



EVALUATION OF REPELLENCY OF PLANT-DERIVED INSECTICIDE AGAINST BRINJAL AND PEPPER PEST POPULATIONS

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ABSTRACT

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The study was carried out on the Evaluation of repellency of plant-derived insecticide against brinjal and pepper pest populations. Two crops brinjal and pepper were sown separately and sprayed with Neem Seed Extract against whitefly, jassid, aphid, borer and predators. The population was significantly higher 3.70 whitefly/ leaf on brinjal variety F₁.advanta-305 as compared to PPL 3.10/ leaf and Black long 3.31/ leaf respectively recorded on 20th January. Similarly, the population was relatively higher was 2.86, 2.72 and 2.44 jassid/ leaf on F₁.advanta-305, PPL and Black long varieties respectively on 25th January. Aphid population was slightly higher 2.79, 2.39 and 2.26/ leaf on Black long, F₁.advanta-305 and PPL varieties respectively. Likewise, the predator population was higher 2.26, 1.99 and 1.94/ plant on brinjal varieties of F₁.advanta-305, Black long and PLL respectively on 4th February. The population was significantly higher 6.33, 5.28 and 4.8 whiteflies/ leaf on Talhari, Moro chilly and Mirch shehzadi respectively on pepper varieties on 25th January. Similarly, the jassid population was relatively higher 1.89, 1.83 and 1.79/ leaf on Moro chilly, Talhari and Mirch shehzadi respectively on 19th February. The population was higher 3.24, 3.04 and 2.58 aphids/ leaf on Talhari, Moro chilly and Mirch shehzadi varieties respectively on 25th January. The predators' population was higher 1.61, 1.53 and 1.33/ plant on Moro chilly, Talhari and Mirch shehzadi varieties respectively on 9th February. Since pest population increased beyond ETL on 25th January. Therefore 2% neem seed extract was applied. These applications kept the pest population below ETL.

Contribution/Originality: The study was carried out on the Evaluation of repellency of plant-derived insecticide against brinjal and pepper pest populations.

1. INTRODUCTION

Vegetables are rich sources of vitamins which are essential for human health [1]. Among vegetables, the solanaceous crops including *pepper* (*Capsicum annum*) and *brinjal* (*Solanum melongena*) are of considerable economic importance. *Brinjal*, The King of Vegetables was first cultivated in China in the 5th century B.C, and was introduced to Africa before the Middle Ages and then into Italy. It subsequently spread throughout Europe and the Middle East. Today, Italy, Greece, Turkey, France, Egypt, China and Japan are the leading growers of brinjal and it is a very good source of vitamin K, B1, B6, copper, dietary fiber, manganese, niacin, potassium, folate Anonymous [2] and Ware [3]. The nutritional value of brinjal in 1 cup (or 82 gms) consists of 11% fiber, 10% manganese, 5.4% molybdenum, 5.3% potassium, 4.5% folate, 3.5% vitamin K, 3.5% copper, 63.5% vitamin B, 3.1% tryptophan, 3% vitamin C, and 2.8% magnesium [4].

Pepper (*Capsicum annum*) is the plant grown in tropical and sub tropical areas and widely cultivated in Pakistan for its pungent fruits. Besides traditional use of pepper as vegetables, spices, condiments, suaces and pickle, it is also used in pharmaceuticals, cosmetics and beverages [5]. There are many sucking insect pests such as Jassid, Whitefly and Aphid which attack pepper crop and cause huge loss by infesting leaves and floral parts. The occurrence of these pests on this crop not only reduces photosynthetic activities but also transmit viral disease which poses serious threat to its production [6]. Among the insect pests infesting brinjal, the major ones are shoot and fruit borer, whitefly and leafhopper. Brinjal shoot and fruit borer, *Leucinodes orbonalis* is considered the main constraint as it losses the crop whole the year. The yield loss due to the pest is to the extent of 60-90% [7].

There are few eco-friendly pest-control systems that can be used to avoid excessive rely on greatly toxic chemicals. These methods and treatments for pest control are greatly effective. They can prevent insect pests to infest the crop. All these eco-friendly pest control systems are the part of Integrated Pest Management (IPM). IPM is a long standing, science-based, decision-making process that identifies and reduces risks from pests and pest management related strategies. It coordinates the use of pest biology, environmental information, and available approach to prevent unacceptable levels of pest damage by the most economical means, while posing the least possible risk to people, property, resources, and the environment. IPM provides an effective strategy for managing pests in all areas from developed residential and public areas to wild lands. IPM serves as an umbrella to provide an effective, all encompassing, low risk approach to protect resources and people from pests [8]. IPM is often mistakenly associated only with entomology and insect pests. However, in contrast to entomology, plant pathology has, since its beginning, approached plant pests through multiple, or integrated strategies [9].

The quality of pepper fruits can be obtained by the organic cultivation methods, which will result in increased export [7]. The use of trap as IPM technique improved crop quality and overall farm profitability [10]. Five percent neem seed extract showed the lowest infestation of aphids and maximum crop yield [11]. The average seasonal population of mites was 6.58 ± 0.45 , thrips 4.37 ± 0.37 , whitefly 1.00 ± 0.18 , mealy bug 7.22 ± 0.48 / leaf, termite 0.51 ± 0.13 percent and *H. armigera* 0.41 ± 0.11 / plant on pepper [12] while the neem extract observed its superiority in efficacy to combat whole the insect pests studied in brinjal, followed by chemical control, tobacco extract, Tooh extract, akk extract and datura remained the least. Regardless the bio-pesticides, the highest efficacy was observed against jassid during both the sprays. Mites persisted more that borers and jassid to remain in the brinjal fields. For effective and safe control of brinjal insect pests in the field, the crop may be preferably sprayed with neem seed extract followed by tobacco and tooh extract; and at least one spray monthly is essential to keep the insect pests below economic injury level. There is no need to apply chemical control, because neem seed extract resulted better than the chemical control [13]. The efficacy of synthetic pesticides alone or in combination with oil of neem against *Bemisia tabaci* did not observe a considerable impact on insect population. Profenofos alone and Profenofos+ neem oil had higher efficacy against whitefly than rest of the treatments reported by Agro [14]. The proposed study will be carried out on the comparison of pest population and integrated pest management on different varieties of brinjal and pepper under field conditions with the objectives to record population of major insect pests on brinjal and pepper, compare major insect pests on different varieties of these vegetables and study botanical pest control material (Neem Seed Extract) against insect pests of these vegetables under field conditions.

2. MATERIALS AND METHODS

The studies were carried out on comparison of pest population on different varieties of brinjal and pepper as affected by spray application of neem extract against key pests such as whitefly, jassid, aphid, borers and their predators. The efficacy of neem based bio-pesticide (neem seed extract) against these insect pests using three varieties each of brinjal and pepper. The experimental crops were grown an experimental field in Coconut Farm, District Lasbella, Balochistan.

Two vegetables were sown and for each vegetable three varieties were cultivated four replicated Randomized Complete Block Design (RCBD). The experimental area consisted of one acre of land which was divided into 2 blocks. Each block was divided into 3 plots. All experimental area was divided into 6 plots. Each plot size was 11 m x 22 m.

The land for sowing the experimental crops was adapted not in season. In the beginning, the experimental area had ploughed with running disc plough & 15 day leave. Later, the tractor had used for crushing of clods and leveling the land. Then the area came in proper condition, finally using strips for isolation of plots & preparing channel of feeding 60 cm for row to row distance & 30 cm for plant to plant distance for all experimental crops.

In this study, neem seed extract was applied for controlling the insect pests and dynamical number of the dominant pest & predators was monitored for the entire growing season of each vegetable crop by using the six plants randomly of each variety from each plot. The treatment details are as under;

2.1. Vegetable Crops and Varieties

Brinjal = V1-PPL Agroimpex India, V2-Black Long F₁ hybrid and V3-F₁-advanta-305.

Pepper = V1- Mirch Shezadi, V2-Talhari and V3- Moro chilly.

The experimental crops were sown at recommended sowing time and all the crop production technologies were adopted from sowing view point, inputs application as well as for crop management. For controlling insect pests, the neem seed extract was prepared & sprayed when insect pest appears.

