Effects of Soybean Cropping Practices on Mexican Bean Beetle[1] and Redlegged Grasshopper[2] Populations[3]

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ABSTRACT

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Variations in cropping practices significantly affected the abundance of the Mexican bean beetle, *Epilachna varivestis* Mulsant, and the redlegged grasshopper, *Melanoplus femurrubrum* (De Geer), in southern Indiana soybeans. Mexican bean beetle adults and larvae were more abundant in tilled soybeans than in no-till soybeans. The Mexican bean beetle was limited to one larval generation on double crop soybeans, while 2 generations developed on early planted soybeans. Late in the season, Mexican bean beetle adults left the nearly mature early planted soybeans and aggregated on the late developing double crop soybeans. No-till planting in conjunction with soybean double cropping favored redlegged grasshopper populations by providing a continuous suitable habitat for their development. Changes in row-width (from 97 to 48 cm) did not significantly affect the abundance of either of these pests in double crop soybeans.

The practice of following winter wheat with soybeans is one of the many double cropping systems being used to increase agricultural production in the Midwest. Although this method of double cropping is not new, only recently have advances in herbicide technology and equipment design allowed soybeans to be planted directly into wheat stubble, thus helping to overcome marginal soil moisture and the shortened growing season which are major problems in double cropping. Another changing aspect of soybean production that is also well adapted to double cropping is the trend for narrower rows. This results in earlier canopy closure, thereby reducing moisture loss and weed competition. Although these changes have been shown to be practical ways to increase agricultural production, very little research has been done concerning the effects of these cropping practices on the soybean insect complex.

The Mexican bean beetle, *Epilachna varivestis* Mulsant, can be a serious pest of soybeans with both larvae and adults causing defoliation. However, little information is available on how cropping practices might affect its abundance. Dietz et al. (1976) concluded that early planted soybeans tend to attract more colonizing beetles and incur more damage than later planted fields. Turner and Friend (1933) noted that the closer that string beans are spaced within the row, the greater the amount of oviposition by Mexican bean beetle adults.

The redlegged grasshopper, *Melanoplus femurrubrum* (De Geer), is also capable of causing extensive damage to soybeans when populations are high and normal food supplies are restricted (Balduf 1923). In addition to the reduction of soybean yields resulting from defoliation, this grasshopper can be very destructive to soybeans by cutting through the pods and predisposing the seeds to mold (Metcalf et al. 1962). Research has shown that the occurrence of a particular grasshopper species is closely correlated with the species composition and the physical structure of the surrounding vegetation (Anderson 1964). Bland and Swayze (1973) concluded that the host species composition may vary considerably as long as the vegetation supplies the nourishment, shade, humidity, temperature, and the clinging or perching surfaces needed for grasshopper survival. It is also known that tillage destroys the preferred habitat of grasshoppers, causing them to leave the area and become concentrated in field borders or adjacent fields (Anon. 1972).

The research reported here was initiated to determine if changes in cropping practices affect the abundance of the Mexican bean beetle and the redlegged grasshopper. Differences between till and no-till, wide and narrow rows, and early planted and late planted (double crop) soybeans were studied.

Materials and Methods

The research was conducted in southern Indiana at the Feldun Purdue Agricultural Center in Lawrence Co. during the summers of 1975 and 1976. A 4.9-ha test area surrounded by a soybean border was divided into 16 plots (61×46 m) in a Latin square design.

In the fall of 1974, the test area was planted to winter wheat (var. 'Arthur 71'). The wheat was harvested on June 25, 1975, and the plots were planted to soybeans (var. 'Williams') the next day.

Half of the 16 plots were plowed and disked prior to planting soybeans. The remaining plots were planted directly into the wheat stubble. In four of the tilled and four of the no-till plots, a row of soybeans was planted between the initial 97 cm rows to form 48 cm rows. Thus, 4 treatments (narrow-row till, narrow-row no-till, wide-row till, and wide-row no-till) were established.

In the fall of 1975, plots that had been in narrow-row soybeans were disked lightly and planted to winter wheat (var. Arthur 71). Wide-row treatments were allowed to lie fallow.

On May 27, 1976, plots which were not planted to winter wheat were planted to soybeans (var. Williams). These early planted plots were arranged so that no-till soybeans were planted where wide-row no-till soybeans had been in 1975. Consequently, tilled soybeans were planted in former wide-row tilled plots.

