30	IV	3	152	14	0	0	0	0	0	0
6	8450	30	IV	4	155	12	0	0	0	0	0	0
6	8450	30	IV	5	122	9	0	0	0	0	0	0
6	8450	30	IV	6	147	13	1	0	0	0	0	0
6	8450	30	IV	7	142	12	0	0	0	0	0	0
6	8450	30	IV	8	147	11	0	0	0	0	0	0
6	M81E0	30	IV	1	267	16	0	0	0	0	0	0
6	M81E0	30	IV	2	198	11	0	0	0	0	0	0
6	M81E0	30	IV	3	178	8	2	2	0	0	0	0
6	M81E0	30	IV	4	213	14	0	0	0	0	0	0
6	M81E0	30	IV	5	183	16	1	1	0	0	0	0
6	M81E0	30	IV	6	193	12	1	0	0	0	0	0
6	M81E0	30	IV	7	274	16	0	0	0	0	0	0
6	M81E0	30	IV	8	246	10	0	0	0	0	0	0
6	M81E0	40	IV	1	211	14	2	2	0	0	1	0
6	M81E0	40	IV	2	168	12	0	0	0	0	0	0
6	M81E0	40	IV	3	127	12	0	0	0	0	0	0

6	M81E0	40	IV	4	216	12	1	0	0	0	0	0
6	M81E0	40	IV	5	183	13	0	0	0	0	0	0
6	M81E0	40	IV	6	211	13	0	0	0	0	0	0
6	M81E0	40	IV	7	152	12	1	1	0	0	0	0
6	M81E0	40	IV	8	147	8	3	2	0	0	0	0
6	M81E0	10	IV	1	203	12	0	0	0	0	0	0
6	M81E0	10	IV	2	234	13	0	0	0	0	0	0
6	M81E0	10	IV	3	185	10	0	0	0	0	0	0
6	M81E0	10	IV	4	218	13	0	0	0	0	0	0
6	M81E0	10	IV	5	244	13	0	0	0	0	0	0
6	M81E0	10	IV	6	183	12	0	0	0	0	0	0
6	M81E0	10	IV	7	193	12	0	0	0	0	0	0
6	M81E0	10	IV	8	165	9	0	0	0	0	0	0
6	M81E0	20	IV	1	234	14	0	0	0	0	0	0
6	M81E0	20	IV	2	216	13	2	2	0	0	0	0
6	M81E0	20	IV	3	203	12	0	0	0	0	0	0
6	M81E1	20	IV	4	229	9	0	0	0	0	0	0
6	M81E0	20	IV	5	259	14	0	0	0	0	0	0
6	M81E0	20	IV	6	203	11	0	0	0	0	0	0
6	M81E0	20	IV	7	244	16	1	1	0	0	0	0
6	M81E0	20	IV	8	180	8	0	0	0	0	0	0
6	51400	30	IV	1	175	13	0	0	0	0	0	0
6	51400	30	IV	2	213	14	0	0	0	0	0	0

6	51400	30	IV	3	198	18	0	0	0	0	0	0
6	51400	30	IV	4	175	12	0	0	0	0	0	0
6	51400	30	IV	5	193	13	0	0	0	0	0	0
6	51400	30	IV	6	142	14	0	0	0	0	0	0
6	51400	30	IV	7	191	13	3	3	0	0	2	0
6	51402	30	IV	8	168	14	0	0	0	0	0	0
6	51400	40	IV	1	140	9	0	0	0	0	0	0
6	51400	40	IV	2	175	10	1	1	0	0	0	0
6	51400	40	IV	3	117	7	0	0	0	0	0	0
6	51400	40	IV	4	155	14	0	0	0	0	0	0
6	51400	40	IV	5	183	13	0	0	0	0	0	0
6	51400	40	IV	6	203	14	0	0	0	0	2	0
6	51400	40	IV	7	198	17	0	0	0	0	0	0
6	51400	40	IV	8	168	13	1	0	0	0	0	0
6	51400	10	IV	1	185	13	0	0	0	0	0	0
6	51400	10	IV	2	208	14	0	0	0	0	0	0
6	51400	10	IV	3	218	16	0	0	0	0	0	0
6	51400	10	IV	4	193	13	0	0	0	0	0	0
6	51400	10	IV	5	191	14	0	0	0	0	0	0
6	51400	10	IV	6	183	13	0	0	0	0	0	0
6	51400	10	IV	7	206	21	0	0	0	0	0	0
6	51400	10	IV	8	241	13	0	0	0	0	0	0
6	51400	20	IV	1	173	14	0	0	0	0	0	0

6	51400	20	IV	2	165	15	0	0	0	0	0	0
6	51400	20	IV	3	152	13	3	3	0	0	1	0
6	51400	20	IV	4	183	15	0	0	0	0	0	0
6	51400	20	IV	5	183	17	0	0	0	0	2	0
6	51400	20	IV	6	188	13	0	0	0	0	1	0
6	51400	20	IV	7	175	14	0	0	0	0	4	0
6	51400	20	IV	8	165	10	0	0	0	0	0	0
6	52000	20	IV	1	191	14	0	0	0	0	0	0
6	52000	20	IV	2	168	8	0	0	0	0	0	0
6	52000	20	IV	3	178	13	0	0	0	0	0	0
6	52000	20	IV	4	155	12	2	2	0	0	0	0
6	52000	20	IV	5	178	11	0	0	0	0	10	0
6	52000	20	IV	6	193	11	0	0	0	0	0	0
6	52000	20	IV	7	168	12	3	3	0	0	0	0
6	52000	20	IV	8	208	12	0	0	0	0	0	0
6	52000	10	IV	1	152	11	0	0	0	0	0	0
6	52000	10	IV	2	185	13	0	0	0	0	0	0
6	52000	10	IV	3	198	11	0	0	0	0	0	0
6	52000	10	IV	4	208	14	0	0	0	0	0	0
6	52000	10	IV	5	216	17	0	0	0	0	0	0
6	52000	10	IV	6	239	18	0	0	0	0	0	0
6	52000	10	IV	7	224	16	0	0	0	0	0	0
6	52000	10	IV	8	191	14	0	0	0	0	0	0

6	52000	40	IV	1	188	13	1	1	0	0	0	0
6	52000	40	IV	2	193	13	0	0	0	0	0	0
6	52000	40	IV	3	203	13	2	2	0	0	0	0
6	52000	40	IV	4	173	11	0	0	0	0	0	0
6	52000	40	IV	5	196	10	0	0	0	0	0	0
6	52000	40	IV	6	193	18	0	0	0	0	3	0
6	52000	40	IV	7	180	13	3	3	0	0	0	0
6	52000	40	IV	8	196	14	2	2	0	0	0	0
6	52000	30	IV	1	168	16	0	0	0	0	0	0
6	52000	30	IV	2	168	10	1	1	0	0	0	0
6	52000	30	IV	3	234	13	0	0	0	0	0	0
6	52000	30	IV	4	185	16	0	0	0	0	0	0
6	52000	30	IV	5	191	13	4	4	0	0	0	0
6	52000	30	IV	6	183	15	0	0	0	0	0	0
6	52000	30	IV	7	183	15	0	0	0	0	0	0
6	52000	30	IV	8	193	13	3	3	0	0	0	0
6	10020	20	IV	1	135	7	0	0	0	0	0	0
6	10020	20	IV	2	117	7	0	0	0	0	0	0
6	10020	20	IV	3	157	8	0	0	0	0	0	0
6	10020	20	IV	4	178	8	0	0	0	0	0	0
6	10020	20	IV	5	180	9	0	0	0	0	0	0
6	10020	20	IV	6	145	8	0	0	0	0	0	0
6	10020	20	IV	7	196	10	0	0	0	0	0	0

6	10020	20	IV	8	168	8	0	0	0	0	0	0
6	10020	10	IV	1	165	7	0	0	0	0	0	0
6	10020	10	IV	2	183	12	0	0	0	0	0	0
6	10020	10	IV	3	221	12	0	0	0	0	0	0
6	10020	10	IV	4	193	7	0	0	0	0	0	0
6	10020	10	IV	5	203	15	0	0	0	0	0	0
6	10020	10	IV	6	183	13	0	0	0	0	0	0
6	10020	10	IV	7	206	9	0	0	0	0	0	0
6	10020	10	IV	8	180	12	0	0	0	0	0	0
6	10020	40	IV	1	168	11	0	0	0	0	0	0
6	10020	40	IV	2	140	7	0	0	0	0	0	0
6	10020	40	IV	3	183	10	1	1	0	0	0	0
6	10020	40	IV	4	119	6	0	0	0	0	0	0
6	10020	40	IV	5	132	7	0	0	0	0	0	0
6	10020	40	IV	6	193	7	0	0	0	0	0	0
6	10020	40	IV	7	168	11	0	0	0	0	0	0
6	10020	40	IV	8	150	8	0	0	0	0	0	0
6	10020	30	IV	1	130	5	0	0	0	0	0	0
6	10020	30	IV	2	152	8	0	0	0	0	0	0
6	10020	30	IV	3	165	8	0	0	0	0	0	0
6	10020	30	IV	4	234	13	0	0	0	0	0	0
6	10020	30	IV	5	180	11	0	0	0	0	0	0
6	10020	30	IV	6	198	10	0	0	0	0	0	0

```
6	1002	3	IV	7	152	8	0	0	0	0	0	0
	0	0
6	1002	3	IV	8	196	13	0	0	0	0	0	0
	0	0
;
proc glimmix data=Infestation2012;
class variety rep infestation date;
model injury = variety|infestation|date /ddfm=KR;
random rep rep*variety rep*infestation rep*variety*infestation;
lsmeans variety|infestation|date /pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include "C:\Users\MVanWeelden\Documents\PhD Plan of Study\PMMIX2013.sas";
	%include "C:\Users\MVanWeelden\Documents\PhD Plan of Study\PDMIX900.sas";
	%PMMIX2013(%nrbquote(
	Proc Mixed Data = Infestation2012;
	Title "Type 5 Example";
	Class variety rep infestation date;
	Model injury = variety|infestation|date /ddfm=KR;
	Random rep rep*variety rep*infestation rep*variety*infestation;
	PMMOPTIONS[AT MEANS, Diff, adjust = Tukey];
	*PMM contrasts are Type 5 Contrasts;
	*PMMCONTRAST 'C 1-3 , 2-4' C 1 0 -1  0, 0 1 0 -1;
	*PMMCONTRAST 'C 1,2 vs 4 ' C 1 1  0 -2  Divisor = 2;
	PDMIX900[pddiffs, pdmeans, sort = NO, alpha = 0.05];
				));
ods rtf close;

"Within-season Injury 2013"
ods rtf file="rtf_file.rtf";
data Infestation2013;
input date$ rep$ infestation$ variety$ stalk$ height internodes feedingsigns bored white yellow
chinch mealy armyworm;
injury = (feedingsigns / internodes);
cards;
7/2/2013	I	1	845		1	29	5	0	0	0	0
	0	0	0
7/2/2013	I	1	845		2	65	9	0	0	0	0
	0	0	0
7/2/2013	I	1	845		3	48	6	0	0	0	0
	0	0	0
7/2/2013	I	1	845		4	52	8	0	0	0	0
	0	0	0
7/2/2013	I	1	845		5	64	5	0	0	0	0
	0	0	0
```

7/2/2013	I	1	845	6	50	5	0	0	0	0	0	0	0
7/2/2013	I	1	845	7	37	4	0	0	0	0	0	0	0
7/2/2013	I	1	845	8	51	6	0	0	0	0	0	0	0
7/2/2013	I	1	845	9	57	7	0	0	0	0	0	0	0
7/2/2013	I	1	845	10	50	5	0	0	0	0	0	0	0
7/2/2013	I	2	845	1	69	8	0	0	0	0	0	0	0
7/2/2013	I	2	845	2	49	6	0	0	0	0	0	0	0
7/2/2013	I	2	845	3	39	7	0	0	0	0	0	0	0
7/2/2013	I	2	845	4	33	5	0	0	0	0	0	0	0
7/2/2013	I	2	845	5	33	7	0	0	0	0	0	0	0
7/2/2013	I	2	845	6	42	5	0	0	0	0	0	0	0
7/2/2013	I	2	845	7	58	7	2	1	0	0	0	0	0
7/2/2013	I	2	845	8	76	9	1	0	0	0	0	0	0
7/2/2013	I	2	845	9	52	6	0	0	0	0	0	0	0
7/2/2013	I	2	845	10	51	8	0	0	0	0	0	0	0
7/2/2013	I	3	845	1	56	9	0	0	0	0	0	0	0
7/2/2013	I	3	845	2	54	7	0	0	0	0	0	0	0
7/2/2013	I	3	845	3	39	3	0	0	0	0	0	0	0
7/2/2013	I	3	845	4	49	6	0	0	0	0	0	0	0
7/2/2013	I	3	845	5	52	7	0	0	0	0	0	0	0
7/2/2013	I	3	845	6	39	6	1	0	0	0	0	0	0
7/2/2013	I	3	845	7	42	5	1	0	0	0	0	0	0

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. . . . . . . . . . . . . .
9/18/2013	IV	2	838	1	146	16	2	4	0	0
	0	0	0
9/18/2013	IV	2	838	2	161	14	0	1	0	0
	0	0	0
9/18/2013	IV	2	838	3	186	19	0	0	0	0
	0	0	0
9/18/2013	IV	2	838	4	164	19	0	0	0	0
	0	0	0
9/18/2013	IV	2	838	5	155	16	2	0	0	0
	0	0	0
9/18/2013	IV	2	838	6	155	16	0	0	0	0
	0	0	0
9/18/2013	IV	2	838	7	181	21	0	2	0	0
	0	0	0
9/18/2013	IV	2	838	8	196	25	3	0	0	0
	0	0	0
9/18/2013	IV	1	838	1	200	18	0	0	0	0
	0	0	0
9/18/2013	IV	1	838	2	188	17	0	0	0	0
	0	0	0
9/18/2013	IV	1	838	3	178	19	0	1	0	0
	0	0	0
9/18/2013	IV	1	838	4	185	18	0	0	0	0
	0	0	0
9/18/2013	IV	1	838	5	173	18	0	0	0	0
	0	0	0
9/18/2013	IV	1	838	6	182	18	0	0	0	0
	0	0	0
9/18/2013	IV	1	838	7	186	20	0	0	0	0
	0	0	0
9/18/2013	IV	1	838	8	182	19	0	0	0	0
	0	0	0
;
proc glimmix data=Infestation2013;
class variety rep infestation date;
model injury = variety|infestation|date /ddfm=KR;
random rep rep*variety rep*infestation rep*variety*infestation;
lsmeans variety|infestation|date /pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include "C:\Users\MVanWeelden\Documents\PhD Plan of Study\PMMIX2013.sas";
	%include "C:\Users\MVanWeelden\Documents\PhD Plan of Study\PDMIX900.sas";
```

```
%PMMIX2013(%nrbquote(
        Proc Mixed Data = Infestation2013;
        Title "Type 5 Example";
        Class variety rep infestation date;
    Model injury = variety|infestation|date /ddfm=KR;
    Random rep rep*variety rep*infestation rep*variety*infestation;
        PMMOPTIONS[AT MEANS, Diff, adjust = Tukey];
      *PMM contrasts are Type 5 Contrasts;
      *PMMCONTRAST 'C 1-3 , 2-4' C 1 0 -1  0, 0 1 0 -1;
      *PMMCONTRAST 'C 1,2 vs 4 ' C 1 1  0 -2  Divisor = 2;
      PDMIX900[pddiffs, pdmeans, sort = NO, alpha = 0.05];
        ));
ods rtf close;
```

"End-of-Season Injury"

