



Effect of biopesticides on cowpea plant aphid (*Aphis craccivora*)

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Abstract

The present study was conducted to know the effect of different biopesticides on aphid *Aphis craccivora* which attacks cowpea plant, *Vigna unguiculata*. Pesticides residues in agricultural commodities are being the issue of major concern besides their harmful effect up on human life, wild life and other flora and fauna. There is also an urgent need for research and development of ecofriendly and biorational insecticides for pestcontrol in Cowpea. About 25 million cases of acute occupational pesticide poisoning in developing countries are being reported each year. Observations were made regarding the influence of biopesticides on the stages of growth. The study was conducted to identify whether biopesticides such as neem oil emulsion, tobacco decoction, neem kemal suspension and ginger garlic extract were effective against cowpea aphid. Among the biopesticides, neem oil was found to be very effective against cowpea aphid. Its cost of production is very less as compared to other chemical pesticides and easily available in nature. Biopesticides are safer to humans and is environmentally sound because it does not cause residue problems.

Keywords: *Aphis craccivora*, *Vigna unguiculata*, biopesticides, neem oil emulsion, tobacco decoction, neem kemal suspension, ginger garlic extract

Introduction

Agriculture and allied activities contribute about 30% to the gross domestic product of India. India is the highest producer of cowpea in the world and it is the most widely grown pulse crop in Kerala. This accounts for about 75 percent of the total area under pulses in the state and is cultivated throughout the year as pure crop or in rice fallows in the garden land. Cowpea (*Vigna unguiculata*) is highly nutritious food legume crop in the production system of Semi-arid tropics and widely grown throughout the tropics. It is an annual legume with seed is rich in protein. It is a warm season, annual, herbaceous legume with strong tap root. The symbiotic relationship with a specific soil bacterium *Rhizobium* fixes atmospheric nitrogen and hence maintains soil fertility by a process known as biological nitrogen fixation. Fixation occurs in root nodules and bacteria utilize sugars produced by the plant.

The productivity of *Vigna unguiculata* is limited by the biotic stresses insect pest are known to be the prime constraint in cowpea production. The crop is damaged intensively by a large number of insect pests at various stages of its growth (Saxena, 1971; Raheja, 1973 and Falerio and Singh, 1985) ^[28, 22, 7]. Major pests that attack *Vigna unguiculata* are aphids, Root Knot Nematodes, Cowpea Curculio, Green Stink Bugs, Pod borers etc. Among these pests, the most common pest that attack *Vigna unguiculata* is Cowpea aphid (*Aphis craccivora*). Aphids are small, green, soft-bodied insects which feed by piercing the plant tissue. Infestations of this pest develop on leaves and the fruiting stems and reduces the amount of plant nutrients available for pod and pea development. The infested plant leaves turns yellow and dies. Aphids excrete large quantities of a sugary substance called honey dew which supports the growth of sooty mold which is dark in color and reduces the amount of sunlight that reaches the leaf. Mild damp weather favors development of aphid populations. The pest reaches its peak population at flowering and fruiting stages that is the pod formation stages of the crop. The vegetables harvested from crops frequently treated with toxic chemicals for the control of *Aphis craccivora* are prone to certain hazardous levels of pesticide residues. The menace has been widely reported and accepted as a serious drawback of chemical control particularly for vegetable and fruit crops. The frequent and massive application of insecticides even in pod bearing stage which often results in persistence of pesticide residues in the harvested pods and grains and thereby making it unfit for consumption.

'Biopesticides' are certain types of pesticides derived from such natural materials as animals, plants, bacteria, and certain minerals. They have a narrow target range and a very specific mode of action, slow acting, suppress, rather than eliminate a pest population and have no residue problems. Biopesticides are best alternatives to conventional pesticides and usually inherently less toxic than conventional pesticides. Biopesticides generally affect only the target pest and closely related organisms, in contrast to broad spectrum, conventional pesticides that may affect organisms such as birds, insects, and mammals. Biopesticides are safer to human sand is environmentally sound because it does not cause residue problems. Benefits of biopesticides include effective control of insects, plant diseases and weeds, as well as human and environmental safety. Biopesticides also play an important role in providing pest management tools in areas where environmental concerns limit the use of

chemical pesticide products. Use of chemical pesticides create many environmental problems and also affect the health of man and animals. It is a best alternative of chemical pesticides.

