Original Research Article

Effect of Cowpea Trap Crop on the Control of [*Aphis gossypii* (Glover)] in Zimbabwean Cotton.

Abstract

Cotton aphids are major cotton pests causing significant yield losses of more than 65% in Zimbabwe. A Field experiment was conducted at Cotton Research Institute (CRI) in Kadoma and Umguza in Matebeleland North in three cropping seasons from 2010/2011, 2011/2012 and 2013/2014. The objectives were to determine the effectiveness of cowpea as a trap crop in reducing aphid pressure on cotton and to assess incidence of aphid predators on cotton and cowpea trap crop. The trial was laid as a Randomized Complete Block Design (RCBD) with three treatments and four replications. At CRI Cowpea trap crop significantly controlled aphids better than chemical control using Acetamiprid 20 SP ($P< 0.05$). Predator Ladybird larval beetle populations were highest in cowpea trap crop. At Umguza poor germination of cowpea resulted in highest Ladybird adults populations in intercropped cotton. Yield of intercropped cotton was comparable to yield from cotton where Acetamiprid 20SP was used. Farmers can adopt this technology of aphid control in cotton using commercial cowpea variety CBC 3.

Key Words: Cultural control, Cotton aphids, Cowpea, Trap crop

1.0 Background/Introduction

Aphis gossypii, the cotton aphid emerged a major pest of cotton in Zimbabwe in the early 1990s (Bretell, 1995). A total of 300 aphids per leaf reduce cotton growth by 38-44%, boll production by 78-80% and yield by 60-65% (Mathews and Tunstall, 1994).

Aphids prefer to feed on young and tender tissues of the cotton plant. The feeding cause severe leaf deformation, curling and crumbling, young plants are considerably damaged and at times the damage can be irreparable. Severe damage occurs during hot and dry periods. Aphids suck juice from the phloem of the cotton plant which is rich in sugars with little amino acids. Since aphids need the amino acids for growth they release the sugars on leaves of cotton plants causing the development of a fungus black sooty mould which stains open bolls (Lewis *et al.*, 2001). Honeydew deposits on leaves of cotton plants cause substantial decrease in harvest and fibre quality and also cause difficulties during the processes of ginning and spinning (Mathews and Tunstall, 1994). Early leaf crumpling due to aphid attack in cotton causes considerable lag of stems and roots, a factor enhancing sticky cotton and late fibre maturity. Cotton aphids were considered the main causal agents for sticky cotton problems in Israel (1983-1985) and in 1986 in Carlifornia, (Henneberry and Jech, 2001). Aphid populations develop very differently in crops and in more natural conditions where the flora is mixed; they also develop differently in crops of different sizes.

In Zimbabwe smallholder farmers rely mostly on chemicals for control of aphids. These chemicals are applied late in the season resulting in considerable damage of cotton by aphids from emergence to the time farmers get the chemicals. Aphicides use has undesirable ecological and economic consequences for cotton growers and administrators in many countries (Kranthi and Russell, 2009). According to worldwide research data about 40% of crop yield losses are experienced in the pre-harvest period due to pests if effective pest management is not practiced (Kennedy *et al*., 2000). Pesticide use alone will easy pest problems in the short run but in the long term leading to problems like public health risks and environmental pollution, pests developing resistance to the pesticides, secondary pest outbreak and eradication of predators thereby leaving farmers in a “vicious pesticide treadmill” (Maumbe and Swinton, 2000). Crop protection in Africa has minimal use of alternative pest control practices while chemical control remains the widely used pest control measure (Maumbe and Swinton, 2000)**.** Massive publication and attention is given to chemical control of pests, no wonder there is a common thinking that all pest management programs should be chemical control based. In the real fact non-chemical control techniques like trap cropping, intercropping, crop rotation, sanitation, cultivation, use of resistant crop cultivars and biological control can be successfully used while chemicals would only be used as the last line of defence (Kennedy *et al*., 2000). Researches done in the region emphasized on legume crop production as an important component in Integrated Pest Management (IPM). This has seen about 20 million people in Africa being dependent on cowpea (*Vigna unguiculata L Walp*) as a major source of protein for those communities who cannot afford animal products (Cork *et al*., 2009). Besides cowpea being an indigenous African grain legume grown widely, it is also the most important food legume, fodder and cover crop. Cowpea matures early and is drought tolerant. It has wide adaption and broad range of genetic diversity which is locally found. Cowpea is very nutritious and is comprised of proteins (20.5-31.7%), carbohydrates (56.0-65.7%), fats (1.1-3.0%), fibre (1.7-4.5%) and moisture (6.2-8.9%) (Makoi, 2009).

