Incorporating a Total Crop Management Approach into Current Soybean IPM Programs

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Currently, soybean IPM programs in Delaware, delivered by both private consultants and agribusiness and supported by University of Delaware Extension and Applied Research programs, have a multi-disciplinary approach including insect, weed, disease, and nematode management. The primary objective of this three year project is to evaluate and demonstrate the role of small grain cover crops in weed management, slug management and maintenance/improvement of soil health, and the management of soybean necrotic vein virus.

I. Small Grain Cover Crops and Weed Management Demonstrations (Mark VanGessel)

In May of 2014, seven fields with cover crops seeded the previous fall were evaluated for cover crop growth and presence of weeds. All fields were expected to be planted with no-tillage soybeans. Three of the fields did not manage the cover crops in a manner that would have impacted summer annual weed control (cover crop density too low and/or cover crop terminated too early before soybean planting). One of the fields was seeded with cereal rye and two with triticale. Four fields (all with the same farmer), seeded with cereal rye, were being managed for weed management. When evaluated in May, the rye was > 4 ft tall and well tillered. Winter annual weeds were present, ranging from 1 to 6 species, but the individual plants were very small and seed production was dramatically reduced compared to plants growing without the presence of the rye. Post-emergence weed control was used in all four fields, however, Palmer amaranth was present late in the growing season.

In the spring of 2015, twelve fields were visited. All the fields had cereal rye planted the previous fall. Eight of the fields had a sparse rye stand that provided little weed suppression. In the fields with tall, ample cereal rye growth, annual bluegrass was the most common species. Common chickweed, henbit, and field pansy were present in at least two fields. The four fields with competitive rye had small, winter annual weeds that produced limited seeds. Fields were not followed throughout the summer to assess the benefit of the rye for management of summer annual weeds.

Most of the fields had cover crops that were not managed to produce high volume of biomass, yet cover crop management appeared to have impacted winter annual weeds. Spraying a non-selective herbicide early in the spring to prevent excessive growth of the cover crop, resulted in excellent control of winter annual weeds. It was not the cover crop per se that contributed to winter annual control, rather it was the early herbicide application that was made in April to small, susceptible weeds. However, the cover crops were not expected to provide any suppression of summer annual weeds, such as Palmer amaranth, common ragweed, or large crabgrass.

To further explore the effect of cover crop management for weed control, replicated trials were conducted at the UD Research and Education Center in 2014 and 2015. The 2014 trial examined the benefit of fall herbicide treatment (Harmony Extra), spring nitrogen to increase biomass production (40 lbs of N or no nitrogen), and burndown herbicide (glyphosate alone or glyphosate plus Envive). Rye was planted at 2 bu/A in the fall of 2013. The rye crop was terminated on May 9 with glyphosate and soybeans were planted with 15-inch planter on May 29. The addition of nitrogen increased rye biomass by 82% when measured at planting. Winter annuals were present in both levels of rye (speedwells and common chickweed) but their number was quite low and were not an issue in terms of competition or significant weed seed production. Summer annual weed control was significantly better if burndown treatments included Envive compare to only glyphosate. The higher rye biomass improved early-season control of summer annual weeds, but a post-emergence herbicide was needed. The entire trial was sprayed with Roundup plus Reflex on July 9 for post-emergence weed control.

In 2015, the trial at the UD-REC was modified and the study examined the combination of three factors: level of rye biomass, timing of spring burndown application, and the benefit of residual herbicides. Rye biomass levels were achieved by spring nitrogen applications and timing of glyphosate application. Two bushels of rye were seeded in the fall. Timing of burndown (glyphosate applications) were March 19, April 29, or May 7. Residual herbicide with this trial was Envive. All combinations of these treatments were examined to determine their compatibility and which factor(s) would have the greatest impact on weed control.

The entire trial was sprayed with a post-emergence application of Roundup plus Reflex on June 25.

At five weeks after spring herbicide applications Palmer amaranth control was highest in plots with Envive used as part of the burndown treatment, averaging over 98% control. High rye biomass had 88% control of Palmer amaranth if only glyphosate was used for burndown, and less than 74% control if rye biomass was moderate or low. Morningglory control was better if the burndown treatment was applied 10 days before planting compared to an application 20 days early pre-plant.

When rated in late summer, the main effects of rye, burndown herbicide treatment and burndown timing were significant for large crabgrass. Large crabgrass control was better with high or moderate levels of rye compared to low levels of rye; control was better if Envive was used with the burndown compared to glyphosate alone; and large crabgrass control was better if burndown treatments were made 10 days before planting compared to 20 days early pre-plant. Palmer amaranth control was greater than 90% for all treatments except low rye levels that was treated with only glyphosate for burndown. Morningglory species was best if burndown treatments were applied at 10 days before planting compared to 20 days early pre-plant.

These replicated trials demonstrated the benefit of a rye cover crop to help suppress annual weeds and thus improve overall weed control. Furthermore, the benefit of applying the residual herbicide (in this case Envive) as close to planting as possible also improved overall weed control.

A rye cover crop can help suppress annual weeds. But a rye cover crop may not eliminate the need for a pre-emergence herbicide. More research is needed to determine the value of a rye cover crop for reducing the risk of developing herbicide-resistant weed populations.

II. Influence of Fall Seeded Small Grain Cover Crops on Slugs and Impact on Soil Health (Joanne Whalen, Bill Cissel, and Richard Taylor)

Slug Monitoring and Management Results -2014

In 2014, eight fields with a fall seeded small grain cover crop and six fields without a cover crop were sampled using shingle trapping methods to monitor slug species composition and abundance and to determine what effect cover crops have on slug populations. Each of the fields included in the project were also sampled, once the fields had been seeded in soybeans, to evaluate crop injury as a result of slug feeding. In addition, soil health measurements were taken to demonstrate the potential benefits of fall seeded cover crops on soil health.

