



Research Article

Determination of the application rate and Frequency of Nimbecidine for the effective management of pea aphid *Acrythosiphon pisum* (Homoptera: Aphididae) on field pea

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Abstract

The development of botanical insecticides as a novel and safer alternative strategy, botanical insecticides which contain plant extracts as active components are safer as well as environmentally friendlier than synthetic insecticides. The field experiment was conducted at Ginir district with the objectives to evaluate the Nimbecidine insecticide against field pea aphid and to determine the application rate and frequencies for the effective management of field pea aphid. The experiment was laid out in RCBD design with three (3) replication. The treatments include five rate of nimbecidine (3, 3.5, 4, 4.5 L/ha) and three frequencies (0, 1, 2 and 3). Aphid population significantly affected by the rate and frequency of nimbecidine at the rate 4.5 lt/ha the mortality reached from 27.89 to 10.67% on two times sprayed plots. The highest yield advantage of 35.61% and 33.86% over the untreated control was obtained from the plots treated at the rate of 4.5 and 4 lt/ha when sprayed two times. Therefore, Their use in pea aphid IPM at the rate of 4.5lt/ha at the frequency of two times application at flowering and pod setting stage provides good results.

Introduction

In the development and promotion of Integrated Pest Management (IPM), interest in using botanicals has gained attention in recent years. This is because of their benefit in reducing environmental pollution, minimum effect on non-target organism and averting insecticide induced resistance among others [1]. Research on botanical control of insect pest in Ethiopia has so far concentrated on storage pest management [1]. Information on their potential against field pest is scanty. Development of bio control based IPM entails replacement of non-synthetic insecticides by selective and IPM compatible products. The misuse and excessive use of synthetic insecticide may cause some undesirable effects not only to the agricultural ecosystem but also to human health due to insecticide residue in food. Therefore, several efforts have been created to reduce the use of synthetic pesticides.

One of the efforts is the development of botanical insecticides as a novel and safer alternative strategy, botanical insecticides which contain plant extracts as active components

are safer as well as environmentally friendlier than synthetic insecticides [2]. A number of insect pest species including pea aphid, *Acrythosiphon pisum* (Homoptera: Aphididae), Pod borer, *Helcoverpa armigera* (Lipdoptera: Noctuadae), Black bean aphid, *Aphis fabae*(Homoptera: Aphididae), Thrips, *Taeniothrips nigricomis* and leaf minor, *Liriomyza brassicae* inflict damage on pulse crops in Ethiopia [3]. Of these, the pea aphid and pod borer are the most important in affecting the field pea production in Ethiopia.

Nimbecidine EC is a neem-oil-based botanical insecticide containing Azadirachtin and other limonoids including Meliantriol, Salanin, Nimbin and a host of other terpinoids in the ratio as it occurs naturally in Neem. Nimbecidine exhibits multiple modes of action. It acts as an: Antifeedant, Repellent, Ovi-position Deterrent, Antifeedant, Insect Growth Regulator, Sterilant.

Features of Nimbecidine

- Nimbecidine is a broad spectrum botanical insecticide.

- Nimbecidine is a natural plant based botanical insecticide.
- Nimbecidine does not create resistance, resurgence or residue problems.
- Nimbecidine forms a good molecule for use in an IPM programme.

Benefits of Nimbecidine

- It effectively controls the economically important pests such as Whitefly, Aphids, Thrips, Mealy bugs, Caterpillars and Leafhoppers in a wide range of crops.
- Does not affect the natural enemies. Safe to use with beneficial parasites and predators and thus offers long-lasting pest control.
- Helps to increase productivity by controlling the pests and improving crop health.
- It is eco-friendly and helps to maintain the Ecological Balance.
- Insects cannot develop resistance against Nimbecidine.
- No residue.

I evaluated Nimbecidine on field pea aphids with the comparison of synthetic insecticide dimethoate at our experimental station and I observed that the efficacy of nimbecidine was less as compared to dimethoate. Hence, it may need the increment of the dosage and frequencies since the botanicals are degraded quickly. Therefore, I want to test its efficacy at different rates, the experiment was proposed with the following objective.

