**EVALUATION OF FYTOMAX 0.1% EC FOR COTTON APHID CONTROL TO OTHER BOTANICALS IN ZIMBABWE.**

**Abstract:**

One of the most common agricultural insect pest in cotton is the cotton aphid, *Aphis gossypii* Glover (*Homoptera*: Aphididae). It is a common sucking pest present in cotton through-out its growing season. Heavy populations on seedling cotton can cause crinkling and cupping of leaves, failing to expand, defoliation, and a server stunting of seedling growth. At a later stage in growth contamination of lint lowers lint quality. Biological pesticides which are contracted as biopesticides are pesticides derived from naturally occurring sources, such as microorganisms, plants, and animals. Biopesticides are found in three broad categories namely microbial pesticides, plant incorporated protectants and biochemical pesticides. Fytomax 0.1% EC is a plant extract comprising neem tree extracts. The product is claimed to have efficacy properties against aphids. The objectives of this experiment were to determine the efficacy of Fytomax 0.1% EC against aphids in cotton, and also to assess the effect of the new insecticide on predators of aphids in cotton. Field trials to evaluated Fytomax 10 for efficacy against aphids in cotton were conducted during the 2022/23 and 2023/24 summer seasons at Cotton research institute, Kuwirirana and at Mutimutema. Randomized Complete Block Design with six treatments replicated four times was used. Four doses of Fytomax 0.1% EC of the following order; 250ml/ha, 500ml/ha, 750ml/ha, and 1000mls/ha were evaluated along with Acetamiprid 20SP at 50grams per hector as the standard and the untreated as the control. Measurements were made on aphid and predator counts. Data was analyzed using Genstat 18th version and the square root transformation of (X + 3/8) was used for data not following normal distribution. In this experiment and at all the sites Fytomax 0.1% EC could control aphids and conserve predators of aphids at 500ml/ha. Fytomax was recommended for registration in Zimbabwe on the control of aphids at a dose of 500ml/ha.

**Key words:** Biopesticides; Neem tree; aphids.

**Introduction**

The cotton aphid, *Aphis gossypii Glover* is a major cotton pest causing significant yield losses of more than 65% in Zimbabwe (Jimu et al., 2023). According to economic importance, the cotton aphid was ranked sixth and seventh in the United States in 2002 and 2003 respectively (Williams, 2003). It is a rather small aphid that ranges in color from yellowish green to greenish black. Both winged and wingless forms are produced. The winged individuals are somewhat slender and are not as robust as the wingless form. A mature individual measures about (1.5 mm) in length. The cotton aphid develops in colonies and prefers the underside of leaves. Unlike other aphids, cotton aphid populations do not diminish with high temperatures; they can also be troublesome late in the season and can reduce the yield and quality of cotton. Heavy populations on seedling cotton can cause crinkling and cupping of leaves, failing to expand, defoliation, and a severe stunting of seedling growth. At a later stage in growth contamination of lint lowers lint quality. Cotton aphids have been reported to transmit over thirty viruses to crops worldwide (Ebert and Cartwright, 1997), and is the only vector reported to transmit cotton leafroll dwarf virus (CLRDV, genus: Poliovirus, family: Solemoviridae) to cotton, Gossypium hirsutum L, in a persistent-circulative and non-propagative manner (McLaughlin et al., 2020). This virus has been reported from Africa, Asia, and South America with losses up to 1500 kg/ ha in South America (Galbieri et al., 2017). Management of disease caused by CLRDV in Brazil, and of a related cotton-infecting poliovirus from Australia, is achieved using resistant varieties and aphid management (Galbieri et al., 2017).

Biopesticide is a generic term generally applied to a substance or mix of substances derived from nature, or are nature-identical synthetic substances, such as microorganisms, botanicals, or semiochemicals that may be formulated and applied like conventional chemical pesticide and normally used for short-term pest control (Ayilara et al., 2023). Biopesticides are becoming an essential biocontrol tool, as part of Integrated pest management program strategies for growers worldwide. Biopesticides generally have low to no toxicity to non-target beneficial organisms and wildlife, reduced environmental contamination and residues, and limited to no likelihood of developing resistance to pests (EAP, 2023). Biopesticides are environmentally safe, and sustainable, not associated with the release of greenhouse gases and their use mitigates the impacts of climate change (Borges et al., 2021) besides ecological safety and target specificity toward their target pests (Essiedu et al., 2020), biopesticide use promotes biodiversity by preserving natural enemies and pollinators. Additionally, their biodegradability reduces pollution concerns associated with some chemical pesticides (Essiedu et al., 2020). Due to their targeted action and effectiveness in small quantities, biopesticides are gaining wide application on crops.

