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Field Evaluation of New Insecticides Against Cabbage Aphid, *Brevicoryne brassicae* L. on Cabbage in South Tigray, Ethiopia

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ABSTRACT

Cabbage aphid is attacks plants in the family Brassicaceae (Cruciferae), which includes such important crops such as oilseed rape, Brassica napus L., mustard, Sinapis (Brassica) alba (L.) and nigra (L.) and cabbage vegetables. Field experiments were conducted at Alamata Agricultural Research Center (AARC) during 2019 cropping season to evaluate and verification of insecticide on Cabbage aphid insects, and the corresponding yield of cabbage. The treatments (three insecticide treatments, including unsprayed plots as a control) were laid out in factorial arrangement in RCBD with three replications. The efficacy of Candidate and standard check were recorded 68.12% and 65.21%, respectively. Insecticide treatments significantly reduced the infestation of the insects. The lowest insect population and incidence values of 81.27% and 66.05% and 8.33% and 3.33% were recorded, when treated with lmida-win and Con-Fidence respectively. Candidate (lmida-win) and standard check (Con-Fidence) reduced cabbage aphid population by 94.6% and 91.2%, as compared to unsprayed plot. In conclusion, the results of the present studies revealed that lmida-win foliar spray was effective in reducing cabbage aphid infestation and increased yield. However, more extensive studies are recommended for developing better management of cabbage aphid through integration of insecticide spray schedules and cultivars to enhance sustainable cabbage production in Ethiopia.

INTRODUCTION

Aphid *Brevicoryne brassicae* (L.) (Homoptera: Aphididae), the cabbage aphid is attacks plants in the family *Brassicaceae* (Cruciferae), which includes such important crops such as oilseed rape, *Brassica napus* L., mustard, *Sinapis* (*Brassica) alba* (L.) and *nigra* (L.) and cabbage vegetables, *Brassica oleracea* L. *B. brassicae* can build up large colonies covering whole plants, and up to 80% yield may be lost directly due to feeding by the aphid (Kift *et al*., 2000). Subsistence farmers in Ethiopia, and elsewhere in Africa, traditionally use a combination of several pest management practices (such as cultural control, habitat manipulation, mechanical and physical control, natural biological control, host plant resistance, use of locally available materials) such that regular insect pest outbreaks of the magnitude experienced in commercial agriculture are rare (Abate and Ampofo 1996: Abate *et al*., 2000).

Aphids display a diverse range of complicated life cycles. Each life cycle has three stages: egg, nymph, and adult. There are two major types of aphid life cycle based on how they utilize their host plants: host alternating (heteroecious) and non-host alternating (monoecious or autoecious) (Williams and Dixon, 2007). Host-alternating aphids live on one plant species in winter (primary host), migrate to an unrelated plant species (secondary host) in summer, and migrate back to the primary host in autumn. Eggs are produced on the primary host after males and sexual females have mated. Non-host-alternating aphids remain either on the same host species or migrate between closely related species throughout the year; in other words, they can produce eggs on the same group of host plant species that are fed on by all of the parthenogenesis generations. Some aphid species never produce eggs, and these are known as anholocyclic. Some species show holocycly and anholocycly, but rarely both monoecy and heteroecy (Williams and Dixon, 2007).

The use of chemicals either to kill or to repel insect pests is the oldest method of pest control. Pfadt, (1985) notes that the Greeks used sulfur against pests almost 3000 years ago and the Romans used asphalt fumes to rid their vineyards of insect pests. The Chinese used arsenic compounds against garden pests before 900 A.D., though arsenic was not used in the Western world until the second half of the 17th century. Chemical pesticides have been used since the early 1940's to control insects that are either harmful to food crops or transmit human diseases (Gillott, 2005). Management of aphids has been done primarily by using chemical methods; however environmental and health problems have arisen due to this practice. Widespread use of insecure synthetic chemical pesticides and demanding crop production causes several socio-economic problems throughout the world. For example, more than twenty aphid species together with *Myzus persicae* (Harrington and Emden, 2007) have shown resistance to a number of carbamate, pyrethroid, and organophosphate based insecticides.

Chemical control is the most efficient and quickest method for the control of aphids. Insecticides belong to different groups like organochlorines, organophosphates, and pyrethriods that have been used to control aphids on *Brassicas* (Dewar, 2007). However, many are associated with undesirable traits such as failure in controlling aphids, high mammalian toxicity, persistence and deposition of oil, and contributing to the development of insecticide resistance. Natural and synthetic chemicals are traditionally used to kill pests and have been used as major methods of pest control for about 90 years. However, these chemicals have created three serious problems such as a great increase in the resistance of pests to the chemicals, the death of many beneficial insects as a result of the chemicals' non-specific activity, and pollution of the environment (Gillott, 2005).

Thiamethoxam ($C_8H_{10}ClN_5O_3S$) is the first commercial neonicotinoid insecticide from the thianicotinyl subclass. The most prominent member of this class of insecticides is thiamethoxam (Nauen *et al*., 2003). Thiamethoxam acts by binding to nicotinic acetylcholine receptors of the insect nervous system. It exhibits exceptional systemic characteristics and provides excellent control of a broad range of commercially important pests, such as aphids, jassids, whiteflies, thrips, rice hoppers, Colorado potato beetle, flea beetles, and wireworms, as well as some lepidopteran species (Maienfisch *et al.*, 2001).