2.2. Preparation of Neem Seed Extract

2 percent neem seed extract was prepared from 40 gm powder of neem seed which had added of 5 gm of detergent. This was wrapped in a muslin cloth and dipped in 2 L of hot water. After 15-20 hours the concentrate was squeezed out and diluted to 2 percent by adding water. During attack of insect pests on crops, application of 2 percent neem seed extract was applied on the crops at 15 days intervals in the field. Neem seed extract spray was applied as repellent in order to keep the insect pests away from the crops.

The result that were together had observed in statistical analysed by using analysis of variance (ANOVA) know the significance differences in insect pests infestation in different treatments and LSD test was employed to compare treatment means. In view of the statistical analysis, the tables containing summarized experimental results were prepared and detailed descriptions are presented.

2.3. Green House Studies

In this trial I had collected 48 nurseries plants in three different vegetables (Brinjal and Pepper) from different field of farmers in Uthal. Then these Plants were kept in gamla. In each vegetable 24 plants were collected then separately for each 24 plants twelve cages were made. In each cage two plants (treated and untreated) were kept for experiment of neem seed extract. Similarly in this pattern in 24 plants 24 cages had made.

This experiment data was taken after (6, 12, 18 hours) intervals. Three control application of neem seed extract (0.5 percent, 1.0 percent and 2.0 percent) were applied in one plant for each cage of two plants (treated and untreated). In every vegetable 1.0 percent were applied in three cages. In every cage ten whiteflies were released and then counted number of whiteflies after every 6 hours, 12 hours and 18 hours interval. Similarly three reading were taken in each vegetable concentration at different time intervals and noted in the diary.

2.4. Statistical Analysis

The collected data were statistically analysed using MSTATc software and entire means were subjected to Least Significant Difference (LSD) as well as Tukey test at $P < 0.05$.

3. RESULTS AND DISCUSSION

Repellent effect of neem seed water extract application to brinjal and pepper plants were initially studied against whitefly in a green house in the Faculty of Agriculture, LUAWMS. Further studies on population dynamics of whitefly, jassid, aphid, borers and predators were compared on different varieties of brinjal, *Solanum melongena* (PPL, Black long, Advanta-305) and pepper, *Capsicum annum* (Mirch shezadi, Talhari, Moro chilly) separately as affected by spray application of neem seed extract. The experimental crops were grown in an experimental area of Coconut Farm, District Lasbella, Balochistan. Three varieties of each vegetable were sown separately in Randomized Complete Block Design (RCBD).

3.1. Repellency of Neem Seed Extract against Whitefly On Vegetables

Two vegetables viz, pepper and brinjal were used to evaluate repellent effect of neem seed extract against whitefly in green house studies by free choice method as given below. The extract was applied in 2.0, 1.0 and 0.5 percent concentrations to vegetable plants.

3.1.1. Repellency of Whitefly on Pepper Crop

A comparison of mean percent repellency of whitefly on pepper crop at different concentrations of neem seed extract (NSE) is presented in Table 1. It revealed that the highest repellency of 41.44 percent was recorded at 2 percent concentrations which was significantly different from 25.88, 23.00 and 16.88 percent at application rates of 1.00, 0.50 and control respectively. Repellency values at 1.0% and 0.5% were non-significant from each other but these were significantly higher than 16.88 percent in control.

A comparison of percent repellency of whitefly on pepper crop after 6 hours, 12 hours and 18 hours interval is presented in Table 2. It revealed that the highest repellency of 34.66% was recorded after 6 hours which was significantly higher than 20.83 and 24.91% after 12 hours and 18 hours respectively. However, repellency recorded after 18 hours was significantly higher than after 12 hours.

A comparison of percent repellency in the interaction between both concentrations of neem seed extract and time intervals is presented in Table 3. The highest repellency of 80.0% was recorded at 2.0% concentration after 6 hours of application. The lowest repellency was recorded in control after 18 hours. Generally, repellency values were higher at higher concentration of neem seed extract.

Table-1. Percent repellency of whitefly at different concentrations of Neem Seed Water Extract applied to pepper plants.

Concentration	% Repellency
2.00%	41.44 ^a
1.00%	25.88 ^b
0.50%	23.00 ^b
Control	16.88 ^c

Note: Mean values having the same letter is not significantly various by Tukey test ($P < 0.05$).

Table-2. Percent repellency of whitefly at different time intervals after application of Neem Seed Water Extract to pepper plants.

Hours	% Repellency
6	34.66 ^a
12	20.83 ^c
18	24.91 ^b

Note: Mean values having the same letter is not significantly different by Tukey test ($P < 0.05$).

Table-3. Percent repellency of whitefly at different concentrations and time intervals.

Concentration	% Repellency After Time Intervals		
	6 hours	12 hours	18 hours
2.00%	80.00 ^a	19.33 ^e	25.00 ^d
1.00%	18.66 ^e	26.66 ^d	32.33 ^b
0.50%	26.00 ^d	14.00 ^f	29.00 ^{bc}
Control	14.00 ^f	23.33 ^d	13.33 ^f

Note: Mean values having the same letter is not significantly different by Tukey test ($P < 0.05$).

3.1.2. Repellency of Whitefly on Brinjal Crop

A comparison of mean percent repellency of whitefly on brinjal crop at different concentrations is presented in Table 4. It revealed that the highest repellency of 49.44% was recorded at 2% concentrations which was significantly different from 37.77, 37.22 and 25.44% at application rates of 1.00%, 0.50% and control respectively. Repellency values at 1.0% and 0.5% were significant from each other but these were significantly higher than 25.44% in control.

A comparison of percent repellency of whitefly on brinjal crop after 6 hours, 12 hours and 18 hours intervals is presented in Table 5. It revealed that the highest repellency of 40.33% was recorded after 18 hours which was significantly higher than 36.58% and 35.50% after 6 hours and 12 hours, respectively. However, repellency recorded after 6 hours was significantly higher than after 12 hours.

A comparison of percent repellency in the interaction between concentrations of Neem Seed Extract and time intervals is presented in Table 6. The highest repellency of 69.66% was recorded at 2.0% concentrations after 6 hours of application. The lowest repellency was recorded in control after 6 hours. Generally, repellency values were higher at higher concentrations of Neem Seed Extract.

Table-4. Percent repellency of whitefly at different concentrations of Neem Seed Water Extract applied to brinjal plants.

Concentration	% Repellency
2.00%	49.44 ^a
1.00%	37.77 ^a
0.50%	37.22 ^a
Control	25.44 ^a

Note: Mean values having the same letter is not significantly different by Tukey test ($P < 0.05$).

Table-5. Percent repellency of whitefly at different time intervals after application of Neem Seed Water Extract to brinjal plants.

Hours	% Repellency
6	36.58 ^a
12	35.50 ^a
18	40.33 ^a

Note: Mean values having the same letter is not significantly different by Tukey test ($P < 0.05$).

Table-6. Percent repellency of whitefly at different concentrations and time intervals.

Concentration	% Repellency After Time Intervals		
	6 hours	12 hours	18 hours
2.00%	69.66 ^a	49.00 ^a	29.66 ^a
1.00%	30.66 ^a	26.00 ^a	56.66 ^a
0.50%	26.00 ^a	40.66 ^a	45.00 ^a
Control	20.00 ^a	26.33 ^a	30.00 ^a

Note: Mean values having the same letter is not significantly different by Tukey test ($P < 0.05$).

3.2. Insect Pests of Brinjal Varieties

3.2.1. Whitefly Population on Brinjal Varieties

The result of per leaf population of whitefly on three brinjal varieties at different dates is presented in Table 7. It revealed that in all three varieties of brinjal highest population of whitefly was recorded on 20th January in F₁.

advanta-305 variety. It was 3.10, 3.31 and 3.70 / leaf on PPL, Black long and F₁-advanta-305 respectively. Therefore, Neem Seed Extract was applied at 2 percent concentrations on 25th January which was continued at 15 days intervals on 9th February and 24th February. However, the lowest number of 1.50 whitefly / leaf was recorded on 14th February in PPL variety which was not significantly different from 1.91 observed on 29th February. In case of Black long variety, the lowest number of 1.64 whitefly / leaf was observed on 14th February which was not significantly different from 1.74 and 1.81 which were recorded on 9th February and 30th January. In case of F₁-advanta-305 variety similar trend was observed that the lowest population of 1.66 whitefly / leaf was recorded on 14th February which was not significantly different from 1.98 observed on 30th January.

