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

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Authors' contributions

This work was carried out in collaboration among all authors. Author FJ designed the study and prepared first draft. Author RM coordinated the data collection. Author BN did data analyses. Author WM supervised the study. Author DK edited the first draft of manuscript and perfected it before sending it to the journal. All authors revised the manuscript.

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ABSTRACT

Cotton aphids are major cotton pests causing significant yield losses of more than 65% in Zimbabwe. Field experiments to investigate the effectiveness of cowpea as a trap crop in reducing aphid pressure on cotton were conducted over three seasons 2010/11 to 2013/14 at Cotton Research Institute (CRI) in Kadoma, and Umguza in Matebeleland North, in Zimbabwe. Incidence of aphid predators on sole cotton, cotton intercropped with cowpea trap crop and the trap crop itself were also assessed. The measurements were aphid scores, aphid predator counts in both sole cotton, intercropped cotton and cowpea trap crop. Seed cotton yield was measured. Aphid scores and predator counts were subjected to Analysis of Variance (ANOVA) using GenStat 14th Edition

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software. The square root transformation [x + 3/8] was used for scores or counts not normally distributed. At CRI Cowpea trap crop significantly controlled aphids in intercropped cotton better than chemical control using Acetamiprid 20 SP ($P< 0.05$). *Coccinellid* grubs (ladybird beetle larval) populations were highest in cowpea trap crop. At Umguza poor germination of cowpea resulted in highest *Coccinellid* adults (ladybird beetle adults) in intercropped cotton. Yield of intercropped cotton was comparable to yield from plots where Acetamiprid 20SP was used as a standard practice. Farmers can adopt this technology of aphid control in cotton using commercial cowpea variety CBC 3 as cotton aphid trap crop.

Keywords: Cultural control; cotton aphids; cowpea; trap crop.

1. INTRODUCTION

Cotton is an important commodity crop in the world economy. It is grown in more than 100 countries. The crop is a heavily traded agricultural commodity, with over 150 countries involved in exports or imports of cotton [1]. *Aphis gossypii*, the cotton aphid emerged a major pest of cotton in Zimbabwe in the early 1990s [2]. It is the most common cotton pest present in the crop at any time during the growing season [3]. Uncontrolled aphid attack leads to cotton growth reduction by 38-44%, boll production by 78-80% and yield loss by 60-65% [4]. Aphids prefer to feed on young and tender tissues of the cotton plant. The feeding causes 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 [5]. Honeydew deposits on leaves of cotton plants cause substantial decrease in harvest and fibre quality and cause difficulties during the processes of ginning and spinning. 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 caused sticky cotton problems in Israel (1983-1985) and in 1986 in Carlifornia [6]. 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. Aphid numbers or populations world-over are determined using a scoring system [7].

In Zimbabwe most smallholder farmers grow cotton under contract farming. The farmers rely mostly on chemicals for control of aphids. At times these aphicides are supplied late in the season by contractors resulting in considerable damage of cotton by aphids from emergence to the time farmers get the aphicides. The use of aphicides has undesirable ecological and economic consequences for cotton producers in many countries [8]. Aphicides use alone eases aphid 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” [9]. In Africa chemical control remains the widely used pest control measure while minimal use of alternative pest control practices is practiced. This has been caused by massive publication and attention which has been given to this method, no wonder there is a common thinking that all pest management programs should be chemical control based. 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 [10]. Past 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 [11]. 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%) [12].

Trap cropping is one of those valuable organic techniques regularly used by organic farmers to keep pests away from main crop. A trap crop,

also known as a sacrificial crop, is a plant that you add to attract pests away from the main crops you are growing. Pests have preferences for what they like to live on. By planting rows of a trap crop near the main crop pests will be attracted to the trap crop and will usually leave your main crops alone. You don't harvest anything from your trap crop ñ it is just there to keep the pests off the plants you want to do well. Different insects prefer different trap crops. The trap crop can be planted as rows within the main crop or as a boarder for the main crop, Fig. 4. Trap crops that flower to attract beneficial insects such as lacewings (*Chrysopa spp*) and ladybugs (*Coccinelids spp*) which feed on the pests [13].

Intercropping cowpea with cotton as a trap crop for cotton aphids would offer cotton protection against pest. According to Aliyu et al. [14] results from an experiment conducted by Uvah, revealed that intercropped sorghum with relay crops of millet and cowpea reduced the population of A*. craccciv*ora 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 [15].

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.

2. METHODOLOGY

2.1 Experimental Design and Sites

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

2.2 Treatments

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.