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On July 2, 1976, after wheat was harvested, the remaining plots were planted to soybeans (var. Williams). Again, former tilled plots were tilled and planted to soybeans and former no-till plots were planted without tillage. Therefore, the four 1976 treatments were early till, early no-till, double crop till, and double crop no-till all planted in 76-cm rows ("double crop", and used here, also implies "late planted").

Sweep samples were used to monitor foliar insects during both years of the study. Sampling dates were those indicated at the bottom of Fig. 1 and 2. In 1975, three subsamples of 5 sweeps each were taken randomly

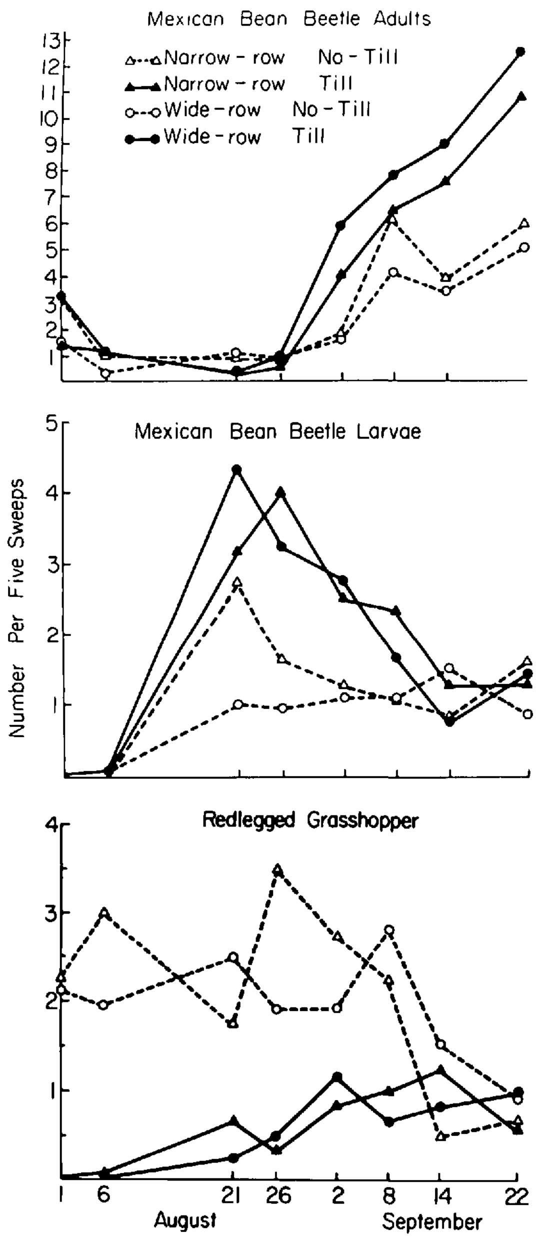

FIG. 1.—Comparison of the effects of row-width and tillage on the abundance of Mexican bean beetle adults and larvae and redlegged grasshoppers, Feldun Purdue Agric. Ctr. (FELPAC), 1975.

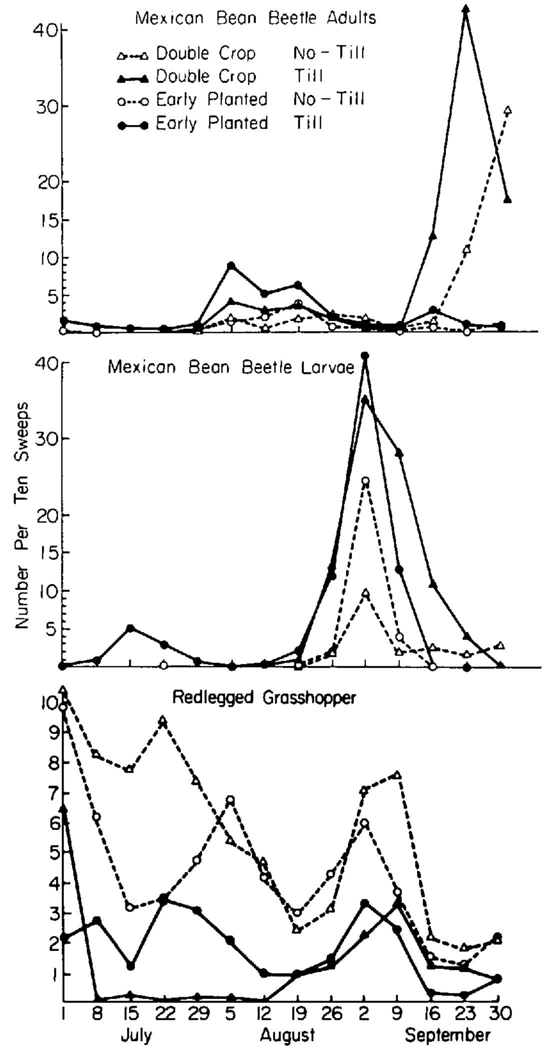

FIG. 2.—Comparison of the effects of planting date and tillage on the abundance of Mexican bean beetle adults and larvae and redlegged grasshoppers, FELPAC, 1976.

