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BIOEFFICACY OF DIFFERENT INSECTICIDES ON COWPEA APHID (*APHIS CRACCIVORA* KOCH)

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A B S T R A C T

Aphid (*Aphis craccivora* Koch) is one of the serious pests of cowpea. Bioefficacy of four insecticides with different concentrations namely Jholmol (125 ml/L), Neemix (2 ml/L), Cannabis extract (100 g/L), Chlorpyrifos 50% EC and Cypermethrin 5% EC (2 ml/L) along with control were evaluated against aphid at Research Station of Agriculture and Forestry University, Rampur, Chitwan, Nepal in 2018. Five treatments; four different insecticides and control were laid out in a randomized complete block design with four replications. The results indicated that all the insecticides were significant for aphid reduction. The effects were higher in Neemix followed by Jholmol and cannabis extract. The yield of cowpea was significantly highest (11.10 t/ha) with Neemix application, while lowest in control (7.58 t/ha). The highest net profit (NRs.61670) was obtained in Neemix followed by treatments of Jholmol (NRs.46175) and Cannabis extract (NRs.35815). The lowest incremental Cost/Benefit ratio was obtained in Neemix (1.341) and followed by treatments of, jholmol (1/1.12) and Cannabis extract (1/0.85), respectively. Thus, application of Neemix @ 2 ml/L could be used in cowpea to control aphid with high yield.

Keywords: Aphid, *Aphis craccivora* Koch, insecticides, bioefficacy, cowpea.

INTRODUCTION

Cowpea (*Vigna unguiculata* Linn.) is the most important legume crop, also known as Lobia, it belongs to family Leguminaceae. It is used as a green legume, fodder, vegetable as well as green manure crop. It is an important source of energy, minerals, vitamins and roughages.

There are about 21 insect pests of different groups which are recorded to damage cowpea crop from germination to maturity (Choudhary *et al.*, 2017). The important insect species attacking cowpea crop are: aphid, *Aphis craccivora Koch*; jassid, *Empoasca fabae (*Harris); thrips*, Megaleurothrips distalis Karny;* armyworm, *Mythimna separata (*Walker); *semilooper, Thysanoplusia orichalcea (Fab.);* Leafminer, *Phytomyza horticola* Meigen and pod borer, *Helicoverpa armigera* (Hubner) resulting in heavy yield losses (Satpathy *et al.*, 2009). Among these, cowpea aphid, *Aphis craccivora* Koch is the most serious pest of this crop, causes 20-40 percent yield loss (Choudhary *et al.*, 2017). The sap-sucking insects like aphids (*A. craccivora* Koch) cause considerable damage to the crop and is reported as one of the important, major and economic pests of cowpea (El-Ghareeb *et al.*, 2002). The cowpea aphid, *A. craccivora* belongs to the family *Aphididae* of order *Hemiptera*, suborder *Homoptera* (Choudhary *et al.*, 2017). The aphid causes both qualitative and quantitative losses in the seed yield and crop production by different ways include: Nutrient drain which cause direct reduction of plant productivity, transmission of viruses, phytotoxicity as a result of saliva toxins and excretion of honeydew leading to the development of black sooty mold and leaf shedding (Kotadia and Bhalani, 1992), which also attract saprophytic fungi covering the leaf surface and accelerating the ageing of leaves (Schepers, 1988).

Integrated pest management (IPM), also known as integrated pest control (IPC) is a broad-based approach that integrates practices for economic control of pests. IPM aims to suppress pest populations below the economic injury level (EIL) IPM emphasizes the growth of a healthy crop with the least possible

disruption to agro-ecosystems and encourages natural pest control mechanisms. Different methods like the physical, cultural, biological, mechanical, chemical method of pest control are justifiably used to suppress them below EIL. Many research and farmers have emphasized on the use of the insecticides solely based on the chemicals, which are not performing well as expected in the later year in both aspects of production and consumer health. Keeping this aspect, we have done research in regard to comparing different IPM based insecticides (including chemical insecticides) on the aspects of production, aphid count and economic efficiency. Use of plant extracts like Neem (*Azadirachta indica*) extract, *Cannabis sativum* extract and use of biological pesticide (Jholmol) are used as biological method whereas the use of chemicals like Chlorpyrifos and Cypermethrin is under the chemical method of IPM.