Due to the low slug populations observed in 2014, only minor differences were recorded between the fields with a fall seeded cover crop compared to the fields without a cover crop for the average number of slugs per shingle trap and the percentage of soybean plants with slug feeding injury. Furthermore, the slight differences in soil health documented between fields with and without a small grain cover crop were most likely attributed to differences in soil type and farming practices than the use of a cover crop. It was concluded that additional investigation was required to fully understand the benefits and challenges associated with the adoption of fall seeded small grain cover crops and the impact it may have on slugs and soil health.

Slug Monitoring and Management Results - 2015

In 2015, to further investigate the influence fall seeded small grain cover crops have on slugs and the potential soil health benefits they may provide, thirteen fields with a cover crop and nine fields without a cover crop were sampled for slugs, monitored for slug feeding injury on soybeans, and assessed for soil health. To determine slug species composition and abundance, shingle trapping methods were used. After crop emergence, slug feeding injury on soybean seedlings was evaluated by recording stand counts and the percentage of plants injured from slug feeding. Soil health was assessed in each of the fields by measuring soil compaction and respiration.

(A) Pre-Plant Sampling for Slugs: In each field included in the project, five shingle traps 1 ft^2 were randomly placed throughout the field in early April and checked on a weekly basis until early May, recording the number of gray garden and marsh slugs, the predominant slug species of economic importance in Delaware. It has been suggested that sampling for slugs using shingle trapping methods in the fall is more effective than sampling in the spring.   To evaluate this, in the fall of 2014, eight of the fields with a small grain cover crop were also sampled using shingle trapping methods in late-October and early November.

Table 1. Slug sampling results: Average number of slugs by species using shingle trapping methods comparing fields with and without a small grain cover crop and fall sampling compared to spring sampling

	Avg. # of Grey Garden Slugs		Avg. # of Marsh Slugs	
	Adult	Juvenile	Adult	Juvenile
Fall Sampling				
Fields with Cover Crop	0.0	0.0	0.3	0.0
Spring Sampling				
Fields with Cover Crop	0.0	0.0	1.4	0.0
Fields without Cover Crop	0.0	0.0	0.6	0.0

Reported average number of slugs per shingle trap is averaged across all fields and sample dates

Overall, slug populations were low, regardless of whether a field was planted in a fall seeded small grain cover crop or not. Sampling for slugs using shingle traps in the fall did not appear to be more effective than spring sampling. However, further investigation is needed to determine if fall sampling is more effective than spring sampling when slug populations are greater than what was observed in the fall of 2014 and spring of 2015.

(B) Slug Injury on Soybean: Thirteen fields with a cover crop and nine fields without a cover crop were sampled on a weekly basis for evidence of slug feeding damage on emerging and seedling soybean. Slug injury on soybean was measured by performing stand counts and by determining the percentage of plants with slug feeding injury. Stand counts were established by counting the number of plants per three linear row ft in ten random locations throughout the field and used to document potential stand reductions as a result of slug feeding. The percentage of slug damaged plants was determined by counting the number of plants with new feeding damage in ten consecutive plants in ten random locations in each field.

Table 2. Slug injury on soybean: Comparison between fields with and without a small grain cover crop for the average number of plants per 3 ft of row and percent of slug damaged plants

	Avg. # of Plants per 3ft of Row	% Slug Damaged Plants
Fields with Cover Crop	11.5	7.8
Fields without Cover Crop	10.6	4.2

Reported average number of plants per 3 ft or row and percent slug damaged plants is averaged across all fields and sample dates

Slug pressure was low in all of the fields sampled. The difference in the average number of plants per 3 ft row between fields with a small grain cover crop and fields without was not a result of slug feeding activity. The percentage of slug damaged plants was greater in the fields with a cover crop compared to fields without but the level of damage and percent damaged plants was so low in each of the fields sampled that the slug injury did not result in economic losses.

Impact of Small Grain Cover Crop on Soil Health

The soil health benefits from adopting cover crops has been well documented in neighboring states but has not been fully evaluated in Delaware. Therefore, the objective of this demonstration was to evaluate the effects of fall seeded small grain cover crop on soil health. To measure soil health, soil compaction was measured in each field at depths of six, twelve, and eighteen inches using a penetrometer and reported as pounds per square inch (psi) at each depth. Soil respiration is a measure of carbon dioxide (CO_2) and is a good indicator of a soil's productivity, biological activity, and health. Soil respiration was measured in each of the fields using the Solvita soil basal respiration test and reported as Co_2 Color. Additional information on soil respiration and sampling methods can be found at: http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051573.pdf.

Table 3. Soil heath measurements: Comparison between fields with and without a small grain cover crop for compaction and Solvita soil respiration

	Compaction (psi)			Solvita Soil Respiration Test	
	6"	12"	18"	CO_2 Color	Ppm
Fields with Cover Crop	239	280	293	3.8	61.6
Fields without Cover Crop	263	288	284	4.2	44.5

Reported compaction and Solvita soil respiration test averaged across all fields

Only minor differences were recorded for soil compaction between fields with and fields without a cover crop at each of the depths evaluated and not thought to be a result of the use of a cover crop. Overall, soil compaction was approaching levels that restrict root growth at twelve and eighteen inches deep. Soil respiration activity for the fields with a small grain cover crop was within the ideal range suggesting soils contained sufficient organic matter and micro-organism activity. Fields without a cover crop was within the unusually high range suggesting either the soils have excessive organic matter content or that the soil organic matter is rapidly decomposing. However, to further understand if there is a relationship between soil respiration and the implementation of fall seeded small grain cover crop, additional research is required.