2.3 Agronomic Practices

Cotton was grown using the basic agronomic practices as outlined in the Cotton Handbook of 1998, partial revised edition standards [16]. (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 inrow graduated sticks. Five seeds of cotton variety CRI MS2 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.

2.4 Data Collection

The measurements were aphid scores, aphid predator counts and seed cotton yield. Aphid scores were determined using a scale as shown in Table 1. 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.

Table 1. Scoring system for aphids used in Zimbabwe

Number of aphids present	Score
0	0
1- 10	I
11- 30	II
>30	III

3. RESULTS AND DISCUSSION

3.1 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 2). 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 [17]. This result confirms earlier findings by earlier researchers that intercropping of cowpea with cotton is a cultural method that decrease target pests of cotton [18]. Studies by Lithourgidis et al. [19] 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 Coccinellid grub (Ladybird beetle larva), (Fig. 1). The Coccinellid grub were responding to high populations of aphids on cowpeas trap crop since the Coccinellid grub (Ladybird beetle larva) are predators of cotton aphids capable of consuming about 450 aphids during their 12 day development period [20]. Studies by Sarina and Zalucki [21] confirm these findings that high predators populations are a response to high prey populations.

3.2 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 (Fig. 2). This could be attributed to the highest population of Ladybird larva which was in intercropped cotton (Fig. 3). Studies by Sharma et al., [22] 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).

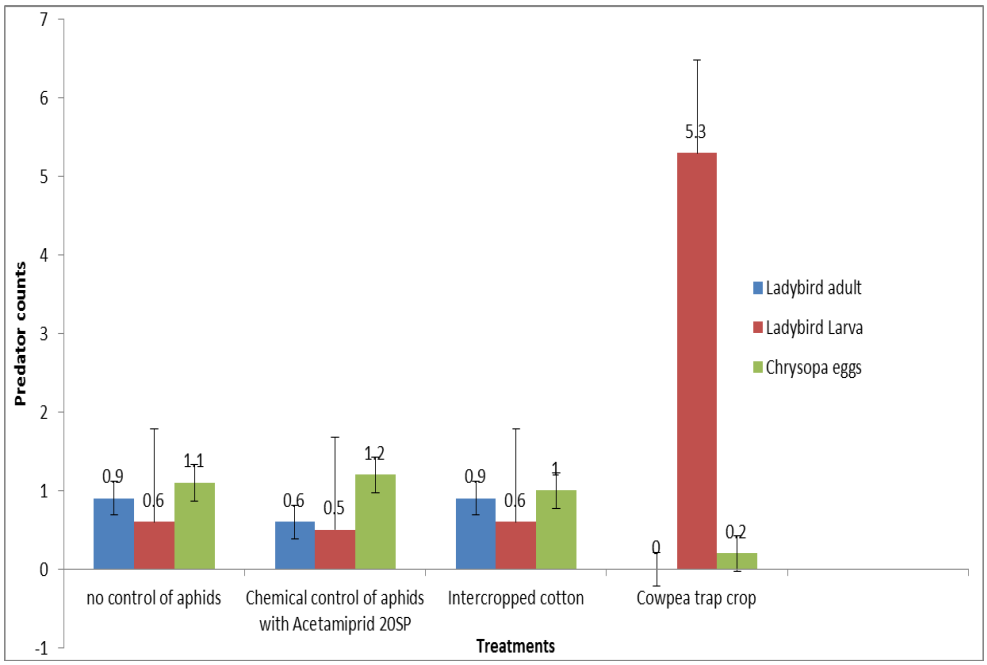

Fig. 1. Shows standard error bars and average predator counts at CRI for three seasons from 2010/11, 2011/12 and 2013/14