MATERIALS AND METHODS

Experimental Site: This experiment was carried out using the cowpea (Variety: Karma Stickless) at Horticultural Research Field of Agriculture and Forestry University, Rampur, Chitwan, Nepal. The geographical location of the experimental field was 27° 37' N latitude, 84° 25' E longitude at an altitude of 256 meters above sea level and has a subtropical climate (Thapa and Dangol, 1988). The maximum and minimum temperatures of 34.5^{0}C and 18.5^{0}C respectively, relative humidity of 80-85% and rainfall of 70-80 mm were detected during the crop growing period.

Experimental design and field layout: The experiment was laid out in a randomized complete block design (RCBD) with four replications. Three treatments were of biological origin and the fourth one was the chemical origin (Table 1). There were altogether 20 plots, where 5 plots are in each replication. The individual plot size was 3m × 3m keeping row to row and plant to plant distance of 60 cm and 60 cm, respectively. The seeds of stickless cowpea variety (Karma stickless) was sown on 2nd March 2018 and the recommended package of practices was followed to raise the crop.

Insecticides and their application: Neemix and Chlorpyrifos 50 % EC and Cypermethrin 5% EC were received from Dawadi Agrovet, Chitwan, Nepal. The cannabis was locally collected. Jholmol was locally prepared. Neem extract was commercially obtained as the trade name "Neemix".

For the preparation of the cannabis extract, the leaves of the mature cannabis plants were dried, and they were ground on the floor. A dose of about 100 g/L was made. Similarly, for the preparation of Jholmol, it was prepared by mixing animal urine, animal dungs (Cow dung) and water at 1:1:1 ratio and fermented for 2-3 weeks. Similarly, for the application of the slurry, it was mixed with the water at the ratio of 1:8, so that the dose of 125 ml/L was made. Also, Neem extracts as Neemix was commercially obtained which was sprayed at the dose of 2 ml/L. The insecticide Chlorpyrifos 50% EC and Cypermethrin 5% EC was sprayed at the dose of 2 ml/L.

Table 1. Name of different insecticides used in the experiment along with their origin and dose.

Sr. No.	Treatments	Origin	Dose
1	Jholmol	Bio-pesticide	125 ml/L
2	Neem extract (Trade Name: Neemix)	Bio-pesticide	2 ml/L
3	Cannabis extract	Bio-pesticide	100 g/L
4	Chloropyrifus 50 % EC and Cypermethrin 5 % EC	Chemical	2 ml/L
5	Control (normal water)	-	-

All the insecticides were applied as a foliar spray. The spraying was done by using a 16 Liter knapsack sprayer. The first insecticides spray was done on the 23rd of March. About 3 sprays of chemical insecticide were done at the 15 days interval. Similarly, the other insecticides of biological origin were sprayed 3 times about weekly interval.

Data collection: The five randomly selected plants inside each plot were tagged, and observation on the aphid population was taken from the tagged plants on three leaves, each from the top, middle and bottom canopy of plants in each plot. Aphid population was counted one day before and 3, 5 and 7 days after application of insecticides. The observations on aphid population were recorded by visual counting method. The crop was harvested when pods reached full maturity. Pod yield is calculated from the tagged plant inside each plot. Pod yield per plot was converted into quintal per hectare and yield data was statistically analyzed.

The data thus obtained were taken into consideration to calculate the percentage reduction in the population which was determined by applying a correction factor given by Henderson and Tilton referring it to Abbott modification (Püntener, 1981);

Percentage reduction = 100 × [1- {(Ta × Cb) / (Tb × Ca)}]

Where;

T_a = Number of insects after treatment.

T_b = Number of insects before treatment.

C_a = Number of insects in untreated control after treatment.