Spinetoram ($C_{41}H_{65}NO_{10}$) provides long-lasting control of a broad spectrum of insect pests in a variety of crops. It is applied at low rates and has a low impact on most beneficial insects. Spinetoram causes excitation of the insect nervous system by altering the known binding sites of other classes of insecticides such as of neonicotinoids, fiproles, or avermectins (Mertz and Yao, 1990).

Lambda-cyhalothrin ($C_{23}H_{19}ClF_3NO_3$) is a pyrethroid insecticide. Pyrethroids are axonic poisons that affect the nerve fiber by binding to a protein that regulates the voltage-gated sodium channel. Normally, this gate opens to cause stimulation of the nerve and closes to terminate the nerve signal. The channels are pathways through which ions are permitted to enter the axon and cause excitation. When the channels are left open, nerve cells produce repetitive discharges and eventually cause paralysis (Bradbury and Coats 1989; Shafer and Meyer 2004). Pyrethroids bind to this gate and prevent it from closing normally, which results in continuous nerve stimulation and tremors in poisoned insects. Poisoned organisms lose control of their nervous system and are unable to produce coordinated movement. Because of the lipophilic nature of pyrethroids, biological membranes and tissues readily absorb them. Specifically, lambda-cyhalothrin penetrates the insect cuticle, disrupting nerve conduction within minutes; this leads to a cessation of feeding, loss of muscular control, paralysis, and eventual death (He, *et al*,. 2008).

Therefore this trial aimed to ensure that to evaluate the candidate chemical, lmidacloprid 200g/l of limda-win for the control of cabbage aphid, in the southern zone of Tigray, Ethiopian.

MATERIALS AND METHODS

Experimental Design:

The experiment consisted of three treatments. The treatments were arranged in a randomized complete block design (RCBD) with three replications. Each plot was 10 meters wide and 10 meters long. The space in between plots, replication, row, and plants was 1m, 1.50m, 60cm and 40 cm of cabbage variety Copenhagen Market was planted respectively. The treatments were Candidate chemical, Imida-Win at 300ml/ha, Standard check; Con-Fidence 350SC at 400ml/ha, and un-treated control were used. Cabbage aphid incidence and was recorded on 10 predetermined plants per plot every week starting from 38 days after planting. The first spray application of the candidate and Standard check fungicide was given at 10 days interval using a manually operated knapsack sprayer with one nozzle. Observation on disease incidence was recorded at 38, 45, and 52 days after planting. Insect incidence and the population was determined. Finally, before spray (pre) and after spray (post) aphid count data were analyzed to efficacy calculation using the formula of (Fleming and Retnakaran, 1985) as below. Cabbage head yield data was also used for comparison as an indicator for the good control of the insect.

$$\% \text{ Efficacy} = (1 - (Ta * Cb) / (Tb - Ca)) * 100$$

Where,

Ta=Post-treatment population in treatment, Cb = Pre-treatment population in check

Tb = Pre- treatment population in treatment, Ca = Post treatment population in check

RESULTS AND DISCUSSION

Efficacy of lmida-win (lmidacloprid 200g/l) showed excellent performance in reducing the cabbage aphid population. The efficacy of lmida-win and Con-Fidence were recorded at 81.27% and 66.05%, respectively (Table 1). From the after spray (post-spray) observation, no phythotoxicity symptoms were seen on the crop plants treated with this chemical. Analysis of variance showed that the number of the colony, the total population, incidence, and Yield have significant differences ($P < 0.05$) among the treatments (Table 2).

Table.1 means efficacy of lmida-win and Con-Fidence insecticides on cabbage aphid population at different time intervals

Treatment	Before spray 38 DAT	After spray 45 DAT	After spray 52 DAT	% Efficacy
Control	19.50 (4.20a)	49.12 (6.80)	78.11 (8.80)	-
Con-Fidence	13.82(3.66a)	1.21 (1.06)	0.67 (0.77)	66.05
Imida-Win	16.81 (4.05a)	2.03 (1.40)	0.25 (0.47)	81.27
LSD	1.521	2.436	1.162	-

DAT: days after transplanting, LSD: critical difference

Among the treatments, the untreated control had the highest number of the colony; the incidence (Fig. 1) and the Total population (Fig. 2) have of the Cabbage aphid as compared to that of the candidate (lmida-win) and standard check (Con-Fidence) (Table 2). Standard check and Candidate reduced Cabbage aphid total population by 91.2 % and 94.6%, respectively as compared to untreated control (Table 2).

The present investigation on the control of cabbage aphid also appeared similar to the finding of Mishra (2002) who reported that Imidacloprid has the best insecticide as compared with other chemicals. Varghese and Mathew (2012) also, concluded that Imidacloprid, Thiamethoxam, and Acetamiprid were highly effective against aphid when compared with Spinosad.