The vegetable Cowpea *Vigna unguiculata* sub sp. *sesquipedalis* is prone to attack by an array of insect pests. Pea aphid *Aphis craccivora* Koch is a common pest of winter and Kharif pulses and sometimes causes severe loss to the crops (Ayyar, 1940) ^[2]. Nagaich and Vaishisth (1965) ^[19] and Sreenivasan and Narayani (1966) ^[31] studied the broad bean virus of pea and reported that it causes the sap transmissible mosaic disease and virus is not seed borne. Mathew et.al (1971) ^[18] reported that pea aphid (*Aphis craccivora* Koch) is a serious pest of Cowpea in Kerala during dry periods. Gupta and Singh (1981) ^[9] stated that *Aphis craccivora* is a wide spread pest of cowpea in India and it caused significant damage by feeding on stems, terminal shoots, petioles and seedlings, pod and flowers. They further emphasized that the aphids in the tropical regions are more important as agents in the transmission of viral disease of Cowpea than as direct feeders. Dhuri and Singh (1983) ^[6] and Attia et.al (1986) ^[1] observed *Aphis craccivora* as the most damaging species in Cowpea from mid May to the end of September in India. This Aphid was reported as one of the most important pests of Cowpea by many scientists (Chabra et.al 1983, Ngugi et.al, 1985, Sudharma et.al, 1987 and Garhwal et.al, 1994) ^[3, 20, 30, 8] Koshy et.al (1987) ^[15] reported an yield loss of 13.33 to 33.89 percentage. Srikanth and Lakkundi (1988) ^[32] found that threat of *Aphis craccivora* was more in Cowpea than in any other pulse crop. The population of *Aphis craccivora* during summer (March-May) and Kharif (Aug-Oct) seasons increased rapidly with crop growth and their peaks coincided with pod formation stage and predation ratio also reached higher value during the peak pod formation stage and at the time of harvest (Srikanth and Lakkundi, 1990) ^[34]. *Aphis craccivora* infests the country bean and the leaves, twigs, inflorescences and even the pods of the plant tum black (Das 2002) by the thick colonies of the blackish-green *A. craccivora*. Both nymphs and adults of *Aphis craccivora* damage bean crops from vegetative to fruiting stages and may cause yield loss up to 100% in divergent species of legumes (Attia et al. 1986) ^[1]. When plants are heavily infested, leaf distortion and stunted growth commonly occur, and the end result is poor quality of fruits (York, 1992) ^[37]. Moreover, *Aphis craccivora* transmits about 20 non persistent plant viruses including broad bean mosaic. Biopesticides generally have a narrow target range and a very specific mode of action, slow acting with critical application timing, suppresses rather than eliminate pest population with less field persistence and a short shelf life. Biopesticides are safe to humans and the environment than chemical pesticide with no residue problems.

Materials and Methods

The duration of study was three months from 5th August 15, 2022 to 5th November 2022. The four biopesticides such as neem oil emulsion, tobacco decoction, neem kernal suspension and ginger garlic extract were used for this study. Five plants each of unsprayed cowpea plant (control) and bioinsecticide sprayed cowpea plant were grown. Cowpea variety Sharika was raised in an area of 10 m². After land preparation, ridges and furrows were taken and seeds were dipped at a spacing of 25 cm with two seeds in each hole total 10 seeds were dibbed in 5 places at a spacing of 25 cm. After 3-4 days seeds germinated and after 15 days plant grown up to become climbing stage. When it becomes 3 weeks old infestation of *Aphis craccivora* occurred. And each plant in the plot is treated with biopesticides such as tobacco decoction, Neem kernel suspension, Neem oil emulsion, Ginger garlic extract from its early stage onwards. And one plant is taken as control in order to note the effect of these biopesticides on *Aphis craccivora*.

Preparation of Bio- Pesticides

Tobacco Decoction

Tobacco decoction can be prepared by steeping 500g of tobacco wastes in 4.5litres of water for 24hrs. Then 120 g of ordinary bar soap is sliced and dissolved separately in another vessel. The soap solution is added to tobacco decoction under violent agitation. Stock solution is diluted 6-7 times before spraying.