Plant-derived biopesticides or botanicals are mainly composed of bioactive extracts and essential oils from plant materials (McCoy et al., 2011). Diverse phytochemical compounds enable botanicals to exhibit various modes of action against target pests, including feeding and oviposition deterrence, repellence, larval toxicity, ovicidal effects, growth inhibition, and other physiological disruptions (Tarasco et al., 2023). Azadrachtin-based insecticide derived from the neem tree (*Azadrachta Indica*) is the most successful botanical pesticide that has been commercialized worldwide (Francesena et al., 2018) and is used against diverse sucking and chewing insect pests (Kilani et al., 2021)

Fytomax (0.01% Azadrachtin) is a plant extract comprising Neem extracts. It is a botanical solution that offers safe control of insects like Fall army worm, White fly and many other insects that can damage fruit and vegetable crops. It acts as a growth regulator and an antifeedant which provides secondary repulsive effects, making crops less attractive to insects. The product is claimed to have efficacy properties against aphids. The objective of this present study was to determine the efficacy of Fytomax 0. 1% Azadrachtin on Aphid control in cotton and also to assess the effect of Fytomax on predators of Aphids.

**Materials and methods**

Experimental Sites

Field studies were conducted in Zimbabwe during the 2022/3 and 2023/24 summer seasons at Cotton research institute (18°19ˈsouth and 29°5ˈ east), and Kuwirirana (agro-ecological region 3) and at Mutimutema in Gokwe South (Agro ecological region 4). During the 2022/23 summer season the trial was conducted at Cotton research institute and Kuwirirana. In the 2023/24 summer season the trial was carried out at Kuwirirana, and Mutimutema.

Experimental Design and Data Analysis

The trials were laid out in a Randomized Complete Block Design with six treatments replicated four times. Data analysis was done using Genstat package. the square root transformation of (X + 3/8) was used for data not following normal distribution. Analysis of variance was done to test for significant differences at P<0.05 for all parameters and where treatment means were significantly different at P=0.05 Fishers Protected LSD was used to separate the means. The measurements were aphid and predator counts, and counts of other non-target pests. The treatments were: the control treatment where no control of aphids was done, chemical control of aphids with acetamiprid 20SP 50 grams per hector, the new chemistry insecticide Fytomax 0.1% EC was evaluated at four doses: 250ml, 500ml, 750ml, and 1000ml per hectare. Data on aphid, and predator counts as well as counts of other pests were done during the first scouting day in the week. Aphid counts were then converted to scores to determine a spray which was score of 36 per 24 scouted plants per treatment.

Trial management and data collection

Trial management was done using the basic agronomic practices according to the Cotton Handbook of 1998, partial revised edition standards, [Cotton hand book, 1998]. Other practices which are not listed in the cotton handbook were that the field trials were hand planted using a commercial cotton variety CRI MS2. Scouting for aphids was done on the growing point, two top fully expanded leaves and the middle leaf. Scouting for bollworms and other sucking pests was done once a week in all treatments by examining the whole plant and paying attention to fruiting points for bollworms, and for sucking pests counting the numbers present on the middle leaf, top two fully expanded leaves and the growing point of the plants. A second scouting for aphid and predator counts was done in the same week whenever a chemical spray for aphid control was applied in any one of the treatments. The first scouting of the week results would determine a treatment application, and the second scouting of the week was used as a check on the efficacy of the treatment applied Chemical sprays for control of other pests were applied over the whole trial area.

**Results and discussions**

The results (table 2) show Across season analysis results for Kuwirirana site were the test chemical controlled aphids at all the test chemical dosages rates, except at Fytomax 0.1% EC (250ml/ha) level were Fytomax was out performed by acetamiprid the standard. Fytomax at the higher rates of Fytomax 0.1%EC (500/ha) up to Fytomax 0.1 %EC (1000ml/ha) out-performed the standard treatment. For predators Ladybird larva, Chrysorpa larva and spiders treatment applications resulted in significant differences, and treatment effect on parasitoids and ladybird adult did not show any significant difference.

