AN UPDATE ON NEW POTATO LEAFHOPPER-TOLERANT ALFALFA PRODUCTS AND THEIR MANAGEMENT GUIDELINES

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Alfalfa is host to an abundance of insect pests that vary in seriousness. One of these, the potato leafhopper, is considered the primary insect pest of alfalfa in Iowa (Figure 1). This insect feeds by sucking plant fluids through its straw-like mouthparts. Feeding can cause serious injury to alfalfa if pest numbers are high, and it is usually too late to treat by the time symptoms become visible. Leafhopper feeding deprives the plant of nutrients and creates wounds where disease can enter. However, the most important effect results from a small amount of saliva that is left in the plant wound. Leafhopper saliva causes plant cells to harden, which restricts the flow of nutrients throughout the plant and causes yield loss.

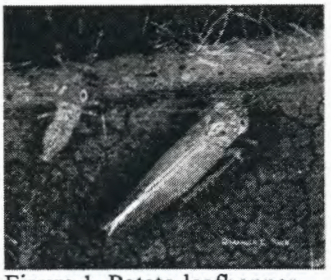

Figure 1. Potato leafhopper nymph (left) and adult (right).

The two types of leafhopper injury are leaf-yellowing (hopperburn), and stunting of stems. Yellow leaves are starved of nutrients and can reduce the forage value of an alfalfa crop. Stunting is the shortening of stems and is estimated by measuring the average distance between nodes on several stems. While hopperburn is the most visible symptom, stunting best explains yield loss from the leafhopper. Stunting occurs over the duration of a cutting and begins before leaf yellowing is apparent. Therefore, scouting for economic leafhopper densities before symptoms of hopperburn appear is imperative in optimizing alfalfa production.

Two years have passed since the release of potato leafhopper-tolerant alfalfa varieties. In this time, producers have given mixed reviews on the yield advantage and consequently, the efficacy of the resistance mechanism that demands a premium price. Moreover, practical production questions have stifled researchers and left extension educators unable to answer producer's questions. Three years of research have identified a biological explanation for this confusion. It is linked to the mechanism of resistance, which was poorly understood when this new alfalfa was released. The objective of this research is to determine how potato leafhopper resistance changes pest management so growers can optimize these production systems. Studies on the yield advantage, mechanism(s) of resistance, and the changes in pest management, have provided some explanations and will be described in this article.

Deciphering the Mechanism of Resistance

There are several types of plant resistance to insects and it is important to understand their differences. The three types of resistance are nonpreference, antibiosis, and tolerance, and each of these describes the interaction of the insect and plant. A nonpreference mechanism deters insects so they move to another source of food. Hairs on stems, tough leaves or stems, or chemical signals, can force insects to find another host and reduce their potential to cause yield loss. Two separate studies were conducted to investigate the role of nonpreference. A lab study caged leafhoppers on stems of tolerant and susceptible alfalfa. Figure 2 shows a cage setup where one stem was susceptible (left) and the other was resistant (right). Results showed that hopperburn increased on the susceptible alfalfa stems when more tolerant stems were replaced in the cage. This was evidence that a nonpreference mechanism can function among individual stems. Another study compared the number of leafhoppers in field plots of several different

resistant alfalfa varieties to the number found in a susceptible variety. The number of adult and nymphal stage leafhoppers was similar between plots, which meant nonpreference did not function among small plots. Combining these results, it seems leafhoppers may feed selectively on less resistant stems in a field, but nonpreference is not a good explanation for the mechanism on a field scale.

Figure 2. An open cage used in laboratory feeding studies.

The next mechanism is antibiosis. An antibiotic mechanism would reduce the number of leafhoppers in the field by killing them or slowing population growth. Glandular hairs and tough stems have been linked to leafhopper resistance. A lab study was conducted to determine if these hairs reduced leafhopper feeding, which could be a source of antibiosis. Results showed that leafhoppers could feed as much on resistant stems as they could on susceptible alfalfa. Another field study examined leafhopper population growth on field-grown resistant alfalfa. Different numbers of leafhoppers were caged on small field-plots of resistant and susceptible alfalfa, and the number of nymphs produced in each cage were counted weeks later (Figure 3). This trial was run on seven different resistant alfalfas and one susceptible alfalfa. There was no evidence that resistant alfalfa slowed leafhopper population growth compared to the susceptible variety. These two studies showed that potato leafhoppers can feed on resistant alfalfa and antibiosis does not function in a field setting. Antibiosis seems an unlikely explanation for the mechanism of resistance as it functions under production conditions.