```
ods rtf file="rtf_file.rtf";
data BeauBioEnergyAll;
input rep$ variety$ infestation$ row$ wetwgt sugar percbored PercBored theoEtOH year$;
if variety='5140' then Z1=1; else Z1=0;
if variety='M81E' then Z2=1; else Z2=0;
if variety='113' then Z3=1; else Z3=0;
if variety='1002' then Z4=1; else Z4=0;
if variety='838' then Z5=1; else Z5=0;
if variety='845' then Z6=1; else Z6=0;
if year='2013' then Z7=1; else Z7=0;
cards;
1   5200   1   A   0.3935 6.5736299   0.000   0.0   .   2013
1   5200   1   B   0.476   5.2391336   0.000   0.0   15370.462   2013
1   5200   1   C   0.61   5.8322431   0.000   0.0   18867.049   2013
1   5200   2   A   0.533   6.5242041   0.014   1.4   20718.649   2013
1   5200   2   B   0.40975   6.6230557   0.022   2.2   15519.476   2013
1   5200   2   C   0.34   5.6345399   0.023   2.3   12424.308   2013
1   5200   3   A   0.319   4.8931531   0.015   1.5   .   2013
1   5200   3   B   0.2805 5.5851141   0.000   0.0   9746.108   2013
1   5200   3   C   0.3715 6.4253525   0.012   1.2   13599.247   2013
1   5200   4   A   0.382   6.8207588   0.045   4.5   14794.498   2013
1   5200   4   B   0.4745 5.0414304   0.060   6.0   16371.504   2013
1   5200   4   C   0.437   5.7333915   0.062   6.2   17348.009   2013
2   5200   1   A   0.6   5.6345399   0.000   0.0   19617.498   2013
2   5200   1   B   0.394   5.6839657   0.000   0.0   14932.486   2013
2   5200   1   C   0.5335 5.6345399   0.000   0.0   16620.981   2013
2   5200   2   A   0.4305 5.5356883   0.039   3.9   .   2013
2   5200   2   B   0.272   5.7828173   0.075   7.5   9921.214   2013
2   5200   2   C   0.479   5.5356883   0.020   2.0   16245.061   2013
2   5200   3   A   0.549   4.6954499   0.011   1.1   15458.293   2013
2   5200   3   B   0.33   5.5356883   0.048   4.8   11102.968   2013
```

2	5200	3	C	0.5475	5.8322431	0.012	1.2	18931.797	2013
2	5200	4	A	.	4.1023405	0.031	3.1	16297.149	2013
2	5200	4	B	0.372	5.1897078	0.164	16.4	14011.214	2013
2	5200	4	C	0.7255	3.6575084	0.184	18.4	17365.344	2013
3	5200	1	A	0.471	5.7333915	0.000	0.0	16486.336	2013
3	5200	1	B	0.82	6.3759267	0.000	0.0	27214.959	2013
3	5200	1	C	0.9115	5.4862625	0.000	0.0	31785.859	2013
3	5200	2	A	0.376	5.6839657	0.103	10.3	13647.705	2013
3	5200	2	B	0.156	5.2391336	0.051	5.1	.	2013
3	5200	2	C	0.288	5.0414304	0.100	10.0	12694.375	2013
3	5200	3	A	0.2125	4.5965983	0.075	7.5	6897.636	2013
3	5200	3	B	0.3355	4.6460241	0.068	6.8	10714.331	2013
3	5200	3	C	0.2505	4.9425789	0.026	2.6	7917.73	2013
3	5200	4	A	0.1315	5.3379852	0.170	17.0	5070.966	2013
3	5200	4	B	0.296	5.7828173	0.139	13.9	11310.798	2013
3	5200	4	C	0.22	6.1287978	0.029	2.9	8618.363	2013
4	5200	1	A	0.5955	6.771333	0.000	0.0	23435.852	2013
4	5200	1	B	0.5265	7.4138683	0.000	0.0	21153.368	2013
4	5200	1	C	0.5205	6.5242041	0.000	0.0	20682.421	2013
4	5200	2	A	0.3315	6.8701846	0.036	3.6	13407.038	2013
4	5200	2	B	0.462	5.4862625	0.058	5.8	18252.091	2013
4	5200	2	C	0.411	6.2276494	0.026	2.6	15038.866	2013
4	5200	3	A	0.4365	6.1782236	0.118	11.8	16188.48	2013
4	5200	3	B	0.4075	6.3265009	0.024	2.4	14579.013	2013
4	5200	3	C	0.3825	6.079372	0.026	2.6	14412.96	2013
4	5200	4	A	0.3275	6.079372	0.027	2.7	12398.508	2013
4	5200	4	B	0.3215	5.7828173	0.051	5.1	11672.711	2013
4	5200	4	C	0.316	5.9805204	0.101	10.1	.	2013
1	5140	1	A	0.1935	4.9425789	0.000	0.0	5926.348	2013
1	5140	1	B	0.211	5.1897078	0.000	0.0	6566.1	2013
1	5140	1	C	0.2	4.3988952	0.000	0.0	5800.699	2013
1	5140	2	A	0.178	5.9310946	0.095	9.5	9871.104	2013
1	5140	2	B	0.178	5.5356883	0.000	0.0	6212.328	2013
1	5140	2	C	0.205	5.0908562	0.183	18.3	7958.321	2013
1	5140	3	A	0.1645	4.3000436	0.024	2.4	5068.161	2013
1	5140	3	B	0.1805	4.8931531	0.043	4.3	5197.776	2013
1	5140	3	C	.	4.0529147	0.000	0.0	8473.602	2013
1	5140	4	A	0.37225	5.7828173	0.124	12.4	8162.053	2013
1	5140	4	B	0.1015	5.140282	0.081	8.1	9647.301	2013
1	5140	4	C	0.156	4.8931531	0.148	14.8	4785.646	2013
2	5140	1	A	0.3355	5.6345399	0.022	2.2	.	2013
2	5140	1	B	0.4285	5.387411	0.000	0.0	13984.763	2013
2	5140	1	C	0.267	4.8931531	0.000	0.0	8607.14	2013
2	5140	2	A	0.2005	5.9805204	0.022	2.2	6895.501	2013
2	5140	2	B	0.2365	5.7333915	0.183	18.3	7170.942	2013
2	5140	2	C	0.1295	4.7943015	0.136	13.6	3612.103	2013

2	5140	3	A	0.2575	5.7333915	0.069	6.9	9415.7	2013
2	5140	3	B	. .	. .	.			2013
2	5140	3	C	0.2795	5.5851141	0.087	8.7	8288.121	2013
2	5140	4	A	0.2125	5.3379852	0.307	30.7	6864.643	2013
2	5140	4	B	0.152	5.5356883	0.288	28.8	5233.405	2013
2	5140	4	C	0.2435	4.7943015	0.299	29.9	7038.384	2013
3	5140	1	A	0.5285	5.1897078	0.000	0.0	17156.094	2013
3	5140	1	B	0.154	4.9920047	0.000	0.0	4724.081	2013
3	5140	1	C	0.439	5.7333915	0.010	1.0	14656.454	2013
3	5140	2	A	0.0925	5.387411	0.047	4.7	3208.498	2013
3	5140	2	B	0.2335	5.0908562	0.012	1.2	8162.278	2013
3	5140	2	C	0.112	5.0908562	0.019	1.9	4254.313	2013
3	5140	3	A	0.1265	5.5851141	0.040	4.0	4328.531	2013
3	5140	3	B	0.067	5.1897078	0.324	32.4	2493.733	2013
3	5140	3	C	0.291	5.4862625	0.088	8.8	8601.528	2013
3	5140	4	A	0.1165	4.2506178	0.167	16.7	4080.323	2013
3	5140	4	B	0.1875	5.6345399	0.174	17.4	6109.429	2013
3	5140	4	C	0.1775	4.2506178	0.439	43.9	5307.45	2013
4	5140	1	A	0.2915	6.3265009	0.000	0.0	10293.637	2013
4	5140	1	B	0.5795	6.3759267	0.000	0.0	20028.765	2013
4	5140	1	C	0.419	6.8207588	0.010	1.0	17028.595	2013
4	5140	2	A	0.179	5.2885594	0.149	14.9	5683.118	2013
4	5140	2	B	0.234	5.6839657	0.042	4.2	5608.922	2013
4	5140	2	C	0.234	5.6839657	0.000	0.0	8998.883	2013
4	5140	3	A	0.199	5.8322431	0.181	18.1	7244.651	2013
4	5140	3	B	0.1765	5.1897078	0.157	15.7	7212.514	2013
4	5140	3	C	0.1335	6.1782236	0.178	17.8	.	2013
4	5140	4	A	0.1425	5.3379852	0.356	35.6	6042.712	2013
4	5140	4	B	0.1905	5.4368367	0.051	5.1	6723.276	2013
4	5140	4	C	0.128	5.140282	0.101	10.1	5791.888	2013
1	M81E	1	A	0.183	7.6115714	0.000	0.0	7428.143	2013
1	M81E	1	B	0.301	6.5242041	0.000	0.0	10089.928	2013
1	M81E	1	C	0.1945	5.3379852	0.017	1.7	3716.697	2013
1	M81E	2	A	0.1985	.	0.119	11.9	.	2013
1	M81E	2	B	0.059	4.5965983	0.000	0.0	2759.179	2013
1	M81E	2	C	0.0745	7.5621457	0.049	4.9	5920.737	2013
1	M81E	3	A	.	.	.	.	.	2013
1	M81E	3	B	.	.	.	.	.	2013
1	M81E	3	C	0.07975	5.9310946	0.041	4.1	3245.35	2013
1	M81E	4	A	.	.	.	.	.	2013
1	M81E	4	B	.	.	.	.	.	2013
1	M81E	4	C	.	.	.	.	.	2013
2	M81E	1	A	0.138	6.6724815	0.000	0.0	5189.562	2013
2	M81E	1	B	0.177	6.6724815	0.000	0.0	.	2013
2	M81E	1	C	0.2185	6.4747783	0.000	0.0	7408.549	2013
2	M81E	2	A	0.128	4.6954499	0.016	1.6	.	2013

2	M81E	2	B	0.0865	4.1517662	0.000	0.0	2990.246	2013
2	M81E	2	C	0.2495	3.0643989	0.024	2.4	6253.869	2013
2	M81E	3	A	0.0545	5.6345399	0.183	18.3	.	2013
2	M81E	3	B	0.095	6.1287978	0.094	9.4	3196.246	2013
2	M81E	3	C	.	3.4103794	0.044	4.4	21643.724	2013
2	M81E	4	A	0.0955	4.0034889	0.094	9.4	3046.679	2013
2	M81E	4	B	0.07675	3.6575084	0.125	12.5	2222.095	2013
2	M81E	4	C	.	3.6575084	0.109	10.9	7167.331	2013
3	M81E	1	A	0.2405	6.9196104	0.000	0.0	8945.283	2013
3	M81E	1	B	0.3145	6.4747783	0.000	0.0	8075.411	2013
3	M81E	1	C	0.1795	6.3265009	0.000	0.0	5827.072	2013
3	M81E	2	A	0.1045	3.5586568	0.018	1.8	2784.112	2013
3	M81E	2	B	0.0815	3.4103794	0.023	2.3	2265.865	2013
3	M81E	2	C	0.051	5.2391336	0.040	4.0	1994.512	2013
3	M81E	3	A	0.117	4.448321	0.033	3.3	3668.507	2013
3	M81E	3	B	0.1215	2.9655473	0.068	6.8	3378.905	2013
3	M81E	3	C	0.1485	2.4712894	0.043	4.3	3386.698	2013
3	M81E	4	A	0.0935	5.1897078	0.103	10.3	3398.943	2013
3	M81E	4	B	0.137	2.5207152	0.049	4.9	3754.427	2013
3	M81E	4	C	0.1295	3.0643989	0.072	7.2	3817.724	2013
4	M81E	1	A	0.408	4.8931531	0.015	1.5	13146.542	2013
4	M81E	1	B	0.4515	6.3759267	0.000	0.0	16699.446	2013
4	M81E	1	C	0.464	6.2770752	0.000	0.0	16432.476	2013
4	M81E	2	A	0.198	5.5851141	0.000	0.0	7134.319	2013
4	M81E	2	B	0.2425	5.2391336	0.048	4.8	7470.992	2013
4	M81E	2	C	0.2355	5.1897078	0.044	4.4	8306.113	2013
4	M81E	3	A	0.3255	4.9920047	0.136	13.6	9453.863	2013
4	M81E	3	B	0.2985	5.1897078	0.097	9.7	10398.283	2013
4	M81E	3	C	0.2905	3.262102	0.016	1.6	8910.64	2013
4	M81E	4	A	0.21	4.1023405	0.031	3.1	.	2013
4	M81E	4	B	0.1185	5.5356883	0.086	8.6	4425.572	2013
4	M81E	4	C	0.1145	6.7219073	0.159	15.9	4809.523	2013
1	113	1	A	0.2625	8.9954935	0.000	0.0	16224.649	2013
1	113	1	B	0.3485	8.4023841	0.012	1.2	.	2013
1	113	1	C	0.252	8.5506614	0.000	0.0	16788.344	2013
1	113	2	A	0.2855	8.3035325	0.000	0.0	13427.251	2013
1	113	2	B	0.197	8.7483646	0.000	0.0	14690.441	2013
1	113	2	C	0.2275	7.710423	0.067	6.7	12657.483	2013
1	113	3	A	0.2605	9.0449193	0.029	2.9	12672.894	2013
1	113	3	B	0.2435	8.4518099	0.000	0.0	14701.263	2013
1	113	3	C	0.209	6.9196104	0.000	0.0	12711.751	2013
1	113	4	A	0.2565	8.4518099	0.000	0.0	12806.429	2013
1	113	4	B	0.257	8.649513	0.000	0.0	14739.597	2013
1	113	4	C	0.2215	7.710423	0.031	3.1	15600.295	2013
1	113	1	A	.	.	.	.	.	2013
2	113	1	B	0.2895	7.7598488	0.000	0.0	16572.51	2013

2	113	1	C	0.334	7.4138683	0.000	0.0	18778.629	2013
2	113	2	A	0.293	8.5506614	0.000	0.0	16063.8	2013
2	113	2	B	0.02155	8.3035325	0.059	5.9	9748.554	2013
2	113	2	C	0.227	8.5012356	0.030	3.0	12087.784	2013
2	113	3	A	0.243	8.9460677	0.029	2.9	15069.771	2013
2	113	3	B	0.2195	7.8092746	0.058	5.8	12144.412	2013
2	113	3	C	0.349	7.8092746	0.058	5.8	19084.932	2013
2	113	4	A	0.1945	8.3035325	0.250	25.0	10274.958	2013
2	113	4	B	0.2085	9.0943451	0.119	11.9	.	2013
2	113	4	C	0.205	8.1058293	0.083	8.3	12365.45	2013
3	113	1	A	0.4135	8.6000872	0.000	0.0	22762.505	2013
3	113	1	B	0.283	8.0069778	0.000	0.0	16191.773	2013
3	113	1	C	0.408	8.5506614	0.013	1.3	22783.067	2013
3	113	2	A	0.3145	8.1552551	0.027	2.7	17831.277	2013
3	113	2	B	0.3005	8.3529583	0.065	6.5	18233.4	2013
3	113	2	C	0.3185	8.2046809	0.070	7.0	17714.992	2013
3	113	3	A	0.2265	8.3035325	.	.	15924.487	2013
3	113	3	B	0.348	8.4023841	.	.	20015.117	2013
3	113	3	C	0.317	8.4518099	.	.	.	2013
3	113	4	A	0.1725	6.771333	0.204	20.4	9674.252	2013
3	113	4	B	0.342	7.8587004	0.051	5.1	19312.942	2013
3	113	4	C	0.183	6.0299462	0.020	2.0	7251.623	2013
4	113	1	A	0.334	7.5127199	0.000	0.0	16725.721	2013
4	113	1	B	0.382	7.5621457	0.000	0.0	20280.443	2013
4	113	1	C	0.267	6.771333	0.000	0.0	14127.509	2013
4	113	2	A	0.317	7.9081262	0.014	1.4	17389.878	2013
4	113	2	B	0.346575	7.1173136	0.000	0.0	17514.412	2013
4	113	2	C	0.355	6.3759267	0.044	4.4	16660.299	2013
4	113	3	A	0.199	6.8701846	0.255	25.5	10586.321	2013
4	113	3	B	0.3505	7.4138683	0.076	7.6	17592.355	2013
4	113	3	C	0.269	6.6724815	0.125	12.5	13774.018	2013
4	113	4	A	0.2795	7.7598488	0.148	14.8	17117.481	2013
4	113	4	B	0.317	7.2655909	0.030	3.0	17003.911	2013
4	113	4	C	0.297	5.9310946	0.109	10.9	.	2013
1	1002	1	A	0.2945	8.1058293	0.000	0.0	14036.881	2013
1	1002	1	B	0.1605	6.9690362	0.015	1.5	9464.415	2013
1	1002	1	C	0.2335	6.9196104	0.014	1.4	11398.281	2013
1	1002	2	A	0.1735	5.8816688	0.033	3.3	8032.152	2013
1	1002	2	B	0.1725	6.1287978	0.177	17.7	8059.641	2013
1	1002	2	C	0.173	6.0299462	0.022	2.2	60818.63	2013
1	1002	3	A	0.171	6.3265009	0.125	12.5	8091.506	2013
1	1002	3	B	0.2155	5.6839657	0.103	10.3	.	2013
1	1002	3	C	0.233	6.0299462	0.103	10.3	10305.064	2013
1	1002	4	A	0.2675	6.4747783	0.067	6.7	13217.093	2013
1	1002	4	B	0.1755	6.4747783	0.092	9.2	9177.952	2013
1	1002	4	C	0.2435	.	0.075	7.5	.	2013

2	1002	1	A	0.217	5.0414304	0.000	0.0	10559.875	2013
2	1002	1	B	0.288	6.1782236	0.013	1.3	15352.019	2013
2	1002	1	C	0.2415	6.4253525	0.000	0.0	12375.575	2013
2	1002	2	A	0.271	6.9196104	0.062	6.2	9740.983	2013
2	1002	2	B	0.205	6.4253525	0.030	3.0	.	2013
2	1002	2	C	0.176	6.9196104	0.035	3.5	9084.237	2013
2	1002	3	A	0.2045	5.8816688	0.069	6.9	9842.952	2013
2	1002	3	B	0.222	6.4747783	0.132	13.2	10349.904	2013
2	1002	3	C	0.154	5.6839657	0.212	21.2	6273.689	2013
2	1002	4	A	0.2	6.1287978	0.214	21.4	10369.375	2013
2	1002	4	B	0.2265	5.7828173	0.172	17.2	11163.782	2013
2	1002	4	C	0.228	6.8207588	0.232	23.2	11867.352	2013
3	1002	1	A	0.2595	6.0299462	0.000	0.0	12879.647	2013
3	1002	1	B	0.2425	6.3265009	0.000	0.0	12490.047	2013
3	1002	1	C	0.1865	6.1782236	0.000	0.0	10019.373	2013
3	1002	2	A	0.1595	6.2770752	0.039	3.9	8087.978	2013
3	1002	2	B	.	.	0.148	14.8	.	2013
3	1002	2	C	0.1375	5.5356883	0.100	10.0	6672.972	2013
3	1002	3	A	0.1545	6.7219073	0.108	10.8	.	2013
3	1002	3	B	0.218	5.8322431	0.190	19.0	10322.632	2013
3	1002	3	C	0.195	4.9425789	0.089	8.9	9468.704	2013
3	1002	4	A	0.1805	5.4862625	0.053	5.3	8300.877	2013
3	1002	4	B	0.172	4.7943015	0.213	21.3	7713.182	2013
3	1002	4	C	0.2285	6.0299462	0.095	9.5	11298.014	2013
4	1002	1	A	0.2095	5.387411	0.000	0.0	10790.166	2013
4	1002	1	B	0.332	5.4368367	0.000	0.0	16020.196	2013
4	1002	1	C	0.225	5.5356883	0.000	0.0	11197.571	2013
4	1002	2	A	0.21	4.9920047	0.107	10.7	.	2013
4	1002	2	B	0.1615	5.2391336	0.021	2.1	7273.328	2013
4	1002	2	C	0.202	5.2391336	0.036	3.6	8541.892	2013
4	1002	3	A	0.0945	4.8931531	0.108	10.8	4816.534	2013
4	1002	3	B	0.122	5.6345399	0.049	4.9	5634.858	2013
4	1002	3	C	0.222	5.7333915	0.068	6.8	9610.995	2013
4	1002	4	A	0.203	6.079372	0.048	4.8	10702.324	2013
4	1002	4	B	0.12	5.4862625	0.128	12.8	5600.764	2013
4	1002	4	C	0.1805	5.3379852	0.125	12.5	7612.11	2013
1	838	1	A	0.6575	10.0334351	0.000	0.0	9015.164	2013
1	838	1	B	0.6197	9.7863061	0.000	0.0	8223.341	2013
1	838	1	C	0.5675	8.4023841	0.000	0.0	11674.475	2013
1	838	2	A	0.4525	9.4897514	0.014	1.4	5767.491	2013
1	838	2	B	0.677	9.4403256	0.000	0.0	9158.294	2013
1	838	2	C	0.5565	9.4897514	0.059	5.9	7001.329	2013
1	838	3	A	0.481	9.4403256	0.093	9.3	5821.829	2013
1	838	3	B	0.557	9.8851577	0.012	1.2	7265.389	2013
1	838	3	C	0.4365	9.6874546	0.014	1.4	5807.564	2013
1	838	4	A	0.536	8.9954935	0.048	4.8	7082.607	2013

1	838	4	B	0.429	9.4403256	0.027	2.7	5315.658	2013
1	838	4	C	0.5605	8.896642	0.055	5.5	7534.882	2013
2	838	1	A	0.615	7.9081262	0.000	0.0	7566.468	2013
2	838	1	B	0.7885	9.7368804	0.000	0.0	10595.055	2013
2	838	1	C	0.692	8.6989388	0.012	1.2	8249.157	2013
2	838	2	A	0.5845	8.6989388	0.035	3.5	7364.183	2013
2	838	2	B	0.562	9.0449193	0.119	11.9	7278.246	2013
2	838	2	C	0.7015	8.9460677	0.098	9.8	9290.056	2013
2	838	3	A	0.4275	9.3414741	0.156	15.6	5706.727	2013
2	838	3	B	0.6355	8.9954935	0.102	10.2	8506.231	2013
2	838	3	C	0.343	8.5506614	0.333	33.3	4619.394	2013
2	838	4	A	0.609	8.5012356	0.143	14.3	7780.652	2013
2	838	4	B	0.5305	7.6609972	0.108	10.8	8186.158	2013
2	838	4	C	0.562	9.0943451	0.133	13.3	6930.168	2013
3	838	1	A	0.532	9.8851577	0.000	0.0	7134.854	2013
3	838	1	B	0.8155	9.1437709	0.000	0.0	10658.314	2013
3	838	1	C	0.727	9.2920483	0.000	0.0	10087.483	2013
3	838	2	A	0.4525	9.2426225	0.000	0.0	5549.535	2013
3	838	2	B	0.363	8.649513	0.181	18.1	5040.145	2013
3	838	2	C	0.599	8.0069778	0.012	1.2	7461.893	2013
3	838	3	A	0.3475	9.2426225	0.068	6.8	4860.147	2013
3	838	3	B	0.3835	9.0943451	0.071	7.1	5603.543	2013
3	838	3	C	0.631	9.6874546	0.000	0.0	8652.233	2013
3	838	4	A	0.221	9.3414741	0.102	10.2	7576.773	2013
3	838	4	B	0.442	9.7368804	0.084	8.4	6629.459	2013
3	838	4	C	0.301	8.7977904	0.153	15.3	4108.541	2013
4	838	1	A	0.634	7.5621457	0.013	1.3	6681.211	2013
4	838	1	B	0.8025	8.7977904	0.013	1.3	9553.949	2013
4	838	1	C	0.761	9.1931967	0.000	0.0	9946.807	2013
4	838	2	A	0.441	7.7598488	0.068	6.8	4840.284	2013
4	838	2	B	0.68	8.896642	0.190	19.0	7774.717	2013
4	838	2	C	0.5945	6.771333	0.137	13.7	6757.637	2013
4	838	3	A	0.367	8.0564035	0.159	15.9	4947.14	2013
4	838	3	B	0.5295	8.5012356	0.122	12.2	6205.194	2013
4	838	3	C	.	.	0.074	7.4	.	2013
4	838	4	A	0.395	7.4632941	0.159	15.9	5008.076	2013
4	838	4	B	0.5625	8.3529583	0.186	18.6	6319.828	2013
4	838	4	C	0.5425	8.6989388	0.203	20.3	7522.213	2013
1	845	1	A	0.602	8.7483646	0.000	0.0	6016.501	2013
1	845	1	B	0.71	8.7483646	0.000	0.0	7260.932	2013
1	845	1	C	0.4865	8.7977904	0.000	0.0	4571.582	2013
1	845	2	A	0.4895	8.5012356	0.015	1.5	5391.718	2013
1	845	2	B	0.493	8.4518099	0.028	2.8	4988.61	2013
1	845	2	C	0.4845	8.6000872	0.000	0.0	4753.885	2013
1	845	3	A	0.431	9.2920483	0.019	1.9	4408.816	2013
1	845	3	B	0.5845	8.5506614	0.028	2.8	5454.504	2013

1	845	3	C	0.367	8.5012356	0.016	1.6	3725.027	2013
1	845	4	A	0.5725	8.9954935	0.057	5.7	6333.833	2013
1	845	4	B	0.5055	8.9954935	0.074	7.4	5407.522	2013
1	845	4	C	0.42	8.9954935	0.164	16.4	4225.801	2013
2	845	1	A	0.874	9.3414741	0.000	0.0	9173.241	2013
2	845	1	B	0.6315	9.3908998	0.000	0.0	6607.027	2013
2	845	1	C	0.6305	9.1931967	0.016	1.6	6538.748	2013
2	845	2	A	0.7145	8.6989388	0.131	13.1	.	2013
2	845	2	B	0.623	8.7483646	0.014	1.4	5973.572	2013
2	845	2	C	0.593	8.3035325	0.100	10.0	5639.595	2013
2	845	3	A	0.386	9.5391772	0.000	0.0	4228.011	2013
2	845	3	B	0.459	9.3908998	0.055	5.5	4724.448	2013
2	845	3	C	0.428	8.649513	0.070	7.0	4171.037	2013
2	845	4	A	0.338	8.8472162	0.033	3.3	3244.064	2013
2	845	4	B	0.481	8.7977904	0.108	10.8	4944.325	2013
2	845	4	C	0.437	9.6380288	0.000	0.0	4760.513	2013
3	845	1	A	.	.	0.000	0.0	.	2013
3	845	1	B	0.5185	8.0069778	0.000	0.0	4986.831	2013
3	845	1	C	0.6345	8.6989388	0.000	0.0	5807.103	2013
3	845	2	A	0.553	9.0449193	0.041	4.1	5568.493	2013
3	845	2	B	0.645	8.7483646	0.094	9.4	6385.437	2013
3	845	2	C	0.4505	8.1552551	0.000	0.0	4187.079	2013
3	845	3	A	0.2975	8.1552551	0.000	0.0	2679.69	2013
3	845	3	B	0.3495	9.2426225	0.000	0.0	3800.667	2013
3	845	3	C	0.2675	7.3150167	0.014	1.4	.	2013
3	845	4	A	0.6025	8.6989388	0.079	7.9	5461.819	2013
3	845	4	B	.	.	0.015	1.5	.	2013
3	845	4	C	0.467	8.8472162	0.013	1.3	4801.153	2013
4	845	1	A	0.692	8.6989388	0.000	0.0	.	2013
4	845	1	B	0.7585	8.3529583	0.000	0.0	7005.71	2013
4	845	1	C	0.6855	8.0564035	0.000	0.0	5946.248	2013
4	845	2	A	0.5825	8.2046809	0.000	0.0	5467.376	2013
4	845	2	B	0.502	9.0449193	0.016	1.6	4971.904	2013
4	845	2	C	0.2175	7.8092746	0.057	5.7	2473.874	2013
4	845	3	A	0.52	8.5012356	0.101	10.1	4744.213	2013
4	845	3	B	0.5585	8.3035325	0.034	3.4	4564.954	2013
4	845	3	C	0.498	8.3529583	0.000	0.0	4596.585	2013
4	845	4	A	0.522	8.2541067	0.000	0.0	5009.006	2013
4	845	4	B	0.3925	7.0678878	0.208	20.8	.	2013
4	845	4	C	0.4505	8.6989388	0.200	20.0	4561.923	2013
1	5200	1	A	0.739	6.3	0.000	0.000	28424.552	2012
1	5200	1	B	0.781	6.6	0.000	0.000	29801.261	2012
1	5200	1	C	0.745	6.7	0.000	0.000	26062.761	2012
1	5200	2	A	0.440	6.1	0.621	62.069	.	2012
1	5200	2	B	0.886	6.5	0.169	16.901	26659.73	2012
1	5200	2	C	0.519	6.1	0.217	21.667	20373.088	2012

1	5200	3	A	0.422	6.0	0.435	43.548	14961.676	2012
1	5200	3	B	0.588	6.2	0.118	11.765	20987.639	2012
1	5200	3	C	0.530	6.0	0.014	1.449	20907.339	2012
1	5200	4	A	0.467	5.9	0.215	21.538	16663.743	2012
1	5200	4	B	0.608	6.1	0.271	27.119	21589.7	2012
1	5200	4	C	0.549	6.6	0.328	32.813	21198.905	2012
2	5200	1	A	0.509	5.4	0.000	0.000	18649.328	2012
2	5200	1	B	0.445	6.5	0.000	0.000	17706.72	2012
2	5200	1	C	0.559	6.2	0.000	0.000	19584.529	2012
2	5200	2	A	0.319	5.4	0.273	27.273	11105.444	2012
2	5200	2	B	0.334	5.1	0.431	43.103	11566.092	2012
2	5200	2	C	0.397	6.3	0.069	6.897	15309.438	2012
2	5200	3	A	0.291	6.4	0.041	4.082	10564.704	2012
2	5200	3	B	0.483	5.8	0.148	14.754	17082.719	2012
2	5200	3	C	0.594	5.8	0.406	40.580	20697.81	2012
2	5200	4	A	0.299	5.9	0.386	38.596	11271.942	2012
2	5200	4	B	0.434	5.3	0.371	37.097	16173.86	2012
2	5200	4	C	0.262	5.8	0.077	7.692	9792.936	2012
3	5200	1	A	0.833	6.8	0.000	0.000	30650.383	2012
3	5200	1	B	0.732	6.5	0.000	0.000	27115.63	2012
3	5200	1	C	0.746	6.4	0.000	0.000	26620.668	2012
3	5200	2	A	0.546	6.3	0.092	9.231	18897.521	2012
3	5200	2	B	0.507	5.5	0.222	22.222	17700.976	2012
3	5200	2	C	0.733	5.6	0.181	18.056	25670.435	2012
3	5200	3	A	0.410	6.0	0.000	0.000	15174.738	2012
3	5200	3	B	0.549	6.3	0.031	3.077	18941.013	2012
3	5200	3	C	0.631	7.0	0.273	27.273	22441.754	2012
3	5200	4	A	0.376	6.0	0.200	20.000	13354.909	2012
3	5200	4	B	0.482	6.1	0.161	16.071	17795.548	2012
3	5200	4	C	0.651	6.3	0.132	13.235	24074.758	2012
4	5200	1	A	0.538	5.6	0.000	0.000	19061.138	2012
4	5200	1	B	0.665	6.0	0.000	0.000	23130.912	2012
4	5200	1	C	0.618	5.6	0.000	0.000	21170.046	2012
4	5200	2	A	0.420	5.1	0.271	27.143	14478.745	2012
4	5200	2	B	0.647	5.5	0.116	11.594	19032.325	2012
4	5200	2	C	0.586	5.5	0.155	15.493	19693.959	2012
4	5200	3	A	0.397	5.6	0.186	18.644	12441.614	2012
4	5200	3	B	0.531	5.7	0.139	13.889	18105.296	2012
4	5200	3	C	0.812	6.2	0.125	12.500	25093.899	2012
4	5200	4	A	0.773	5.0	0.243	24.324	23157.396	2012
4	5200	4	B	0.542	5.6	0.269	26.866	19042.325	2012
4	5200	4	C	0.696	5.9	0.153	15.278	24783.398	2012
1	5140	1	A	0.334	5.8	0.000	0.000	11225.491	2012
1	5140	1	B	0.395	5.4	0.000	0.000	13435.07	2012
1	5140	1	C	0.421	5.2	0.000	0.000	14168.975	2012
1	5140	2	A	0.305	5.7	0.100	10.000	10490.831	2012

1	5140	2	B	0.232		6.0		0.076	7.576	7827.576		2012
1	5140	2	C	0.228		6.1		0.067	6.667	7893.043		2012
1	5140	3	A	0.273		5.3		0.107	10.667	9182.899		2012
1	5140	3	B	0.234		5.7		0.016	1.639	7802.176		2012
1	5140	3	C	0.200		5.4		0.157	15.686	6683.014		2012
1	5140	4	A	0.273		5.2		0.060	5.970	8084.409		2012
1	5140	4	B	0.331		5.0		0.192	19.178	9290.114		2012
1	5140	4	C	0.264	5.0	0.152	15.152		7381.666		2012	
2	5140	1	A	0.329	5.2	0.000	0.000		10986.439		2012	
2	5140	1	B	0.326	5.9	0.000	0.000		10821.793		2012	
2	5140	1	C	0.416	6.3	0.000	0.000		13706.695		2012	
2	5140	2	A	0.254	5.6	0.133	13.333		8696.402		2012	
2	5140	2	B	0.207	5.1	0.172	17.241		6672.982		2012	
2	5140	2	C	0.313	5.5	0.115	11.475		9845.203		2012	
2	5140	3	A	0.221	4.4	0.182	18.182		7808.917		2012	
2	5140	3	B	0.202	5.4	0.143	14.286		6659.103		2012	
2	5140	3	C	0.286	5.3	0.176	17.647		9326.001		2012	
2	5140	4	A	0.145	4.5	0.083	8.333		4137.296		2012	
2	5140	4	B	0.208	4.6	0.274	27.419		6058.99		2012	
2	5140	4	C	0.168	4.6	0.367	36.735		4922.476		2012	
3	5140	1	A	0.396	5.8	0.000	0.000		12926.422		2012	
3	5140	1	B	0.316	5.1	0.000	0.000		10349.005		2012	
3	5140	1	C	0.342	5.2	0.000	0.000		11357.946		2012	
3	5140	2	A	0.292	4.3	0.075	7.463		9795.43		2012	
3	5140	2	B	0.318	9.2	0.203	20.290		12259.065		2012	
3	5140	2	C	0.314	4.8	0.155	15.493		9335.347		2012	
3	5140	3	A	0.267	4.3	0.145	14.516		7656.333		2012	
3	5140	3	B	0.281	4.7	0.214	21.429		8690.188		2012	
3	5140	3	C	0.226	5.0	0.160	16.000		7176.516		2012	
3	5140	4	A	0.140	5.1	0.169	16.949		4384.93		2012	
3	5140	4	B	0.205	4.9	0.188	18.750		5924.114		2012	
3	5140	4	C	0.282	5.2	0.221	22.059		8273.019		2012	
4	5140	1	A	0.365	5.1	0.000	0.000		11187.838		2012	
4	5140	1	B	0.292	4.9	0.000	0.000		9584.903		2012	
4	5140	1	C	0.355	5.1	0.000	0.000		11787.429		2012	
4	5140	2	A	0.382	5.0	0.096	9.639		12259.389		2012	
4	5140	2	B	0.291	5.1	0.077	7.692		9055.132		2012	
4	5140	2	C	0.313	8.2	0.195	19.512		7695.599		2012	
4	5140	3	A	0.292	5.0	0.257	25.714		9710.006		2012	
4	5140	3	B	0.197	4.6	0.108	10.769		6101.714		2012	
4	5140	3	C	0.189	4.7	0.234	23.438		6064.251		2012	
4	5140	4	A	0.413	5.4	0.114	11.392		12663.146		2012	
4	5140	4	B	0.180	4.9	0.121	12.121		5112.909		2012	
4	5140	4	C	0.250	5.0	0.213	21.311		7259.875		2012	
1	M81E	1	A	0.334	7.9	0.000	0.000		11443.663		2012	
1	M81E	1	B	0.263	8.0	0.019	1.852		9553.703		2012	

1	M81E	1	C	0.269	8.3	0.000	0.000	10021.262	2012
1	M81E	2	A	0.188	7.7	0.060	6.000	6896.887	2012
1	M81E	2	B	0.218	8.0	0.208	20.755	7740.789	2012
1	M81E	2	C	0.229	7.9	0.100	10.000	7701.146	2012
1	M81E	3	A	0.189	7.7	0.148	14.815	6621.635	2012
1	M81E	3	B	0.054	4.9	0.020	1.961	8039.378	2012
1	M81E	3	C	0.152	7.9	0.176	17.647	5624.136	2012
1	M81E	4	A	0.203	8.3	0.106	10.638	6523.118	2012
1	M81E	4	B	0.178	8.0	0.140	13.953	5844.952	2012
1	M81E	4	C	0.189	7.6	0.151	15.094	5898.679	2012
2	M81E	1	A	0.277	8.4	0.000	0.000	10061.02	2012
2	M81E	1	B	0.244	8.5	0.000	0.000	9412.983	2012
2	M81E	1	C	0.222	8.3	0.000	0.000	8118.402	2012
2	M81E	2	A	0.115	8.2	0.286	28.571	3819.231	2012
2	M81E	2	B	0.111	8.6	0.089	8.889	4218.055	2012
2	M81E	2	C	0.076	9.0	0.167	16.667	2497.658	2012
2	M81E	3	A	0.126	8.3	0.043	4.348	4727.277	2012
2	M81E	3	B	0.097	8.6	0.111	11.111	3294.01	2012
2	M81E	3	C	0.082	8.6	0.045	4.545	2943.286	2012
2	M81E	4	A	0.087	7.9	0.333	33.333	3115.402	2012
2	M81E	4	B	0.089	9.3	0.022	2.222	3252.021	2012
2	M81E	4	C	0.100	8.9	0.059	5.882	3439.119	2012
3	M81E	1	A	0.266	8.3	0.000	0.000	9726.472	2012
3	M81E	1	B	0.362	8.0	0.000	0.000	12988.227	2012
3	M81E	1	C	0.269	8.5	0.000	0.000	9565.119	2012
3	M81E	2	A	0.192	7.3	0.137	13.725	6671.297	2012
3	M81E	2	B	0.273	8.0	0.102	10.204	9486.46	2012
3	M81E	2	C	0.335	8.1	0.232	23.214	11496.25	2012
3	M81E	3	A	0.163	8.0	0.000	0.000	5832.03	2012
3	M81E	3	B	0.207	7.6	0.000	0.000	6841.825	2012
3	M81E	3	C	0.158	8.1	0.213	21.277	5459.979	2012
3	M81E	4	A	0.161	7.9	0.130	12.963	5758.757	2012
3	M81E	4	B	0.197	7.3	0.109	10.909	6488.855	2012
3	M81E	4	C	0.175	7.4	0.053	5.263	6183.614	2012
4	M81E	1	A	0.250	8.4	0.000	0.000	9522.515	2012
4	M81E	1	B	0.259	8.6	0.000	0.000	9895.16	2012
4	M81E	1	C	0.212	8.6	0.000	0.000	8057.913	2012
4	M81E	2	A	0.266	7.7	0.196	19.643	8941.912	2012
4	M81E	2	B	0.262	7.9	0.056	5.600	8872.697	2012
4	M81E	2	C	0.212	8.1	0.094	9.434	7181.512	2012
4	M81E	3	A	0.277	8.0	0.105	10.526	9603.076	2012
4	M81E	3	B	0.188	8.4	0.158	15.789	6722.979	2012
4	M81E	3	C	0.219	8.3	0.078	7.843	7655.247	2012
4	M81E	4	A	0.206	7.6	0.255	25.455	6821.648	2012
4	M81E	4	B	0.232	8.1	0.093	9.259	7660.03	2012
4	M81E	4	C	0.262	7.9	0.056	5.556	8488.796	2012

1	113	1	A	0.318	7.6	0.020	2.041	17089.334	2012
1	113	1	B	0.322	8.4	0.000	0.000	17679.902	2012
1	113	1	C	0.325	7.6	0.034	3.448	17654.81	2012
1	113	2	A	0.247	8.4	0.020	1.961	13706.397	2012
1	113	2	B	0.310	8.3	0.019	1.887	17221.404	2012
1	113	2	C	0.261	7.6	0.188	18.750	14312.091	2012
1	113	3	A	0.234	8.2	0.000	0.000	12919.52	2012
1	113	3	B	0.237	7.5	0.020	2.041	12568.962	2012
1	113	3	C	0.268	7.1	0.000	0.000	14773.201	2012
1	113	4	A	0.312	7.0	0.000	0.000	16917.346	2012
1	113	4	B	0.262	8.3	0.019	1.923	16107.519	2012
1	113	4	C	0.277	8.2	0.098	9.804	15967.531	2012
2	113	1	A	0.349	7.5	0.000	0.000	18153.618	2012
2	113	1	B	0.341	8.1	0.000	0.000	17905.891	2012
2	113	1	C	0.362	8.2	0.017	1.724	20322.083	2012
2	113	2	A	0.314	7.4	0.127	12.727	16966.356	2012
2	113	2	B	0.318	7.4	0.000	0.000	17145.346	2012
2	113	2	C	0.328	7.7	0.069	6.897	17644.231	2012
2	113	3	A	0.236	7.9	0.116	11.628	13437.497	2012
2	113	3	B	0.246	8.1	0.163	16.327	13759.801	2012
2	113	3	C	0.349	7.3	0.235	23.529	19072.59	2012
2	113	4	A	0.247	7.9	0.176	17.647	13748.331	2012
2	113	4	B	0.235	7.7	0.020	2.041	12525.507	2012
2	113	4	C	0.269	7.7	0.116	11.628	14894.318	2012
3	113	1	A	0.382	7.4	0.018	1.754	21114.858	2012
3	113	1	B	0.345	7.9	0.000	0.000	18707.278	2012
3	113	1	C	0.395	7.5	0.000	0.000	21313.814	2012
3	113	2	A	0.270	7.0	0.137	13.725	14637.234	2012
3	113	2	B	0.346	7.9	0.000	0.000	17724.029	2012
3	113	2	C	0.300	7.5	0.098	9.804	16604.545	2012
3	113	3	A	0.237	6.7	0.140	13.953	12658.452	2012
3	113	3	B	0.263	6.9	0.022	2.174	13964.166	2012
3	113	3	C	0.235	7.6	0.000	0.000	13024.273	2012
3	113	4	A	0.224	6.8	0.340	34.043	12510.968	2012
3	113	4	B	0.205	6.7	0.106	10.638	11070.35	2012
3	113	4	C	0.214	8.1	0.195	19.512	11559.275	2012
4	113	1	A	0.443	7.3	0.000	0.000	21669.389	2012
4	113	1	B	0.393	7.8	0.000	0.000	20394.571	2012
4	113	1	C	0.358	7.4	0.000	0.000	18127.805	2012
4	113	2	A	0.377	6.7	0.000	0.000	19310.901	2012
4	113	2	B	0.388	7.0	0.089	8.929	19425.594	2012
4	113	2	C	0.359	7.3	0.113	11.321	18691.88	2012
4	113	3	A	0.300	7.3	0.042	4.167	16036.58	2012
4	113	3	B	0.337	7.1	0.034	3.390	17198.861	2012
4	113	3	C	0.248	6.6	0.214	21.429	13173.106	2012
4	113	4	A	0.285	6.9	0.250	25.000	16255.576	2012

4	113	4	B	0.223	7.7	0.267	26.667	12133.261	2012
4	113	4	C	0.228	7.5	0.214	21.429	12796.901	2012
1	1002	1	A	0.337	7.5	0.000	0.000	17200.08	2012
1	1002	1	B	0.364	7.4	0.000	0.000	18264.778	2012
1	1002	1	C	0.337	6.7	0.019	1.923	16038.718	2012
1	1002	2	A	0.236	5.9	0.083	8.333	10367.293	2012
1	1002	2	B	0.252	5.5	0.000	0.000	10390.92	2012
1	1002	2	C	0.251	5.6	0.020	2.000	10830.028	2012
1	1002	3	A	0.262	7.1	0.143	14.286	12626.651	2012
1	1002	3	B	0.305	6.7	0.105	10.526	14051.502	2012
1	1002	3	C	0.323	6.9	0.000	0.000	15015.794	2012
1	1002	4	A	0.386	6.3	0.015	1.493	17617.367	2012
1	1002	4	B	0.263	6.8	0.000	0.000	12880.291	2012
1	1002	4	C	0.268	7.2	0.109	10.870	13161.447	2012
2	1002	1	A	0.380	6.4	0.000	0.000	18613.144	2012
2	1002	1	B	0.838	6.7	0.000	0.000	26883.646	2012
2	1002	1	C	0.423	7.4	0.000	0.000	21408.213	2012
2	1002	2	A	0.267	6.5	0.204	20.370	12231.378	2012
2	1002	2	B	0.296	6.5	0.102	10.204	13347.495	2012
2	1002	2	C	0.381	6.0	0.000	0.000	16360.583	2012
2	1002	3	A	0.220	5.2	0.043	4.348	9901.057	2012
2	1002	3	B	0.204	6.1	0.213	21.277	9464.082	2012
2	1002	3	C	0.278	6.7	0.204	20.408	12762.095	2012
2	1002	4	A	0.256	6.2	0.176	17.647	12060.069	2012
2	1002	4	B	0.249	7.3	0.286	28.571	12697.315	2012
2	1002	4	C	0.245	6.7	0.212	21.154	11503.462	2012
3	1002	1	A	0.329	5.6	0.000	0.000	15288.68	2012
3	1002	1	B	0.468	6.4	0.000	0.000	21405.696	2012
3	1002	1	C	0.456	6.3	0.000	0.000	22954.148	2012
3	1002	2	A	0.344	5.6	0.000	0.000	14737.511	2012
3	1002	2	B	0.335	5.0	0.040	4.000	13824.285	2012
3	1002	2	C	0.366	4.7	0.073	7.273	14923.099	2012
3	1002	3	A	0.271	6.3	0.333	33.333	11974.736	2012
3	1002	3	B	0.243	4.9	0.200	20.000	10336.383	2012
3	1002	3	C	0.520	4.7	0.143	14.286	11411.466	2012
3	1002	4	A	0.282	4.5	0.222	22.222	12365.362	2012
3	1002	4	B	0.275	4.7	0.071	7.143	11165.063	2012
3	1002	4	C	0.250	5.2	0.148	14.815	10944.559	2012
4	1002	1	A	0.456	5.5	0.016	1.639	21171.251	2012
4	1002	1	B	0.505	5.4	0.000	0.000	22428.424	2012
4	1002	1	C	0.441	5.4	0.017	1.695	19018.736	2012
4	1002	2	A	0.370	4.7	0.036	3.636	14518.059	2012
4	1002	2	B	0.395	4.8	0.017	1.667	15921.442	2012
4	1002	2	C	0.385	5.0	0.065	6.452	16370.514	2012
4	1002	3	A	0.166	5.0	0.157	15.686	7412.309	2012
4	1002	3	B	0.313	5.6	0.000	0.000	13341.866	2012

4	1002	3	C	0.263	5.3	0.083	8.333	11851.958	2012
4	1002	4	A	0.294	5.7	0.039	3.922	12698.297	2012
4	1002	4	B	0.356	5.2	0.018	1.786	15704.016	2012
4	1002	4	C	0.227	4.9	0.125	12.500	8221.208	2012
1	838	1	A	0.760	10.2	0.000	0.000	10287.907	2012
1	838	1	B	0.801	9.8	0.000	0.000	10684.273	2012
1	838	1	C	0.838	10.0	0.024	2.410	11081.931	2012
1	838	2	A	0.637	8.8	0.182	18.182	7941.578	2012
1	838	2	B	0.683	9.6	0.103	10.294	8504.576	2012
1	838	2	C	0.592	10.1	0.032	3.175	7908.431	2012
1	838	3	A	0.585	8.5	0.044	4.412	7339.474	2012
1	838	3	B	0.919	9.2	0.143	14.286	11669.179	2012
1	838	3	C	0.669	9.9	0.050	5.000	8682.874	2012
1	838	4	A	0.400	8.8	0.327	32.692	4921.845	2012
1	838	4	B	0.527	10.3	0.149	14.925	7064.232	2012
1	838	4	C	0.742	10.2	0.103	10.256	10147.169	2012
2	838	1	A	0.665	10.0	0.000	0.000	8948.134	2012
2	838	1	B	0.633	9.2	0.013	1.333	8286.948	2012
2	838	1	C	0.540	9.5	0.000	0.000	7206.042	2012
2	838	2	A	0.494	9.3	0.154	15.385	6358.451	2012
2	838	2	B	0.689	9.9	0.057	5.714	8802.52	2012
2	838	2	C	0.466	9.4	0.217	21.739	6127.141	2012
2	838	3	A	0.395	8.8	0.313	31.250	5263.136	2012
2	838	3	B	0.379	9.3	0.188	18.750	5047.708	2012
2	838	3	C	0.446	9.9	0.232	23.214	5935.849	2012
2	838	4	A	0.355	8.9	0.550	55.000	5084.262	2012
2	838	4	B	0.432	9.5	0.221	22.059	6066.738	2012
2	838	4	C	0.484	9.2	0.365	36.508	6631.546	2012
3	838	1	A	0.615	9.7	0.014	1.351	7930.676	2012
3	838	1	B	0.651	9.6	0.014	1.351	8834.182	2012
3	838	1	C	0.607	9.7	0.029	2.941	8068.215	2012
3	838	2	A	0.511	8.7	0.179	17.910	6659.899	2012
3	838	2	B	0.561	8.5	0.138	13.846	6908.081	2012
3	838	2	C	0.715	9.3	0.068	6.849	9337.374	2012
3	838	3	A	0.301	9.0	0.212	21.154	3990.545	2012
3	838	3	B	0.393	8.6	0.321	32.143	5326.563	2012
3	838	3	C	0.473	9.9	0.211	21.053	6403.563	2012
3	838	4	A	0.326	9.4	0.333	33.333	4391.43	2012
3	838	4	B	0.274	8.9	0.246	24.590	3746.521	2012
3	838	4	C	0.319	9.5	0.206	20.635	4492.433	2012
4	838	1	A	0.806	9.9	0.039	3.896	10763.596	2012
4	838	1	B	0.744	9.2	0.012	1.235	9320.424	2012
4	838	1	C	1.035	9.3	0.000	0.000	12701.533	2012
4	838	2	A	0.521	9.5	0.157	15.714	6905.52	2012
4	838	2	B	0.625	7.7	0.425	42.466	7851.651	2012
4	838	2	C	0.615	8.9	0.213	21.333	.	2012

4	838	3	A	0.562	9.2	0.191	19.118	7523.274	2012
4	838	3	B	0.388	9.1	0.485	48.485	5226.569	2012
4	838	3	C	0.307	7.9	0.328	32.813	4085.323	2012
4	838	4	A	0.410	8.7	0.313	31.250	5454.884	2012
4	838	4	B	0.487	8.5	0.259	25.862	6199.169	2012
4	838	4	C	0.475	9.3	0.246	24.590	6430.775	2012
1	845	1	A	0.431	8.7	0.000	0.000	4472.298	2012
1	845	1	B	0.637	9.0	0.000	0.000	6171.484	2012
1	845	1	C	0.658	9.3	0.000	0.000	6591.924	2012
1	845	2	A	0.497	8.2	0.034	3.448	4668.614	2012
1	845	2	B	0.431	8.8	0.069	6.897	4178.909	2012
1	845	2	C	0.653	8.8	0.079	7.937	6315.478	2012
1	845	3	A	0.424	8.6	0.230	22.951	4249.387	2012
1	845	3	B	0.503	9.5	0.224	22.388	5197.139	2012
1	845	3	C	0.496	9.5	0.100	10.000	4920.002	2012
1	845	4	A	0.571	8.9	0.246	24.615	5956.375	2012
1	845	4	B	0.557	9.3	0.200	20.000	6003.05	2012
1	845	4	C	0.429	9.4	0.000	0.000	4547.748	2012
2	845	1	A	0.855	9.3	0.000	0.000	8615.595	2012
2	845	1	B	0.852	8.8	0.000	0.000	8277.558	2012
2	845	1	C	0.904	7.8	0.000	0.000	8188.696	2012
2	845	2	A	0.686	9.1	0.044	4.412	6730.764	2012
2	845	2	B	0.572	8.9	0.015	1.515	5676.496	2012
2	845	2	C	0.630	8.7	0.000	0.000	6129.038	2012
2	845	3	A	0.555	9.1	0.245	24.528	5323.539	2012
2	845	3	B	0.461	9.1	0.270	26.984	4759.531	2012
2	845	3	C	0.474	9.5	0.321	32.143	5568.829	2012
2	845	4	A	0.421	8.7	0.500	50.000	4389.325	2012
2	845	4	B	0.499	9.3	0.387	38.710	5157.017	2012
2	845	4	C	0.467	9.2	0.320	32.000	4919.437	2012
3	845	1	A	0.581	8.1	0.054	5.357	5735.919	2012
3	845	1	B	0.758	7.6	0.000	0.000	6934.932	2012
3	845	1	C	0.672	6.4	0.000	0.000	6062.432	2012
3	845	2	A	0.440	8.4	0.085	8.475	4369.205	2012
3	845	2	B	0.479	8.4	0.062	6.154	4889.426	2012
3	845	2	C	0.316	8.4	0.056	5.556	3284.423	2012
3	845	3	A	0.391	9.1	0.185	18.519	3986.63	2012
3	845	3	B	0.441	8.6	0.158	15.789	4599.994	2012
3	845	3	C	0.383	8.6	0.111	11.111	3971.865	2012
3	845	4	A	0.241	8.3	0.083	8.333	2534.412	2012
3	845	4	B	0.283	8.4	0.098	9.804	2974.731	2012
3	845	4	C	0.456	7.9	0.230	22.973	4652.669	2012
4	845	1	A	0.818	8.8	0.118	11.765	7812.28	2012
4	845	1	B	0.921	8.2	0.028	2.778	5119.356	2012
4	845	1	C	0.924	8.8	0.029	2.857	8792.905	2012
4	845	2	A	0.636	8.7	0.032	3.175	6138.848	2012

