PRE-BLOOM SQUARE LOSS, CAUSES AND DIAGNOSIS

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Abstract

The pre-bloom period of fruiting is an important period in cotton production. The loss of pre-bloom squares may cause serious yield losses if square loss is allowed to continue for a period of time. Square loss may be due to physiological stress or physical injury. Physiological shed may be attributed to either biotic or abiotic factors. Abiotic factors that contribute to square shed include moisture, nutrients, cultivation, stress from the general feeding of insects or nematodes. Aphid and thrips may be present in large numbers and the feeding pressure great enough to result in a type of physiological stress that causes square shed similar to moisture stress. Square loss as the result of physical injury from feeding by insects include plant bugs, lepidopterous larvae, and boll weevil. The plant bug is the primary cause of early season square shed and squares usually shed within 1 to 4 days after being feed upon by plant bugs species.

The monitoring of square set and diagnosis of the cause of square shed is necessary for early season management of the cotton crop. The newest approach to management of square set is the use of plant mapping procedures that identify square shed by nodes. Furthermore, field diagnosis procedures have been developed that allow consultants and scouts to identify quickly the cause of square shed.

Introduction

The course of the cotton production is charted during the early squaring periods, primarily through first bloom. The loss of small squares during this time period is obviously of concern to producers, consultants, and county extension agents. In general, plants bugs are the primary cause of early season but several other factors also may cause significant square shed prior to bloom. Square shed has been the subject of many studies by a large number of scientists across the cotton belt.

Discussion

The loss of squares in pre-blooming cotton may be described as the result of physical injury or physiological stress (Williams et. al., 1987; Mauney and Henneberry 1984). The loss of small squares was described as due to plant bug feeding that caused dissolotion of plant tissue, thrips activity that caused soft rot of small squares, square damage due to lepidopterous pests, and dessication without physical damage indicating physiological stress. Physilological stress may be induced by moisture stress, aphid feeding that stresses the plant system and nutrient related stress on the plant physiology.

Plant bug feeding on small squares appears to be the major cause of square shed. Mauney and Henneberry (1984) studied the cause of shed by examination of the small squares. The experiment addressed the cause of the square shed but not the quantative shed field wide. The square shed was caused 67 percent of the time by plant bugs, thrips feeding caused 18 percent shed, lepidopterous larvae caused 2 percent and physiological shed accounted for 13 percent shed (Table 1). In other studies, clouded plant bug feeding resulted in 26 percent shed of small squares but the tarnished plant bug feeding only resulted in 10 percent shed (Pack and Tugwell, 1976). The clouded plant bug damaged 74 percent of the anthers feed upon compared to 36.7 percent damaged anthers by the the nymph stage. On the other hand, the tarnished plant bug adults damaged 39.8 percent of the plants compared to11.8 percent damaged anthers by the nymph stage. The clouded plant bug in both stages have a much greater potential to damage the plant compared to the tarnished plant bug. Furthermore, the adult stage in both species damaged significantly more anthers than the nymphal stage. Plant bugs feeding on squares 3 mm in size caused the small squares to shed within 1 to 4 days. Squares that were exposed 24 hours to feeding by clouded plant bugs and tarnished plant bugs showed varing rates of shed (Table 3). Plant bug are clearly a major cause of early season square loss.

Thrips are also documented as contributors to loss of squares. The damage and yield reduction in cotton that is not protected from thrips has also been shown to significantly reduce yields and delay maturity. Data collected from plant mapping in Arkansas (Klein et al. 1994, Unpublished Data) shows that square loss is a result of the direct injury of thrips to the plant. The loss is probably associated with the loss of leaf surface area and reduced phosynthetis capacity of the plant. The injury would indirectly affect the plant physiology and associated stress from thrips injury. Thrips caused increased square shed in untreated plots compared to the Temik treated plots during 1994 (Table 4). The untreated check had square shed ranging for 14 to 22 percent compared to shed of 4.8 to 14.8 percent in the Temik treated cotton. A similar trend was observed in other varieties during 1994.