Treatment effect on the lady bird larva had significant deference and revealed that, Fytomax 0.1 % EC (250 ml/ha, and Fytomax 0.1 % EC (1000ml/ha) could conserve the predator better and was comparable to the no spray treatment. Treatment applications on lady bird adult did not show significant difference among all treatments. Chrysorpa larva were noticed in the no spray and Fytomax 0.1 % EC (250ml/ha) treatments only. Fytomax 0.1 % EC at 500ml/ha and above was comparable to Acetamiprid 20 SP 50g/ha and could not conserve the predator as it whipped off the predator at these high doses. There was no significant difference among treatments for the ladybird adult and the parasitoids. Spiders were noticed across all treatments except in the Fytomax 0.1 % EC (100ml/ha). All treatments were comparable to each other although Fytomax 0.1 % EC (250) had the highest count of all the treatments, Table 2 has the summary of these results.

**Table 1 Across seasons on Effect of Fytomax on aphid and predator counts, for Kuwirirana**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TREATMENT |  |  | APHID | LADY BIRD LARVA | SPIDERCHRIS OPER  LARV   | LADYBIRDADULT | PARASITOID |  |  |
| No spray |  |  |  19.98d  | 1.390bc | 0.250ab 0.333b | 1.833 | 1.202 |  |  |
| Acetamiprid20SP (50g/ha) |  |  |  10.86b | 0,956a | 0.250ab 0.000a  | 1.250 | 1.014 |  |  |
| Fytomax(250ml/ha) |  |  | 14.00c | 1.485c | 0.583c 0.167ab | 1.583 | 1.059 |  |  |
| Fytomax(500ml/ha)  |  |  |  9.20ab | 0.912a | 0.333bc 0.000a | 1.333  | 1.097 |  |  |
| Fytomax(750ml/ha) |  |  |  7.37a | 1.056a | 0.083ab 0.000a | 1.083 | 0.924 |  |  |
| Fytomax (1000ml/ha) |  |  |  8.61ab | 1.123ab | 0.000a 0. 000a | 1.083 | 0.886 |  |  |
| Grand mean |  |  |  13.2 | 1.155 | 0.250 0.083 | 1.361 | 1.030 |  |  |
| P-Value |  |  | <0.001 | 0.004 | 0.005 0.008 | 0.213 | 0.218 |  |  |
| LSD |  |  |  1.72 | 0.296 | 0.265 0.191 | 0.701 | 0.275 |  |  |
| CV (%) |  |  |  12.9 | 17.0 | 14.4 12.1 | 14.5 | 17.7 |  |  |

**Effect of Fytomax 0.1% EC on aphid counts (Across site analysis).**

Cotton aphid populations were present in this study, but not at high levels. Numerically, aphid numbers were higher in the no treatment. Fytomax 0.1% EC treatments compared with Acetamiprid 20SP 50g/ha (Table 1). Aphid control was witnessed with declined aphid populations from the Fytomax 0.1% EC (500ml/ha) to the Fytomax (1000ml/ha) treatments, were populations declined to levels less than the standard treatment, the Acetamiprid 20SP 50g/ha; however, the aphid numbers were still somewhat high in the Fytomax 0.1% EC (250ml/ha). This trend continued such that there were significantly more aphids in this treatment compared with the Acetamiprid 20SP (50g/ha) (Table 2). Aphid control in the Fytomax 0.1 % EC (500ml/ha) was 98% better than the standard (Acetamiprid 20SP 50g/ha) (Table 1)