Table 2: Combined mean of Aphid colony, population, incidence, and Yield

Treatments	Number of colonies	Total population	Reduction (%)	Number of populations per colony	Incidence (%)	Yield (tone/ha)
Standard	0.962b(0.633)	0.774b (0.67)	91.2	1.000b	8.33b	75.91a
Control	3.554a(6.267)	8.803a(78.11)	0	12.667a	90.00a	59.46b
candidate	0.806b(6.267)	0.472b(37.1)	94.6	0.700b	3.33 b	80.71a
CV (%)	13.9(42.9)	15.3 (37.1)		19.4	13.0	10.4
LSD (5%)	0.5571(2.346)	1.162(22.15)		2.106	10.00	16.99

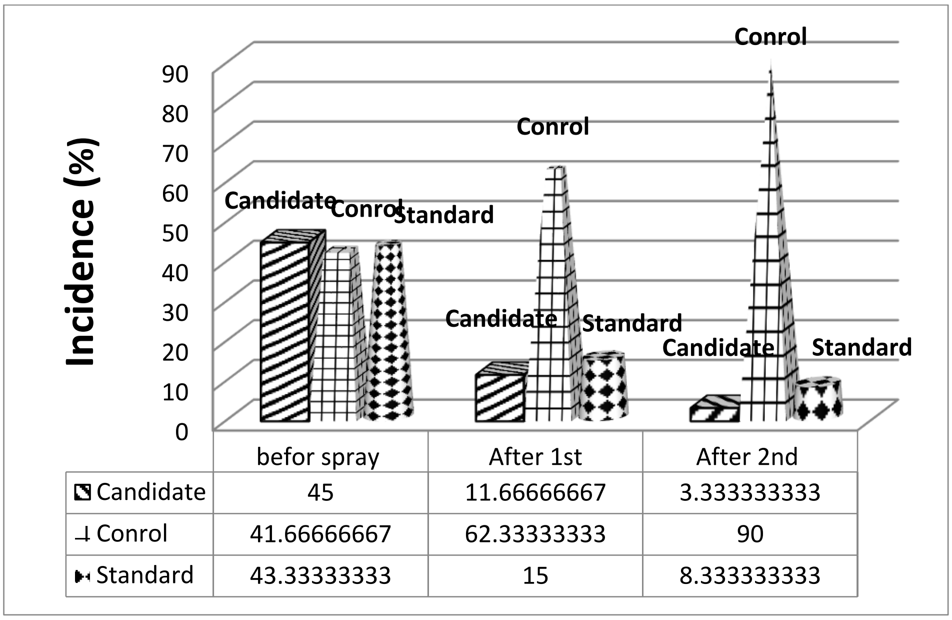

Fig. 1: Cabbage aphid Incidence before spray, first and after second round insecticide

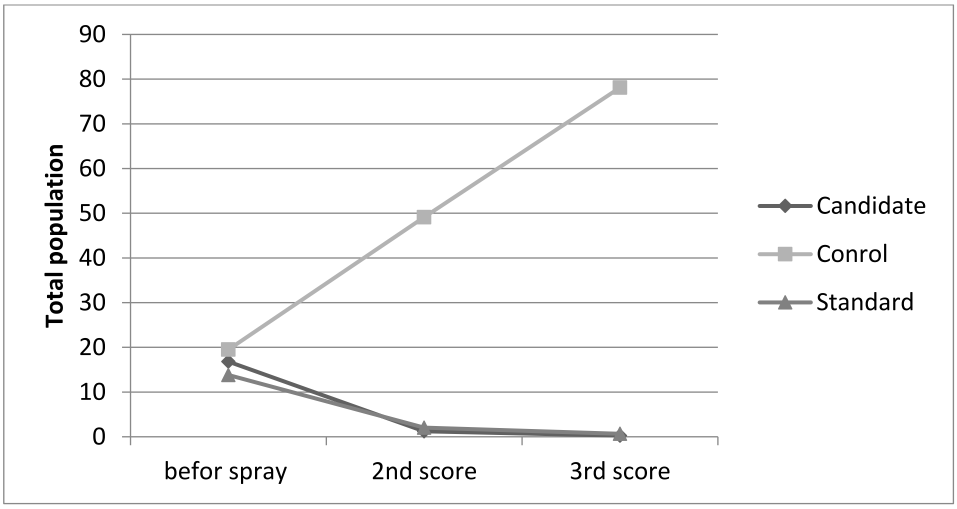

Fig. 2. Cabbage aphid Total populations before spray, first and after second round insecticide

Conclusion and Recommendation:

The study concluded that the new insecticide product lmidacloprid 200g/l has shown better performance than the standard check Con-Fidence 350 Sc. However, lmidacloprid 200g/l recorded a low aphid population than Con-Fidence 350 Sc. Therefore, it can be concluded that the lmidacloprid 200g/l insecticide product is the best candidate for higher productivity of head cabbage and could be an alternative insecticide for cabbage aphid management in South Tigray.

Hence, this study recommended that the private pesticide traders and agriculture and rural development district office should disseminate the lmidacloprid 200g/l to the community.

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