Tolerance is the last type of plant resistance. It is unique because it doesn't deter or kill the insect. A tolerant plant will support a normal size pest population and out-yield a normal plant when the pest population is large. Yield estimates were also taken from the same cage study described above. Yield loss was related to the number of leafhoppers in each cage. Results showed that yield loss caused by the leafhopper was much less on resistant alfalfa compared to susceptible alfalfa. However, this yield benefit was not apparent until after the first cutting of the seeding year. These results support the presence of a tolerance mechanism. This type of tolerance likely results from an inter-play of all three mechanisms. However, this description emphasizes the impact tolerant alfalfa will have on pest management in production systems, namely raising the economic threshold.

Tolerance and its Effect on the Economic Threshold

A useful procedure for making economically sound pest-management decisions in alfalfa is pest scouting and using an economic-threshold (ET). Iowa State University Extension recommends scouting leafhoppers by sweeping the alfalfa canopy using a muslin net. Adult leafhoppers can be counted after 10 sweeps and compared to an economic threshold. An application of insecticide is warranted if the number of leafhoppers recovered per 10 sweeps exceeds the economic threshold.

Figure 3. Example of cages used to test antibiosis and tolerance.

Results from these studies showed the potato leafhopper's effect on yield is distinct enough between tolerant and susceptible alfalfa to warrant calculating separate economic thresholds. However, this difference is not apparent until after the first cutting of the seeding

year. Therefore, the recommendation is to use the same threshold for tolerant and susceptible alfalfa during the initial growth of the seeding year. Figure 4 is a schematic of a two-step decision process for determining the optimal economic threshold. Earlier results showed the important factors to consider are the type (tolerant / susceptible) and the age of the stand.

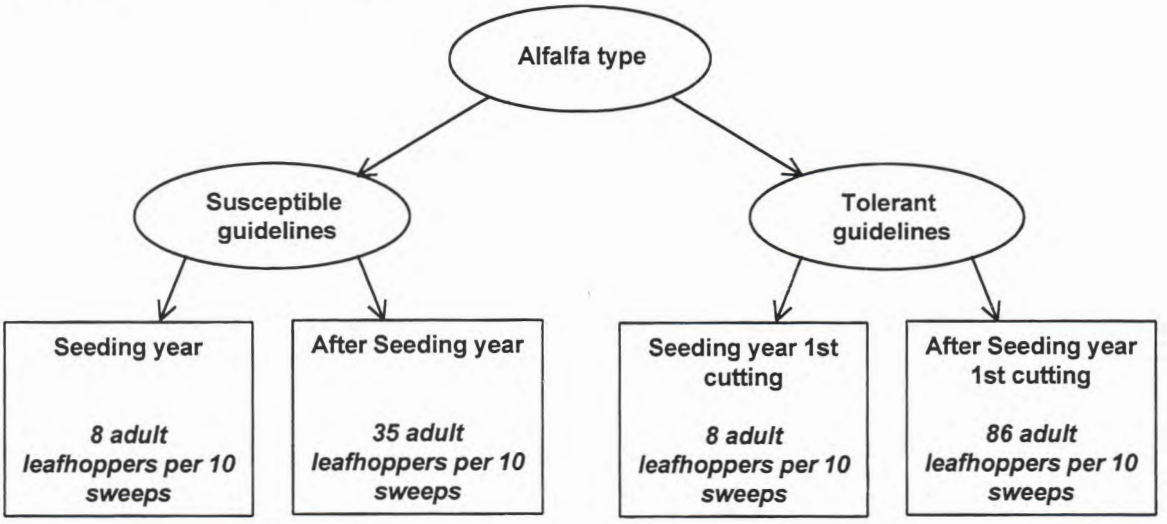

Figure 4. Two-tiered decision process for determining the correct economic threshold.

The economic threshold (8) is similar for seedling alfalfa regardless of its type. Tolerance builds in these new varieties during this interval and the economic threshold increases to 86 for all subsequent cuttings. The establishment of a strong root systems is probably why leafhoppers cause less loss in susceptible alfalfa after the first year, and also is why the threshold goes up to 35.

Conclusion

Potato leafhopper-resistant alfalfa varieties show significant yield advantages compared to susceptible alfalfa after the initial growth of the seeding year, and under moderate to high leafhopper population densities. Additionally, tolerance best describes the interaction of the potato leafhopper and a stand of alfalfa. It is imperative that producers understand a field of leafhopper-tolerant alfalfa will not be void of leafhoppers, and that economic loss is still possible, but can be avoided by scouting and using the correct economic threshold. Leafhopper-tolerant varieties, and future improvements, will undoubtedly increase the quantity and quality of alfalfa produced in areas where potato leafhopper is a recurring pest.

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