PREDATION OF SENTINEL EGGS IN COTTON AND SORGHUM IN NEW MEXICO

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Abstract

Cotton glands produce gossypol, a natural defense against insect pests. Glandless cotton varieties are available, but losses from pests have prevented commercial development. Some areas of New Mexico have lower insect pressure, with high predation and desiccation suppressing pest populations. With appropriate management and monitoring of insect pests, growers could potentially produce glandless varieties as a niche crop with greatly added seed value. Field to lab trials were conducted on New Mexico State University farms to evaluate predation rates in glandless vs. glanded cotton in an effort to develop pest management strategies for glandless cotton protection. Sentinel cotton bollworm eggs were attached to glanded and glandless cotton plants on multiple dates in 2015 to 2016 to evaluate potential differences in predation. Insects were also sampled from plots weekly using sweep nets.

In 2016, unlike earlier years, there was only one date where sentinel eggs had significantly higher predation in Acala 1517-08 a glanded cultivar. More importantly, there was not significantly higher predation in the second glanded cultivar indicating that any differences are unlikely due to the presence of glands. Early flowering was recorded in 2016 as a possible explanation for higher spider presence in Acala1517-08 in 2015 but was not found to be significantly different. Direct observations of predators for 24 hours indicated that sweep net samples underestimate predation by a few important predators particularly ants and hooded beetles. Overall similarity in predation rates in glanded and glandless cotton suggests that predation will be an important source of control of insect pests in commercial glandless cotton production.

Introduction

Cotton has glands that produce natural toxins, primarily gossypol, that provide resistance to insects. Cottonseed is high in protein, and could be a value-added product but it also contains 1% gossypol. Only ruminant animals can digest it well. Glandless, gossypol-free varieties of cotton, show promise in utilizing cotton seed as a protein source in food products increasing seed value for growers (Jenkins et. al. 1966, Bottger et. al. 1964, Lukefahr et. al. 1966). However, both laboratory and field trials showed greater larval growth of cotton bollworm and tobacco budworm on glandless cotton (Lukefahr et. al. 1966). Diet containing gossypol fed to beet armyworm and bollworm reduced 10 day larval weights and increased the number of days required for pupation (Bottger, et. al. 1966). Bollworm and beet armyworm survival was 2-6 times higher at pupation when reared on glandless cotton (Pierce et al 2012, 2014)

Glandless cotton was not considered a viable option in much of the cotton belt due to losses from pests. Lower insect pest pressure in New Mexico might allow commercialization of glandless cotton as a niche crop. Beneficial insect populations are also high in New Mexico, and could help control the higher populations of insect pests. Bt cotton and eradication programs have also reduced the prevalence of once key insect pests such as pink bollworm and boll weevil (Pierce et al. 2013). Bt crops may have reduced populations of *H. zea* and *H. virescens* as well.

In 2011-2014, field trials were conducted to evaluate compatibility with biological control. Predators were, surprisingly, often significantly more numerous in glanded 1517-08 compared to glandless cotton varieties. Overall, predation was generally not significantly different, but predation by predators with chewing mouthparts was often significantly higher in the glanded A1517-08 as determined by microscopic examination of egg debris after feeding (Pierce et al. 2015). In 2015 and 2016, follow-up field trials were conducted to further evaluate these issues.

Material and Methods

One to two varieties each of a glandless and glanded variety were planted in plots with 32 rows by 100 feet replicated 4-6 times. Sweep net samples were collected weekly with the number of pests and predators recorded. Sentinel bollworm, *Heliocoverpa zea* (Boddie) eggs were attached to plants in each plot and examined after 48 hours to determine predation levels. Since there were significantly more spiders in glanded cotton in

previous years, all spiders were identified at least to genus in 2015. To determine possible attraction for spiders, early flowering was recorded and direct observations of predation were recorded over 24 hours in 4 varieties in 2016. Sentinel egg predation in cotton was also compared to predation in nearby sorghum and sorghum x sudan plots.

Results and Discussion

Predation in Cotton and Sorghum, Sorghum x Sudan

In August 2016 a sentinel egg trial was conducted comparing predation in 2 glanded and 2 glandless cotton varieties. On the same day a trial was conducted in nearby sorghum and sorghum x sudan plots. The rate of predation in three of four cotton cultivars was similar to that in three sorghum varieties with all averaging 55-56% predation (Fig. 1). However, predation in Acala1517-08 a glanded upland cotton was significantly higher than the other three cotton varieties with 71% predation in the glanded Acala 1517-08 variety. Predation in sorghum x sudan plots was significantly higher than the three other sorghum varieties with 67% predation in the sorghum x sudan plots. The higher predation in the sorghum x sudan was not surprising late season when plants were over 6 ft tall providing a much more favorable microclimate compared to the less dense canopies particularly in this desert environment.