```
4	845	2	B	0.822	8.7	0.085	8.451		7884.644	2012
4	845	2	C	0.528	8.7	0.159	15.873		5177.788	2012
4	845	3	A	0.588	8.1	0.308	30.769		5690.697	2012
4	845	3	B	0.424	8.0	0.420	42.000		4109.602	2012
4	845	3	C	0.366	6.7	0.538	53.846		3481.575	2012
4	845	4	A	0.461	8.8	0.227	22.727		4517.085	2012
4	845	4	B	0.351	8.7	0.200	20.000		3668.791	2012
4	845	4	C	0.350	8.7	0.157	15.686		3531.911	2012
;
proc glimmix data=BeauBioEnergyAll;
class variety rep infestation year;
model wetwgt = variety|infestation /ddfm=KR;
random year rep(year) variety*rep(year) infestation*rep(year) infestation*variety*rep(year);
lsmeans variety|infestation / diff lines pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data=BeauBioEnergyAll;
class variety rep infestation year;
model sugar = variety|infestation /ddfm=KR;
random year rep(year) variety*rep(year) infestation*rep(year) infestation*variety*rep(year);
lsmeans variety|infestation / diff lines pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data=BeauBioEnergyAll;
class variety rep infestation year;
model PercBored = variety|infestation /ddfm=KR;
random year rep(year) variety*rep(year) infestation*rep(year) infestation*variety*rep(year);
lsmeans variety|infestation / diff lines pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data=BeauBioEnergyAll;
class variety rep infestation year;
model theoEtOH = variety|infestation /ddfm=KR;
random year rep(year) variety*rep(year) infestation*rep(year) infestation*variety*rep(year);
```