Intercropping is a traditionally practiced agronomic technique of cultivating two or more crops in the same space of land at the same time. This practice has in past decades achieved the goal of agriculture (Thayamini and Brinth, 2010**)**. Intercropping increases production per unit of land through better use of resources, minimizes risks, reduces need for competition while stabilizing the yield. Other advantages of intercropping are: production of greater yield per unit area through good use of available growth resources by using a mixture of crops of different rooting ability, canopy structure, height and nutrient requirement based on the complimentary utilization of growth resources by the component crops (Lithourgidis *et al*., 2011). Intercropping leads to soil fertility improvement through biological nitrogen fixation with the use of legumes, soil conservation is increased through more ground cover than sole cropping, at the same time providing better lodging resistance for crops susceptible to lodging than when grown in monoculture (Lithourgidis *et al*., 2011). Cowpea makes one of the best intercropping options with cotton (Rusinamhodzi, 2006), so its use as a trap crop for the control of aphids in cotton will be a relief to the resource poor farmers since cowpea is abundantly available. Cowpea is tolerant to drought and poor soil fertility environments, and have a good combining ability in intercropping systems (Rusinamhodzi, 2006). Intercropping has been observed to offer protection against insect pests. According to Aliyu *et al.*, 2011, results from an experiment conducted by Uvah, revealed that intercropped sorghum with relay crops of millet and cowpea reduced the population of A. *cracccivora* Koch, *M. vitrata*, *M. sjostedti* and pod sucking bugs by 92%, 45%, 35% and 90%. Cowpea trap crop can be used as an alternative to chemical control of aphids in cotton since cowpea attracts and harbours cotton aphids. This will allow the cotton plant to grow and mature while the aphids are in the trap crop. On harvesting, the farmer can burn residues of the trap crop or plough down the trap crop to kill and break the life cycle of the aphid pest. The use of cowpea as a trap crop for control of aphids reduces aphicides usage, enhance conservation biological control by preserving locally found predators (PAN Germany OISAT, 2012).

2.0 Objectives

The objectives of this field experiment were to determine the effectiveness of cowpea as a trap crop in reducing aphid pressure on cotton early in the season. The experiment also checked the effect of cowpea trap crop on predators of cotton pests.

3.0 Methodology

Investigation into the effectiveness of cowpea trap crop in controlling aphids in Zimbabwean cotton was carried out in field experiment during the 2010/2011, 2011/2012, and 2013/2014 cropping seasons at the Cotton Research Institute (CRI) in Kadoma and Umguza communal land in Matebeleland North. The experiment was laid out in a randomized complete block design with three treatments and four replicates. The treatments were:

1. No control of aphids,

2. Chemical control of aphids with Acetamiprid 20 SP,

3. Cowpea trap crop for control of aphids intercropped as four rows of cowpea to ten rows of cotton.

Cotton was grown using the basic agronomic practices as outlined in the Cotton Handbook of 1998, partial revised edition standards (CGA, 1998). Other practices done not listed in the cotton handbook were: the experiment was hand planted at all sites using a commercial Cotton Variety CRI MS2 and a commercial cowpea variety CBC3. Planting of cotton and cowpea was done on the same day using 30cm graduated sticks. Five seeds of cotton variety SZ 9314 were placed per planting station while three cowpea seeds of variety CBC3 were also placed per planting station. The difference in number of seeds per planting station is due to the fact that cowpea emerges better from the soil than cotton.

The measurements were aphid scores, aphid predator counts and seed cotton yield. Scouting for aphids and predators of cotton aphids was done once a week in all treatments in cotton and in the trap crop. Other sucking pests, bollworms and predators were also scouted once a week. Chemical sprays for aphids control with Acetamiprid 20 SP were only applied in chemical control treatment, while in the no control treatment and the cotton-cowpea intercrop treatment no aphicide was applied.

4.0 Results and Discussion

4.1 Aphid populations and yield of seed cotton at CRI

The cowpea trap crop significantly lowered aphid populations in intercropped cotton at CRI better than chemical control of aphids with Acetamiprid 20 SP (Table 1). This could have been caused by the cowpea's ability to attract and trap the cotton aphids since cowpea produces chemical cues which guide the cotton aphid to locate it as the most preferred host (Atieno, 2011). This result confirms earlier findings by earlier researchers that intercropping of cowpea with cotton is a cultural method that decrease target pests of cotton (Fakharany *et al.*, 2012). Studies by Lithourgidis *et al.*, (2011) also confirm recent findings that intercrops often reduce pest incidence in targeted crop. There were no significant differences in seed cotton yield between the treatments. Cowpea trap crop attracted the highest populations of Ladybird larva (Figure 1). The ladybird larvae were responding to high populations of aphids on cowpeas trap crop since the Ladybird larvae are predators of cotton aphids capable of consuming about 450 aphids during their 12 day development period (Hopkinson et al., 2016). Studies by Sarina and Zalucki (2005) confirm these findings that high predators populations are a response to high prey populations.