A comparison of mean number of whitefly on three varieties of brinjal is presented in Figure 1. It revealed that the lowest population of 2.37 whitefly / leaf was observed in Black long variety which was not significantly different from 2.42 recorded in PPL variety, whereas significantly the highest number of 2.73 whitefly / leaf was recorded from F₁-advanta-305 variety. A comparison of mean number of whitefly on brinjal varieties at different dates is presented in Figure 2. It revealed that the lowest number of 1.6 whitefly / leaf was observed on 14th February which was not significantly different from 2.0 recorded on 29th February. However, the highest number of whitefly 3.27 and 3.1 / leaf was recorded on 20th and 25th January which was not significantly different from each other. Interaction between all the three varieties indicated that highest and significantly different whitefly population was recorded on 25th January which dropped significantly with the application of neem seed extract on 25th January and after 15 days intervals. The population of whitefly remained lower but significantly different on different varieties.

Table-7. Mean number of whitefly nymph / leaf on brinjal varieties at different observation dates.

Obs. Dates	Brinjal Varieties		
	V1= PPL	V2= Black long	V3= F1 advanta-305
20-Jan	2.70 ^{bc}	2.91 ^{ab}	3.70 ^a
25-Jan	3.10 ^{ab}	3.31 ^{ab}	3.39 ^{ab}
30-Jan	2.81 ^{bc}	1.81 ^{hi}	1.98 ^{gh}
4-Feb	2.39 ^{de}	2.91 ^{ab}	3.14 ^{ab}
9-Feb	2.06 ^{ef}	1.74 ^{ij}	3.52 ^{ab}
14-Feb	1.50 ^j	1.64 ^{ij}	1.66 ^{ij}
19-Feb	2.94 ^{ab}	2.64 ^{cd}	3.16 ^{ab}
24-Feb	2.43 ^{de}	2.18 ^{ef}	2.26 ^{ef}
29 Feb	1.91 ^{gh}	2.04 ^{ef}	2.04 ^{ef}
5-Mar	2.36 ^{de}	2.61 ^{cd}	2.44 ^{de}

Note: Means sharing similar letters are not significantly different by Fisher's LSD test at P = 0.05.

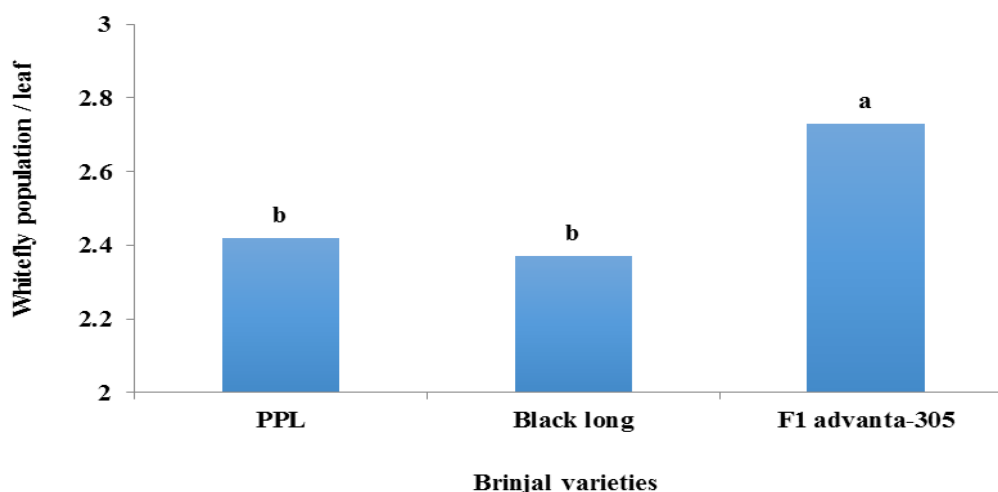


Figure-1. Mean number of whitefly on brinjal varieties.

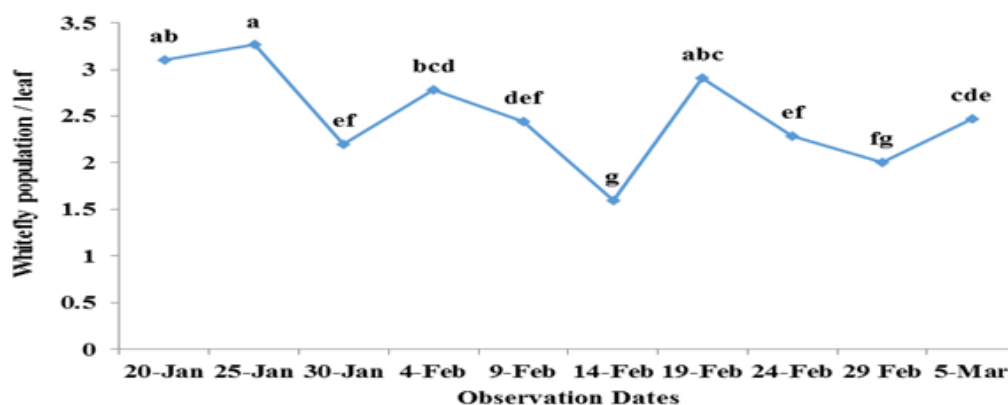


Figure-2. Mean number of whitefly on brinjal varieties at different observation dates.

Note: Means sharing similar letters are not significantly different by Fisher's LSD test at P = 0.05.

3.2.2. Jassid Population on Brinjal Varieties

The result of per leaf population of jassid on three brinjal varieties at different dates is presented in Table 8. It revealed that the highest population of jassid was recorded on 25th January in F₁-advanta-305 variety. It was 2.72, 2.44 and 2.86 / leaf on PPL, Black long and F₁-advanta-305 respectively. Therefore, Neem Seed Extract was applied at 2 percent concentrations on 25th January which was continued at 15 days intervals on 9th February and 24th February. However, the lowest number of 0.14 jassid / leaf was recorded on 29th February in PPL variety which was not significantly different from 0.56, 0.43 and 0.51, which was observed on 20th January, 14th February and 5th March respectively. In case of Black long variety the lowest number of jassid 0.18 and 0.19 / leaf was observed on 14th February and 29th February which was not significantly different from each other. In case of F₁-advanta-305 variety similar trend was observed, the lowest number of 0.14 jassid / leaf was observed on 29th February which was not significantly different from 0.18 was recorded on 14th February.

A comparison of mean number of jassid on three varieties of brinjal is presented in Figure 3. It revealed that the lowest population of 1.23 jassid / leaf was recorded in F₁-advanta-305 variety which was not significantly different from 1.3 and 1.31 / leaf were recorded in PPL and Black long varieties. However, these all values of three varieties were not significantly different from each other.

A comparison of mean number of jassid on brinjal varieties at different dates is presented in Figure 4. It revealed that the lowest number of 0.16 jassid / leaf was observed on 29th February which was not significantly different from 0.26 was recorded on 14th February. While the highest number of 2.68 jassid / leaf was recorded on 25th January. Interaction between all the three varieties indicated that highest and significantly different jassid population was recorded on 25th January which dropped significantly with the application of neem seed extract on 25th January and after 15 days intervals. The population of jassid remained lower but significantly different on different varieties.

Table-8. Mean number of jassid nymph / leaf on brinjal varieties at different observation dates.

Obs. Dates	Brinjal varieties		
	V1= PPL	V2= Black long	V3= F1 advanta-305
20-Jan	0.56 ^{ghi}	0.51 ^{ghi}	0.46 ^{ghi}
25-Jan	2.72 ^a	2.44 ^{ab}	2.86 ^a
30-Jan	2.04 ^{cd}	1.91 ^{def}	1.69 ^{def}
4-Feb	1.84 ^{def}	2.18 ^{cd}	2.13 ^{cd}
9-Feb	1.33 ^{hi}	1.18 ^{efg}	1.06 ^{fg}
14-Feb	0.43 ^{hi}	0.18 ^{jkl}	0.18 ^{jkl}
19-Feb	2.21 ^{bcd}	2.31 ^{bcd}	2.29 ^{bcd}
24-Feb	1.22 ^{efg}	1.26 ^{ef}	1.19 ^{efg}
29 Feb	0.14 ^{kl}	0.19 ^{jkl}	0.14 ^{kl}
5-Mar	0.51 ^{ghi}	0.98 ^{fg}	0.34 ^{hi}

Note: Means sharing similar letters are not significantly different by Fisher's LSD test at P = 0.05.