```
lsmeans variety|infestation / diff lines pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc reg data=BeauBioenergyAll;
model wetwgt = PercBored Z1 Z2 Z3 Z4 Z5 Z6 Z7 / xpx i influence;
run;
proc reg data=BeauBioEnergyAll;
model sugar = PercBored Z1 Z2 Z3 Z4 Z5 Z6 Z7 / xpx i influence;
run;
proc reg data=BeauBioEnergyAll;
model theoETOH = PercBored Z1 Z2 Z3 Z4 Z5 Z6 Z7 / xpx i influence;
run;
ods rtf close;
```

APPENDIX C: SAS PROGRAMS FOR CHAPTER 4

"*Eoreuma loftini* Oviposition and Plant Characteristics"

```
ods rtf file="rtf_file.rtf";
data Oviposition;
input Var$ Rep$ Stage$ Trt$ Height Diameter Internodes DryLeaves FreshLeaves TotLeaves
Events Eggs EggsPerEvent Crop$ MaxEggs Pref RelativeSelectionEggs
RelativeSelectionsEvents;
cards;
5200	1	I	5200I	157	9	9	1	9	10	1	22	22.0
	HBS	392	0.06	7.9	0.1
5200	2	I	5200I	168	8	8	2	7	9	0	0	.
	HBS	388	0.00	0.0	0.0
5200	3	I	5200I	182	12	9	4	9	13	0	0	.
	HBS	400	0.00	0.0	0.0
5200	4	I	5200I	148	8	8	3	6	9	1	10	10.0
	HBS	402	0.02	2.4	0.0
5200	5	I	5200I	161	8	9	4	6	10	0	0	.
	HBS	412	0.00	0.0	0.0
5200	1	M	5200M	247	9	16	13	6	19	2	288	144.0
	HBS	392	0.73	104.0	1.3
5200	2	M	5200M	230	10	15	11	7	18	0	0	.
	HBS	388	0.00	0.0	0.0
5200	3	M	5200M	244	9.5	17	13	6	19	1	32	32.0
	HBS	400	0.08	5.7	0.1
5200	4	M	5200M	225	11	21	17	7	23	0	0	.
	HBS	402	0.00	0.0	0.0
5200	5	M	5200M	281	11	19	13	9	22	0	0	.
	HBS	412	0.00	0.0	0.0
5140	1	I	5140I	152	12	8	1	9	10	0	0	.
	HBS	392	0.00	0.0	0.0
5140	2	I	5140I	177	10	9	2	10	12	1	10	10.0
	HBS	388	0.03	1.2	0.0
5140	3	I	5140I	177	8	8	4	6	10	2	11	5.5
	HBS	400	0.03	2.0	0.0
5140	4	I	5140I	179	7	12	5	8	13	0	0	.
	HBS	402	0.00	0.0	0.0
5140	5	I	5140I	182	9	9	4	8	12	1	9	9.0
	HBS	412	0.02	0.9	0.0
5140	1	M	5140M	210	10	13	10	7	17	2	77	38.5
	HBS	392	0.20	27.8	0.4
5140	2	M	5140M	199	8	13	7	8	15	0	0	.
	HBS	388	0.00	0.0	0.0
5140	3	M	5140M	246	11.5	18	16	7	23	0	0	.
	HBS	400	0.00	0.0	0.0
```

5140	4	M	5140M	201	12	15	14	5	19	4	269	67.3
	HBS	402	0.67	63.6	1.3							
5140	5	M	5140M	210	8	16	12	7	19	0	0	.
	HBS	412	0.00	0.0	0.0							
M81E	1	I	M81EI	148	11	7	1	7	8	4	278	69.5
	SS	392	0.71	100.4	1.3							
M81E	2	I	M81EI	155	11	8	3	8	11	4	204	51.0
	SS	388	0.53	24.6	0.9							
M81E	3	I	M81EI	164	9.5	8	5	6	11	0	0	.
	SS	400	0.00	0.0	0.0							
M81E	4	I	M81EI	161	9	9	4	7	11	0	0	.
	SS	402	0.00	0.0	0.0							
M81E	5	I	M81EI	160	9	7	3	7	10	1	32	32.0
	SS	412	0.08	3.3	0.1							
M81E	1	M	M81EM		271	12	16	10	8	18	1	156
	156.0	SS	392	0.40	56.3	0.7						
M81E	2	M	M81EM		251	9	18	12	7	19	0	0
	.	SS	388	0.00	0.0	0.0						
M81E	3	M	M81EM		264	8	18	10	7	17	3	174
	58.0	SS	400	0.44	31.2	0.7						
M81E	4	M	M81EM		231	5	19	11	4	15	0	0
	.	SS	402	0.00	0.0	0.0						
M81E	5	M	M81EM		186	5	13	8	6	14	3	157
	52.3	SS	412	0.38	16.1	0.5						
113	1	I	113I	229	9	8	2	8	10	0	0	.
	EC	392	0.00	0.0	0.0							
113	2	I	113I	201	10	7	2	7	9	2	25	12.5
	EC	388	0.06	3.0	0.1							
113	3	I	113I	197	7.5	7	5	5	10	0	0	.
	EC	400	0.00	0.0	0.0							
113	4	I	113I	175	7	8	3	5	8	0	0	.
	EC	402	0.00	0.0	0.0							
113	5	I	113I	162	8	7	3	5	8	0	0	.
	EC	412	0.00	0.0	0.0							
113	1	M	113M	391	9	15	10	9	19	2	284	142.0
	EC	392	0.72	102.5	1.3							
113	2	M	113M	381	10	18	17	6	23	1	26	26.0
	EC	388	0.07	3.1	0.1							
113	3	M	113M	358	9	17	15	4	19	1	152	152.0
	EC	400	0.38	27.3	0.6							
113	4	M	113M	374	11	16	13	5	18	4	264	66.0
	EC	402	0.66	62.4	1.3							
113	5	M	113M	362	10	19	11	8	19	0	0	.
	EC	412	0.00	0.0	0.0							
1002	1	I	1002I	292	11	8	3	8	11	1	42	42.0
	EC	392	0.11	15.2	0.2							

1002	2	I	1002I	179	10	12	1	11	12	0	0	.
	EC	388	0.00	0.0	0.0							
1002	3	I	1002I	201	8	8	3	5	8	0	0	.
	EC	400	0.00	0.0	0.0							
1002	4	I	1002I	203	8	9	4	5	9	2	82	41.0
	EC	402	0.20	19.4	0.4							
1002	5	I	1002I	187	8	7	4	5	9	1	15	15.0
	EC	412	0.04	1.5	0.0							
1002	1	M	1002M	392	8	19	15	7	22	0	0	.
	EC	392	0.00	0.0	0.0							
1002	2	M	1002M	410	9	19	16	6	22	0	0	.
	EC	388	0.00	0.0	0.0							
1002	3	M	1002M	402	8	21	17	7	24	4	139	34.8
	EC	400	0.35	24.9	0.5							
1002	4	M	1002M	402	8	17	11	6	17	2	123	61.5
	EC	402	0.31	29.1	0.6							
1002	5	M	1002M	412	12	18	12	7	19	1	12	12.0
	EC	412	0.03	1.2	0.0							
838	1	I	838I	197	14	10	4	7	11	2	51	25.5
	SC	392	0.13	18.4	0.2							
838	2	I	838I	170	11	7	2	6	8	2	19	9.5
	SC	388	0.05	2.3	0.1							
838	3	I	838I	146	10	6	4	6	10	0	0	.
	SC	400	0.00	0.0	0.0							
838	4	I	838I	136	12	6	2	6	8	0	0	.
	SC	402	0.00	0.0	0.0							
838	5	I	838I	142	9	6	2	5	7	0	0	.
	SC	412	0.00	0.0	0.0							
838	1	M	838M	361	10	19	13	8	21	1	56	56.0
	SC	392	0.14	20.2	0.3							
838	2	M	838M	387	15	25	19	8	27	1	4	4.0
	SC	388	0.01	0.5	0.0							
838	3	M	838M	376	16	24	18	9	27	2	107	53.5
	SC	400	0.27	19.2	0.4							
838	4	M	838M	345	19	16	15	4	19	3	84	28.0
	SC	402	0.21	19.9	0.4							
838	5	M	838M	379	17	21	11	9	20	0	0	.
	SC	412	0.00	0.0	0.0							
845	1	I	845I	161	10	7	2	7	9	0	0	.
	SC	392	0.00	0.0	0.0							
845	2	I	845I	164	10	8	2	8	10	3	115	38.3
	SC	388	0.30	13.8	0.5							
845	3	I	845I	181	11	9	5	5	10	1	21	21.0
	SC	400	0.05	3.8	0.1							
845	4	I	845I	181	12	7	3	6	9	1	10	10.0
	SC	402	0.02	2.4	0.0							