Predators are an essential component of integrated pest management. Preservation of these biological agents increases bio diversity and a reduction in agro chemical contamination of the environment. In this study Ladybird larva and its beetle, Chrysorpa larva, syrphid and spiders were noticed in the experimental sites though not uniformly spread. Chrysorpa larva was high in the no spray treatment and was comparable to Fytomax 0.1 % EC at 250ml/ha. This shows that Fytomax can conserve chrisopids, but however at all the other rates of Fytomax no chrisopids could be found. In the Acetamiprid (50g/ha) chrisopids were also not present after treatment application and thus Acetamiprid could not conserve predators. Predators were found in small numbers, and the spider was found at all the sites. All treatments could conserve spiders except for the Fytomax 0.1 % EC (1000ml/ha) The insignificant difference among treatments is a sign of the ability of Fytomax 0.1 % EC to conserve predators. Other predators could be found in low counts across all sites, and this could be due to the nature of spiders as generalist predators to cannibalize other predators when aphid populations had been reduced by Fytomax 0.1% EC. This finding agrees with (Jonsson et al., 2017) who found out that sometimes, intraguild predation or other forms of predator-predator

interference can disrupt biological control as arthropod diversity increases. Most often this happens when a particularly effective (often large) intraguild predator species is added (Rae et al., 2023). In a study carried out (Maumbe *et* al. 2003) in Gokwe it was shown that although a diversity of pests was encountered, there have, however, been assertions that here is, in general, more dependence on pesticides by Zimbabwean farmers than is really required. The low predator counts could also have been caused by the use of hazardous insecticides which are not selective and have a broad spectrum action on insects. All the currently recommended aphicides in Zimbabwe have contact, systemic or trans laminar action and they are all lethal to predators found in cotton fields because they have broad-spectrum action (Tibugari *et* al.2017). This reliance on pesticide use could be a factor which has caused the low predator counts in this present study. Table 3 is the table of mean counts for aphid and its predators for the across site results.

**Table 2: across site for average mean counts for aphid, spider counts, and seed cotton yield**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| TREATMENT | APHIDCOUNT | SPIDER COUNT | LADYBIRB ADULT | CHRISOPALARVA | PARASITOID |  |
| No spray | 177.8d | 0.250ab | 1.83 | 0.333b | 1.083 |  |
| Acetamiprid (50g/ha) | 112.3c | 0.250ab | 1.250 | 0.000a | 0.667 |  |
| Fytomax (250ml/ha) | 162.8d | 0.583bc | 1.583 | 0.167ab | 0.833 |  |
| Fytomax (500ml/ha) | 85.3b | 0.333bc | 1.333 | 0.000a | 0.833 |  |
| Fytomax (750ml/ha) | 63.5a | 0.083ab | 1.083 | 0.000a | 0.500 |  |
| Fytomax (1000ml/ha) | 67.8ab | 0.000a | 1.083 | 0.000a | 0.417 |  |
| Grand mean | 111.6 | 0.250 | 1.361 | 0.083 | 0.722 |  |
| P-Value | <0.001 | 0.005 | 0.213 | 0.008 | 0.196 |  |
| LSD | 21.77 | 0.265 | 0.701 | 0.191 | 0.568 |  |
| CV (%) | 12.9 | 15.3 | 14.5 | 12.1 | 17.7 |  |

**Summary and conclusion**

In this study Fytomax 0.1 % EC controlled aphid populations below economic threshold, and also conserve predators of aphids at a minimum dose application of Fytomax 0.1 % EC at 500ml/ha. Fytomax 0.1 % EC managed to conserve spiders although the natural occurrence of spiders was low. The insignificant difference found on the conservation of Lady bird adult and parasitoids shows that Fytomax is selective to other insects and can conserve bio diversity in insect crop interactions.

**Reference:**

Ayilara MS, Adeleke BS, Akinola SA, Fayose CA, Adeyemi UT, Gbadegesin LA, et al. Biopesticides as a promising alternative to synthetic pesticides: A case for microbial pesticides, Phyto pesticides, and nano biopesticides. Frontiers in Microbiology. 2023; 14:1040901. DOI: 10.3389/fmicb.2023.1040901

Borges assessment of effects of microbial pesticides on bees: Strengths, challenges and perspectives. Apidologie. 2021; 52:1256-1277. DOI: 10.1007/s13592-021-00900-7S, Alkassab AT, Collison E, Hinarejos S, Jones B, McVey E. Overview of the testing and Bjornlund V, Bjornlund H, van R. Andre. Why food insecurity persists in sub-Saharan Africa: A review of existing evidence. Food Security. 2022; 14:845864. DOI: 10.1007/s12571-022-01256-1

Ebert, T.A., Cartwright, B., 1997. Biology and ecology of Aphis gossypii Glover

(Homoptera: Aphididae). Southwest. Entomol. 118, 1067–1077.