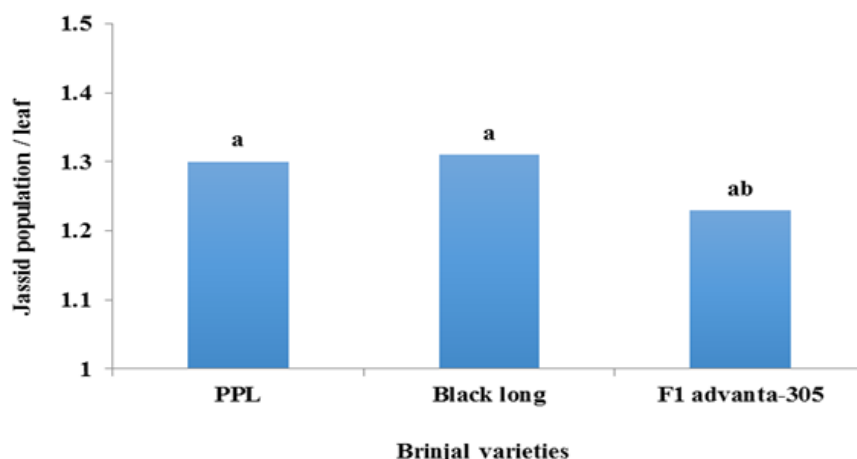


Figure-3. Mean number of jassid on brinjal varieties.



Figure-4. Mean number of jassid on brinjal varieties at different observation dates.

Note: Means sharing similar letters are not significantly different by Fisher's LSD test at P = 0.05.

3.2.3. Aphid Population on Brinjal Varieties

The result of per leaf population of aphid on three brinjal varieties at different dates is presented in Table 9. It revealed that the highest population of aphid was recorded on 25th January in Black long variety. It was 2.26, 2.39 and 2.79/ leaf on PPL, F₁-advanta-305 and Black long varieties respectively. Therefore, Neem Seed Extract was applied at 2 percent concentration on 25th January which was continued at 15 days intervals on 9th February and 24th February. The lowest number of 0.04 aphid/ leaf was recorded on 5th March in PPL variety which was not significantly different from 0.11, 0.07 and 0.18/ leaf was recorded from 14th February, 24th February and 29th February respectively. In all three varieties, However, the values of 0.11 aphid / leaf in PPL on 14th February and 0.09 aphid / leaf in Black long, 0.09 aphid / leaf in F₁-advanta-305 on 14th February were also not significantly different from one another.

A comparison of mean number of aphid on three varieties of brinjal is presented in Figure 5. It revealed that the lowest population of 1.23 aphid / leaf was recorded in F₁-advanta-305 variety which was significantly lower than 1.3 in PPL and 1.31 in Black long varieties. However, these two values were not significant from each other.

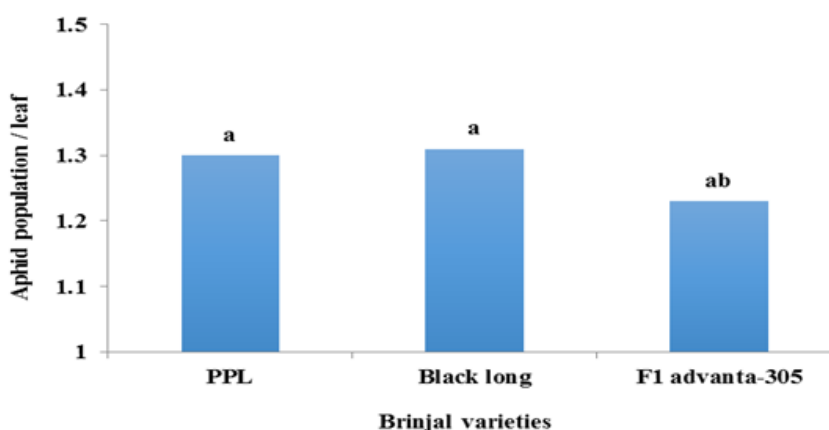
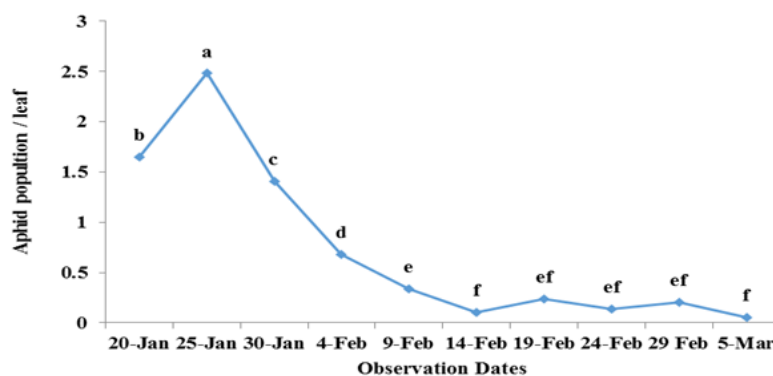
A comparison of mean number of aphid on brinjal varieties at different dates is presented in Figure 6. It revealed that the lowest number of 0.05 aphid / leaf was observed on 5th March which was not significantly different from those values which was recorded on 14th February to 29th February. While the highest number of 2.48 aphid / leaf was recorded on 25th January which was significantly different from all those values recorded from 20th January to 5th March.

Interaction between all the three varieties indicated that highest and significantly different aphid population was observed on 25th January which dropped significantly with the application of neem seed extract on 25th January and after 15 days intervals. The population of aphid remained lower but different on different varieties.

Table-9. Mean number of aphid nymph / leaf on brinjal varieties at different observation dates.

Obs. Dates	Brinjal Varieties		
	V1= PPL	V2= Black long	V3= F1 advanta-305
20-Jan	1.38 ^{de}	1.85 ^{bcd}	1.73 ^{cd}
25-Jan	2.26 ^b	2.79 ^a	2.39 ^b
30-Jan	1.51 ^{cde}	1.49 ^{cde}	1.23 ^{def}
4-Feb	0.69 ^{fg}	0.89 ^{ef}	0.46 ^{fg}
9-Feb	0.53 ^{fg}	0.28 ^{hij}	0.23 ^{ijk}
14-Feb	0.11 ^{jk}	0.09 ^k	0.09 ^k
19-Feb	0.29 ^{hij}	0.21 ^{ijk}	0.23 ^{ijk}
24-Feb	0.07 ^k	0.13 ^{jk}	0.23 ^{ijk}
29 Feb	0.18 ^{jk}	0.24 ^{ijk}	0.18 ^{jk}
5-Mar	0.04 ^k	0.04 ^k	0.06 ^k

Note: Means sharing similar letters are not significantly different by Fisher's LSD test at P = 0.05.

**Figure-5.** Mean number of aphid on brinjal varieties.**Figure-6.** Mean number of aphid on brinjal varieties at different observation dates.

Note: Means sharing similar letters are not significantly different by Fisher's LSD test at P = 0.05.

3.2.4. Predators Population on Brinjal Varieties

The result of per plant population of ladybird beetle (*Coccinella septempunctata*) adults on three brinjal varieties at different dates is presented in Table 10. It revealed that in all three varieties the highest population of *C. septempunctata* was recorded on 4th February in F₁-advanta-305 variety. It was 1.94, 1.99 and 2.26 / plant on PPL, Black long and F₁-advanta-305 varieties respectively. Therefore, Neem Seed Extract was applied at 2 percent concentrations on 25th January which was continued at 15 days intervals on 9th February and 24th February. However, the lowest number of 0.03 *C. septempunctata* / plant was recorded on 20th January in PPL variety which was not significantly different from 0.09 was recorded from 25th January. In case of Black long variety, the lowest number of 0.05 *C. septempunctata* / plant was observed on 20th January which was not significantly different from 0.08 was recorded on 25th January. In case of F₁-advanta-305 variety similar trend was observed, whereas the lowest

number of 0.03 *C. septempunctata* / plant was observed on 20th and 25th January which was not significantly different from 0.28, 0.29 and 0.33/ plant were recorded on 24th February, 29th February and 5th March respectively.

A comparison of mean number of predators on three varieties of brinjal is presented in Figure 7. It revealed that the lowest number of 0.86 *C. septempunctata*/ plant was recorded in PPL variety. Whereas significantly the highest number of 0.98 and 0.95 *C. septempunctata*/ plant were recorded in Black long and F₁-advanta-305 varieties which was not significantly different from each other.