Objective

- To determine the appropriate rate and frequencies for the effective management of pea aphid.

Materials and methods

Treatments and experimental design

The experiment was done at Agarfa research sub-station during 2017–2019 crop seasons. The experiment was laid out in RCBD design with three (3) replications. The treatments included five rate of nimbecidine (3, 3.5, 4, 4.5 L/ha) and three frequencies (0, 1, 2 and 3). The plot was size of 4m x 1.2m with 6 rows, 0.2m apart. Recommended agronomic practices were followed for cultivation. Insecticides were sprayed during the crop growing season following the appearance of pea aphid and continued at 8 days intervals.

Data to be collected

Data on date of flowering, date of maturity, %of infestation (No_ of aphid/plot), efficacy (No_ of aphid/plant) before and after spray, number of pods/plant, number of seed /pod, thousand seed weight and grain yield were collected.

Data management and statistical analysis

Both the field data (%infestation, efficacy and agronomic data) and laboratory data (yield & yield related data) were collected. Data were subjected to the analysis of variance using GLM Procedure SAS software (SAS 2002). The means were compared using Duncan's Multiple Range Test (DRMT) (Duncan, 1955) at 0.05 probability level.

Result and discussion

Aphid population

The activity of the Nimbecidine against pea aphid (*Acrythosiphon pisum*) at the four rates sprayed (3, 3.5, 4 and 4.5lt/ha). At 4.5 lt/ha the mortality reached from 27.89 to 10.67% in the twice sprayed plots. The maximum percent of aphid infestation (70.44%) after spray was recorded from untreated control and followed by Nimbecidine sprayed at the rate of 3 and 3.5 lt/ha (31.33% and 31.11%, respectively while the lowest (18.67%, 10.67%, 17.33) were recorded from Nimbecidine sprayed at the rate of 4.5 lt/ha on one, two and three times treated plots, respectively. The observed lower number of pea aphids in the high rate of application than the low rate agrees with reports of Swaminathan, et al. [4]. They reported a higher percentage (73.3%) of *Adonia variegata* (Goeze) mortality from a 10% neem seed kernel extract than a 5% neem seed oil which caused 65% mortality.

Yield and yield components

Analysis of variance for grain yield depicted that there was a significant difference ($P < 0.05$) between treatments (Table 1). Yields in kg/ hectare ranged between 3385 and 5257.08 among treatments. The highest grain yield of 5257.08 kg/ha, 5118.02kg/ha were harvested from Nimbecidine sprayed at the rate of 4.5lt/ha and 4l/ha on the plot sprayed twice, respectively. Whereas, the lowest grain yield of 3385 kg/ha was harvested from untreated plots followed by the plot sprayed at the rate of 3lt/ha (3487.71 kg/ha) and 3.5 l/ha (3439.90 kg/ha) (Table 1).

Pods per plant, seeds per pod and thousand seed weight ranged between 8.1 – 11, 4.3 – 4.87 and 170.60 and 182.53 gm, respectively (Table 1). The differences between the rates were not significant for pods per plant, seeds per pod and thousand seed weight. Differences between different rates of Nimbecidine for yield was significant. The lowest values for all yield and yield component variables were obtained from the untreated plots and from the lowest rates of Nimbecidine (at the rate of 3 and 3.5 lt /ha) and the highest were obtained from higher rates (4 and 4.5 lt/ha) treatment. The yield advantage of 35.61% and 33.86% over the untreated control was obtained from the plots treated at the rate of 4.5 and 4 lt/ha when sprayed twice.

Simple regression analysis between aphid infestation % age and yield

The estimated slope of the regression line obtained for the field pea yield was -10.37. The estimate showed that for each unit increase in percent infestation of aphid, there was a grain



yield loss of 10.37 kg/ha (Figure 1) Based on the coefficient of determination (R^2) value, the equations explained about 12% of variation in yield due to aphid infestation.