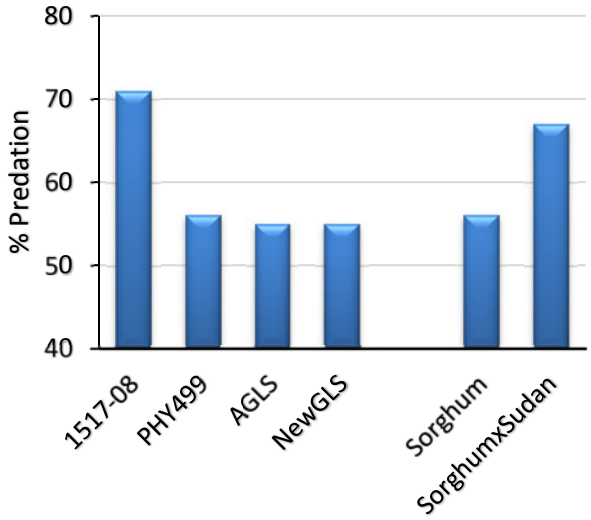


Figure 1. Percent Predation in Glanded Cotton, Glandless Cotton, Sorghum and Sorghum x Sudan

Unlike some previous trials predation of sentinel eggs was generally similar in glanded and glandless cotton in 2016. However, predation was significantly higher in glanded Acala 1517-08 compared to all other cultivars on 8/26. Predation on 1517-08 was 71% compared to 55-56% on the two glandless cultivars Acala GLS and New GLS and a glanded cultivar, PhytoGen 499 (Table 1.). This suggests that the higher predation sometimes seen in Acala 1517-08 is likely specific to that cultivar rather than related to having glands. Possible differences in plant architecture are being considered.

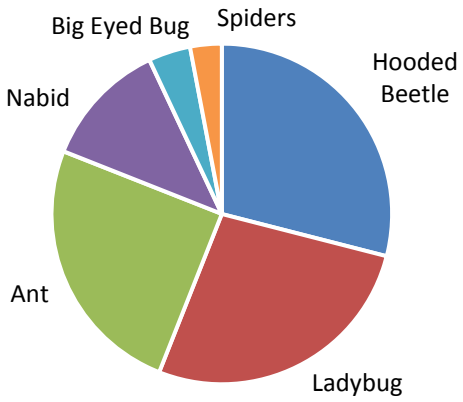
Table 1. Sentinel Bollworm Egg Predation in glanded and glandless cotton varieties in 2016

Variety	7/20	8/7	8/26
Acala 1517-05	52a	35a (3)	71a (6)
Acala GLS	59a	55a (4)	55b (7)
New GLS	55a	41a (4)	55b (7)
PhytoGen 499	65a	44a (4)	56b (7)

Direct Observations of Predation

Predation on sentinel eggs was directly observed for 24 hours in field plots of glanded and glandless cotton. Often the highest number of predators collected in sweep net samples was spiders, nabids and lacewings. In 2016, direct observations of predators on sentinel eggs in August indicated that predators actually feeding on eggs were primarily ants, hooded beetles and ladybugs (Fig. 2). Those three groups of insects represented almost 75% of total predation. Nabids were 10% of predators observed, while big eyed bugs were 4%. Surprisingly, spiders were only 3% of observations despite doing observations over a 24 hour period to accommodate predators like many spiders that are more active at night.

Figure 2. Percent of Insects Directly Observed on Sentinel Eggs.



There was some variation in predation among cultivars. Also there were differences in observed predation compared to predation estimated by collecting predators in sweep nets. Ants were commonly observed feeding on sentinel eggs with 5-30% of total predation in the four cultivars (Fig. 3). Ants were rarely collected in sweep net samples from 2011-2015. Similarly, collops and hooded beetles were represented more frequently in direct observations than from previous sweep net collections. Collops were 6-20% of total predation in the four cultivars while hooded beetles were 21-35% of observations. Ladybugs represented 10-38% of observations consistent with both previous sweep net collections and examinations of egg debris after feeding. Nabids and spiders however were underrepresented in direct observations with only 6-15% predation by nabids and only 0-10% predation by spiders.