A comparison of mean number of predators on brinjal varieties at different dates is presented in Figure 8. It revealed that the lowest number of 0.04 and 0.06 *C. septempunctata*/ plant was observed on 20th and 25th January which was not significantly different from each other. While the highest number of 2.06 *C. septempunctata* / plant was recorded on 4th February.

Interaction between all the three varieties indicated that highest and significantly different predator population was recorded on 4th February which was not be dropped significantly with the application of neem seed extract on 25th January and after 15 days intervals. The population of predators were not decreased but significantly different on different varieties.

Table-10. Mean number of predators on brinjal varieties at different observation dates.

Obs. Dates	Brinjal Varieties		
	V1= PPL	V2= Black long	V3= F1 advanta-305
20-Jan	0.03 ^g	0.05 ^g	0.03 ^g
25-Jan	0.09 ^g	0.08 ^g	0.03 ^g
30-Jan	1.57 ^c	1.31 ^d	1.48 ^c
4-Feb	1.94 ^b	1.99 ^b	2.26 ^a
9-Feb	1.48 ^c	1.84 ^b	1.44 ^c
14-Feb	1.57 ^c	1.62 ^c	1.57 ^c
19-Feb	1.09 ^e	1.67 ^c	2.06 ^a
24-Feb	0.38 ^f	0.44 ^f	0.28 ^f
29 Feb	0.21 ^f	0.34 ^f	0.29 ^f
5-Mar	0.26 ^f	0.21 ^f	0.33 ^f

Note: Means sharing similar letters are not significantly different by Fisher's LSD test at P = 0.05.

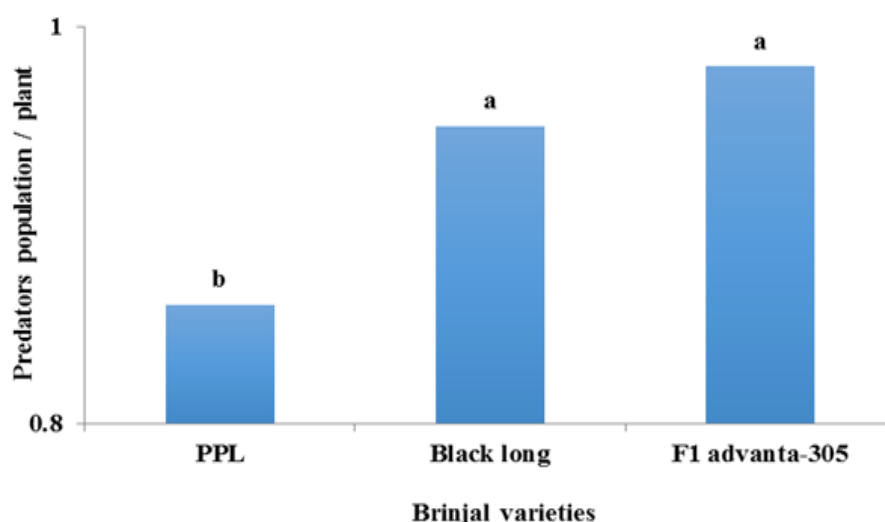


Figure-7. Mean number of predators on brinjal varieties.

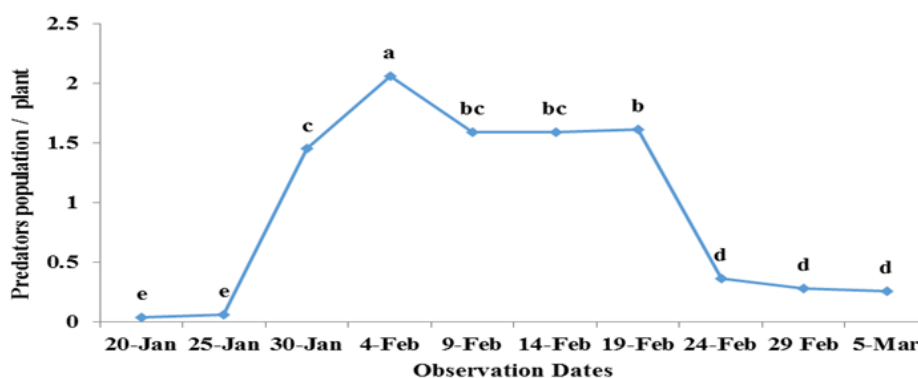


Figure-8. Mean number of predators on brinjal varieties at different observation dates.

Note: Means sharing similar letters are not significantly different by Fisher's LSD test at P = 0.05.

3.3. Insect Pests of Pepper Varieties

3.3.1. Whitefly Population on Pepper Varieties

The result of per leaf population of whitefly on three pepper varieties at different dates is presented in Table 11. It revealed that in all the three varieties the highest population of whitefly was recorded on 25th January in Talhari variety. It was 4.89, 5.28 and 6.33 / leaf on Mirch shezadi, Talhari and Moro chilly respectively. Therefore, Neem Seed Extract was applied at 2 percent concentrations on 25th January which was continued at 15 days intervals on 9th February and 24th February. However, the lowest number of 0.49 whitefly / leaf was recorded on 5th March in Mirch shezadi variety which was not significantly different from 0.86 observed on 29th February. In case of Talhari variety, the lowest number of whitefly 0.64 and 0.76 / leaf was observed on 29th February and 5th March which was not significantly different from each other. In case of Moro chilly variety similar trend was observed, the lowest number of whitefly 0.49 and 0.51 / leaf was observed on 29th February and 5th March which was not significantly different from each other. A comparison of mean number of whitefly on three varieties of pepper is presented in Figure 9. It revealed that the lowest number of 1.82 whitefly / leaf was observed in Mirch shezadi variety, whereas the highest number of 2.10 and 1.97 whiteflies/ leaf was recorded from Talhari and Moro chilly variety which was not significantly different from each other. Moreover, the values of Mirch shezadi and Talhari varieties were significantly different from each other.

A comparison of mean number of whitefly on pepper varieties at different dates is presented in Figure 10. It revealed that the lowest number of 0.55 whitefly/ leaf was observed on 5th March which was not significantly different from 0.7 was recorded on 29th February. However, the highest number of 5.5 whitefly/ leaf was recorded on 25th January which was significant different from population which was recorded on all other dates.

Interaction between all the three varieties indicated that highest and significantly different whitefly population was recorded on 25th January which dropped significantly with the application of neem seed extract on 25th January after 15 days intervals. The population of whitefly remained lower but significantly different on different varieties.

Table-11. Mean number of whitefly nymph / leaf on pepper varieties at different Observation dates.

Obs. Dates	Pepper Varieties		
	V1= Mirchshezadi	V2= Talhari	V3= Moro chilly
20-Jan	1.83 ^{ef}	1.94 ^{def}	1.90 ^{def}
25-Jan	4.89 ^{ab}	6.33 ^a	5.28 ^{ab}
30-Jan	1.99 ^{def}	2.26 ^{cde}	2.46 ^{cd}
4-Feb	1.81 ^{ef}	1.61 ^{efg}	1.83 ^{ef}
9-Feb	1.88 ^{ef}	2.09 ^{de}	2.11 ^{de}
14-Feb	1.44 ^{fgh}	1.74 ^{efg}	1.49 ^{fg}
19-Feb	1.81 ^{ef}	1.96 ^{def}	2.16 ^{de}
24-Feb	1.19 ^{hi}	1.64 ^{efg}	1.47 ^{fg}
29 Feb	0.86 ⁱ	0.76 ^{ij}	0.49 ^{jk}
5-Mar	0.49 ^{jk}	0.64 ^{jk}	0.51 ^{jk}

Note: Means sharing similar letters are not significantly different by Fisher's LSD test at P = 0.05.

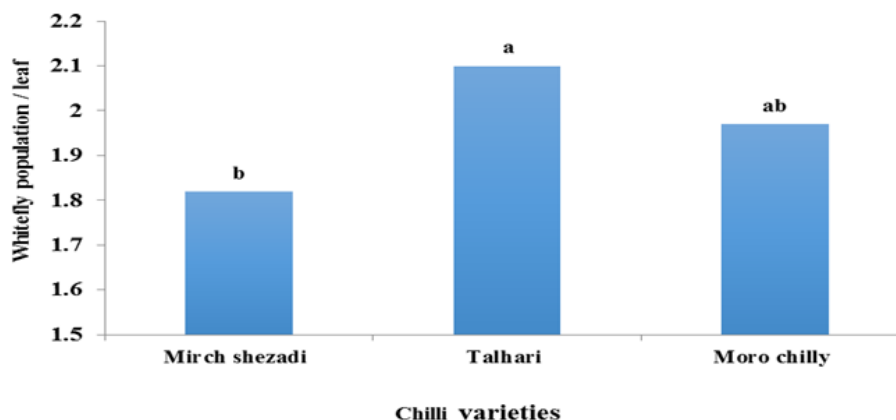


Figure-9. Mean number of whitefly on pepper varieties.