within each plot with a 38 cm diam sweep net. In 1976, the number of sweeps per subsample was increased to 10. A sweep was defined as one 180° swing across the soybean foliage. To reduce variability, the speed, length, and depth of the sweep, as well as the distance between sweeps, were kept as uniform as possible.

Data from these studies are shown in graphs so that comparisons between treatment means throughout the season can be made easily. The Student-Newman-Keul's range test was used to determine if differences between individual treatment means were significant. In addition, calculated F-values were used to determine when a specific cultural practice accounted for a significant amount of the variation between the treatments. Only differences that were significant at the 5% level are discussed.

Results

1975 (Fig. 1)

Adult Mexican bean beetle numbers were low in all plots during Aug. as the soybeans progressed from prebloom to pod development stage of growth (stage V6 – stage R4 as described by Fehr et al. 1971). However, the number of adults present in the samples rapidly increased during Sept. as the soybeans advanced from early pod fill through physiological maturity (stages R5 – R7). Although row width did not appear to affect the abundance of adult Mexican bean beetles, tillage was found to influence the number of adult beetles collected. Samples taken on Sept. 2, 14, and 23 from tilled treatments contained significantly more adult beetles than samples from no-till treatments.

Maximum numbers of Mexican bean beetle larvae were collected in late Aug. when adult numbers were at their lowest levels. Larval population peaks occurred as soybeans were developing pods (stages R3 and R4). As with the adults, row-width was shown to have little effect on larval populations, but samples taken during the peak larval period did indicate differences due to tillage. The general trend throughout this period was that Mexican bean beetle larvae were more abundant in samples from the tilled plots. This difference was significant on Aug. 26.

Redlegged grasshopper nymphs were first observed in the wheat stubble in late June, prior to planting the double crop soybeans. Once the soybeans were planted, grasshoppers were significantly more abundant in no-till plots than in the till plots. This held true until late in the season when the soybeans became mature. The nearly equal numbers of redlegged grasshoppers collected in wide-row and narrow-row treatments indicated that their abundance was not affected by row-width.

1976 (Fig. 2)

Large fluctuations in adult Mexican bean beetle numbers occurred during this growing season. In July, adult populations were very low and nearly all adults collected were from the early planted tilled soybeans that were in the early reproductive stages of development (stages R1 – R3), and no adults were taken from the double crop soybeans which were in the early vegetative stages of growth (stages V0 – V4). In early Aug., as adult numbers began to increase, both tillage and planting date were significantly affecting the abundance of adult beetles. On Aug. 5, significantly more adults were collected from the early planted tilled plots than from either of the double crop treatments. On Aug. 12, significantly more adults were collected from the early planted tilled plots than from any of the other treatments, while samples from the double crop no-till plots contained significantly fewer beetles than any of the other treatments. During this time, early planted soybeans were in late pod development and early pod fill (stages R4 and R5), while the double crop soybeans were just beginning to bloom (stage R1). From late Aug. until early Sept. adult numbers were low and no differences between treatments were found. Samples taken from mid-, to late-September showed an increase in adult numbers swept from double crop plots where the soybeans were in late pod fill to physiological maturity (stages R6 – R7), while adult numbers from early planted plots where the soybeans had reached harvest maturity (stage R8) remained low. Tillage also affected the Mexican bean beetle, with significantly more beetles being collected in the double crop till samples than the double crop no-till samples until the end of Sept. when this trend reversed.

The seasonal abundance of Mexican bean beetle larvae showed 2 distinct periods of larval development. The 1st of these occurred in mid-July, while the early planted soybeans were blooming (stage R2) and the double crop soybeans were in very early vegetative growth (stage V1). The peak of the 2nd period of larval development occurred Sept. 2, when developing seeds of the early planted soybeans were nearly full size (stage R6) and the pods of the double crop soybeans were just beginning to fill (stages R4 and R5).