EPA. Ingredients used in pesticide products: Pesticides. What are biopesticides? Available Online.

Essiedu JA, Adepoju FO, Maria I. Benefits and limitations in using biopesticides: A review. In: Proceedings of the VII International Young Researchers’ Conference. In Proceedings of the Physics, Technology, Innovations (PTI-2020). Ekaterinburg, Russia: AIP Publishing; 2020. p. 080002

FAO. Climate- Smart Agriculture Source Book. 2nd ed. Rome, Italy: Food and Agriculture Organization of the United Nations; 2017. ISBN 978-92-5-109988-9

Francesena, N., and Schneider, M. I. (2018). Selectivity assessment of two biorational insecticides, azadirachtin and pyriproxyfen, in comparison to a neonicotinoid, acetamiprid, on pupae and adults of a Neotropical strain Eretmocerus mundus mercet. Chemosphere 206, 349–358. doi: 10.1016/j.chemosphere.2018.05.010

Galbieri, R., Boldt, A.S., Scoz, L.B., Rodrigues, S.M., Rabel, D.O., Belot, J.L., Vaslin, M., da Franca Silva, T., Kobayasti, L., Chitarra, L.G., 2017. Cotton blue disease in central- west Brazil: occurrence, vector (Aphis gossypii) control levels and cultivar reaction.

Trop. Plant Pathol. 42, 468–474.

Jimu F, Mapuranga R, Mubvekeri W, Ngara B, Kutywayo D., 2023. Effect of Cowpea Trap Crop on the Control of [Aphis gossypii (Glover)] in Zimbabwean Cotton. Asian Journal of Research in Crop Science. Volume 8, Issue 4, Page 49-55, 2023; Article no. AJRCS.59316

ISSN: 2581-7167

Jonsson, M., Kaartinen, R., Straub, C.S., 2017. Relationships between natural enemy

diversity and biological control. Current Opinions in Insect Science 20, 1–6

Kilani-Morakchi S, Morakchi-Goudjil H and Sifi K (2021) Azadirachtin-Based Insecticide: Overview, Risk Assessments, and Future Directions. Front. Agron. 3:676208.

doi: 10.3389/fagro.2021.676208

Maumbe BM, Swinton SM. Hidden health costs of pesticide use in Zimbabwe's smallholder cotton growers. Soc Sci Med. 2003; 57: 1559±1571. https://doi.org/10.1016/S0277-9536(03)00016-9 PMID:

McCoy CW, Samson RA, Boucias DG, Osborne LS, Pena J, Buss L. Pathogens Infecting Insects and Mites of Citrus. LLC Friends of Microbes: Winter Park, FL, USA; 2009. p. 193

McLaughlin, A., Conner, K., Bowen, K.L., Hagan, A.K., Groover, W., Lawrence, K.,

Jacobson, A.L., 2020. Investigating the Interaction between Crop Age and Timing of

Cotton Leafroll Dwarf Virus Inoculation on Disease Severity and Yield Loss. In:

Beltwide Cott. Conf. Austin, TX, pp. 358–360.

Rae R, Sheehy L, McDonald-Howard K. Thirty years of slug control using the parasitic nematode phasmarhabditis hermaphrodita and beyond. Pest Management Science. 2023; 79:3408-3424. DOI: 10.1002/ ps.7636

Tarasco E, Fanelli E, Salvemini C, El-Khoury Y, Troccoli A, Vovlas A, et al. Entomopathogenic nematodes and their symbiotic bacteria: From genes to field uses. Frontiers in Insect Science. 2023; 3:1195254. DOI: 10.3389/ finsc.2023.1195254

Tibugari H, Mandumbu R (2017) Pest resistance management strategies: A mini review of the case of cotton (*Gossypium hirsutum*) in Zimbabwe. Zimbabwe Journal of Science & Technology pp 41 – 48 Vol.12 [2017] e-ISSN 2409-0360 Zimbabwe. sci. technol 41

Williams, M.R. (2003). Cotton insect losses 2002. In Proc. Beltwide Cotton Conf, Nat. Cotton Council of Amer.,Memphis, TN: 101-109