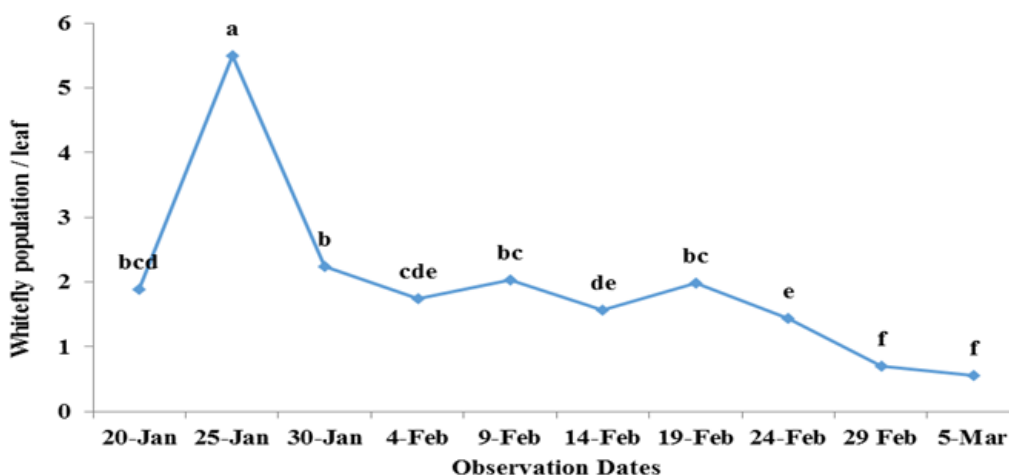


Figure-10. Mean number of whitefly on pepper varieties at different observation dates.

Note: Means sharing similar letters are not significantly different by Fisher's LSD test at P = 0.05.

3.3.2. Jassid Population on Pepper Varieties

The result of per leaf population of jassid on three pepper varieties at different dates is presented in Table 12. It revealed that the highest population of jassid was recorded on 25th January in Moro chilly variety. It was 1.79, 1.83 and 1.89/ leaf on Mirch shezadi, Talhari and Moro chilly respectively. Therefore, Neem Seed Extract was applied at 2 percent concentrations on 25th January which was continued at 15 days intervals on 9th February and 24th February. However, the lowest population of 0.08 jassid/ leaf was recorded on 29th February in Mirch shezadi variety which was not significantly different from 0.16 and 0.11 / leaf recorded on 20th January and 5th March respectively. In case of Talhari variety, the lowest number of jassid 0.14 was observed on 20th January which was not significantly different from 0.17 and 0.16 / leaf recorded on 29th February and 5th March respectively. In case of Moro chilly variety similar trend was observed, the lowest number of 0.09 jassid / leaf was observed on 5th March which was not significantly different from 0.11 and 0.13 recorded on 29th February and 20th January.

A comparison of mean number of jassid on three varieties of pepper is presented in Figure 11. It revealed that the lowest number of 0.87 jassid / leaf was observed in Mirch shezadi and Talhari varieties which was not significant different from each other. However, the highest number of 0.96 jassid / leaf was recorded in Moro chilly variety.

A comparison of mean number of jassid on pepper varieties at different dates is presented in Figure 12. It revealed that the lowest number of 0.12 jassid/ leaf was observed on 29th February and 5th March which was not significantly different from 0.14 recorded on 20th January. However, the highest number of 1.8 jassid/ leaf was recorded on 19th February which was not significantly different from 1.68 and 1.63 jassids/ leaf was recorded on

25th January and 30th January both was not significant different from each other but significantly higher than the number which was recorded on all other dates. Jassid population fluctuated during 30th Jan. to 5th March.

Interaction between all the three varieties indicated that highest and significantly different jassid population was recorded on 25th January which dropped significantly with the application of neem seed extract on 25th January and 15 days intervals. The population of jassid remained lower but significantly different on different varieties.

Table-12. Mean number of jassid nymph / leaf on pepper varieties at different observation dates.

Obs. Dates	Pepper Varieties		
	V1= Mirchshezadi	V2= Talhari	V3= Moro chilly
20-Jan	0.16 ^{ij}	0.14 ^{ij}	0.13 ^{ij}
25-Jan	1.79 ^{ab}	1.50 ^{bcd}	1.76 ^{ab}
30-Jan	1.59 ^{bcd}	1.59 ^{bcd}	1.69 ^{abc}
4-Feb	0.74 ^{ef}	1.38 ^{cd}	1.54 ^{bcd}
9-Feb	1.01 ^{cde}	0.78 ^{def}	0.93 ^{de}
14-Feb	0.71 ^{ef}	0.47 ^{fg}	0.56 ^{efg}
19-Feb	1.68 ^{bc}	1.83 ^{ab}	1.89 ^a
24-Feb	0.81 ^{def}	0.71 ^{ef}	0.89 ^{de}
29 Feb	0.08 ⁱ	0.17 ^{hij}	0.11 ^{ij}
5-Mar	0.11 ^{ij}	0.16 ^{hij}	0.09 ⁱ

Note: Means sharing similar letters are not significantly different by Fisher's LSD test at P = 0.05.

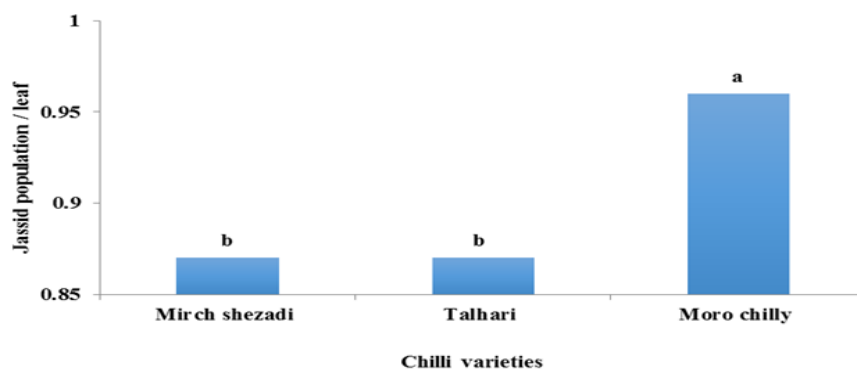


Figure-11. Mean number of jassid on pepper varieties.

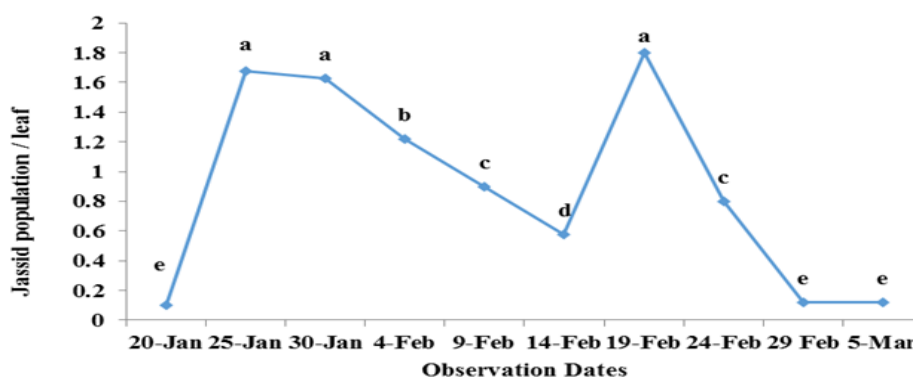


Figure-12. Mean number of jassid on pepper varieties at different observation dates.

Note: Means sharing similar letters are not significantly different by Fisher's LSD test at P = 0.05.