C_b = Number of insects in untreated control before treatment.

Economics analysis

Cost of treatments: Cost of different insecticide: Neem extract (Neemix): NRs.160 for 100 ml, Cannabis extract: NRs. 35/kg, Jholmol: NRs. 50/L and Chemical (Chlorpyriphos 50% EC and Cypermethrin 5% EC) =NRs.200 for 100 ml., Labor charge: NRs 1000/ha, the Market price of cowpea: NRs. 25/kg pod.

Net return (NRs. /ha): This was calculated separately by subtracting the cost of treatment from additional income of respective treatment.

Incremental Cost-Benefit ratio: This was calculated separately for each treatment as per the following formulae suggested by (Chejara, 2013).

Incremental Cost-Benefit ratio (ICBR) = Net return/Cost of treatment.

Statistical analysis: The analysis was carried out by transforming the percentage reduction data into angular transformation values (Gomez and Gomez, 1984). Microsoft Excel was used and statistical software, R stat was done for the statistical analysis.

RESULTS AND DISCUSSION

First insecticidal application: After the insecticide's application, all the treatments were found significantly different than the untreated control (Table 2). At the 3rd day, the effect of Neem extract of dose 2ml/L was found significantly higher for aphid population reduction (90.17%) than the other treatments over control. The chemical treatment of Chlorophyriphos50% EC and Cypermethrin5% EC (2 ml/L) was found similar to the Neem extract and with Jholmol. The cannabis extract was found significantly lower than the other insecticides treatments having percent reduction over control value of 66.16%.

Table 2. Effects of insecticides on percent reduction of cowpea aphid population after 1st spray

Sr. No.	Insecticides	Percent reduction of aphid over control after 1st spray			
		3rd day after spray	5th day after spray	7th day after spray	Mean
1	Jholmol	78.36^{b} (62.28)	73.86^{b} (59.25)	62.08^{bc} (51.99)	71.67 ^{b} (57.84)
2	Neem extract (Neemix)	90.17^{a} (71.73)	96.26^{a} (78.85)	88.9^{a} (70.55)	91.75 ^{a} (73.71)
3	Cannabis extract	66.16 ^{c} (54.43)	55.09^{b} (47.92)	39.04^{c} (38.67)	53.51^{c} (47.01)
4.	Chloropyriphos 50% EC and Cypermethrin 5% EC	75.36^{ab} (60.24)	79.16^{ab} (62.84)	62.92^{b} (56.74)	74.91^{b} (59.94)
5	Control (water)	-	-	-	-
	CV (%)	10.5	13.6	12.9	8.79
	$LSD_{0.05}$	10.4	11.6	12.8	8.08

Means with the same letter do not differ significantly at p= 0.05 by DMRT. CV = Coefficient of variation. LSD= least significant difference. The figures in the parentheses are the angular transformed values.

At the 5th day after the 1st insecticides application, the effect of Neem extract was found significant (96.26% reduction for aphid) than the other treatments over control. The effect of cannabis extract on aphid reduction was found lower than the other insecticidal treatments.

Similarly, on the 7th day of the 1st insecticides treatment, again the effect of Neem extract was found significantly higher (88.9% reduction in aphid) than the other treatments over control. After that, chemical treatment was significantly similar to Jholmol but superior to cannabis extract. Jholmol and cannabis extract was found significantly similar. The effect of cannabis extract was significantly lower than the other insecticides treatments with a 39.04% reduction over control.

After the 1st insecticides treatment, the overall effect was found to be significantly higher at Neem extract which was followed by chemical treatment. The chemical

treatment was found significantly similar to the Jholmol which was followed by cannabis extract.

Second insecticidal application: Similarly, after the 2nd insecticidal treatment, the effects of all the insecticides treatments were found significantly higher than the untreated control (Table 3). At the 3rd day after the 2nd insecticidal treatment, effect of Chlorpyriphos 50% EC and Cypermethrin 5% EC was found significantly higher (96.70 % aphid reduction) than the other treatments over control. The chemical treatment was found significantly similar to the Neem extract and also to Jholmol. Similarly, Jholmol was found significantly similar to the cannabis extract and cannabis extract was found significantly lower than the insecticides treatment with the 66.18% reduction over control.