Neem Kernal Suspension (NKS)

The kernels should be ground into a coarse powder. The effective concentration of NKS ranges from 0.1 to 0.3%.for obtaining 0.1 % concentration 1 gm of powdered neem seed was required per liter of water. The required quantity of the coarse powder should be put in a small bag of muslin cloth and dipped in water contained in a bucket of about 12 hrs. There after squeeze the cloth bag repeatedly after dipping in the fluid unit. The out-flow fluid turns light brownish. The NKS is now ready to be sprayed as such on crops.

Ginger Garlic Extract

About 1 gm of ginger and garlic each, 2 gm of green chili paste and half liters of cow's urine and water were taken. The garlic ginger and green chilly are ground into a paste and mixed with cow's urine and water. After 10 days mixture is filtered and used.

Neem Oil Emulsion

20 ml neem oil is dissolved in 50 ml water then slice 1/10 bar soap and dissolve it and stir the emulsion. Then this 70 ml solution was converted in to 1 liter by adding 930 ml water and filter the solution (2% solution) Biopesticides were sprayed during early morning in two days intervals with a hand sprayer. Observations were taken at an interval of seven days. Statistical analysis like percentage, average, correlation and T-test were used

wherever necessary for the purpose of analysis. Data was analyzed and represented in the form of Line Graphs. Techniques like was used. General parameter studied were, a) germination time of cowpea plant, incidence of first attack by aphid on cowpea plant, effect of biopesticides in reducing the aphid number.

Observation and Results

A comparative study was conducted on the attack of aphids on bioinsecticide sprayed and control cowpea plant. It was found that 70% of seeds germinated on the 4th day and 30% on the 3rd day of sowing. Table-1 shows the infestation of cowpea aphid in control cowpea plant. During first two weeks after germination there was no infestation but by third week the infestation of aphids commenced in the fields and the mean number of aphids were 30.6 per 5 cm shoot length, and after fourth week the aphid population showed a steady increase (Figure 1). The population of aphids reached its peak period during the eighth and ninth week, that was during pod formation and maturation period of cowpea (Table-1). In the treatment group the Neem oil was sprayed plants were sprayed from fifth day onwards and it was seen that infestation of aphid that occurred on 21 st day and mean number of aphids/5cm shoot length was 0.66 which was very less compared to the control and the infestation during sixth and seventh week was 10.6 and 11.33 respectively. And on the eighth week no new infestation occurred and in the ninth and 10th week infestation decreased. Neem oil shows a considerable reduction in the number of aphids (Table1). The incidence in tobacco decoction sprayed cowpea plant also occurred by the 21 st day and mean number of aphids/5cm shoot length was 1.66. The peak period of infestation occurred in sixth and seventh week and its mean number was 11.6 and 13.3 respectively. In the eighth week aphid number decreased and from ninth week there was slight increase in mean number of aphids but it was a very much less than that of control. The mean number of aphid/5cm shoot length on the 21 st day on the plant sprayed with ginger garlic extract was 1.66 but from sixth and seventh weeks onwards aphid population started showing steady increase with mean number of aphids reach 22.3 on ninth week. In the neem kernel sprayed cowpea plant, during 21 st day the infestation of aphids commenced and mean number of aphids per 5 cm shoot length was 2.66, but in the succeeding weeks there was a drastic increase in the number of aphids. The peak number reached up to 24.6 per 5 c.m shoot length during ninth week (Table 1, Figure 2). The one factor ANOVA results shows significant difference in mean number of aphids per 5cm shoot length in control and biopesticide treated plants as $P < 0.05$ (Table 2).

Neem oil was found to be very effective (Figure 2 & 5). Students t-test was done to see, whether use of biopesticides neem oil has lessened the infestation on cowpea. The paired t-test between the mean number of aphids/5cm shoot length before and after neem oil treatment in cowpea plant was calculated and found to be 0.0345, as ($P < 0.05$) significant difference before and after neem oil spraying was found. Hence the hypothesis that neem oil is effective in decreasing the aphid infestation in cowpea was true (Table 3). Correlation was calculated for the mean number of aphids/5c.m shoot length and height of the cowpea plant for both unsprayed and neem oil sprayed plant. It was observed that there was strong positive correlation with the height of the plant and aphid number in untreated cowpea (Figure 3). The r value = - 0.96 was statistically significant as ($P = 0.021$, $P < 0.05$). The correlation between the height of cowpea plant and mean number of aphids in neem oil sprayed cowpea plant showed strong negative correlation (Figure 4). The r value - 0.94 was statistically significant as ($P = 0.017199$, $P < 0.05$).