3.3.3. Aphid Population on Pepper Varieties

The result of per leaf population of aphid on three pepper varieties at different dates is presented in Table 13. It revealed that the highest population of aphid was recorded on 25th January in Talhari variety. It was 2.58, 3.04 and 3.24 / leaf on Mirch shezadi, Moro chilly and Talhari varieties respectively. Therefore, Neem Seed Extract was applied at 2 percent concentrations on 25th January which was continued at 15 days intervals on 9th February and 24th February. However, the lowest number of 0.06 aphid / leaf was recorded in Mirch shehzadi variety on 29th

February which was not significantly different from all other values except on 25th January, 30th January, 19th February and 24th February. The lowest population of 0.04 aphid / leaf was observed on 29th February in Talhari variety which was not significant different from 0.07 recorded on 5th March. The lowest number of 0.03 aphid / leaf was recorded on 5th March in Moro chilly variety which was not significantly different from 0.06 observed on 29th February.

A comparison of mean number of aphid on three varieties of pepper is presented in Figure 13. It revealed that the lowest number of 0.57 aphid/ leaf was observed in Mirch shezadi variety which was significantly lower than 0.74 in Talhari and Moro chilly varieties. However, these two values were not significantly different from each other. But the highest number of 0.74 aphid / leaf was recorded in Moro chilly and Talhari varieties.

A comparison of mean number of aphid on pepper varieties at different dates is presented in Figure 14. It revealed that the lowest number of 0.05 aphid / leaf was observed on 29th February which was not significantly different from 0.15, 0.2 and 0.06 / leaf recorded on 20th January, 9th February and 5th March respectively. However, the highest number of 2.95 aphid / leaf was recorded on 25th January which was significantly different from all other values which was recorded from 20th January to 5th March.

Interaction between all the three varieties indicated that highest and significantly different aphid population was recorded on 25th January which dropped significantly with the application of need seed extract (NSE) on 25th January and after 15 days intervals. The population of aphid remained decreased but significantly different in different varieties.

Table-13. Mean number of aphid nymph / leaf on pepper varieties at different observation dates.

Obs. Dates	Pepper Varieties		
	V1= Mirchshezadi	V2= Talhari	V3= Moro chilly
20-Jan	0.09 ⁱ	0.21 ^{hi}	0.16 ^{hi}
25-Jan	2.58 ^b	3.24 ^a	3.04 ^a
30-Jan	1.33 ^{cd}	1.26 ^d	1.63 ^c
4-Feb	0.29 ^{ghi}	0.69 ^f	1.06 ^{de}
9-Feb	0.21 ^{hi}	0.19 ^{hi}	0.19 ^{hi}
14-Feb	0.12 ⁱ	0.47 ^{fgh}	0.31 ^{ghi}
19-Feb	0.46 ^{fgh}	0.56 ^{fg}	0.19 ^{hi}
24-Feb	0.49 ^{fgh}	0.68 ^f	0.76 ^{ef}
29 Feb	0.06 ⁱ	0.04 ⁱ	0.06 ⁱ
5-Mar	0.08 ⁱ	0.07 ⁱ	0.03 ⁱ

Note: Means sharing similar letters are not significantly different by Fisher's LSD test at P = 0.05.

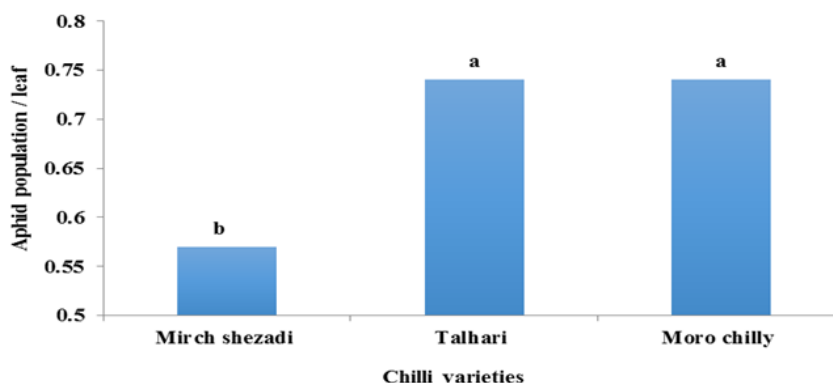


Figure-13. Mean number of aphid on pepper varieties.

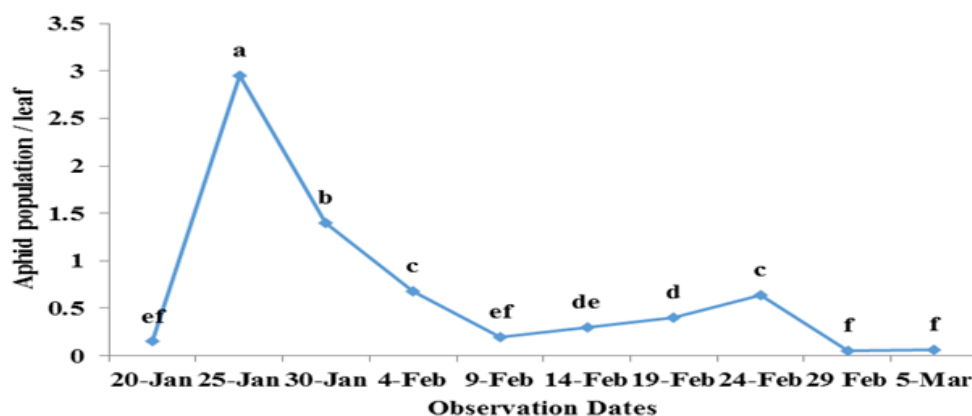


Figure-14. Mean number of aphid on pepper varieties at different observation dates.

Note: Means sharing similar letters are not significantly different by Fisher's LSD test at P = 0.05.

3.3.4. Predators Population on Pepper Varieties

The result of per plant population of ladybird beetle (*Coccinella septempunctata*) adults on three pepper varieties at different dates is presented in Table 14. It revealed that the highest population of *C. septempunctata* was recorded on 9th February in Talhari variety. It was 1.33, 1.53 and 1.61 / plant on Mirch shezadi, Moro chilly and Talhari varieties respectively. Therefore, Neem Seed Extract was applied at 2 percent concentrations on 25th January which was continued at 15 days intervals on 9th February and 24th February. However, the lowest number of 0.03 *C. septempunctata* / plant was recorded on 20th January and 29th February which was not significantly different from 0.13 recorded on 5th March in Mirch shezadi variety. In case of Talhari variety, the lowest number of 0.04 *C. septempunctata* / plant was observed on 20th January which was not significantly different from 0.11, 0.18 and 0.21 / plant recorded on 25th January, 29th February and 5th March respectively. In case of Moro chilly variety similar trend was observed, the lowest number of 0.03 *C. septempunctata* / plant was observed on 20th January which was not significantly different from 0.11, 0.14 and 0.09 / plant recorded on 25th January, 29th February and 5th March respectively. A comparison of mean number of predators on three varieties of pepper is presented in Figure 15. It revealed that the lowest number of 0.59 *C. septempunctata* / plant was observed in Mirch shezadi. However, the highest number of predators 0.74 and 0.72 / plant was recorded in Moro chilly and Talhari varieties which was not significantly different from each other. A comparison of mean number of predators on pepper varieties at different dates is presented in Figure 16. It revealed that the lowest number of 0.03 *C. septempunctata* / plant was observed on 20th January which was not significantly different from 0.14, 0.14 and 0.11 / plant recorded on 25th January, 5th March and 29th February respectively. However, the highest number of 1.49 *C. septempunctata* / plant was recorded on 9th February which was not significantly different from 1.36 was recorded on 30th January.

Table-14. Mean number of predators on pepper varieties at different observation dates.

Obs. Dates	Pepper Varieties		
	V1= Mirchshezadi	V2= Talhari	V3= Moro chilly
20-Jan	0.03 ^l	0.04 ^l	0.03 ^l
25-Jan	0.21 ^{kl}	0.11 ^k	0.11 ^k
30-Jan	1.13 ^{de}	1.48 ^{ab}	1.49 ^{ab}
4-Feb	1.14 ^{de}	1.21 ^{de}	1.29 ^{bc}
9-Feb	1.33 ^{bc}	1.61 ^a	1.53 ^{ab}
14-Feb	0.68 ^{hi}	0.88 ^{gh}	0.48 ^{ij}
19-Feb	0.89 ^{fg}	0.71 ^{hi}	1.23 ^{cd}
24-Feb	0.34 ^{jk}	0.74 ^h	1.06 ^{rf}
29-Feb	0.03 ^l	0.18 ^k	0.14 ^{kl}
5-Mar	0.13 ^{kl}	0.21 ^{kl}	0.09 ^{kl}

Note: Means sharing similar letters are not significantly different by Fisher's LSD test at P = 0.05.