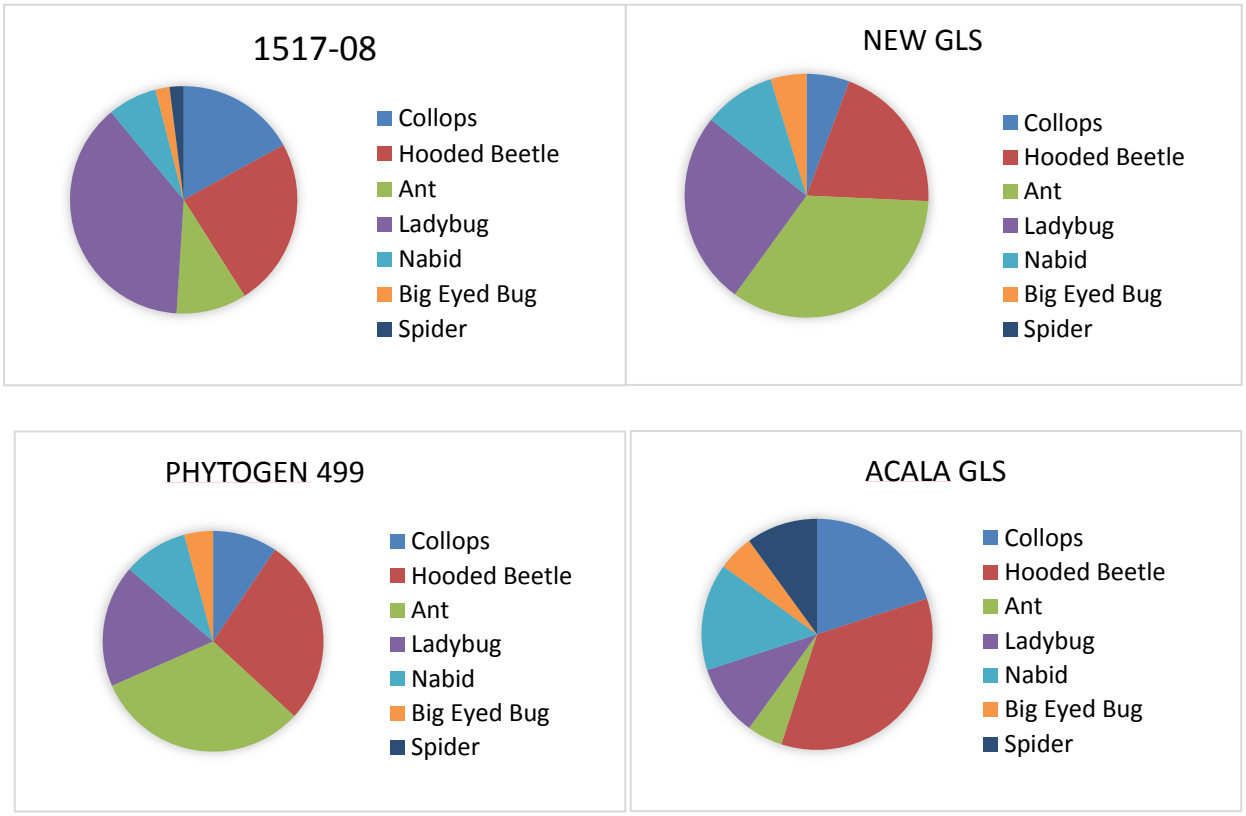


Figure 3. Percent of Insects Observed by Variety

Predation was observed directly for 24 hours on 8/26/2016 with observations recorded every two hours. Acala 1517-08 had the highest predation representing 35% of the total (Fig 4). There was no apparent relationship to glands however as the other glanded cultivar PhytoGen 499 had only 19% of predation observations.

This was consistent with examination of sentinel eggs to determine predation by evaluating egg debris after 48 hours in a separate trial the same day where 30% of total predation was in Acala 1517-08.