Fig 1: *Aphis craccivora* infested cowpea plant

Table 1: Mean number of aphids (per 5cm shoot length) in control and biopesticide treated plants

Days	Mean number of aphids (per 5cm shoot length)				
	Control	Neem Oil	Tobacco Decoction	Ginger Garlic Extract	Neem Kernal
1	0	0	0	0	0
7	0	0	0	0	0
14	0	0	0	0	0
21	30.6	0.66	1.66	1.66	2.66
28	31.6	1.66	3.33	8.33	6.33
35	35.3	8.33	10.6	14.66	14
42	37.3	10.6	11.6	15.66	17.6
49	41.0	11.33	13.3	17.33	19.3
56	46.0	5.66	11.0	18	21.6
63	57	4.66	14	22.3	24.6

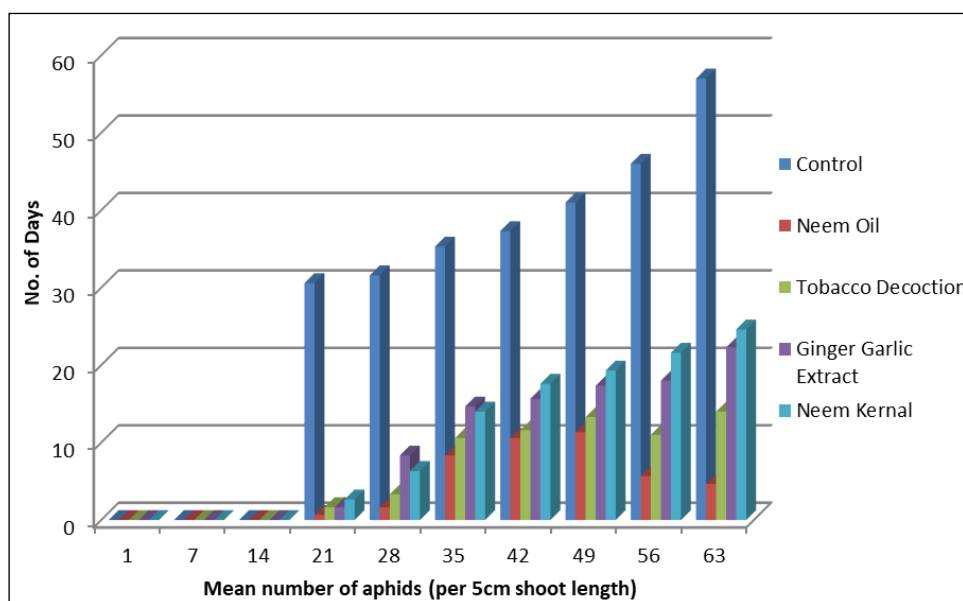


Fig 2: Graphical representation of mean number of aphids (per 5cm shoot length) in control and biopesticide treated plants

Table 2: One-factor ANOVA between control and biopesticide treated plants

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	3479.790412	4	869.9476	6.612295	0.000283	2.578739
Within Groups	5920.43162	45	131.5651			
Total	9400.222032	49				