```
845     5       I       845I    151     10      5       3       5       8       2       97      48.5
        SC      412     0.24    10.0    0.3
845     1       M       845M    342     13      23      12      9       21      0       0       .
        SC      392     0.00    0.0     0.0
845     2       M       845M    388     16      21      13      10      23      1       11      11.0
        SC      388     0.03    1.3     0.0
845     3       M       845M    400     14      22      16      8       24      0       0       .
        SC      400     0.00    0.0     0.0
845     4       M       845M    346     14      25      17      9       26      0       0       .
        SC      402     0.00    0.0     0.0
845     5       M       845M    393     12      21      11      10      21      2       53      26.5
        SC      412     0.13    5.4     0.2
;
proc glimmix data=Oviposition;
class Var Rep Stage Crop Trt;
model Height = Trt /ddfm=KR;
random Rep;
lsmeans Trt / diff lines pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data=Oviposition;
class Var Rep Stage Crop Trt;
model Diameter = Trt /ddfm=KR;
random Rep;
lsmeans Trt / diff lines pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data=Oviposition;
class Var Rep Stage Crop Trt;
model Internodes = Trt /ddfm=KR;
random Rep;
lsmeans Trt / diff lines pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
```

```
proc glimmix data=Oviposition;
class Var Rep Stage Crop Trt;
model DryLeaves = Trt /ddfm=KR;
random Rep;
lsmeans Trt / diff lines pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data=Oviposition;
class Var Rep Stage Crop Trt;
model TotLeaves = Trt /ddfm=KR;
random Rep;
lsmeans Trt / diff lines pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data=Oviposition;
class Var Rep Stage Crop Trt;
model Eggs = Trt /ddfm=KR;
random Rep;
lsmeans Trt / diff lines pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data=Oviposition;
class Var Rep Stage Crop Trt;
model Pref = Trt /ddfm=KR;
random Rep;
lsmeans Trt / diff lines pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data=Oviposition;
class Var Rep Stage Crop Trt;
```

```
model Events = Trt /ddfm=KR;
random Rep;
lsmeans Trt / diff lines pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data=Oviposition;
class Var Rep Stage Crop Trt;
model EggsPerEvent = Trt /ddfm=KR;
random Rep;
lsmeans Trt / diff lines pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data=Oviposition;
class Var Rep Stage Crop Trt;
model DryLeaves = Trt /ddfm=KR;
random Rep;
lsmeans Trt / diff lines pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data=Oviposition;
class Var Rep Stage Crop Trt;
model FreshLeaves = Trt /ddfm=KR;
random Rep;
lsmeans Trt / diff lines pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data=Oviposition;
class Var Rep Stage Crop Trt;
model Diameter = Trt /ddfm=KR;
random Rep;
```

```
lsmeans Trt / diff lines pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data=Oviposition;
class Var Rep Stage Crop Trt;
model Height = Trt /ddfm=KR;
random Rep;
lsmeans Trt / diff lines pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc mixed data=Oviposition;
class Var Rep Stage Crop;
model Eggs = Height Var / htype=1 3 solution outp=resid1;
run;
proc reg data=Oviposition;
model Eggs = Height;
run;
proc reg data=Oviposition;
model EggsPerEvent = Height;
run;
proc reg data=Oviposition;
model Eggs = DryLeaves;
run;
proc reg data=Oviposition;
model EggsPerEvent = DryLeaves;
run;
proc glimmix data =Oviposition;
class Var Rep Stage Crop Trt;;
model Eggs = Trt / htype=3;
random Rep;
contrast 'EC vs SC' Trt 1 1 1 1 0 0 0 0 -1 -1 -1 -1 0 0;
contrast 'EC vs HBS' Trt 1 1 1 1 -1 -1 -1 -1 0 0 0 0 0 0;
contrast 'HBS vs SC' Trt 0 0 0 0 1 1 1 1 -1 -1 -1 -1 0 0;
contrast 'HBS vs SS' Trt 0 0 0 0 1 1 1 1 0 0 0 0 -2 -2;
contrast '838 vs 845' Trt 0 0 0 0 0 0 0 0 1 1 -1 -1 0 0;
contrast 'SC vs SS' Trt 0 0 0 0 0 0 0 0 1 1 1 1 -2 -2;
contrast 'EC vs SS' Trt 1 1 1 1 0 0 0 0 0 0 0 0 -2 -2;
contrast 'Sugarcane vs Sorghum' Trt 3 3 3 3 -4 -4 -4 -4 3 3 3 3 -4 -4;
```

```
contrast 'Immature vs Mature' Trt 1 -1 1 -1 1 -1 1 -1 1 -1 1 -1 1 -1;
lsmeans Trt / pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data =Oviposition;
class Var Rep Stage Crop Trt;;
model Events = Trt / htype=3;
random Rep;
contrast 'EC vs SC' Trt 1 1 1 1 0 0 0 0 -1 -1 -1 -1 0 0;
contrast 'EC vs HBS' Trt 1 1 1 1 -1 -1 -1 -1 0 0 0 0 0 0;
contrast 'HBS vs SC' Trt 0 0 0 0 1 1 1 1 -1 -1 -1 -1 0 0;
contrast 'HBS vs SS' Trt 0 0 0 0 1 1 1 1 0 0 0 0 -2 -2;
contrast '838 vs 845' Trt 0 0 0 0 0 0 0 0 1 1 -1 -1 0 0;
contrast 'SC vs SS' Trt 0 0 0 0 0 0 0 0 1 1 1 1 -2 -2;
contrast 'EC vs SS' Trt 1 1 1 1 0 0 0 0 0 0 0 0 -2 -2;
contrast 'Sugarcane vs Sorghum' Trt 3 3 3 3 -4 -4 -4 -4 3 3 3 3 -4 -4;
contrast 'Immature vs Mature' Trt 1 -1 1 -1 1 -1 1 -1 1 -1 1 -1 1 -1;
lsmeans Trt / pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data =Oviposition;
class Var Rep Stage Crop Trt;;
model EggsPerEvent = Trt / htype=3;
random Rep;
contrast 'EC vs SC' Trt 1 1 1 1 0 0 0 0 -1 -1 -1 -1 0 0;
contrast 'EC vs HBS' Trt 1 1 1 1 -1 -1 -1 -1 0 0 0 0 0 0;
contrast 'HBS vs SC' Trt 0 0 0 0 1 1 1 1 -1 -1 -1 -1 0 0;
contrast 'HBS vs SS' Trt 0 0 0 0 1 1 1 1 0 0 0 0 -2 -2;
contrast '838 vs 845' Trt 0 0 0 0 0 0 0 0 1 1 -1 -1 0 0;
contrast 'SC vs SS' Trt 0 0 0 0 0 0 0 0 1 1 1 1 -2 -2;
contrast 'EC vs SS' Trt 1 1 1 1 0 0 0 0 0 0 0 0 -2 -2;
contrast 'Sugarcane vs Sorghum' Trt 3 3 3 3 -4 -4 -4 -4 3 3 3 3 -4 -4;
contrast 'Immature vs Mature' Trt 1 -1 1 -1 1 -1 1 -1 1 -1 1 -1 1 -1;
lsmeans Trt / pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\pdmix800.sas';
```

```
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
ods rtf close;
```
"*Eoreuma loftini* Mortality and Plant Characteristics"

```
ods rtf file="rtf_file.rtf";
data GreenhouseSurvival2013;
input Rep$ Crop$ Cultivar$ Stage$ Eggs Neonates PercSurvivaltoN      Larvae
PercSurvivaltoL Pupae PercSurvivaltoP Adults PercTotalSurvival DeadEggs PercMortalitytoN
DeadNeonates PercMortalityNtoL DeadLarvae PercMortalityLtoP DeadPupae
PercMortalityPtoA;
cards;
1    EC    1002  I    89    9     0.101  9    0.101  9    0.101  7    0.079
     80    0.899 0    0.000 0     0.000  2    0.222
1    EC    113   I    91    12    0.132  0    0.000  0    0.000  0    0.000
     79    0.868 12   1.000 0     0.000  0    0.000
1    SC    838   I    97    6     0.062  0    0.000  0    0.000  0    0.000
     91    0.938 6    1.000 0     0.000  0    0.000
1    SC    845   I    97    7     0.072  1    0.010  1    0.010  1    0.010
     90    0.928 6    0.857 0     0.000  0    0.000
1    HBS   5200  I    97    3     0.031  1    0.010  0    0.000  0    0.000
     94    0.969 2    0.667 1     1.000  0    0.000
1    HBS   5140  I    98    4     0.041  0    0.000  0    0.000  0    0.000
     94    0.959 4    1.000 0     0.000  0    0.000
1    SS    M81E  I    78    3     0.038  3    0.038  3    0.038  2    0.026
     75    0.962 0    0.000 0     0.000  1    0.333
1    EC    1002  M    115   4     0.035  0    0.000  0    0.000  0    0.000
     111   0.965 4    1.000 0     0.000  0    0.000
1    EC    113   M    110   10    0.091  1    0.009  0    0.000  0    0.000
     100   0.909 9    0.900 1     1.000  0    0.000
1    SC    838   M    97    5     0.052  3    0.031  3    0.031  3    0.031
     92    0.948 2    0.400 0     0.000  0    0.000
1    SC    845   M    85    11    0.129  6    0.071  5    0.059  5    0.059
     74    0.871 5    0.455 1     0.167  0    0.000
1    HBS   5200  M    85    1     0.012  1    0.012  0    0.000  0    0.000
     84    0.988 0    0.000 1     1.000  0    0.000
1    HBS   5140  M    88    5     0.057  3    0.034  3    0.034  3    0.034
     83    0.943 2    0.400 0     0.000  0    0.000
1    SS    M81E  M    85    3     0.035  1    0.012  1    0.012  1    0.012
     82    0.965 2    0.667 0     0.000  0    0.000
2    EC    1002  I    95    5     0.053  4    0.042  3    0.032  3    0.032
     90    0.947 1    0.200 1     0.250  0    0.000
2    EC    113   I    100   7     0.070  1    0.010  0    0.000  0    0.000
     93    0.930 6    0.857 1     1.000  0    0.000
2    SC    838   I    76    5     0.066  1    0.013  0    0.000  0    0.000
     71    0.934 4    0.800 1     1.000  0    0.000
```

2	SC	845	I	84	6	0.071	0	0.000	0	0.000	0	0.000
	78	0.929	6	1.000	0	0.000	0	0.000				
2	HBS	5200	I	71	3	0.042	0	0.000	0	0.000	0	0.000
	68	0.958	3	1.000	0	0.000	0	0.000				
2	HBS	5140	I	75	5	0.067	0	0.000	0	0.000	0	0.000
	70	0.933	5	1.000	0	0.000	0	0.000				
2	SS	M81E	I	60	2	0.033	1	0.017	1	0.017	1	0.017
	58	0.967	1	0.500	0	0.000	0	0.000				
2	EC	1002	M	115	2	0.017	2	0.017	0	0.000	0	0.000
	113	0.983	0	0.000	2	1.000	0	0.000				
2	EC	113	M	98	7	0.071	0	0.000	0	0.000	0	0.000
	91	0.929	7	1.000	0	0.000	0	0.000				
2	SC	838	M	106	4	0.038	3	0.028	0	0.000	0	0.000
	102	0.962	1	0.250	3	1.000	0	0.000				
2	SC	845	M	96	4	0.042	3	0.031	1	0.010	1	0.010
	92	0.958	1	0.250	2	0.667	0	0.000				
2	HBS	5200	M	95	1	0.011	1	0.011	0	0.000	0	0.000
	94	0.989	0	0.000	1	1.000	0	0.000				
2	HBS	5140	M	86	3	0.035	3	0.035	3	0.035	2	0.023
	83	0.965	0	0.000	0	0.000	1	0.333				
2	SS	M81E	M	94	8	0.085	8	0.085	5	0.053	4	0.043
	86	0.915	0	0.000	3	0.375	1	0.200				
3	EC	1002	I	67	7	0.104	0	0.000	0	0.000	0	0.000
	60	0.896	7	1.000	0	0.000	0	0.000				
3	EC	113	I	58	10	0.172	2	0.034	0	0.000	0	0.000
	48	0.828	8	0.800	2	1.000	0	0.000				
3	SC	838	I	63	4	0.063	1	0.016	0	0.000	0	0.000
	59	0.937	3	0.750	1	1.000	0	0.000				
3	SC	845	I	60	11	0.183	2	0.033	0	0.000	0	0.000
	49	0.817	9	0.818	2	1.000	0	0.000				
3	HBS	5200	I	52	4	0.077	2	0.038	2	0.038	2	0.038
	48	0.923	2	0.500	0	0.000	0	0.000				
3	HBS	5140	I	70	3	0.043	2	0.029	2	0.029	2	0.029
	67	0.957	1	0.333	0	0.000	0	0.000				
3	SS	M81E	I	25	1	0.040	0	0.000	0	0.000	0	0.000
	24	0.960	1	1.000	0	0.000	0	0.000				
3	EC	1002	M	122	5	0.041	0	0.000	0	0.000	0	0.000
	117	0.959	5	1.000	0	0.000	0	0.000				
3	EC	113	M	50	6	0.120	1	0.020	0	0.000	0	0.000
	44	0.880	5	0.833	1	1.000	0	0.000				
3	SC	838	M	140	9	0.064	9	0.064	8	0.057	4	0.029
	131	0.936	0	0.000	1	0.111	4	0.500				
3	SC	845	M	160	10	0.063	5	0.031	1	0.006	1	0.006
	150	0.938	5	0.500	4	0.800	0	0.000				
3	HBS	5200	M	50	8	0.160	0	0.000	0	0.000	0	0.000
	42	0.840	8	1.000	0	0.000	0	0.000				

3	HBS	5140	M	69	3	0.043	3	0.043	3	0.043	3	0.043
	66	0.957	0	0.000	0	0.000	0	0.000				
3	SS	M81E	M	50	4	0.080	4	0.080	3	0.060	3	0.060
	46	0.920	0	0.000	1	0.250	0	0.000				
4	EC	1002	I	62	4	0.065	0	0.000	0	0.000	0	0.000
	58	0.935	4	1.000	0	0.000	0	0.000				
4	EC	113	I	150	4	0.027	0	0.000	0	0.000	0	0.000
	146	0.973	4	1.000	0	0.000	0	0.000				
4	SC	838	I	73	8	0.110	2	0.027	0	0.000	0	0.000
	65	0.890	6	0.750	2	1.000	0	0.000				
4	SC	845	I	117	6	0.051	0	0.000	0	0.000	0	0.000
	111	0.949	6	1.000	0	0.000	0	0.000				
4	HBS	5200	I	95	4	0.042	0	0.000	0	0.000	0	0.000
	91	0.958	4	1.000	0	0.000	0	0.000				
4	HBS	5140	I	53	2	0.038	0	0.000	0	0.000	0	0.000
	51	0.962	2	1.000	0	0.000	0	0.000				
4	SS	M81E	I	95	2	0.021	0	0.000	0	0.000	0	0.000
	93	0.979	2	1.000	0	0.000	0	0.000				
4	EC	1002	M	75	0	0.000	0	0.000	0	0.000	0	0.000
	75	1.000	0	0.000	0	0.000	0	0.000				
4	EC	113	M	82	2	0.024	2	0.024	0	0.000	0	0.000
	80	0.976	0	0.000	2	1.000	0	0.000				
4	SC	838	M	93	1	0.011	1	0.011	1	0.011	1	0.011
	92	0.989	0	0.000	0	0.000	0	0.000				
4	SC	845	M	122	5	0.041	1	0.008	0	0.000	0	0.000
	117	0.959	4	0.800	1	1.000	0	0.000				
4	HBS	5200	M	110	1	0.009	1	0.009	1	0.009	1	0.009
	109	0.991	0	0.000	0	0.000	0	0.000				
4	HBS	5140	M	104	1	0.010	0	0.000	0	0.000	0	0.000
	103	0.990	1	1.000	0	0.000	0	0.000				
4	SS	M81E	M	73	2	0.027	2	0.027	2	0.027	1	0.014
	71	0.973	0	0.000	0	0.000	1	0.500				
5	EC	1002	I	58	4	0.069	1	0.017	0	0.000	0	0.000
	54	0.931	3	0.750	1	1.000	0	0.000				
5	EC	113	I	82	2	0.024	0	0.000	0	0.000	0	0.000
	80	0.976	2	1.000	0	0.000	0	0.000				
5	SC	838	I	70	7	0.100	0	0.000	0	0.000	0	0.000
	63	0.900	7	1.000	0	0.000	0	0.000				
5	SC	845	I	90	4	0.044	0	0.000	0	0.000	0	0.000
	86	0.956	4	1.000	0	0.000	0	0.000				
5	HBS	5200	I	89	5	0.056	1	0.011	0	0.000	0	0.000
	84	0.944	4	0.800	1	1.000	0	0.000				
5	HBS	5140	I	89	3	0.034	2	0.022	2	0.022	1	0.011
	86	0.966	1	0.333	0	0.000	1	0.500				
5	SS	M81E	I	79	1	0.013	0	0.000	0	0.000	0	0.000
	78	0.987	1	1.000	0	0.000	0	0.000				

5	EC	1002	M	82	1	0.012	1	0.012	0	0.000	0	0.000
	81	0.988	0	0.000	1	1.000	0	0.000				
5	EC	113	M	99	5	0.051	1	0.010	0	0.000	0	0.000
	94	0.949	4	0.800	1	1.000	0	0.000				
5	SC	838	M	85	1	0.012	0	0.000	0	0.000	0	0.000
	84	0.988	1	1.000	0	0.000	0	0.000				
5	SC	845	M	110	5	0.045	0	0.000	0	0.000	0	0.000
	105	0.955	5	1.000	0	0.000	0	0.000				
5	HBS	5200	M	89	3	0.034	3	0.034	3	0.034	3	0.034
	86	0.966	0	0.000	0	0.000	0	0.000				
5	HBS	5140	M	50	1	0.020	0	0.000	0	0.000	0	0.000
	49	0.980	1	1.000	0	0.000	0	0.000				
5	SS	M81E	M	66	2	0.030	2	0.030	2	0.030	2	0.030
	64	0.970	0	0.000	0	0.000	0	0.000				
6	EC	1002	I	59	4	0.068	0	0.000	0	0.000	0	0.000
	55	0.932	4	1.000	0	0.000	0	0.000				
6	EC	113	I	76	3	0.039	0	0.000	0	0.000	0	0.000
	73	0.961	3	1.000	0	0.000	0	0.000				
6	SC	838	I	51	6	0.118	0	0.000	0	0.000	0	0.000
	45	0.882	6	1.000	0	0.000	0	0.000				
6	SC	845	I	57	7	0.123	1	0.018	1	0.018	1	0.018
	50	0.877	6	0.857	0	0.000	0	0.000				
6	HBS	5200	I	51	3	0.059	0	0.000	0	0.000	0	0.000
	48	0.941	3	1.000	0	0.000	0	0.000				
6	HBS	5140	I	53	2	0.038	0	0.000	0	0.000	0	0.000
	51	0.962	2	1.000	0	0.000	0	0.000				
6	SS	M81E	I	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.				
6	EC	1002	M	90	3	0.033	2	0.022	1	0.011	1	0.011
	87	0.967	1	0.333	1	0.500	0	0.000				
6	EC	113	M	60	6	0.100	0	0.000	0	0.000	0	0.000
	54	0.900	6	1.000	0	0.000	0	0.000				
6	SC	838	M	51	6	0.118	1	0.020	0	0.000	0	0.000
	45	0.882	5	0.833	1	1.000	0	0.000				
6	SC	845	M	136	8	0.059	8	0.059	3	0.022	2	0.015
	128	0.941	0	0.000	5	0.625	1	0.333				
6	HBS	5200	M	84	3	0.036	3	0.036	0	0.000	0	0.000
	81	0.964	0	0.000	3	1.000	0	0.000				
6	HBS	5140	M	48	4	0.083	4	0.083	0	0.000	0	0.000
	44	0.917	0	0.000	4	1.000	0	0.000				
6	SS	M81E	M	56	2	0.036	0	0.000	0	0.000	0	0.000
	54	0.964	2	1.000	0	0.000	0	0.000				
7	EC	1002	I	75	1	0.013	0	0.000	0	0.000	0	0.000
	74	0.987	1	1.000	0	0.000	0	0.000				
7	EC	113	I	106	10	0.094	0	0.000	0	0.000	0	0.000
	96	0.906	10	1.000	0	0.000	0	0.000				