Aphids are not often associated with square loss but have been given credit for yield reduction after having several years aphid outbreaks in Mid-South cotton. Aphids are estimated to have reduced yields by 0.3 percent across the cotton producing areas for both 1993 and 1994 (William,1994; Williams, 1995). In Arkansas during 1995,

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many growers are placing some of the blame for significantly lower yields on the earlier and higher aphid population. In field research with Provado (imidacloprid), the plot treated three times at weekly intervals starting at pin head square had very light populations of aphids compared to very heavy populations in the untreated areas. Plant mapping of the plots showed increased square shed in the plots with the heavier aphid populations (Table 5). Square shed in the plot treated three times with Provado had at the highest point 1.1 percent square shed compared to a high of 8.7 percent shed in the untreated plots. Furthermore, a distinct height difference was observed in the plots with the untreated being about six inches shorter that the treated plots. The increased square shed was also reported by several consultants and county agents across Arkansas. The increased square shed is most likely due to indirect stress to plant. Aphid feeding would probably create a shift or change in the plant physiology. The difference in plant height is the result of extreme stress placed on the plant by the aphid population and it is not unreasonable to assume that the same stress could be the reason for the increased square shed in the untreated plots.

Square shed may also be the result of feeding by small Heliothine larvae (Williams et al., 1987; Mauney and Henneberry, 1984). The incidence of square shed due to larvae in the pre-bloom period is usually relatively small. Mauney and Henneberry (1984) reported that two percent of the squares that shed were due to Heliothine damage. The occurrance of damage to squares in general would be low because the population level of the Heliothine complex is generally low. However, some areas may see higher level of damage from lepidopterous larvae such as the Heliothine complex because of regional difference in overwintering populations.

The boll weevil would also contribute to square loss in the pre-bloom period but the damage would be restricted to the larger squares in contrast to the losses from plant bugs, thrips and aphid populations. Square shed due to the boll weevil would not be uniform in fields because of the low population level in general as a result of the overwintering mortality in the boll weevil population. Winter mortality in the boll weevil population would vary from region to region because of differences in temperatures, available boll weevil habitat and the implementation of the boll weevil eradication program. In addition, the boll weevil feeding activity tends to be restricted to field borders next to the overwintering sites. In general, the boll weevil would not be a major cause of square shed because of the biological factors that limit the boll weevil activity in the pre-bloom period.

The diagnosis and scouting methods used to detect the various insects that cause square shed varies form state. The primary methods for monitoring insect populations are the shake sheet method, sweep net and field scouting. Survey methods for plant bugs was evaluated by Young and Tugwell (1975). The shake sheet and the sweep net methods were found to be the most effecient and the field observations were the least effecient. The monitoring of square shed is another method of detecting insect injury and is based the plant rather that the insect population. The accumulation of injury from a complex of insects present in cotton below insect population treatment levels has been of concern among cotton production scientist for some time. The plant monitoring or plant mapping techniques under development appear to offer a possible solution to this complex problem. A plant mapping technique under development by Tugwell and associates at the University of Arkansas has the capability of tracking square shed by nodal postion(Bourland, 1994). The development of square shed tolerance levels in the model will be the completion of a model that accounts for accumulation of square loss on the cotton plant.

The diagnosis of the cause of the square shed in the field is aided by recognition of the symptoms of injury to squares that shed (Williams et al., 1987; Mauney and Henneberry, 1979). The shed of squares is due either to physiological reasons or insect related causes. Physiological shed is characterized by the anthers, staminal columns and carpels are uniformly dessicated basipetally, but not structurally damaged. The structures may be slightly yellow or tan, but necrosis of the tissue seldom occurs. Plant bug injury or damage is characterized by localized areas of necrosis on the anthers and staminal columns or necrosis throughout the square. Moist, jellylike amorphous tissue was normally associated with necrotic areas and desiccation of internal structures was irrregular. A diagnostic key showing the difference between physiological shed and plant bug injury is available from the University of Arkansas Cooperative Extension Service(Johnson, 1993; Johnson, 1994)

The identification of squares damaged by Heliothine or lepidopterous larvae is usually clearly defined in the small squares. The larvae usually eats an entry hole less than one millimeter in diameter through the bract and sepal or just above the peduncle. The internal structures are usually absent and frass is usually present. Often, the small larvae are still present in the shed squares. In some cases, the injury and entrance hole is not clear especially with newly hatched larvae. In these cases, close examination is required to find the damage related to larval feeding. The small square is sensitive to the feeding of Lepidopterous larvae and is thought to shed from the slightest injury.