Table 1 shows average aphid populations and yield of seed cotton at CRI for 2010/11, 2011/12 and 2013/14 seasons

Treatment	**Mean aphid Score**	**Seed Cotton Yield kg/ha**
1.No control of aphids in cotton	10.4c	2013
2.Chemical control of Aphids with Acetamiprid 20 SP.	8.9b	2048
3. Cotton intercropped with cowpea	7.6a	2070
p-value	<0.001	0.851

N.B. Values followed by the same letter in a column are not significantly different at the 5% level (Duncan `s Multiple Range Test).

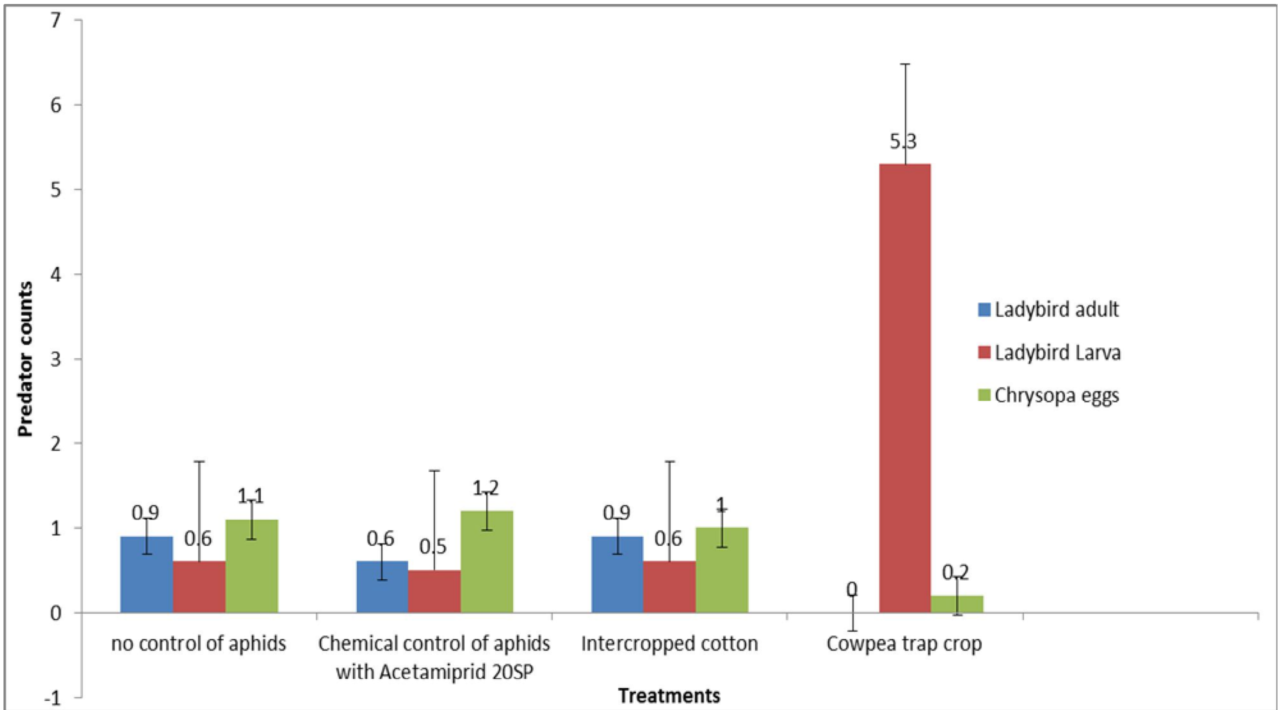

Figure 1 shows standard error bars and average predator counts at CRI for three seasons from 2010/11, 2011/12 and 2013/14

4.2 Aphid populations and seed cotton yield at Umguza

At Umguza Chemical control of aphids with acetamiprid 20SP had the least aphid populations while intercropped cotton had the highest aphid populations. This scenario was caused by poor germination of the cowpea trap crop. The poor trap crop stand caused the aphids to quickly exhaust food reserves in the trap crop thereby afterwards moving to adjacent intercropped cotton crop. Cowpea cotton intercrop produced significantly high seed cotton yield comparable to chemical control of aphids with Acetamiprid 20 SP, while the no control treatment had the least yield of seed cotton (*Figure 2*). This could be attributed to the highest population of Ladybird larva which was in intercropped cotton (Figure 3). Studies by Sharma *et al*., (2013) concur with these findings that, if a pest population increases the numbers of predators that attack the pest also proportionally increase and provide density dependant relationship. As a result habitat manipulation seeks to manage the pest, crop and crop plants relationship to enhance the impact of natural enemies on pest population. This approach is one of the key elements in the use of indigenous natural enemies (conservation biological control) in Integrated Pest Management ((IPM) (Sharma *et al*., 2013).