```
7   SC   838   I   77   3   0.039   1   0.013   0   0.000   0   0.000
    74   0.961 2   0.667 1  1.000   0   0.000
7   SC   845   I   73   4   0.055   1   0.014   0   0.000   0   0.000
    69   0.945 3   0.750 1  1.000   0   0.000
7   HBS  5200  I   101  7   0.069   1   0.010   0   0.000   0   0.000
    94   0.931 6   0.857 1  1.000   0   0.000
7   HBS  5140  I   80   2   0.025   0   0.000   0   0.000   0   0.000
    78   0.975 2   1.000 0  0.000   0   0.000
7   SS   M81E  I   61   1   0.016   0   0.000   0   0.000   0   0.000
    60   0.984 1   1.000 0  0.000   0   0.000
7   EC   1002  M   87   1   0.011   0   0.000   0   0.000   0   0.000
    86   0.989 1   1.000 0  0.000   0   0.000
7   EC   113   M   119  4   0.034   0   0.000   0   0.000   0   0.000
    115  0.966 4   1.000 0  0.000   0   0.000
7   SC   838   M   70   3   0.043   3   0.043   0   0.000   0   0.000
    67   0.957 0   0.000 3  1.000   0   0.000
7   SC   845   M   103  4   0.039   2   0.019   0   0.000   0   0.000
    99   0.961 2   0.500 2  1.000   0   0.000
7   HBS  5200  M   60   3   0.050   3   0.050   3   0.050   3   0.050
    57   0.950 0   0.000 0  0.000   0   0.000
7   HBS  5140  M   77   4   0.052   2   0.026   2   0.026   2   0.026
    73   0.948 2   0.500 0  0.000   0   0.000
7   SS   M81E  M   90   3   0.033   3   0.033   3   0.033   2   0.022
    87   0.967 0   0.000 0  0.000   1   0.333
;
proc glimmix data=GreenhouseSurvival2013;
class Rep Crop Cultivar Stage;
model PercSurvivaltoN = Cultivar|Stage /ddfm=KR;
random Rep Rep*Cultivar Rep*Cultivar*Stage;
lsmeans Cultivar|Stage /pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
proc glimmix data=GreenhouseSurvival2013;
class Rep Crop Cultivar Stage;
model PercSurvivaltoL = Cultivar|Stage /ddfm=KR;
random Rep Rep*Cultivar Rep*Cultivar*Stage;
lsmeans Cultivar|Stage /pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
proc glimmix data=GreenhouseSurvival2013;
class Rep Crop Cultivar Stage;
model PercSurvivaltoP = Cultivar|Stage /ddfm=KR;
random Rep Rep*Cultivar Rep*Cultivar*Stage;
lsmeans Cultivar|Stage /pdiff adjust=tukey;
```

```
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
proc glimmix data=GreenhouseSurvival2013;
class Rep Crop Cultivar Stage;
model PercTotalSurvival = Cultivar|Stage /ddfm=KR;
random Rep Rep*Cultivar Rep*Cultivar*Stage;
lsmeans Cultivar|Stage /pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
proc glimmix data=GreenhouseSurvival2013;
class Rep Crop Cultivar Stage;
model PercMortalitytoN = Cultivar|Stage /ddfm=KR;
random Rep Rep*Cultivar Rep*Cultivar*Stage;
lsmeans Cultivar|Stage /pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
proc glimmix data=GreenhouseSurvival2013;
class Rep Crop Cultivar Stage;
model PercMortalityNtoL = Cultivar|Stage /ddfm=KR;
random Rep Rep*Cultivar Rep*Cultivar*Stage;
lsmeans Cultivar|Stage /pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
proc glimmix data=GreenhouseSurvival2013;
class Rep Crop Cultivar Stage;
model PercMortalityLtoP = Cultivar|Stage /ddfm=KR;
random Rep Rep*Cultivar Rep*Cultivar*Stage;
lsmeans Cultivar|Stage /pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
proc glimmix data=GreenhouseSurvival2013;
class Rep Crop Cultivar Stage;
model PercMortalityPtoA = Cultivar|Stage /ddfm=KR;
random Rep Rep*Cultivar Rep*Cultivar*Stage;
lsmeans Cultivar|Stage /pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
ods rtf close;
```

APPENDIX D: SAS PROGRAMS FOR CHAPTER 5

```
"2013 Infestation Counts"
ods rtf file="rtf_file.rtf";
data FertInfestation2013;
input date$ rep$ level$ variety$ stalk$ height internodes feedingsigns bored percbored aphid
aphidleaf;
cards;
7/17/2013    I    3    M81E  1     58    8     0     0    0    5
7/17/2013    I    3    M81E  2     51    7     0     0    0    5
7/17/2013    I    3    M81E  3     43    7     0     0    0    5
7/17/2013    I    3    M81E  4     53    8     0     0    0    5
7/17/2013    I    3    M81E  5     27    5     0     0    0    5
7/17/2013    I    3    M81E  6     43    9     0     0    0    5
7/17/2013    I    3    M81E  7     38    8     0     0    0    5
7/17/2013    I    3    M81E  8     50    10    0     0    0    5
7/17/2013    I    3    M81E  9     39    5     0     0    0    5
7/17/2013    I    3    M81E  10    32    5     0     0    0    5
7/17/2013    I    3    5200  1     48    9     0     0    0    5
7/17/2013    I    3    5200  2     50    7     70    0    0    4
7/17/2013    I    3    5200  3     44    7     0     0    0    5
7/17/2013    I    3    5200  4     42    8     0     0    0    5
7/17/2013    I    3    5200  5     66    11    0     0    0    5
7/17/2013    I    3    5200  6     57    9     0     0    0    4
7/17/2013    I    3    5200  7     57    7     0     0    0    5
7/17/2013    I    3    5200  8     46    8     0     0    0    5
7/17/2013    I    3    5200  9     43    8     0     0    0    3
7/17/2013    I    3    5200  10    64    11    0     0    0    5
7/17/2013    I    3    5140  1     45    8     0     0    0    5
7/17/2013    I    3    5140  2     59    10    0     0    0    5
7/17/2013    I    3    5140  3     53    8     0     0    0    5
7/17/2013    I    3    5140  4     46    8     0     0    0    5
7/17/2013    I    3    5140  5     58    9     0     0    0    5
7/17/2013    I    3    5140  6     49    10    0     0    0    5
7/17/2013    I    3    5140  7     33    6     0     0    0    5
7/17/2013    I    3    5140  8     33    6     0     0    0    5
7/17/2013    I    3    5140  9     39    7     0     0    0    5
7/17/2013    I    3    5140  10    50    9     0     0    0    5
7/17/2013    I    4    5200  1     49    9     0     0    0    1
7/17/2013    I    4    5200  2     40    7     0     0    0    1
7/17/2013    I    4    5200  3     63    12    0     0    0    5
7/17/2013    I    4    5200  4     56    9     0     0    0    5
7/17/2013    I    4    5200  5     61    9     0     0    0    0
. . . . . . . . . . .
. . . . . . . . . . .
. . . . . . . . . . .
```

```
. . . . . . . . . . .
. . . . . . . . . . .
. . . . . . . . . . .
10/2/2013	II	4	5140	7	184	21	0	0	0	1
10/2/2013	II	4	5140	8	161	16	0	0	0	5
10/2/2013	II	4	5200	1	233	23	0	0	0	1
10/2/2013	II	4	5200	2	243	19	0	0	0	0
10/2/2013	II	4	5200	3	160	16	0	0	0	5
10/2/2013	II	4	5200	4	186	19	0	0	0	5
10/2/2013	II	4	5200	5	220	20	0	0	0	5
10/2/2013	II	4	5200	6	226	22	0	2	9.090909091	3
10/2/2013	II	4	5200	7	240	24	0	0	0	3
10/2/2013	II	4	5200	8	214	21	0	0	0	5
10/2/2013	II	4	M81E	1	147	17	0	0	0	3
10/2/2013	II	4	M81E	2	173	18	0	0	0	2
10/2/2013	II	4	M81E	3	173	18	0	0	0	4
10/2/2013	II	4	M81E	4	167	16	0	0	0	5
10/2/2013	II	4	M81E	5	197	20	2	2	10	1
10/2/2013	II	4	M81E	6	210	23	0	0	0	5
10/2/2013	II	4	M81E	7	159	17	0	0	0	5
10/2/2013	II	4	M81E	8	166	17	0	2	11.76470588	1
;
proc glimmix data=FertInfestation2013;
class date variety level rep;
model percbored = date|variety|level /ddfm=KR;
random rep rep*variety rep*variety*level;
lsmeans date|variety|level / pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
proc glimmix data=FertInfestation2013;
class date variety level rep;
model aphidleaf = date|variety|level /ddfm=KR;
random rep rep*variety rep*variety*level;
lsmeans date|variety|level / pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
ods rtf close;
```

“2013 Yield Data”

```
dm'output;clear;log;clear';
ods rtf file="rtf_file.rtf";
data BeauFertSorghum2013;
input Var$ Rep$ Level$ Row$ PercBored EmergperStalk TotSugar WetWgtperstalk EtOH Year;
if variety='5140' then Z1=1; else Z1=0;
```

```
if variety='M81E' then Z2=1; else Z2=0;
cards;
5200	1	0	A	6.98	0.17	4.5	0.25	13951.61379	2013
5200	1	0	B	1.07	0	4.3	0.26	11885.68829	2013
5200	1	45	A	1.33	0	4.4	0.36	17726.13894	2013
5200	1	45	B	2.22	0	4.7	0.34	15051.41992	2013
5200	1	90	A	4.2	0.33	5	0.4	.	2013
5200	1	90	B	1.94	0	4.7	0.57	22447.60401	2013
5200	1	135	A	10.05	0.25	5.8	0.38	20620.60673	2013
5200	1	135	B	12.39	0.83	5.4	0.42	19353.52205	2013
5200	2	0	A	0	0	4.9	0.43	24079.1371	2013
5200	2	0	B	4.35	0.08	5.9	0.47	31582.73044	2013
5200	2	45	A	2.75	0	5	.	25372.7008	2013
5200	2	45	B	5.38	0.25	5.6	0.5	30440.54988	2013
5200	2	90	A	4.41	0.25	6.1	0.76	35070.40138	2013
5200	2	90	B	2.54	0.17	5.5	0.58	32005.97685	2013
5200	2	135	A	3.51	0.25	5.8	0.72	39466.51026	2013
5200	2	135	B	4.96	0.33	5.4	0.74	36499.78714	2013
5200	3	0	A	5.08	0.17	6.3	0.53	33285.19248	2013
5200	3	0	B	3.08	0.25	5.8	0.66	35493.89215	2013
5200	3	45	A	5.95	0.17	6.3	0.56	30052.90155	2013
5200	3	45	B	5.19	0.08	6.6	0.59	17413.24086	2013
5200	3	90	A	5.68	0.58	5.8	0.5	27820.54701	2013
5200	3	90	B	2.95	0.17	6.4	0.59	30831.45494	2013
5200	3	135	A	10.17	1.25	7	0.67	33187.00496	2013
5200	3	135	B	8.48	1.42	6.6	0.51	32486.9308	2013
5200	4	0	A	2.23	0.08	6	0.4	19366.13861	2013
5200	4	0	B	5.28	0.25	5.8	0.36	16260.44085	2013
5200	4	45	A	4.93	0.08	6.5	0.57	28404.9594	2013
5200	4	45	B	5.67	0.17	6.5	0.46	24165.68057	2013
5200	4	90	A	8.28	0.33	5.9	0.49	25353.5571	2013
5200	4	90	B	2.88	0.25	6.1	0.41	20720.58636	2013
5200	4	135	A	9.3	1.08	6.9	0.86	52405.31094	2013
5200	4	135	B	10.53	0.83	5.9	0.74	50993.93403	2013
5140	1	0	A	3.63	0	3.8	0.14	6505.607641	2013
5140	1	0	B	9.55	0.42	4	0.25	16446.69754	2013
5140	1	45	A	1.69	0	4.6	0.15	9129.630182	2013
5140	1	45	B	1.14	0	4.4	0.14	7655.271882	2013
5140	1	90	A	12.05	0.17	4.5	0.19	8888.718911	2013
5140	1	90	B	6.63	0.08	4	0.13	6653.181322	2013
5140	1	135	A	7.17	0.58	4.8	0.33	.	2013
5140	1	135	B	12.11	0.33	4.5	0.22	10070.01019	2013
5140	2	0	A	0.45	0	4.3	0.24	10458.37394	2013
5140	2	0	B	1.67	0.17	4.4	0.25	11031.19552	2013
5140	2	45	A	3.38	0.08	4.1	0.2	8926.049372	2013
5140	2	45	B	7.69	0.08	3.7	0.18	8087.264768	2013
```

5140	2	90	A	5.84	0	4.5	0.26	13552.143	2013
5140	2	90	B	2.45	0.33	3.9	0.21	10639.23372	2013
5140	2	135	A	4.98	0.5	4.7	0.18	10320.71782	2013
5140	2	135	B	11.51	0.42	4.7	0.27	18595.83861	2013
5140	3	0	A	3.16	0.17	5	0.13	16737.76358	2013
5140	3	0	B	1.09	0	5.7	0.13	6093.832965	2013
5140	3	45	A	2.09	0	5.8	0.06	3018.071201	2013
5140	3	45	B	4.18	0.08	5.4	0.27	14471.76763	2013
5140	3	90	A	2.61	0	5	0.12	5925.668223	2013
5140	3	90	B	9.35	0.5	5.1	0.11	6241.320483	2013
5140	3	135	A	11.46	0.5	5.8	0.19	8572.370765	2013
5140	3	135	B	13.52	0.83	6.1	0.26	14751.74162	2013
5140	4	0	A	3.5	0	5.1	0.15	7173.933551	2013
5140	4	0	B	1.63	0	4.9	0.15	7428.779026	2013
5140	4	45	A	2.58	0	5.6	0.2	10509.08731	2013
5140	4	45	B	5.44	0	4.9	0.11	5722.891039	2013
5140	4	90	A	5.36	0.17	5.4	0.17	7974.405401	2013
5140	4	90	B	11.07	0.08	5.4	0.13	6526.158856	2013
5140	4	135	A	4.9	0.33	7.1	0.56	31706.02364	2013
5140	4	135	B	12.77	1	5.9	0.19	10137.2754	2013
M81E	1	0	A	6.54	0	5.3	0.04	2644.841567	2013
M81E	1	0	B	1.15	0	6.3	0.09	4898.430239	2013
M81E	1	45	A	2.08	0	6	0.16	9770.819807	2013
M81E	1	45	B	1.91	0	8	0.09	6898.158021	2013
M81E	1	90	A	5.33	0	6	0.1	5942.244575	2013
M81E	1	90	B	1.68	0.08	6	0.55	29001.42032	2013
M81E	1	135	A	1.95	0.08	6.9	0.08	5061.673903	2013
M81E	1	135	B	10.65	0.5	7	0.12	7867.786892	2013
M81E	2	0	A	0.56	0	6.4	0.1	5832.327449	2013
M81E	2	0	B	1.16	0	6.7	0.06	4155.368969	2013
M81E	2	45	A	6.45	0.17	5.5	0.1	4907.507476	2013
M81E	2	45	B	0.55	0	5.3	0.11	6119.887894	2013
M81E	2	90	A	0.57	0	5.2	0.1	6713.041049	2013
M81E	2	90	B	4.52	0	5.4	0.13	.	2013
M81E	2	135	A	9.85	0.33	5.8	0.15	6541.636515	2013
M81E	2	135	B	8	0.5	5.5	0.1	5914.339904	2013
M81E	3	0	A	0	0	8.7	0.01	368.4365296	2013
M81E	3	0	B	1.69	0	8.5	0.03	1753.117959	2013
M81E	3	45	A	6.9	0.25	7.1	0.09	3729.014854	2013
M81E	3	45	B	4.42	0.08	8.3	0.07	4207.861147	2013
M81E	3	90	A	5.18	0	7.7	0.02	1025.129301	2013
M81E	3	90	B	5.03	0.17	8.1	0.01	859.0476676	2013
M81E	3	135	A	3.83	0	5.2	0.04	1790.581571	2013
M81E	3	135	B	4.79	0.17	4.5	0.04	1951.149614	2013
M81E	4	0	A	4.44	0	6.9	0.04	2544.600338	2013
M81E	4	0	B	2.02	0	.	0.07	3341.858876	2013