At the 5th day after the 2nd insecticides treatments, instead of Neem extract, the chemical treatment was found significantly superior to the other treatments with the 77.31% reduction over control. It was found similar to the Neem extract. Neem extract was found significantly similar to the Jholmol, whereas the effect of cannabis extract was found significantly lower than the other insecticides treatment.

At the 7th day after the 2nd insecticides treatments, again the chemical treatment was found significantly higher than the other treatments. It was found similar to the Neem extract. Neem extract was found significantly similar with the Jholmol and Cannabis extract. Jholmol was found significantly similar with the cannabis extract which were found significantly lower than the other insecticides treatment.

After the 2nd insecticides treatments, the overall effect was found to be significantly higher in Neem extract which was found significantly similar to the Chlorpyriphos 50% EC and Cypermethrin 5% EC and followed by Jholmol. The effect of cannabis extract was significantly lower among all the insecticidal treatment which is significantly similar to the Jholmol.

Table 3. Effects of insecticides on percent reduction of cowpea aphid population after 2nd spray.

Sr. No.	Insecticides	Percent reduction of aphid over control after 2nd spray			Mean
		3rd day after spray	5th day after spray	7th day after spray	
1	Jholmol	77.31 bc (61.55)	47.87b (43.78)	64.89b (53.66)	63.77 b (52.99)
2	Neem extract (Neemix)	90.44ab (71.99)	77.31a (61.55)	93.93a (75.74)	88.03a (69.76)
3	Cannabis extract	66.18 c (54.44)	28.81c (32.463)	54.32b (47.48)	49.63 b (44.79)
4.	Chloropyriphos 50%EC and Cypermethrin 5% EC	96.70a (79.53)	65.87ab (54.28)	88.2ab (69.95)	85.87 a (67.922)
5	Control (water)	-	-	-	-
	CV (%)	15.7	14.6	13.8	10.2
	$LSD_{0.05}$	16.8	11.2	13.6	9.6

Means with the same letter do not differ significantly at p=0.05 by DMRT. CV = Coefficient of variation. LSD= least significant difference. The figures in the parentheses are the angular transformed values.

Third insecticidal application: Similarly, after the 3rd insecticides treatment, the effect of all the insecticides treatments were found significantly higher than the untreated control (Table 4). At the 3rd day after the 3rd insecticides treatment, effect of neem extract was found significantly higher than the other treatments with the 93.60 % reduction over control. Chemical treatment and Jholmol were found significantly similar to each other and Neem extract. They were also found significantly similar to the Cannabis extract which was found significantly lower than the other insecticides treatments.

At the 5th day after the 3rd insecticide application, instead of Neem extract, the chemical treatment was found significantly higher than the other treatments with the 66.41% reduction in aphid population over control. It was found similar to the Neem extract. Neem extract was found significantly similar with the Jholmol and Jholmol was found significantly similar to the Cannabis extract which was found significantly lower than the other insecticides treatments.

At the 7th day, Neem extract was found significantly superior to the other treatments. The chemical treatment was found significantly similar to all the

insecticides treatments. Similarly, Jholmol was found significantly similar to the Cannabis extract and Cannabis extract was found significantly lower than the insecticides treatment with the 66.41% reduction over control.

After the 3rd insecticides treatment, again, the overall effect was found to be significantly higher in Neem extract which is similar to Chlorpyriphos 50% EC and Cypermethrin 5% EC and followed by Jholmol which was significantly similar to the Cannabis extract.

Table 4. Effects of insecticides against the cowpea aphid population after 3rd spray.