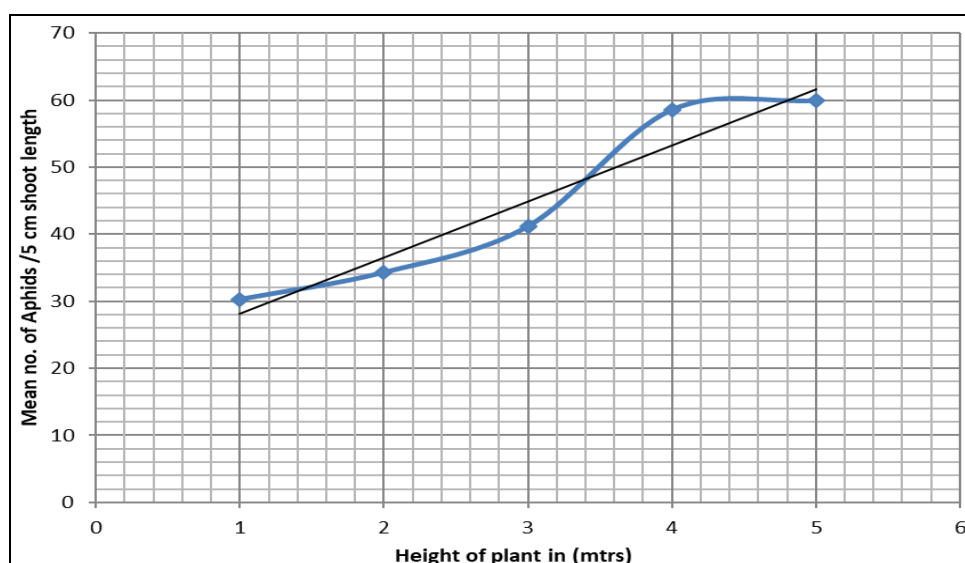


Fig 3: Correlation between height of plant and mean no. of aphids on control plant

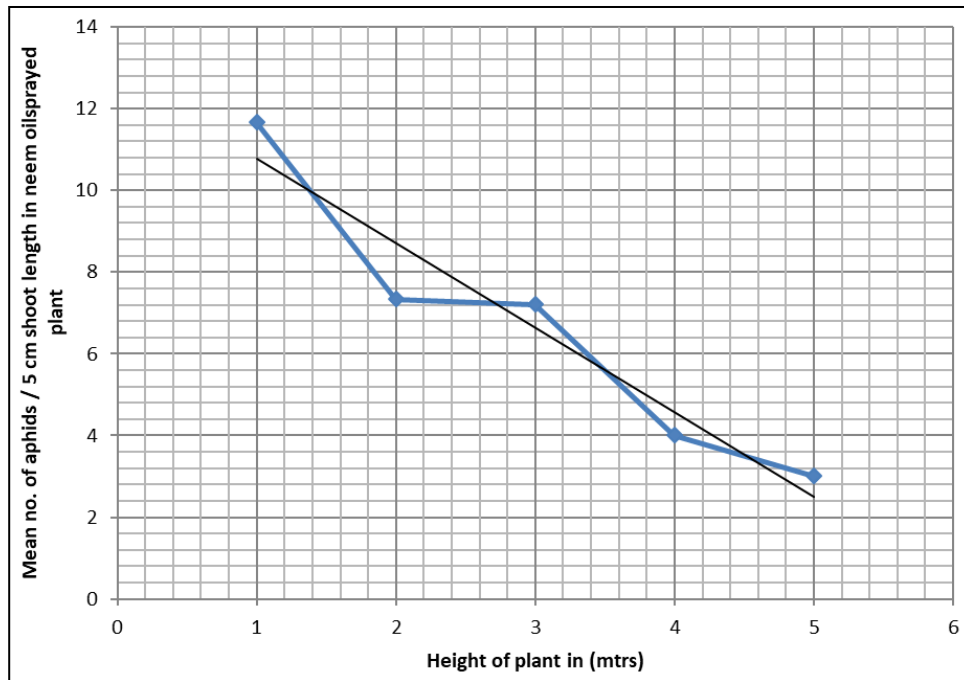


Fig 4: Correlation between height of plant and mean no. of aphids on cowpea plant sprayed with neem oil