```
M81E  4    45    A    3.26   0.08   6.4   0.15   8257.772364   2013
M81E  4    45    B    2.46   0      7.2   0.02   485.5336245   2013
M81E  4    90    A    3.64   0.08   7.7   0.02   962.8150515   2013
M81E  4    90    B    6.63   0.25   8.5   0.03   .             2013
M81E  4    135   A    4.31   0      6.5   0.21   12993.81332   2013
M81E  4    135   B    9.59   0.17   7.3   0.19   .             2013
;
proc glm data=BeauFertSorghum2013;
class Var Rep Level Row;
model PercBored EmergperStalk WetWgtperstalk TotSugar EtOH
        = Var Level Var*Level
        Rep Rep*Var Rep*Var*Level / nouni ;
random Rep Rep*Var Rep*Var*Level;
manova H = Var e=Rep*Var/ printh printe htype=3 etype=3 ;
manova H = Level Var*Level e=Rep*Var*Level/ printh printe htype=3 etype=3 ;
run;
proc glimmix data=BeauFertSorghum2013;
class Var Rep Level Row;
model PercBored = Var Level Var*Level /ddfm=KR;
random Rep Rep*Var Rep*Var*Level Row(Rep*Var*Level);
lsmeans Var Level Var*Level / pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Documents and Settings\MVanWeelden\My Documents\PhD Plan of
Study\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;

proc glimmix data=BeauFertSorghum2013;
class Var Rep Level Row;
model EmergperStalk = Var Level Var*Level /ddfm=KR;
random Rep Rep*Var Rep*Var*Level Row(Rep*Var*Level);
lsmeans Var Level Var*Level / pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Documents and Settings\MVanWeelden\My Documents\PhD Plan of
Study\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;

proc glimmix data=BeauFertSorghum2013;
class Var Rep Level Row;
model WetWgtperstalk = Var Level Var*Level /ddfm=KR;
random Rep Rep*Var Rep*Var*Level Row(Rep*Var*Level);
```

```
lsmeans Var Level Var*Level / pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Documents and Settings\MVanWeelden\My Documents\PhD Plan of Study\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data=BeauFertSorghum2013;
class Var Rep Level Row;
model TotSugar = Var Level Var*Level /ddfm=KR;
random Rep Rep*Var Rep*Var*Level Row(Rep*Var*Level);
lsmeans Var Level Var*Level / pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Documents and Settings\MVanWeelden\My Documents\PhD Plan of Study\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data=BeauFertSorghum2013;
class Var Rep Level Row;
model EtOH = Var Level Var*Level /ddfm=KR;
random Rep Rep*Var Rep*Var*Level Row(Rep*Var*Level);
lsmeans Var Level Var*Level / pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Documents and Settings\MVanWeelden\My Documents\PhD Plan of Study\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc reg data=BeauFertSorghum20132013;
model PercBored = fert / xpx i influence;
run;
proc reg data=BeauFertSorghum2013;
model WetWhtPerStalk = PercBored / xpx i influence;
run;
proc reg data=BeauFertSorghum2013;
model TotSugar = PercBored / xpx i influence;
run;
proc reg data=BeauFertSorghum2013;
model theoEtOH = PercBored / xpx i influence;
run;
ods rtf close;
```

“2014 Infestation Counts”

```
ods rtf file="rtf_file.rtf";
data FertInfestation2014;
input date$ rep$ level$ variety$ stalk$ height internodes feedingsigns bored percbored aphid
aphidleaf;
cards;
7/17/2014	I	4	5200	1	58	6	0	0	0	1
	16.66666667
7/17/2014	I	4	5200	2	38	5	0	0	0	1
	20
7/17/2014	I	4	5200	3	56	6	0	0	0	4
	66.66666667
7/17/2014	I	4	5200	4	42	6	0	0	0	1
	16.66666667
7/17/2014	I	4	5200	5	49	6	0	0	0	1
	16.66666667
7/17/2014	I	4	5200	6	47	6	0	0	0	0
	0
7/17/2014	I	4	5200	7	41	6	0	0	0	2
	33.33333333
7/17/2014	I	4	5200	8	35	9	0	0	0	1
	11.11111111
7/17/2014	I	4	5200	9	32	6	0	0	0	1
	16.66666667
7/17/2014	I	4	5200	10	45	6	0	0	0	2
	33.33333333
7/17/2014	I	4	5140	1	49	7	0	0	0	1
	14.28571429
7/17/2014	I	4	5140	2	37	7	0	0	0	0
	0
7/17/2014	I	4	5140	3	53	7	0	0	0	1
	14.28571429
7/17/2014	I	4	5140	4	34	8	0	0	0	2
	25
7/17/2014	I	4	5140	5	55	7	0	0	0	0
	0
7/17/2014	I	4	5140	6	33	8	0	0	0	5
	62.5
7/17/2014	I	4	5140	7	51	6	0	0	0	1
	16.66666667
7/17/2014	I	4	5140	8	39	7	0	0	0	0
	0
7/17/2014	I	4	5140	9	31	7	0	0	0	3
	42.85714286
7/17/2014	I	4	5140	10	42	7	0	0	0	1
	14.28571429
```

7/17/2014	I	4	M81E	1	42	5	0	0	0	5	100
7/17/2014	I	4	M81E	2	38	8	0	0	0	8	100
7/17/2014	I	4	M81E	3	46	7	0	0	0	4	57.14285714
7/17/2014	I	4	M81E	4	34	6	0	0	0	3	50
7/17/2014	I	4	M81E	5	34	6	0	0	0	3	50
7/17/2014	I	4	M81E	6	38	7	0	0	0	5	71.42857143
7/17/2014	I	4	M81E	7	24	4	0	0	0	2	50
7/17/2014	I	4	M81E	8	41	8	0	0	0	5	62.5
7/17/2014	I	4	M81E	9	52	9	0	0	0	7	77.77777778
7/17/2014	I	4	M81E	10	36	8	0	0	0	6	75
7/17/2014	I	3	M81E	1	45	7	0	0	0	3	42.85714286
7/17/2014	I	3	M81E	2	44	7	0	0	0	1	14.28571429
7/17/2014	I	3	M81E	3	45	8	0	0	0	1	12.5
7/17/2014	I	3	M81E	4	43	6	0	0	0	1	16.66666667
7/17/2014	I	3	M81E	5	44	5	0	0	0	0	0
7/17/2014	I	3	M81E	6	43	7	0	0	0	1	14.28571429
7/17/2014	I	3	M81E	7	52	8	0	0	0	1	12.5
7/17/2014	I	3	M81E	8	39	6	0	0	0	5	83.33333333
7/17/2014	I	3	M81E	9	49	7	0	0	0	1	14.28571429
7/17/2014	I	3	M81E	10	37	6	0	0	0	3	50
7/17/2014	I	3	5200	1	46	6	0	0	0	2	33.33333333
7/17/2014	I	3	5200	2	38	6	0	0	0	0	0
7/17/2014	I	3	5200	3	42	5	0	0	0	0	0

7/17/2014	I	3	5200	4	38	6	0	0	0	0	0
. . . .											
. . . .											
. . . .											
. . . .											
. . . .											
. . . .											
. . . .											
10/3/2014	IV	4	5200	7	180	13	0	0	0	1	7.692307692
10/3/2014	IV	4	5200	8	249	17	0	0	0	0	0
10/3/2014	IV	4	5200	9	.	.	.	.	.	.	.
10/3/2014	IV	4	5200	10	.	.	.	.	.	.	.
10/3/2014	IV	2	M81E	1	238	16	0	0	0	2	12.5
10/3/2014	IV	2	M81E	2	283	21	0	0	0	3	14.28571429
10/3/2014	IV	2	M81E	3	292	21	1	0	0	0	0
10/3/2014	IV	2	M81E	4	198	20	0	0	0	7	35
10/3/2014	IV	2	M81E	5	249	19	0	0	0	2	10.52631579
10/3/2014	IV	2	M81E	6	217	15	0	0	0	1	6.666666667
10/3/2014	IV	2	M81E	7	251	18	0	0	0	0	0
10/3/2014	IV	2	M81E	8	214	15	0	0	0	2	13.33333333
10/3/2014	IV	2	M81E	9	.	.	.	.	.	.	.
10/3/2014	IV	2	M81E	10	.	.	.	.	.	.	.
10/3/2014	IV	2	5140	1	229	18	0	0	0	0	0
10/3/2014	IV	2	5140	2	251	19	0	0	0	1	5.263157895
10/3/2014	IV	2	5140	3	216	15	0	0	0	1	6.666666667
10/3/2014	IV	2	5140	4	180	13	0	0	0	0	0

```
10/3/2014	IV	2	5140	5	252	18	0	0	0	0
	0
10/3/2014	IV	2	5140	6	165	12	1	0	0	0
	0
10/3/2014	IV	2	5140	7	167	15	0	0	0	0
	0
10/3/2014	IV	2	5140	8	216	17	0	1	5.882352941
	0	0
10/3/2014	IV	2	5140	9	.	.	.	.	.	.
	.
10/3/2014	IV	2	5140	10	.	.	.	.	.	.
	.
10/3/2014	IV	2	5200	1	222	14	0	0	0	0
	0
10/3/2014	IV	2	5200	2	253	17	0	0	0	0
	0
10/3/2014	IV	2	5200	3	228	15	0	1	6.666666667
	0	0
10/3/2014	IV	2	5200	4	229	18	0	0	0	0
	0
10/3/2014	IV	2	5200	5	156	13	0	0	0	1
	7.692307692
10/3/2014	IV	2	5200	6	155	12	0	0	0	0
	0
10/3/2014	IV	2	5200	7	232	18	0	0	0	0
	0
10/3/2014	IV	2	5200	8	219	19	2	0	0	0
	0
10/3/2014	IV	2	5200	9	.	.	.	.	.	.
	.
10/3/2014	IV	2	5200	10	.	.	.	.	.	.
	.
;
proc glimmix data=FertInfestation2014;
class date variety level rep;
model percbored = date|variety|level /ddfm=KR;
random rep rep*variety rep*variety*level;
lsmeans date|variety|level / pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
proc glimmix data=FertInfestation2014;
class date variety level rep;
model aphidleaf = date|variety|level /ddfm=KR;
random rep rep*variety rep*variety*level;
lsmeans date|variety|level / pdiff adjust=tukey;
```

```
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
ods rtf close;

“2014 Yield Data”
dm'output;clear;log;clear';
ods rtf file="rtf_file.rtf";
data BeauFertSorghum2014;
input Var$ Rep$ Level$ Row$ PercBored EmergperStalk TotSugar WetWgtperstalk EtOH Year;
if Var='5140' then Z1=1; else Z1=0;
if Var='M81E' then Z2=1; else Z2=0;
cards;
5200 1 1 A 0.69 0    4.7 0.06 2880.942787 2014
5200 1 1 B 0    0    5.1 0.07 2714.033666 2014
5200 1 2 A 4.37 0.17 4.3 0.2  7440.711805 2014
5200 1 2 B 6.02 0    3.5 0.08 2859.478381 2014
5200 1 3 A 4.26 0    5.2 0.1  4212.051434 2014
5200 1 3 B 4.67 0    5.2 0.1  4342.459485 2014
5200 1 4 A 1.5  0    4.7 0.1  5227.320525 2014
5200 1 4 B 3.93 0    4.9 0.18 7136.934499 2014
5200 2 1 A 0.7  0.08 4.9 0.07 2742.833496 2014
5200 2 1 B 1.36 0.08 4.9 0.07 2749.001328 2014
5200 2 2 A 0.65 0.08 5   0.12 4824.201524 2014
5200 2 2 B 3.27 0.25 4.7 0.14 5956.804635 2014
5200 2 3 A 4.62 0    5.7 0.18 6074.256032 2014
5200 2 3 B 2.19 0.08 4.3 0.08 3608.963299 2014
5200 2 4 A 1.4  0.08 5.1 0.13 6275.516646 2014
5200 2 4 B 2.88 0    5.2 0.09 4077.159971 2014
5200 3 1 A 1.09 0    5.1 0.22 9679.350939 2014
5200 3 1 B 1.34 0.17 4.6 0.15 6779.206651 2014
5200 3 2 A 2.53 0    5   0.16 7276.069772 2014
5200 3 2 B 2.21 0.17 5.4 0.11 5134.751808 2014
5200 3 3 A 3.83 0.33 3.7 0.21 10191.87195 2014
5200 3 3 B 5.07 0.08 5.9 0.12 5589.68814  2014
5200 3 4 A 3.4  0.08 5.6 0.13 6879.707973 2014
5200 3 4 B 1.71 0.08 5.3 0.19 10000.8743  2014
5200 4 1 A 2.03 0    6   0.14 6597.448033 2014
5200 4 1 B 0    0    5.4 0.12 5086.621054 2014
5200 4 2 A 0    0    5.5 0.18 8943.855908 2014
5200 4 2 B 1.7  0.08 6   0.2  11749.59672 2014
5200 4 3 A 0.52 0    5.3 0.26 16110.93233 2014
5200 4 3 B 1.7  0    6.2 0.2  10693.06163 2014
5200 4 4 A 1.71 0    4.6 0.22 12080.38929 2014
5200 4 4 B 1.21 0    6   0.21 12408.62311 2014
5140 1 1 A 0.56 0.08 3.4 0.11 3744.252448 2014
```

5140	1	1	B	1.89	0	3.6	0.07	2174.084895	2014
5140	1	2	A	1.97	0	3.2	0.12	3374.550642	2014
5140	1	2	B	5.37	0.08	3.3	0.09	2828.550549	2014
5140	1	3	A	3.7	0	4.7	0.11	4124.294087	2014
5140	1	3	B	2.01	0	4	0.1	3690.631879	2014
5140	1	4	A	7.91	0.17	3.6	0.17	5163.919045	2014
5140	1	4	B	7.97	0	3.8	0.09	3526.381646	2014
5140	2	1	A	0.63	0	3.7	0.09	3224.380697	2014
5140	2	1	B	0	0	3.7	0.07	2295.516562	2014
5140	2	2	A	1.75	0.08	3.1	0.16	6149.581349	2014
5140	2	2	B	3.91	0.25	3.8	0.07	2213.23418	2014
5140	2	3	A	4.08	0.08	4.2	0.23	7696.006548	2014
5140	2	3	B	5.45	0.33	3.8	0.16	4925.196692	2014
5140	2	4	A	4.69	0.33	3.9	0.23	7242.752923	2014
5140	2	4	B	5.26	0.08	3.6	0.16	6725.502674	2014
5140	3	1	A	5.56	0.5	3.1	0.31	10257.0015	2014
5140	3	1	B	1.64	0	3.7	0.21	6907.812824	2014
5140	3	2	A	5.2	0	3.6	0.08	2452.544785	2014
5140	3	2	B	0	0	4.4	0.08	3790.126249	2014
5140	3	3	A	5.85	0.17	4.2	0.25	10297.90296	2014
5140	3	3	B	0.65	0	4.6	0.15	6417.235436	2014
5140	3	4	A	5.26	0.5	4.6	0.25	11966.84245	2014
5140	3	4	B	8.09	0.25	4.9	0.2	8611.182624	2014
5140	4	1	A	1.98	0.08	4.4	0.26	11017.1828	2014
5140	4	1	B	0	0	3.2	0.18	7176.620067	2014
5140	4	2	A	2.29	0	4.3	0.28	14248.86608	2014
5140	4	2	B	3.49	0	3.7	0.15	5338.718491	2014
5140	4	3	A	3	0.25	3.9	0.27	11410.64171	2014
5140	4	3	B	1.78	0	4.1	0.19	9105.754648	2014
5140	4	4	A	0	0	4.7	0.24	10512.99338	2014
5140	4	4	B	1.42	0	5.7	0.15	9364.209978	2014
M81E	1	1	A	0.63	0	6	0.07	2932.085622	2014
M81E	1	1	B	0	0	7.1	0.07	3709.951972	2014
M81E	1	2	A	0.65	0	3.5	0.12	4457.630651	2014
M81E	1	2	B	2.76	0	4.3	0.09	3807.424365	2014
M81E	1	3	A	5.07	0	6.4	0.11	5088.783046	2014
M81E	1	3	B	5.67	0.08	5.5	0.09	3381.746164	2014
M81E	1	4	A	5.04	0.17	4.3	0.12	4421.66727	2014
M81E	1	4	B	6.16	0.33	3.4	0.12	4345.2456	2014
M81E	2	1	A	0	0	5.5	0.09	4208.224845	2014
M81E	2	1	B	0	0	4.3	0.1	4728.042265	2014
M81E	2	2	A	1.2	0.08	4.1	0.17	7880.345434	2014
M81E	2	2	B	1.35	0	4.5	0.12	4643.989945	2014
M81E	2	3	A	9.72	0.5	4.2	0.13	4900.488784	2014
M81E	2	3	B	7.41	0.08	3.5	0.1	3690.765032	2014
M81E	2	4	A	5.93	0.17	4.1	0.18	5498.311451	2014

```
M81E  2    4    B    1.48   0.08   5.6   0.1    4514.660693   2014
M81E  3    1    A    2.75   0.25   4.3   0.23   6772.359228   2014
M81E  3    1    B    0      0      3.9   0.15   5463.378839   2014
M81E  3    2    A    2.74   0.25   6.1   0.18   8740.543799   2014
M81E  3    2    B    3.31   0      3.1   0.17   6931.653432   2014
M81E  3    3    A    1.95   0      5.3   0.17   7042.599255   2014
M81E  3    3    B    4.93   0.17   4.7   0.14   5793.057392   2014
M81E  3    4    A    6.55   0.42   3     0.27   10251.8746    2014
M81E  3    4    B    1.75   0      3     0.27   6997.31606    2014
M81E  4    1    A    0      0      7     0.08   4105.252001   2014
M81E  4    1    B    2.46   0      6.4   0.1    4751.733726   2014
M81E  4    2    A    4.91   0      6.1   0.35   16715.0722    2014
M81E  4    2    B    0      0      5     0.32   11216.68655   2014
M81E  4    3    A    1.82   0      4.3   0.22   7628.432209   2014
M81E  4    3    B    1.05   0      3.5   0.25   9996.94432    2014
M81E  4    4    A    2.99   0      4.1   0.19   6014.059324   2014
M81E  4    4    B    4.76   0      4     0.34   12860.00162   2014
;
proc glm data=BeauFertSorghum2014;
class Var Rep Level Row;
model PercBored EmergperStalk WetWgtperstalk TotSugar EtOH
        = Var Level Var*Level
        Rep Rep*Var Rep*Var*Level / nouni ;
random Rep Rep*Var Rep*Var*Level;
manova H = Var e=Rep*Var/ printh printe htype=3 etype=3 ;
manova H = Level Var*Level e=Rep*Var*Level/ printh printe htype=3 etype=3 ;
run;
proc glimmix data=BeauFertSorghum2014;
class Var Rep Level Row Year;
model PercBored = Var|Level /ddfm=KR;
random Rep Rep*Var Rep*Var*Level;
lsmeans Var|Level / pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\Documents\PhD Plan of Study\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data=BeauFertSorghum2014;
class Var Rep Level Row Year;
model EmergperStalk = Var|Level /ddfm=KR;
random Rep Rep*Var Rep*Var*Level;
lsmeans Var|Level / pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
```