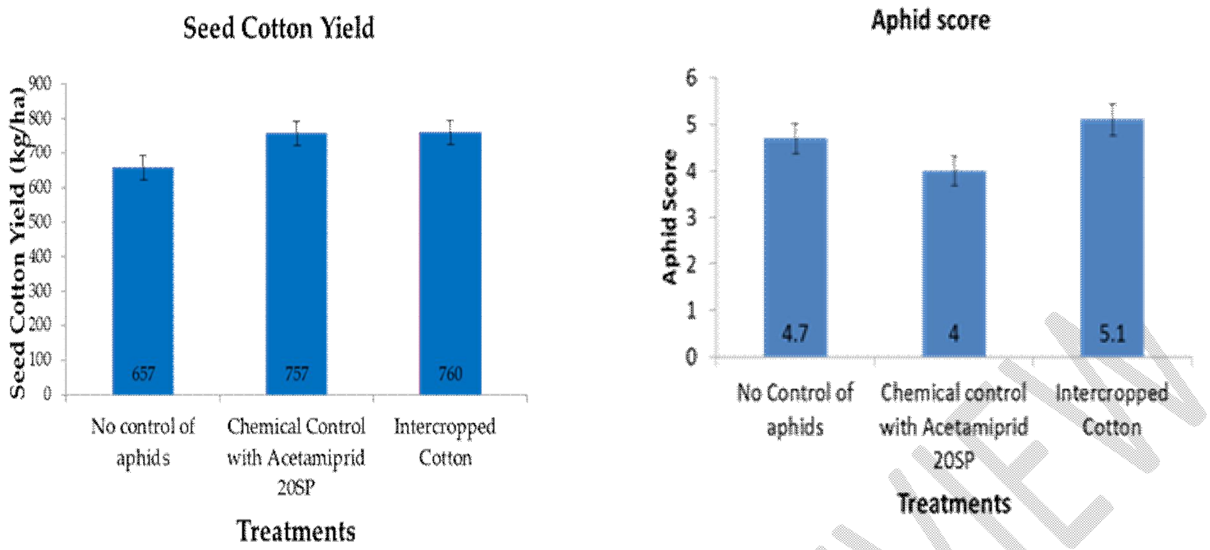

Figure 2 shows standard error bars and average aphid populations and seed Cotton yield at Umguza from 2010/11, 2011/12 and 2013/14 seasons.

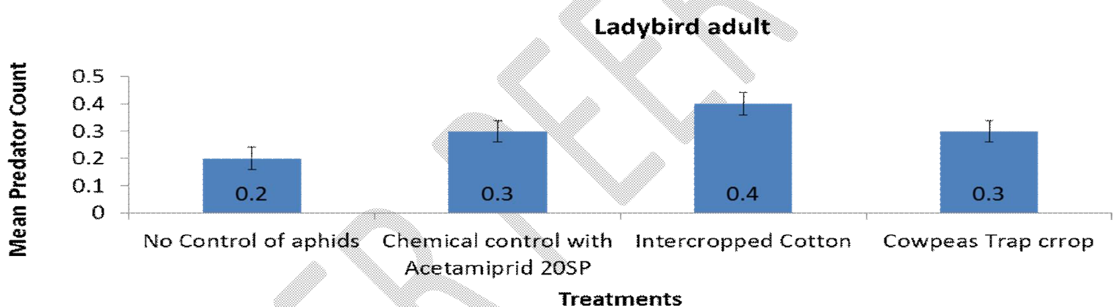

Figure 3 shows standard error bars and average predator populations at Umguza from 2010/11, 2011/12 and 2013/14 seasons.

5.0 Conclusion

The cowpea trap crop controlled aphids better than chemical control with Acetamiprid 20SP at CRI. Poor germination of cowpea trap crop at Umguza resulted in high populations of aphids in intercropped cotton at Umguza. At CRI cowpea trap crop attracted the highest populations of predator Ladybird beetle larva while at Umguza intercropped cotton had the highest populations of the predator Ladybird adult beetle. Cotton intercropped with cowpea yielded as much as cotton where aphids were controlled using Acetamiprid 20 SP

6.0 Recommendation

Farmers are encouraged to adopt this technology of the use of cowpea trap crop for aphid control in cotton using cowpea.

7.0 References

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