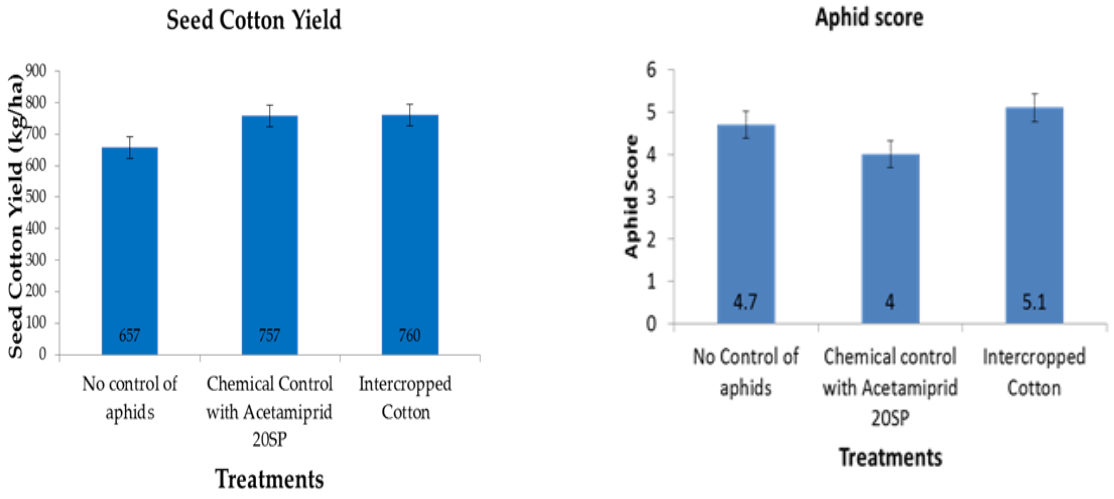

Fig. 2. Shows standard error bars and average aphid populations and seed cotton yield at Umguza from 2010/11, 2011/12 and 2013/14 seasons

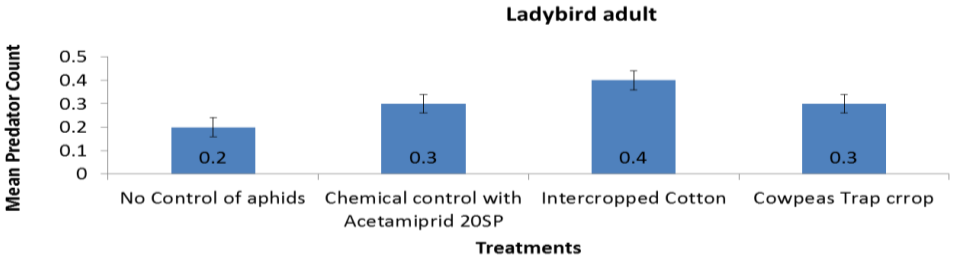

Fig. 3. Shows standard error bars and average predator populations at Umguza from 2010/11, 2011/12 and 2013/14 seasons

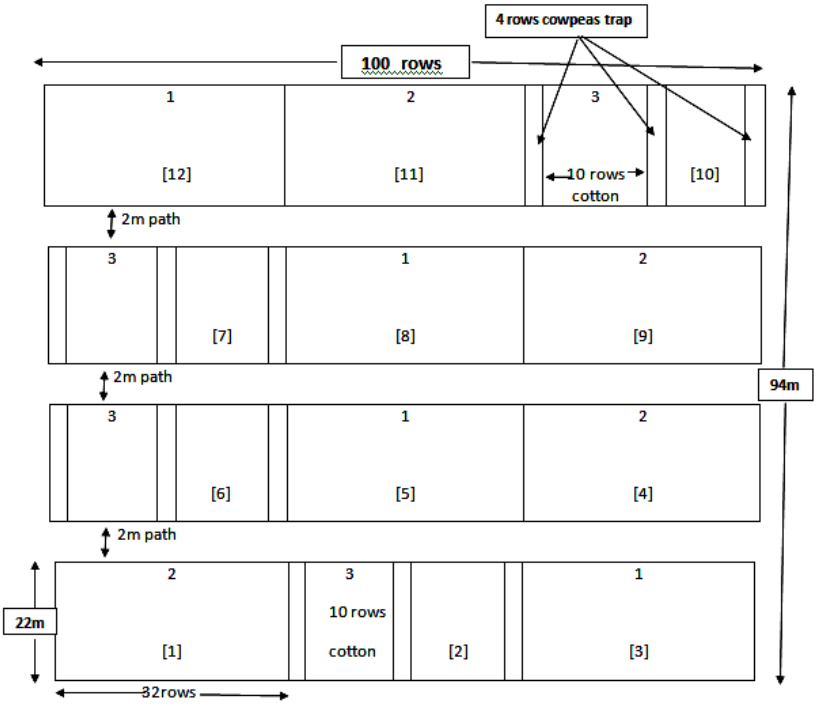

Fig. 4. Field layout of the experiment

Table 2. 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)

4. 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 grubs of lady bird beetle while at Umguza intercropped cotton had the highest populations of the Ladybird adults. Cotton intercropped with cowpea yielded comparably to cotton where aphids were controlled using Acetamiprid 20 SP.

5. RECOMMENDATION

Farmers can adopt this technology of early aphid control in cotton using commercial cowpea variety CBC 3 as cotton aphid trap crop.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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