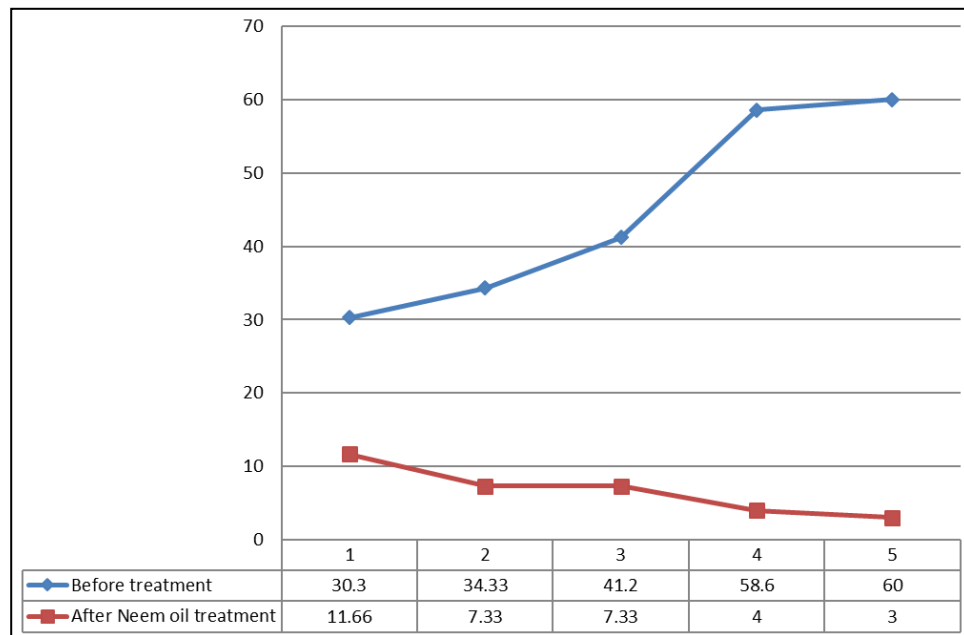


Fig 5: Mean no. of aphids /5 cm shoot length before and after treatment with neem oil in cowpea plants

Discussion

Young colonies of *Aphis craccivora* concentrate on growing points of plants and are often tended by ants (mutualism). This symbiotic association with ants helps in dispersal of aphids from plant to plant. Parthenogenetic reproduction is common and noticed throughout the year. The aphid is ovoviviparous with female retaining eggs inside their bodies and giving birth to nymphs. Males are winged and females are both winged and wingless. Total lifecycle varies from 10-12 days depending on the weather condition, growth factors or aphid feeding. Many species of aphids produce winged forms that migrate to other hosts. The winged aphids produce wingless forms and cycle repeats itself. Distribution and host plant Cowpea aphids occur in many temperate and subtropical regions of the world. A few of its vegetable hosts include asparagus, carrot, corn, cowpea, Cucumber, onion, pea, pepper, tomato, potato. It feed on young leaves, shoot, flowers and immature pods by sucking sap. Symptoms of damage include stunting of plants and seed shriveling in developing pods. Yield losses are severe when aphid colonies concentrate on the growing tips of plants. Indirect damage caused by aphids is due to the production of honey dew which hampers plant respiration and photosynthetic efficiency. Aphids are known to transmit several plant viruses leading to complete crop loss.

The indiscriminate and large-scale use of synthetic chemical pesticides to control this pest has resulted in ecological imbalances, besides their toxic effects on other living organisms, including human beings. Hence,

there is an urgent need for developing methods and materials with eco-friendly standards (Rajappan *et al.* 2000)^[23]. The growth of predator, *Coccinella septempunctata* Linn (coleopteran coccinellidae), also occurs to limit the attack of aphids due to predation (Indu, 2004 and 2006 a, b); Bielawski (1960), Sarospataki and Marko (1995)^[26] Chander (1996)^[4], Kanjuczak (2000)^[14], Omakan and Singh (2000), Singh (2002)^[21], Indu (2000 and 2006 a,b). One of the advantages of the insecticidal use of nicotine is its reported high margin of safety for plants causing little or no damage to foliage (Isely, 1944)^[12]. Indoo, N.E (1958)^[10] points out nicotine produces tremors, convulsions and finally paralysis in insects rather rapidly, death usually comes within an hour. Yamamoto (1965)^[36] presents a most lucid account of the action of Nicotine as it penetrates the insect, arrives at the site of action and imposes its effect. When fumigated with pure nicotine step wise, it appears that insects subjected to nicotine vapors first pass through a period of excitement followed by one of depression and finally through a state of total loss of movement and sensibility to aphid death Shafer (1971). Nicotine penetrates Insect body through cuticle as well as through spiracles and trachea. The CNS is richly supplied with tracheoles becomes readily accessible to nicotine nonetheless Richardson *et al.*, (1973) have shown that cuticle plays an important role in concentrating and transporting nicotine into insect body. Koshy *et al* (1987)^[15] reported that the predominant alkaloid that present in tobacco decoction is effective against sucking pest like Aphid, White flies scales, trips etc. Mariappan and Samuel (1993)^[17] revealed that neem oil exhibited high aphicidal activity against *Aphis craccivora* due to contact toxicity. Neem Seed Oil at 1 % applied to leaf disc resulted in 94 to 100% mortality of aphids after 9 days (Lowry and Isman, 1993)^[16].