The diagnosis of square shed in the field is made easier using a technique developed by William et al. (1987). The field diagnosis of shed squares was made easier by the use of a square slicer. The slicer is made of two pieces of plexiglass with different size holes that allow the square to be sliced uniformly with a razorblade. The sliced square may then be examined with a portable field microscope or 20 to 30 power to determine the cause of shed using the above description. The diagnosis is rather easy ,the equipment is simple, and adapts well to the field environment.

Summary

The loss of pre-bloom squares may categorized as due to physiological stress or physical injury. Physiological shed may be attributed to either biotic or abiotic factors. Abiotic factors that contribute to square shed include moisture, nutrients, cultivation, stress from the general feeding of insects or nematodes. Aphid and thrips may be present in large numbers and the feeding pressure great enough to result in a type of physiological stress that causes square shed similar to moisture stress. Square loss as the result of physical injury from feeding by insects include plant bugs, lepidopterous larvae, and boll weevil. The primary cause of pre-bloom shed is generally considered to be due to plant bug feeding.

The diagnosis of the occurrance and cause of square shed is accomplished by field monitoring and examination of shed squares. The conventional method of scouting for insect populations does not allow for accumulation of damage and treatment thresholds may not account for square losses. The monitoring of square shed as a plant based indicator of insect population pressure on the small square is perhaps a better method of managing pre-bloom square set. Newly developed plant mapping procedures should be used to monitor square set in cotton fields. When the square set declines and square set is occurring, field diagnosis of the squares that shed would determine the cause of square abscission. Once the cause is determined, a management decision can be made based on the need of the cotton plant. A physiological shedding of squares would require a different solution than perhaps an insect related problem. An insect related square shed problem would also require a species determination to make a correct insecticide selection.

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Table 1. Cotton square abscission due to damage by plant bugs, thrips, Lepidopterous larval feeding and physiological shed.

	Percent Square Shed			
Week No.	Plant Bug	Thrips	Larvae	Phy
1	73	24	0	3
2	81	13	1	5
3	81	14	1	4
4	75	19	0	6
5	68	15	5	12
6	26	26	1	47
Average	67	18	2	13

Mauney and Henneberry, 1984
Phy. = Physiological Shed

Table 2. Anther damage to squares by clouded and tarnished plant bugs.

	Percent Anther Damage		
Stage	Clouded	Tarnished	Mean
Adult	74.0	39.8	56.9
Nymphs	36.7	11.8	24.2
Mean	55.3	25.8	

Pack and Tugwell, 1976

Table 3. Shed of 3 mm squares after 24 hours exposure to clouded and tarnished plant bugs

	Percent Square Shed	
Days After Feeding	Clouded Plantbug	Tarnished Plantbug
1	1.2	0
2	16.6	3.9
3	3.0	3.3
4	3.0	1.1
7	1.8	0.6
13	0.6	0.6
15	0	0.6
Total	26.0	10.0

Pack and Tugwell, 1976

Table 4. The effect of thrips on small square shed, DPL 20.

	Percent Small Square Shed	
Date	Temik	Untreated
July 7	4.8	22.0
July 11	14.8	22.1
July 14	11.2	14.0
Yield		

Table 5. The effect of Provado and aphid populations on cotton small square shed, 1995.

	Percent Square Shed			
Date	Untreated	1 App.	2 App.	3 App.
June 29	1.6	1.4	0.8	0.0
July 6	1.4	0.5	2.1	1.1
July 12	8.7	3.3	4.1	0.0
Aphid Level	Very High	High	Moderate	Low
Yield Lint/A	669	705	720	742