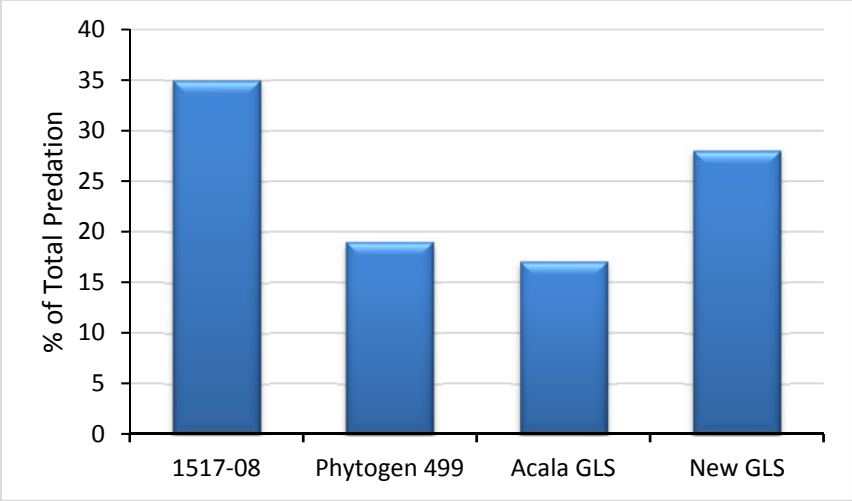


Figure 4. Percent Total Predation by Variety in 2016.

Spider Predation in Glanded and Glandless Cotton

In 2015, total predation was similar in glanded and glandless plots (Pierce 2016). However, residue of exposed eggs indicated predation by chewing predators was significantly higher in glanded cotton on August 4. 2015. This was consistent with a significantly higher numbers of spiders collected with 7.5 per 100 ft in glanded cotton compared to only 0.8 in glandless cotton. However, the majority of spiders collected were crab spiders *Mecaphesa spp*. representing 80% of spiders collected in glanded cotton (Table 3). There were 3 times more *Mecaphesa spp* in glanded cotton. Since this species prefers floral habitats, a difference in early flowering was considered a possible reason for higher numbers and was evaluated in 2016.

The number of flowers/plant was recorded weekly to determine if more early season flowers in glanded cotton might have attracted more crab spiders to glanded compared to glandless cotton. Glanded cotton varieties, Acala 1517-08 and Phytogen 499 did not produce earlier season flowers compared to glandless cotton varieties, AGLS and NewGLS, so this was not a reason for higher spider counts in Acala 1517-08 in 2015 (Figure 5).

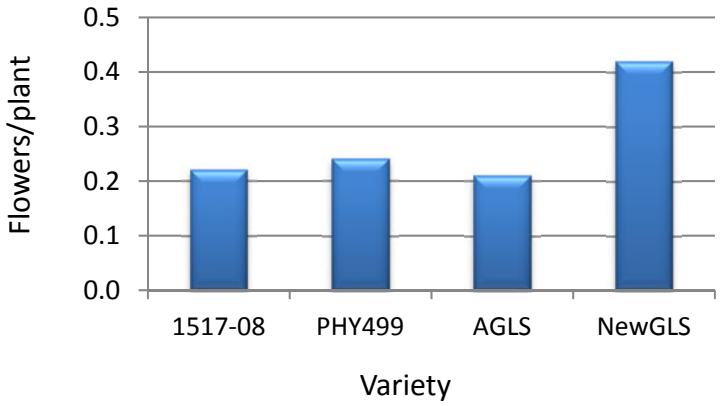


Figure 5. Flowers per plant on 7/19/16 in glanded and glandless cotton varieties

Conclusion

Direct observations of predation in 2016 indicate that sweep net samples can underestimate predation by predators that are less likely to be collected in such samples. Sentinel egg predation gives a better estimate of actual predation levels than collections of predators and direct observation since higher numbers of eggs can be used. While we can narrow the source of such predation at least to chewing vs sucking predators it may not be possible to identify the genus, let alone species, of predator though examination of the egg residue as damage by insects with similar feeding patterns appears similar. A combination of direct observations, collections of predators and sentinel eggs provides a better understanding of predation at a specific time and location. However tremendous variation in predation among locations and over time even within a season mean these more accurate measures should not be too broadly interpreted.

Glandless cotton is more susceptible to injury by insect pests, but the higher value of glandless cottonseed likely compensates for that risk in areas with lower insect pressure. There are some interesting differences at times in level of predation by specific predators in different cultivars. These differences however seem to be related to specific cultivar differences rather than to the presence of glands which was a concern. Field and lab data suggests that glandless cotton will require close monitoring but that development of insect pest management strategies can make it a viable niche option in areas with lower insect pest pressure. Overall predation levels are not lower in glandless cotton, so predation will be a significant source of control of insect pests.

Acknowledgement

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