```
%include 'C:\Users\MVanWeelden\Documents\PhD Plan of Study\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data=BeauFertSorghum2014;
class Var Rep Level Row Year;
model WetWgtperstalk = Var|Level /ddfm=KR;
random Rep Rep*Var Rep*Var*Level;
lsmeans Var|Level / pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\Documents\PhD Plan of Study\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data=BeauFertSorghum2014;
class Var Rep Level Row Year;
model TotSugar = Var|Level /ddfm=KR;
random Rep Rep*Var Rep*Var*Level;
lsmeans Var|Level / pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\Documents\PhD Plan of Study\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc glimmix data=BeauFertSorghum2014;
class Var Rep Level Row Year;
model EtOH = Var|Level /ddfm=KR;
random Rep Rep*Var Rep*Var*Level;
lsmeans Var|Level / pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
%include 'C:\Users\MVanWeelden\Documents\PhD Plan of Study\pdmix800.sas';
%pdmix800(ppp,mmm,alpha=.05,sort=yes);
run;
proc reg data=BeauFertSorghum2014;
model PercBored = Level / xpx i influence;
run;
proc reg data=BeauFertSorghum2014;
model WetWgtperstalk = PercBored / xpx i influence;
run;
proc reg data=BeauFertSorghum2014;
model TotSugar = PercBored / xpx i influence;
run;
proc reg data=BeauFertSorghum2014;
```

```
model EtOH = PercBored / xpx i influence;
run;
ods rtf close;
```

APPENDIX E: SAS PROGRAMS FOR CHAPTER 6

“Predation in Crops”

```
ods rtf file="rtf_file.rtf";
data predationall;
input rep$ var$ trt$ total bored percbored emerg eps ants spiders relativesurvival year$ type$;
cards;
4	5200	T	196	45	23.0	18	1.500	4	17 40 2012 HB
3	5140	U	207	30	14.5	5	0.417	22	0 16.7 2012 HB
3	M81E	U	156	25	16.0	5	0.416	50	4 20 2012 SS
3	113	U	155	12	7.7	1	0.083	79	1 8.3 2012 EC
4	113	T	163	11	6.7	0	0.000	7	1 0 2012 EC
4	1002	T	177	7	4.0	0	0.000	28	3 0 2012 EC
3	1002	U	157	3	1.9	0	0.000	16	4 0 2012 EC
4	838	T	218	58	26.9	11	0.917	50	2 19 2012 SC
3	838	U	205	26	12.7	13	1.083	24	7 50 2012 SC
4	845	T	197	18	9.1	4	0.250	13	9 22.2 2012 SC
5	5140	U	207	25	12.1	2	0.167	48	3 8 2012 HB
4	5140	T	243	30	12.3	7	0.583	12	4 23.3 2012 HB
4	M81E	T	163	19	11.7	7	0.583	10	6 36.8 2012 SS
5	838	U	208	48	23.1	12	1.000	97	7 25 2012 SC
5	5200	U	270	53	19.6	17	1.417	35	3 32.1 2012 HB
5	113	U	162	10	6.2	0	0.000	26	1 0 2012 EC
5	M81E	U	144	29	20.1	6	0.500	71	0 20.7 2012 SS
5	845	U	189	24	12.7	5	0.417	19	5 20.8 2012 SC
5	1002	U	155	12	7.7	1	0.083	23	8 8.3 2012 EC
6	M81E	T	172	41	23.8	8	0.667	8	3 19.5 2012 SS
6	113	T	170	26	15.3	6	0.500	8	7 23.1 2012 EC
6	1002	T	142	14	9.9	2	0.167	7	7 14.3 2012 EC
6	838	T	227	24	10.6	14	1.166	14	10 58.3 2012 SC
3	845	U	178	12	6.7	3	0.250	72	7 25 2012 SC
3	5200	U	200	33	16.5	4	0.333	31	6 12.1 2012 HB
2	5200	T	185	37	20.0	18	1.500	4	3 48.6 2012 HB
2	838	T	204	29	14.2	18	1.500	17	5 62.1 2012 SC
2	113	T	164	11	6.6	0	0.000	23	0 0 2012 EC
2	845	T	192	4	2.1	1	0.083	6	1 25 2012 SC
6	5140	T	217	60	27.6	12	1.000	9	7 20 2012 HB
2	5140	T	179	25	14.0	8	0.666	3	0 32 2012 HB
2	M81E	T	129	23	17.8	5	0.416	8	5 21.7 2012 SS
2	1002	T	157	16	10.2	2	0.167	6	3 12.5 2012 EC
1	113	U	152	11	7.2	1	0.083	31	3 9.1 2012 EC
1	5200	U	189	61	32.3	19	1.583	9	6 31.1 2012 HB
1	M81E	U	153	19	12.4	5	0.416	83	2 26.3 2012 SS
1	838	U	197	21	10.7	5	0.417	67	2 23.8 2012 SC
1	5140	U	196	16	8.2	1	0.083	58	8 6.3 2012 HB
1	1002	U	148	8	5.4	1	0.083	13	4 12.5 2012 EC
```

```
1	845	U	179	11	6.1	4	0.333	17	2 36.4 2012 SC
6	845	T	190	12	6.3	6	0.500	10	5 50 2012 SC
1	1002	U	167	14	8.38	2	0.166666667	43	. 14.29 2013	EC
2	1002	T	188	8	4.26	2	0.166666667	6	. 25	2013	EC
3	1002	U	162	16	9.88	2	0.166666667	34	. 12.5	2013	EC
4	1002	T	179	11	6.15	3	0.25	16	.	27.27	2013	EC
5	1002	U	160	8	5	0	0	35	.	0	2013	EC
6	1002	T	165	13	7.88	2	0.166666667	27	. 15.38 2013	EC
1	113	U	196	4	2.04	1	0.083333333	43 . 25 2013		EC
2	113	T	209	6	2.87	0	0	4	. 0	2013		EC
3	113	U	223	12	5.38	4	0.333333333	17 . 33.33 2013		EC
4	113	T	204	4	1.96	0	0	12	.	0	2013	EC
5	113	U	186	4	2.15	0	0	51	.	0	2013	EC
6	113	T	205	6	2.93	1	0.083333333	9	. 16.67 2013	EC
1	838	U	243	6	2.47	4	0.333333333	18	. 66.67 2013	SC
2	838	T	271	22	8.12	6	0.5	6	.	27.27	2013	SC
3	838	U	224	14	6.25	3	0.25	64	.	21.43	2013	SC
4	838	T	211	16	7.58	4	0.333333333	9	. 25	2013	SC
5	838	U	192	11	5.73	4	0.333333333	21	. 36.36 2013	SC
6	838	T	204	26	12.75	8	0.666666667	7	. 30.77 2013	SC
1	845	U	208	3	1.44	0	0	15	.	0	2013	SC
2	845	T	245	21	8.57	9	0.75	8	.	42.86	2013	SC
3	845	U	194	9	4.64	0	0	128	.	0	2013	SC
4	845	T	189	4	2.12	1	0.083333333	14 . 25 2013		SC
5	845	U	199	1	0.5	1	0.083333333	34	. 100	2013	SC
6	845	T	221	5	2.26	1	0.083333333	18	. 20	2013	SC
1	5200	U	253	5	1.98	2	0.166666667	33	. 40	2013	HB
2	5200	T	271	12	4.43	1	0.083333333	4	. 8.33	2013	HB
3	5200	U	217	19	8.76	3	0.25	50	.	15.79	2013	HB
4	5200	T	246	10	4.07	2	0.166666667	13	. 20	2013	HB
5	5200	U	231	18	7.79	5	0.416666667	18	. 27.78 2013	HB
6	5200	T	217	44	20.28	19	1.583333333	22	. 43.18 2013	HB
1	5140	U	231	21	9.09	1	0.083333333	30	. 4.76	2013	HB
2	5140	T	207	21	10.14	3	0.25	3	.	14.29	2013	HB
3	5140	U	182	4	2.2	1	0.083333333	74	. 25	2013	HB
4	5140	T	213	24	11.27	3	0.25	30	.	12.5	2013	HB
5	5140	U	.	.	.	.	.	25	.	.	2013	HB
6	5140	T	.	.	.	.	.	9	.	.	2013	HB
1	M81E	U	168	10	5.95	2	0.166666667	22	. 20	2013	SS
2	M81E	T	204	3	1.47	0	0	11	.	0	2013	SS
3	M81E	U	151	4	2.65	0	0	31	.	0	2013	SS
4	M81E	T	186	6	3.23	1	0.083333333	12	. 16.67 2013	SS
5	M81E	U	.	.	.	.	.	27	.	.	2013	SS
6	M81E	T	.	.	.	.	.	5	.	.	2013	SS
;
proc glimmix data=predationall;
```

```
class rep year var trt;
model ants = trt var trt*var/ddfm=KR;
random year rep(year) var*rep(year);
lsmeans trt /pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
proc glimmix data=predationall;
class rep year var trt;
model percbored = trt var trt*var /ddfm=KR;
random year rep(year) var*rep(year);
lsmeans trt /pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
proc glimmix data=predationall;
class rep year var trt;
model eps = trt var trt*var /ddfm=KR;
random year rep(year) var*rep(year);
lsmeans trt /pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
proc glimmix data=predationall;
class rep year var trt;
model relativesurvival = trt var trt*var /ddfm=KR;
random year rep(year) var*rep(year);
lsmeans trt /pdiff adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
proc mixed data=predationall;
class rep year var;
model percbored = ants var / htype=1 3 solution outp=resid1;
run;
proc mixed data=predationall;
class rep year var;
model eps = ants var / htype=1 3 solution outp=resid1;
run;
proc mixed data=predationall;
class rep year var;
model relativesurvival = ants var / htype=1 3 solution outp=resid1;
run;
ods rtf close;
```

“Predation in Non-Crops”

```
ods rtf file="rtf_file.rtf";
data weeds;
input Farm$ Trt$ Border$ Quadrat$ Date$ Year$ Density Height Diameter Injury PerPlant Ants;
Injuryperplant = Injury / Density;
cards;
1	U	1	1	1	2011	95	108.6	3.7	0	.	7
1	U	1	2	1	2011	40	96.2	4.7	0	.	22
1	T	1	1	1	2011	60	117.2	4.16	1	0.017	14
1	T	1	2	1	2011	23	86.2	4.6	0	.	53
1	U	2	1	1	2011	.	.	.	.	.	7
1	U	2	2	1	2011	39	148.2	6.14	1	0.026	9
1	T	2	1	1	2011	113	157.6	5.66	4	0.035	12
1	T	2	2	1	2011	132	126.8	4.5	4	0.030	6
1	U	3	1	1	2011	78	166.8	5.52	1	0.013	27
1	U	3	2	1	2011	59	154.8	6.18	0	.	78
1	T	3	1	1	2011	63	123.8	6.2	5	0.079	23
1	T	3	2	1	2011	73	97.2	6.14	5	0.068	19
2	U	1	1	1	2011	61	136.6	4.5	9	0.148	98
2	U	1	2	1	2011	54	102	3.4	6	0.111	72
2	T	1	1	1	2011	47	120.6	4.72	3	0.064	47
2	T	1	2	1	2011	64	113.4	3.6	22	0.344	29
2	U	2	1	1	2011	69	115.2	5.06	4	0.058	18
2	U	2	2	1	2011	61	141.2	6.22	1	0.016	46
2	T	2	1	1	2011	50	126.8	5.96	5	0.100	15
2	T	2	2	1	2011	82	144	5.9	9	0.110	178
2	U	3	1	1	2011	45	122.6	5.5	8	0.178	41
2	U	3	2	1	2011	48	120.2	3.82	12	0.250	9
2	T	3	1	1	2011	32	123	3.4	3	0.094	45
2	T	3	2	1	2011	45	162.4	5.7	66	1.467	15
1	U	1	1	2	2011	45	132.8	5.2	10	0.222	7
1	U	1	2	2	2011	33	135.4	4.3	3	0.091	22
1	T	1	1	2	2011	18	103.2	3.7	5	0.278	14
1	T	1	2	2	2011	41	97.6	3.5	14	0.341	53
1	U	2	1	2	2011	31	117.8	4.9	4	0.129	7
1	U	2	2	2	2011	70	126.2	5.6	2	0.029	9
1	T	2	1	2	2011	54	138.8	6.1	2	0.037	12
1	T	2	2	2	2011	52	128.6	5	10	0.192	6
1	U	3	1	2	2011	46	115.4	4.5	13	0.283	27
1	U	3	2	2	2011	63	118	4.2	4	0.063	78
1	T	3	1	2	2011	61	117.8	5.8	16	0.262	23
1	T	3	2	2	2011	49	129.2	4.3	7	0.143	19
2	U	1	1	2	2011	60	114.2	3.7	0	.	98
2	U	1	2	2	2011	47	130.8	5	3	0.064	72
2	T	1	1	2	2011	29	109.6	3.1	0	.	47
2	T	1	2	2	2011	23	115.6	4.7	2	0.087	29
```

2	U	2	1	2	2011	88	115.2	5.1	5	0.057	18
2	U	2	2	2	2011	47	122.2	5.5	0	.	46
2	T	2	1	2	2011	85	143.8	6.3	5	0.059	15
2	T	2	2	2	2011	53	130	6.5	5	0.094	178
2	U	3	1	2	2011	40	129.8	5.5	1	0.025	41
2	U	3	2	2	2011	33	168.2	5.3	1	0.03	9
2	T	3	1	2	2011	67	140.6	5.7	9	0.134	45
2	T	3	2	2	2011	30	107.8	4.5	0	.	15
1	U	1	1	1	2012	107	220	4.38	2	0.019	52
1	U	1	2	1	2012	70	221.6	4.8	2	0.029	64
1	T	1	1	1	2012	66	223.4	5.24	5	0.076	18
1	T	1	2	1	2012	99	223.4	5.32	17	0.172	10
1	U	2	1	1	2012	51	164.4	7.54	3	0.059	156
1	U	2	2	1	2012	37	234.6	6.9	9	0.243	24
1	T	2	1	1	2012	99	189.2	5.26	9	0.091	25
1	T	2	2	1	2012	61	189	6.64	3	0.049	63
1	U	3	1	1	2012	50	194.2	6.22	4	0.080	83
1	U	3	2	1	2012	60	72.8	3.4	5	0.083	58
1	T	3	1	1	2012	79	128.2	4.32	9	0.114	24
1	T	3	2	1	2012	44	170.4	5.98	3	0.068	67
2	U	1	1	1	2012	100	189.4	5.82	19	0.190	82
2	U	1	2	1	2012	62	172	5.64	3	0.048	59
2	T	1	1	1	2012	64	150.6	5.38	4	0.063	26
2	T	1	2	1	2012	49	160.8	5.98	14	0.286	67
2	U	2	1	1	2012	55	171.4	5.28	9	0.164	52
2	U	2	2	1	2012	29	166.4	5.48	3	0.103	24
2	T	2	1	1	2012	50	170.8	5.9	20	0.400	72
2	T	2	2	1	2012	49	173.4	5.74	2	0.041	76
2	U	3	1	1	2012	56	144.2	4.98	6	0.107	8
2	U	3	2	1	2012	51	165.4	4.94	7	0.137	19
2	T	3	1	1	2012	24	122.8	5.32	6	0.250	173
2	T	3	2	1	2012	58	172	5.98	12	0.207	292
1	U	1	1	2	2012	48	205	5.3	2	0.042	52
1	U	1	2	2	2012	47	231.4	5.4	5	0.106	64
1	T	1	1	2	2012	40	230.8	6.4	2	0.050	18
1	T	1	2	2	2012	39	186.4	5.6	1	0.026	10
1	U	2	1	2	2012	42	188.2	5.8	5	0.119	156
1	U	2	2	2	2012	49	175.8	4.6	4	0.082	24
1	T	2	1	2	2012	44	194	6	1	0.023	25
1	T	2	2	2	2012	43	181.2	5.4	1	0.023	63
1	U	3	1	2	2012	39	186.2	6.8	4	0.103	83
1	U	3	2	2	2012	46	153.4	4.8	9	0.196	58
1	T	3	1	2	2012	64	182	4.7	3	0.047	24
1	T	3	2	2	2012	52	187	6.2	3	0.058	67
2	U	1	1	2	2012	52	179.6	5	15	0.288	82
2	U	1	2	2	2012	43	205.8	6	2	0.047	59

```
2	T	1	1	2	2012	38	149.4	5.2	0	.	26
2	T	1	2	2	2012	60	171.6	4.4	3	0.050	67
2	U	2	1	2	2012	41	163	5.7	1	0.024	52
2	U	2	2	2	2012	51	162.6	4.8	1	0.020	24
2	T	2	1	2	2012	56	175	5.8	5	0.089	72
2	T	2	2	2	2012	46	192.6	6.2	11	0.239	76
2	U	3	1	2	2012	34	120.4	4.7	1	0.029	8
2	U	3	2	2	2012	34	156.4	6.1	7	0.206	19
2	T	3	1	2	2012	42	156	5.4	4	0.095	173
2	T	3	2	2	2012	48	163.4	5.1	5	0.104	292
;
Proc glimmix data=weeds;
class Farm Trt Border Quadrat Date Year;
model Density = Trt / htype=3 ddfm=kr dist=gaussian;
random Year Farm Year*Farm Border(Year*Farm) Trt*Border(Year*Farm)
Date*Trt*Border(Year*Farm);
lsmeans Trt / ilink diff cl adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
Proc glimmix data=weeds;
class Farm Trt Border Quadrat Date Year;
model Injury = Trt / htype=3 ddfm=kr dist=gaussian;
random Year Farm Year*Farm Border(Year*Farm) Trt*Border(Year*Farm)
Date*Trt*Border(Year*Farm);
lsmeans Trt / ilink diff cl adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
Proc glimmix data=weeds;
class Farm Trt Border Quadrat Date Year;
model Injuryperplant = Trt / htype=3 ddfm=kr dist=gaussian;
random Year Farm Year*Farm Border(Year*Farm) Trt*Border(Year*Farm)
Date*Trt*Border(Year*Farm);
lsmeans Trt / ilink diff cl adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
run;
Proc glimmix data=weeds;
class Farm Trt Border Quadrat Date Year;
model Ants = Trt / htype=3 ddfm=kr dist=gaussian;
random Year Farm Year*Farm Border(Year*Farm) Trt*Border(Year*Farm)
Date*Trt*Border(Year*Farm);
lsmeans Trt / ilink diff cl adjust=tukey;
ods output diffs=ppp lsmeans=mmm;
ods listing exclude diffs lsmeans;
```

```
run;
Proc reg data=weeds;
model Injury = Ants;
run;
Proc reg data=weeds;
model Injuryperplant = Ants;
run;
ods rtf close;
```

VITA

Matthew Travis VanWeelden was born in 1986 in the town of Troy, Ohio, where his family then moved to Indianapolis, Indiana. Upon completion of high school, Matthew attended Purdue University, pursuing a Bachelors of Science degree in entomology. As an undergraduate, Matthew worked as a lab technician in the Purdue University Urban Center laboratory where he maintained insect colonies and assisted in ongoing research projects.

Matthew graduated in 2007 and then entered a Master's degree program under the guidance of Dr. Grzegorz Buczkowski, where he studied the impacts of colony structure and resource abundance in foraging behaviors of the odorous house ant, *Tapinoma sessile*. In addition to his graduate student duties, Matthew assisted in coordinating the annual Purdue University Pest Management Conference and the urban entomology distance learning program.

Matthew moved to Baton Rouge, Louisiana in 2011 to pursue a doctoral degree at Louisiana State University under the guidance of Dr. T. E. Reagan. Matthew's research at LSU focused on the evaluation of cultural and biological management practices in reducing Mexican rice borer, *Eoreuma loftini*, in sugarcane and sorghum. He also examined the susceptibility of bioenergy sugarcane (energycane) and high-biomass sorghum to *E. loftini* infestations to help determine whether these crops are suitable for production in the Gulf Coast region. Matthew is currently completing the requirements for the degree of Doctor of Philosophy and plans to pursue a career in agricultural extension.

While in Baton Rouge, Matthew met his future fiancée, Melissa Crowe, who is noted for keeping him in line. Mathew's hobbies include running, swimming, kayaking, traveling, and playing board games. Matthew and his fiancé have two dogs (children), Kesha and Zoe.