Cost/benefit analysis

The result showed that Nimbecidine twice sprayed plots at the rate of 4.5 l/ha provided the highest gross returns (ETB 165,585/ha) and the lowest gross return ETB 106,610.00/ha was obtained from the untreated check. The plot sprayed with Nimbecidine sprayed plots at the rate of 4.5 l/ha gave the maximum net return ETB 150, 238.80 /ha and also gave the highest benefit cost ratio (9.79). Nimbecidine once sprayed plots at the rate of 4.5 l/ha plots also provided the higher gross returns (ETB 155,750 /ha) and gave the higher net return ETB 142,235 /ha and also gave the higher benefit cost ratio (10.52).

The highest (ETB 358.96) marginal rate of return was obtained from Nimbecidine twice sprayed plots at the rate of 4.5 l/ha. In other words, for every ETB 1.00 investment in Nimbecidine at the rate of 4.5l/ha cost and spraying, there was a gain of ETB 3.59. Therefore the most economic benefit for pea aphid management was obtained from Nimbecidine twice sprayed plots at the rate of 4.5l/ha Table 2.

Conclusions and recommendations

Results of the study showed that Nimbecidine insecticide at 4lt/ha and 4.5 lt/ha application rate can reduce pea aphid population and their damage on field pea. The pesticidal characteristics of extracts from different parts of the neem tree, *Azadirachta indica* against several pests of crops are well documented [5,6]. The observed lower number of pea aphids in

Table 1: Effect of rate and frequencies of Nimbecidine insecticide on aphid infestation, yield and yield components at Agarfa in 2017-2019 GC cropping season.

No.	Rate	Frequency	% age infestation before spray	% age infestation After spray	Pod per plant	Seed per pod	HSW	Yield (kg/ha)	Yield advantage Over control
1	R1	F1	30.34	29.89	8.87	4.77	180.07	3941.35	14.12
2	R1	F2	38.22	28.78	9.67	4.6	182.53	4551.98	25.64
3	R1	F3	53	31.11	9.13	4.37	168.93	3487.71	2.9
4	R2	F1	26.22	31.33	8.1	4.58	177.33	4001.77	15.41
5	R2	F2	29.33	24.32	11	4.73	176.6	3439.90	1.6
6	R2	F3	45.22	17.89	10.67	4.37	174.47	4620.83	26.74
7	R3	F1	66.22	22.56	11	4.67	168.8	4513.44	25.00
8	R3	F2	86.11	30.22	9	4.47	173.07	5118.02	33.86
9	R3	F3	52.78	21.33	10.53	4.73	172.8	3786.35	10.60
10	R4	F1	39.11	18.67	9	4.87	172.33	4945	31.55
11	R4	F2	27.89	10.67	10.57	4.73	178.13	5257.08	35.61
12	R4	F3	24	17.33	9.53	4.53	174.2	4860.63	30.36
	Control		35.33	70.44	9.77	4.57	170.6	3385	
	CV (%)			32.60	26.58	7.05	5.13	18.49	
	LSD (0.05)		35.97	10.34	3.47	0.43	12.04	1084.6	

Note: R1: Rate1; R2: Rate2; R3: Rate3 and R4: Rate4; F1: Frequency 1 times; F2: Frequency 2 times and F3: Frequency 3 times