Vegetable cowpea grown and marketed in Kerala is often loaded with insecticides (Mathew *et al.*1995) due to the unilateral dependence on pesticides by farmers to tackle the pests in the flowering and pod formation stages. Approximately, 25 million cases of acute occupational pesticide poisoning in developing countries are being reported each year. Pesticide residues in agricultural commodities are being the issue of major concern besides their harmful effect up on human life, wild life and other flora and fauna. Equally worrying thing is about development of resistance in pest to pesticides. The only solution of this is use of biopesticides that reduces pesticide risk. Biopesticides are best alternatives to conventional pesticides and inherently less toxic than conventional pesticides. It generally affects only the target pest and closely related organisms and often are effective in very small quantities and often decompose quickly, thereby resulting in lower exposure and largely avoiding the pollution problems. The raw material for preparing biopesticides is easily available in nature. Since it is a traditional method of pest control the cost of production is very low and has no side effects. Performance wise it is highly effective. Results revealed that cowpea aphid was a regular pest of cowpea and invariably present in the biopesticides sprayed and unsprayed vegetable cowpea. The population of aphids started from early vegetative phase of the crop that is from third week of growth period. The aphid population increased during fifth to sixth week onwards after sowing, this was the flowering and pod formation stage. The mean number of aphid was very high in unsprayed control plant and it showed a steady increase from third week. On 21 st day the mean number of aphids was 30.6 in unsprayed control plant but in bioinsecticide sprayed plants it was 0.66, 1.66, 1.66, 2.66 in neem oil, tobacco decoction, ginger garlic and neem kernel suspension sprayed cowpea plant respectively. That means the bioinsecticide helps to decrease the number of aphids in cowpea. Among these biopesticides used neem oil seemed to be very effective as it decrease the number of aphids during eighth and ninth week. Though there was reduction in the mean number of aphids using biopesticides such as neem oil, tobacco decoction, gmger garlic, neem kernel suspension sprayed cowpea in early stage of growth but it showed slight increase towards the ninth week. But in neem oil sprayed plants the result was positive, were decrease in the number of aphids was seen in ninth week also. In neem oil sprayed plant the initial infestation on 21st day is 0.66 and in the ninth week the mean number of aphids was only 4.66. when compared to other botanicals used, so neem oil is highly effective. In case of Tobacco decoction sprayed cowpea plant, infestation of aphids started on the 21st day and the mean number was 1.66. from the fifth week onwards there was a increase in the mean number of aphids and it was 10.6, 11.6 and 13.3 respectively on fifth, sixth and seventh week. It again decreased to 11 on the 8th week but there was a further increase in the number in the next week itself to 14.0. The mean number of aphids was only 1.66 on the 21st day when ginger garlic was sprayed on the cowpea plant but there was a rapid increase from the forth week onwards. The mean number of aphids increased from 8.33 to 22.3 in the 9th week showing a consistent increase during 5th to 8th week of the project period. Neem kernal was the next biopesticide used, 'in this case also the infestation started in the 21st week. Mean number of aphids/5cm shoot length was 2.66. In the succeeding weeks there was a drastic increase putting the mean number of aphids to 24.6. During 9th week increase in mean number of aphids was noted from 4th to 8th week. Neem kemal was found to be less effective one when compared to other botanicals used. From these results relative efficiency of pesticides may be written as; Neem oil emulsion > Tobacco decoction > Ginger garlic extract > Neem kemal suspension. Correlation and t-test studies revealed that biopesticides are effective against aphid. In neem oil sprayed plant there was a very high negative correlation between number of cowpea aphid and plant height which means as the height increased number of aphids decreased. In the case of control it was found that there was a very good positive correlation which means when the plant height increased number of aphids also increased. T-test also revealed that biopesticides were effective against cowpea aphid.

The chemical pesticides will still continue to be the tool of Indian farmers in pest control strategies. While selecting chemicals for use in Cowpea, the selectivity in action, biodegradability persistence and toxicity to beneficial organism will have to be considered. The status of pests in cowpea is related to its interaction with abiotic factor like temperature, humidity, rainfall and sunshine hours and biotic factors like natural enemies.

Economic and environmentally sound pest management strategies involving the use of different pest control methods especially biopesticides are required against major pest of. Further studies can be carried out on whether biopesticides can affect yield in comparison to plants treated with chemical pesticides

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