Sr. No.	Insecticides	Percent reduction of aphid over control after 3rd spray			
		3rd day after spray	5th day after spray	7th day after spray	Mean
1	Jholmol	79.87 ab (63.34)	30.21bc (33.34)	65.83bc (54.23)	59.21 b (50.31)
2	Neem extract (Neemix)	93.60a (75.35)	49.41ab (44.66)	88.95a (70.58)	80.13 a (63.53)
3	Cannabis extract (Ganja)	66.41 b (54.58)	17.30c (24.58)	51.66c (45.95)	44.25 b (41.70)
4.	Chloropyriphos 50% EC and Cypermethrin 5% EC	85.34ab (67.49)	66.41a (54.58)	81.78ab (64.73)	78.35a (62.27)
5	Control (water)	-	-	-	-
6.	CV (%)	13	18.5	11.9	11.5
7	$LSD_{0.05}$	13.6	11.7	11.2	10

Means with the same letter do not differ significantly at p= 0.05 by DMRT. CV = Coefficient of variation. LSD= least significant difference. The figures in the parentheses are the angular transformed values.

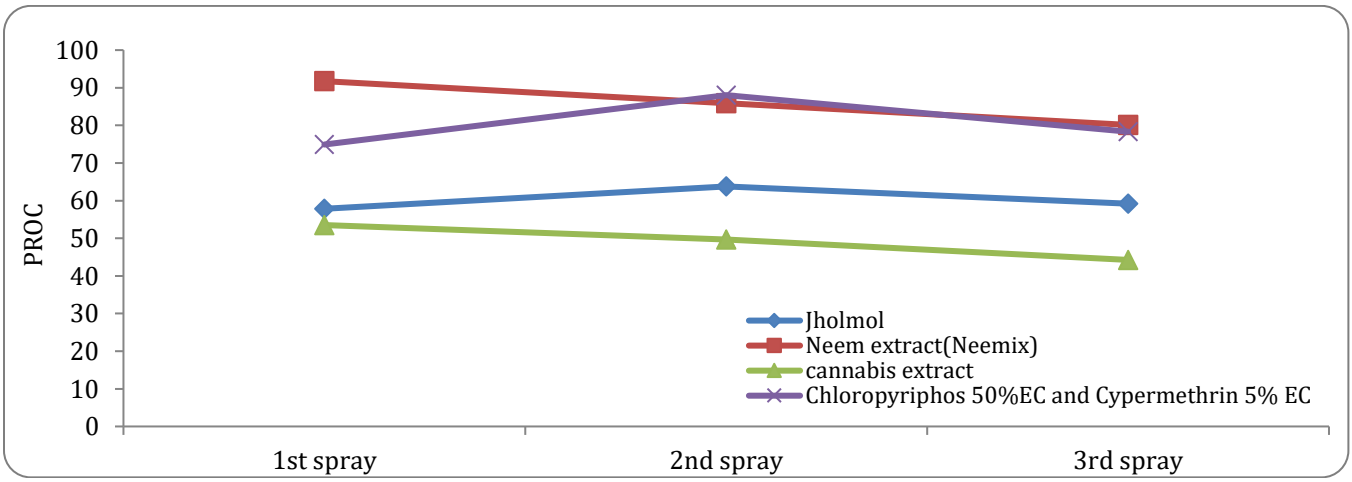

Figure1. Effects of different sprays of different insecticides on percent reduction in aphid over control.

Neem extract was more effective than all treatments (Figure 1). Azadirachtin is a chemical complex found in seeds of neem, *Azadirachta indica*, *A. Juss*, it is the main component responsible for the toxic, repellent, anti-feed ant, growth-inhibiting, oviposition-inhibiting and sterilizing effects in insects (Kumar and Navaratnam, 2013; Mordue and Nisbet, 2000). The extract of this plant reduces the population of several aphid species, causing high mortality and decreasing fecundity, as well as inhibiting population growth (Partridge and Borden, 1997; Tang *et al.*, 2002; Ulrichs *et al.*, 2001). The use of a chemical method was also very effective. It is a special combination insecticide contains chlorpyrifos (organophosphorus compound) and cypermethrin (pyrethroid compound) which means a special efficiency to control a wide range of soil and foliar insects which acts as strong contact, stomach and respiratory action. Similarly, the application of Jholmol contributed to increased farm production with a lesser attack of insects and diseases (LWF Nepal, 2017). The effectiveness of the cannabis extract is minimum than the other insecticides treatments, but it is highly significant than the control.