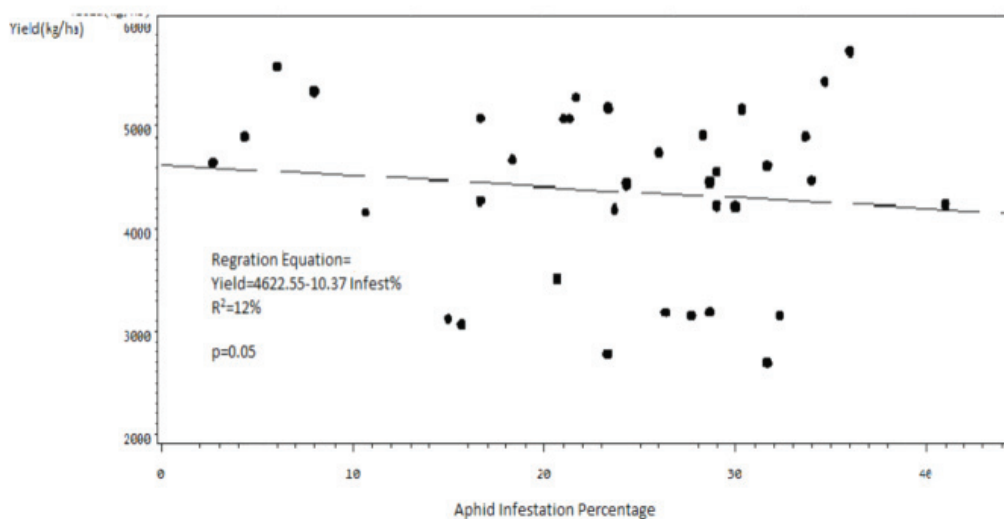


Figure 1: Estimated relationship between losses in grain yield with aphid infestation % age at Agarfa 2018/19 cropping season.



Table 2: Cost-benefit analysis of Nimbecidine application rate and frequencies against pea aphid on field pea during 2017/19 GC Season at Agarfa.

Rate	Frequency	Yield obtained (qt/ha)	Adjusted	Sale price (ETB/qt)	Total Variable Cost (ETB/ha)	Gross Return (Price x Qt)	Net Return (GR-TVC)	Benefit cost ratio (GMP/TVC)	MRR (NR-NR of Control /TVC)	MRR %
R1	F1	39.41	35.5	3500	12810	124,250.00	111,440.00	8.70	1.27	127.16
R1	F2	45.6	41.04	3500	14170.8	143,640.00	129,469.20	9.14	2.42	242.1769
R1	F3	34.88	31.4	3500	15228	109,900.00	94,672.00	6.22	-0.03	-3.14421
R2	F1	40.1	36.09	3500	12996.8	126,315.00	113,318.20	8.72	1.40	139.7836
R2	F2	34.4	30.96	3500	14319.2	108,360.00	94,040.80	6.57	-0.08	-7.75183
R2	F3	46.21	41.59	3500	15956.8	145,565.00	129,608.20	8.12	2.16	215.9418
R3	F1	45.13	40.62	3500	13262.4	142,170.00	128,907.60	9.72	2.55	254.5301
R3	F2	51.18	46.06	3500	14971.4	161,210.00	146,238.60	9.77	3.41	341.236
R3	F3	37.86	34.07	3500	16331.4	119,245.00	102,913.60	6.30	0.48	47.53297
R4	F1	49.45	44.5	3500	13515	155,750.00	142,235.00	10.52	3.48	348.3848
R4	F2	52.57	47.31	3500	15346.2	165,585.00	150,238.80	9.79	3.59	358.9683
R4	F3	48.61	43.75	3500	17050	153,125.00	136,075.00	7.98	2.40	240.0246
	Control	33.85	30.46	3500	11459.2	106,610.00	95,150.80	8.30	0.00	

the high rate of application than the low rate agrees with reports of Swaminathan, et al. [4]. They reported a higher percentage (73.3%) of *Adonia variegata* (Goeze) mortality from a 10% neem seed kernel extract than a 5% neem seed oil which caused 65% mortality. The plot sprayed with Nimbecidine sprayed plots at the rate of 4.5 l/ha gave the maximum net return ETB 150, 238.80 /ha. The highest (ETB 358.96) marginal rate of return was obtained from Nimbecidine twice sprayed plots at the rate of 4.5 l/ha. Synthesized Nimbecidine was able to provide varying degree of protection on pea from pea aphid attack and safer to pea aphid natural enemies than the synthetic insecticide suggesting their potential in the Integrated Management of the Pest (IPM). Therefore, Nimbecidine twice sprayed plots at the rate of 4.5l/ha application was recommended for the management of field pea aphid.

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