During July and early Aug., most of the larvae obtained in sweep samples were collected from the early planted tilled plots. Larvae were not collected from the double crop soybeans until Aug. 19. On this date, as well as on Aug. 26, significantly higher larval counts were obtained from the tilled plots. After reaching peak numbers on Sept. 2, larval populations in all plots began to decline rapidly. On Sept. 9, 16, and 23, samples taken from the double crop tilled plots contained significantly more larvae than samples taken in any of the other plots, while on the last sampling date (Sept. 30) samples from the double crop no-till plots contained significantly more larvae than samples from the other plots.

The distribution of the redlegged grasshopper between plots during 1976 varied greatly with the date of the samples. The sweep samples taken on July 1 actually compared the number of nymphs present on early planted soybeans (stage V6) with the number present on wheat stubble. On this date, individual treatments were not significantly different. On July 8, the number of nymphs collected from the double crop tilled plots was significantly less than that collected from either of the no-till treatments. Thus, there was a rapid decline in the number of grasshoppers present in the wheat stubble once the plots were tilled. The double crop tilled plots had significantly fewer grasshoppers than either of the no-till treatments through Aug. 12 at which time the double crop soybeans were beginning to bloom (stage R1). In addition, the effect of tillage continued to account for a significant amount of the variation between treatments during the remainder of the season as more grasshoppers continued to be collected from no-till plots than tilled plots.

Discussion

The results indicate that Mexican bean beetles would be more of a threat to tilled soybeans than no-till soybeans because both adults and larvae were normally more abundant in samples from the tilled plots than in samples from no-till plots. The exact reason for this is not clear, although it is possibly related to a preference of adult beetles for the tilled soybeans. The tilled plots were virtually a mono-culture, whereas the no-till soybeans were in a more varied ecosystem due to the stubble and increased weed competition. The only notable exception to the trend of Mexican bean beetles being more abundant in the tilled plots occurred on the last sampling date of 1976 when significantly more adults and larvae were collected from the double crop no-till soybeans than from any of the other treatments. This exception is thought to have been caused by a slight difference in plant maturity, as the double crop no-till soybeans were the last of the treatments to reach full maturity.

Differences between early planted and double crop soybeans also were shown to affect the seasonal distribution of the Mexican bean beetle. The most noticeable difference was that 2 generations of larvae were produced on early planted soybeans, whereas only one generation occurred on double crop soybeans. This occurred because the double crop soybeans were not suitable for oviposition until after the 1st-generation eggs were laid. The potential for damage from 2nd-generation larvae appeared to be greater for late planted or double crop soybeans since early planted soybeans were nearing physiological maturity at the time the larval populations peaked, whereas the double crop soybeans were still in the early pod fill stage of development (stage R5) and still vulnerable to defoliation damage. More research is needed to determine how much this relationship would vary from year to year. Differences in time of maturity due to planting date between early and double crop soybeans also caused the Mexican bean beetle to congregate in the double crop soybeans late in the season as early planted soybeans reached harvest maturity.

The data indicate that the redlegged grasshopper has the potential to be a major pest of double crop soybeans, whereas tilled soybeans are much less likely to have a severe infestation. Nymphs of the redlegged grasshopper were observed to be present in large numbers in the wheat stubble prior to planting. These nymphs were either destroyed or forced to leave the plots in which the stubble was plowed under. However, the stubble of the no-till plots continued to provide a suitable habitat for nymphal development. Differences in the abundance of grasshoppers between till and no-till plots became negligible toward the end of the season as soybeans could then provide a suitable habitat, and the grasshoppers became equally dispersed throughout the plots.

The differences in planting date between the early planted and double crop soybeans seemed to have only an indirect effect on the grasshopper populations. The fact that differences between treatments on July 1, 1976, were not significant was related to a large amount of variation within treatments possibly caused by the dispersal of grasshopper nymphs from the recently harvested wheat. Also, the moderate numbers of grasshoppers found in the early planted tilled plots throughout July are thought to have immigrated there from the wheat. Except for the difference in grasshopper abundance between early planted tilled soybeans and double crop tilled soybeans during July, differences between early planted soybeans and double crop soybeans probably were related to differences in habitat structure, such as weeds or crop residue, rather than actually being caused by differences in soybean maturity related to planting dates.

The results also indicate that changes in row width between 97 and 48 cm had little effect on either Mexican bean beetle or redlegged grasshopper populations in double crop soybeans since no significant differences or trends were attributed to row-width. However, more research into the effects of row-width is needed, especially in relation to more extreme variations in row-width.

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