Effects of insecticides on the yield of cowpea: The pod yield of cowpea under all the insecticides treatments were significantly higher over control. Neem extract produced the highest pod yield of 11.10 t/ha which was significantly higher than the other all treatments. Similarly, the chemical treatments were significantly similar to the Neem extract and Cannabis extract, which produced a yield of 10.33 t/ha. Among the insecticide's treatments, Cannabis extract produced the lowest yield of 9.18 t/ha but it was also significantly higher than the control and significantly similar to the Jholmol and chemical treatment.

The similar type of trend is obtained from the effectiveness of the insecticide's treatments on the basis of aphid reduction over control.

Table 5. Effects of insecticides on the yield of Cowpea.

Sr. No.	Treatments	Yield (t/ha)
1	Jholmol	10.56^{ab}
2	Neem extract (Neemix)	11.10^{a}
3	Cannabis extract	9.18^{b}
4	Chloropyrifus 50% EC and Cypermethrin 5% EC	10.33^{ab}
5	Control (water)	7.58^{c}
	CV (%)	10
	$LSD_{0.05}$	1.51

Means with the same letter do not differ significantly at p= 0.05 by DMRT. CV = Coefficient of variation, LSD= least significant difference.

Similar results were reported by Baidoo *et al.* (2012), that neem products were effective in controlling *A. craccivora* on cowpea. They reported that the aqueous product of the neem extract was effective against the *Aphis craccivora*, the yield was better than that on the control plots and yield from the neem-treated plots, also compared favourably with that of the insecticide-treated plots. Similarly, Prasannath and Mahendran (2013) revealed that neem seed extract 5% showed a significant reduction ($P<0.05$) in aphid population and his study elucidates that use of neem seed extract 5% could be suggested to manage the cowpea pests as it has been found to have very promising bioefficacy against this pest.

Economics of insecticides application: The highest net profit was obtained in Neem extract which was NRs.61670 among the insecticides treatment which is followed by chemical treatment, Jholmol and cannabis extract with the net profit of NRs.46175, NRs. 35815 and NRs.16696 respectively. Similarly, the Incremental Cost-Benefit Ratio (ICBR) was observed from 1/3.14 to 1/0.85. Among the insecticide's treatment, lowest Cost/Benefit ratio (1/3.14) was obtained in Neem extract and followed by chemical treatment (1/2.85), jholmol (1/1.12) and cannabis extract (1/0.85).

Table 6. Economics of different insecticides applications against aphid on cowpea.

Sr. No.	Treatments	Cost of treatments (NRS. / ha)	Yield (t/ha)	Gross return (NRs/ha)	Net profit over control	Incremental cost benefit-cost ratio (ICBR)
1	Jholmol	31760	10.56	67575	35815	1:1.12
2	Neem extract (Neemix)	18080	11.10	79750	61670	1:3.41
3	Cannabis extract (Ganja)	19554	9.18	36250	16696	1:0.85
4	Chloropyrifus 50 EC and Cypermethrin EC	16200	10.33	62375	46175	1:2.85
5	Control (water)	-	10.56	-	-	-

The effective value of the IBCR for different IPM methods suggests that they were economic, which is the core theme of IPM. Similar finding was obtained by Jackai (1993) who reviewed the current status of the use of neem (*Azadirachta indica* A. Juss) on cowpea, which shows due to the high cost and unavailability of the conventional insecticide, the use of neem extract has been intensified (Singh *et al.*, 1997) as it is relatively cheap, available and effective.

CONCLUSION

Neemix (neem extract) was more effective insecticide against cowpea aphids. Neemix treated plots produced higher yield and economic returns. Moreover, other plant extracts namely cannabis extract, Jholmol were also found relatively effective insecticides, so their commercialization is necessary for pest control.

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