Interaction between all the three varieties indicated that highest and significantly different predator population was recorded on 9th February which dropped significantly with the application of neem seed extract on 25th January after 15 days intervals. Population of predator remained not decrease but significantly different on different varieties.

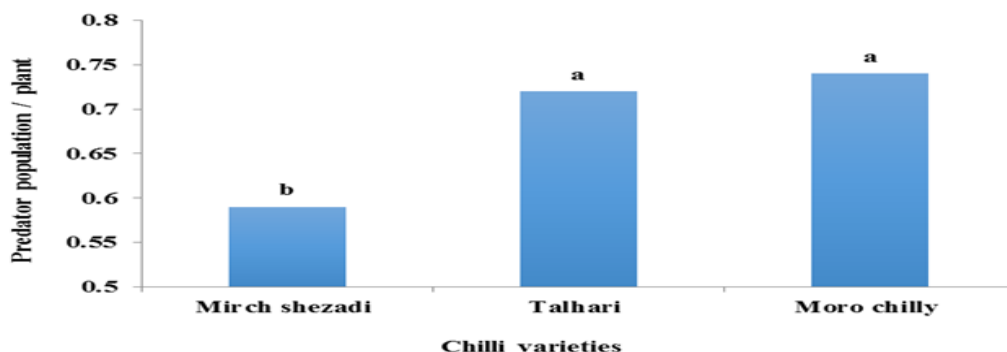


Figure-15. Mean number of predators on pepper varieties.

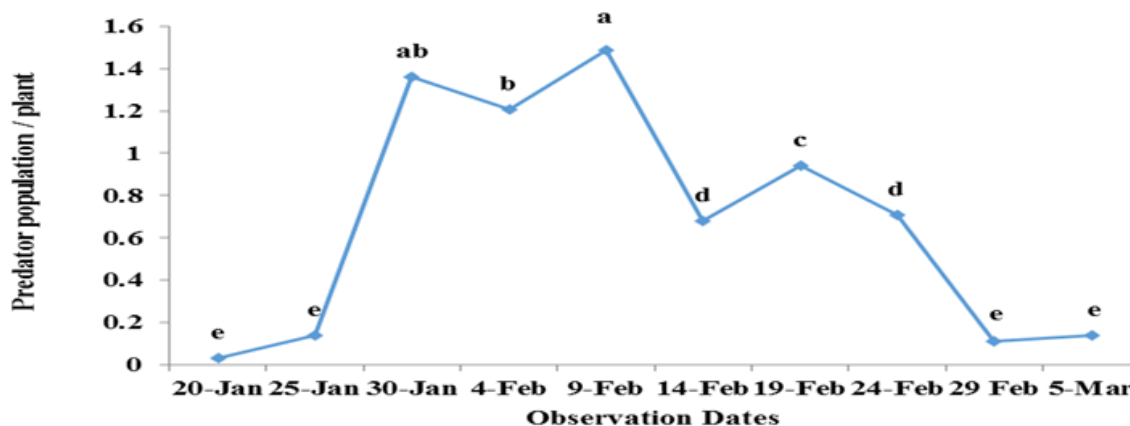


Figure-16. Mean number of predators on pepper varieties at different observation dates.

Note: Means sharing similar letters are not significantly different by Fisher's LSD test at P = 0.05.

4. DISCUSSION

Repellency of Neem Seed Extract was studied against whitefly on brinjal, pepper and tomato plants by free choice method in the green house of the Faculty of Agriculture, LUAWMS. Two vegetable crops viz brinjal and pepper sown had sprayed with Neem Seed Extract against whitefly, jassid, aphid, borer and population of these insect pests and predators was compared on three varieties of each crop separately sown in Randomized Complete Block Design (RCBD) at Coconut Farm, Uthal in 2017. In brinjal varieties, Black long had greater resistance to whitefly as compared to PPL and F₁Advanta-305. The highest population was recorded on 25th January. Against Jassid brinjal variety F₁ advanta-305 showed some resistance to jassid and aphid as compared to PPL and Black long; while the highest population was recorded on 25th January and lowest population on 5th March. Brinjal varieties F₁-Advanta-305 and Black long attracted more predators as compared to PPL variety; and predator population was highest on 4th February [15]. Examined bio-pesticide against jassid on brinjal using oil of neem, leaves of Tobacco, powder of Neem, oil of Neem and beneficial micro-organism. The first spray of neem oil caused 71.97 percent mortality of jassid; powder of Neem 61.56 percent and Tobacco leaves 54.75 per cent. In the second spray tobacco leave caused maximum reduction of followed by 80 percent neem seed, oil of Neem + B.M. Beneficial micro-organism 75.7 percent and 70.7 percent in neem seed. Bhutto [16] examined the effect of plant extracts of Datura, Khabar, Neem Akk, Sufaida on larval development of brinjal fruit borer, *Leucinodes orbonalis*. This indicates that the plant extracts had effectively controlled the development of brinjal fruit borer. It is suggestible that Datura

extract and Neem extract may preferably to be used to combat the development of brinjal fruit borer. The fertility was highest in control, while no fertility was observed in fruit borers treated with Datura, Neem and Khabbar extracts. However, the insect longevity was higher (20 days) under neem extract treatment and lowest when brinjal fruits were treated with Datura extract. Puttaswamy [6] reported that neem extract observed its highly activity to conflict whole the insect pests observed in brinjal, followed by chemical control, tobacco extract, tooh extract, akk extract and datura remained the least. Regardless the bio-pesticides, the apex potential was observed against *Amrasca davastan* during both the sprays. Mites persisted more than borer and jassid to remain in the brinjal fields. For effective and safe control of brinjal insect pests in the field, the crop may be sprayed with neem extract followed by extracts of tobacco & tooh . Atleast on spray monthly is essential to keep the insect pests below economic injury level. There is no need to apply chemical control, because neem extract resulted better than the chemical control.

Pepper variety Mirch shehzadi showed relative resistance to whitefly over Moro chilly and Talhari. The highest population was recorded on 25th January. Talhari and Mirch shehzadi varieties also showed some resistance to jassid as compared to Moro chilly. While apex population was recorded on 25th January and lowest population was observed on 5th March after spray of neem seed extract on 25th January, 09th February and 24th February. Mirch shehzadi suffered markedly lesser with aphid population than Talhari and Moro chilly varieties; However, the highest population was seen on 25th January and lowest on 5th March. Moro chilly and Talhari pepper varieties were attracted more predators as compared to Mirch shehzadi and highest population was on 14th February but predators remained in minor population upto the final observation on 5th March. Agro [14] who stated that thrips, mite and aphid populations were 16.9, 8.8 and 4 percent as compared to 26.3, 12.8 and 3.2 percent reduction, respectively in conventional plot. Similarly, Krishna, et al. [9] found that neem seed extract against aphid population was highly effective to suppress the insect below economic injury level. Ahmed, et al. [17] suggested that all the use of trial plant extracts particularly these bio-pesticides have been established for controlling of insect pests; garlic, sweetsop and tobacco they have been found to be very promising botanical pesticide in the control of insect pests on pepper. It has been performed that the field trials to evaluate the effectiveness of botanical extracts and reported that extracts of (Neem) *Azadirachta indica* and (garlic) *Allium sativum* on the concentrations of 0.01 percent were effective to control insect pests. Mode of action of Neem on the sucking insect pests were sufficient due to repellent effect on insect pests. First spray on the crop was in 25th January after this the population of insect pests was decreased and repel from crop but in the 2nd spray of neem seed extract was done in 9th February and 3rd spray in 24th February. Preference and non-preference of pests due to biochemicals especially secondary compounds. Predator population is dependent on the availability of pests. In the current research it was deserved that predator population decreased after the decrease of sucking pests but later on it slightly increase due to the availability of less active insect pests in the field. Finally it was deserved that population of all the pests on various crop varieties remained below EIL after the application of 2 percent NSE on 25th Janaury and later on at fortnightly intervals. These showed that insect pests of all these vegetable crop varieties can be managed with this treatment.

4.1. Conclusion

The results of present study revealed varietal preference of monitored insect pests differed significantly in tomato varieties. Since pest population increased beyond ETL on 25th January. Therefore, 2 percent neem seed extract was applied on the test vegetables on 25th January, 09th and 24th February. These applications kept the pest population below ETL till the last observation on 5th March. Population of predators were not affected significantly by application of 2 percent neem seed extract because of predators which are not phytophagous like other pests.

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