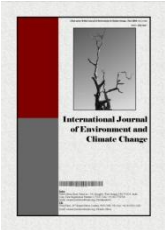

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Efficacy of Capsaicin Rich Botanicals on the Aphid Population in Lablab (*Dolichos lablab* L.) under Organic Production System

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The growing concern for environmental safety and the demand for pesticide residue –free food worldwide have evoked interest in pest management through the use of botanicals, which offers a good alternative to manage the insect pests in an eco-friendly manner. This research was carried out to study the efficiency of botanicals on the aphid population in lablab under organic production system.
Study Design: The study was carried out in Randomized Block Design (RBD) with eight treatments and three replications.
Place and Duration of Study: The study was carried out at College Orchard, Department of Vegetable Science, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during 2021 - 2022.
Methodology: The study was performed using chilli extract with three concentrations (2.5, 5.0 and 7.5%) and compared with other botanicals such as neem oil, neem seed kernel extract, garlic extract and panchagavya. The aphid population was counted visually before and 1, 3, 5 and 7 days after spraying.
Results: The results showed that after 7 days spraying 95.81 per cent of aphid population was reduced in T3 (7.5% chilli extract) followed by T2 & T1 (5 % & 2.5%) with a population reduction to

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the level of 95.62 and 91.54 per cent, respectively. This was followed by neem oil with a reduction of 83.50 per cent followed by garlic extract (79.74%), neem extract (76.94%) and panchagavya (62.81%). The inflorescence infestation was also lower in T3 (4.94) which were compared to control.

Conclusion: The application of chilli extract resulted in reduction of aphid population in lablab under organic cultivation. Infloresecence infestation was also recorded minimum in chilli extract treated plots. The chilli extract is non-toxic to humans and does not harm the environment and hence this can be utilized as an alternative to chemical pesticides.

Keywords: Lablab; chilli extract powder; capsaicin; aphid; botanicals; pest population.

1. INTRODUCTION

Indian bean (*Dolichos lablab* L.; Family: Fabaceae), also known as the Australian pea, Egyptian bean, kidney bean, dolichos bean, Lablab bean, seim bean, or chicharo is grown in Asia and Africa [1]. It is a perennial herbaceous plant that plays a significant role in both field and home garden-grown fruit and vegetable crops. While the dried seeds are utilized in a variety of vegetable food recipes, the green pods are the main reason it is farmed. It is one of the main sources of minerals, dietary fiber, and proteins [2].

Pest insects have a significant negative impact on Indian bean yield. Numerous insect pests attack the crop, including the aphid *Aphis craccivora* Koch., jassids *Empoasca fabae* (Harris), *E*. *krameri* Ross & Moore, and *E. kerri* Pruthi; pod borer *Etiella zinckenella* (Treit.); white fly *Bemisia tabaci* (Genn.); stem fly *Ophiomyia phaseoli* (Tryon). Among them, aphids (*Aphis craccivora* Koch.), jassids (*Empoasca fabae* Harris.), and whiteflies (*Bemisia tabaci* Genn.) are three of the most prevalent sucking pests infesting Indian beans in Rajasthan's semi-arid climate. By sucking the cell sap from the vulnerable parts of the plant as well as the lower region of the leaves, both nymphs and adults harm the environment. When plants are severely infested, these pests damage every part of the plant, including the pods, which stunts growth and reduces output [3].

Many researchers have advocated using chemicals to control sucking pests in order to effectively reduce their population [4,5,6]. However, because the continuous and widespread use of insecticides from the same class has led to issues with resistance, negative effects on parasites and predators, residue hazards for people and animals, and environmental pollution [7]. One of the most effective control measures for synthetic chemical hazards is the use of plant-derived products. Plant products are becoming increasingly popular due to their biodegradability, low persistence and toxicity to non-target organisms, low cost, and ease of availability. There are currently about 200 plants known to have insecticidal properties. Azadirachtin, an active compound extracted from the *Azadirachta indica* A. Juss (neem) tree (Family Meliaceae) whose antiviral, antifungal, antibacterial, and insecticidal properties have been known for several years, is one of the most promising natural compounds [8]. Capsaicinoids (capsaicin, dihydrocapsaicin, nordihydrocapsaicin, homocapsaicin, and homodihydrocapsaicin) are a class of phenolic alkaloids present in chilli. Capsaicin is the active ingredient in chilli peppers and the most abundant irritant compound in hot peppers that causes humans to experience a burning sensation [9]. Capsaicin has broad-spectrum insecticidal activity against many species of insects, eg, stored product beetles (*Sitophilus zeamais* and *Tribolium castaneum*), rice grain insects (*Sitotroga cerealella*), Alfalfa weevil, *Myzus persicae*, *Bemisia tabaci* and *Plutella xylostella* [10].

2. MATERIALS AND METHODS

The experiment was conducted at the College Orchard, Department of Vegetable science, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. The experimental plot was ploughed 2-3 times and leveled thoroughly. During the last ploughing adequate amount of FYM were applied to the field and raised beds were prepared. Irrigation was given through drip.

The seeds were sown directly in the main field with a spacing of 60 × 30 cm. The crop was sprayed at 50 days after sowing at each replication with knapsack hand sprayer. Recommended package of practices were followed to raise the crop except plant protective

measures. The weight of the pods were recorded at final harvest and it is expressed in kilograms (kg) .Experiment was laid out in Randomized Block Design (RBD) with eight treatments and replicated thrice.

Table 1. Treatment details

	Treatments	Concentration (%)
T 1	Chilli extract powder	2.5
T 2	Chilli extract powder	5.0
T 3	Chilli extract powder	7.5
T 4	Neem oil	0.5
T 5	Neem seed kernel extract	5
T 6	Garlic extract	3
T 7	Panchagavya	5
T 8	Control	Untreated

2.1 Collection and Processing of Plant Powders

The chilli fruits having high capsaicin content (more than 1 lakh Scoillie Heat Unit (SHU)) collected from the TNAU orchard, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore were dried under shade. The dried fruits were ground into powder.

2.2 Preparation of Chilli Extracts

The chilli powder weighed at different concentration viz., 2.5, 5.0 and 7.5 per cent and was mixed with 100ml of water. The solution was shaken for an hour in an electric shaker. Sticking agent was added to the extract and sprayed in the field.

2.3 Preparation of Neem Seed Kernel Extract

Fifty grams of well pulverized neem seeds were soaked in a little amount of water overnight. One litre of suspension was produced by filtering it through a muslin cloth with additional water. Three ml of sticking agent per litre was added to the extract and carefully mixed. The extract was immediately applied to the plot.

2.4 Preparation of Neem Oil Emulsion

The neem oil emulsion was made by thoroughly mixing the neem oil (0.5 ml) and sticking agent (1 ml). Water (1 litre) was added to the mixture and thoroughly mixed.

2.5 Preparation of Garlic Extract

Garlic bulbs were first skinned and thoroughly mixed in sterile distilled water (1:1). Supernatant was collected after centrifugation and passed through a No. 1 Whatman filter paper and then a micropore filter (0.45 µm). The solution thus obtained was stored in a refrigerator (4^{o} C) until use [11].

2.6 Preparation of Panchagavya

Panchagavya is made up of nine ingredients such as cow dung, cow urine, milk, curd, jaggery, ghee, banana, tender coconut and water. In a wide mouthed mud vessel 5 kg of Cow dung and 500 gm of cow ghee were mixed thoroughly and kept for 3 days. After 3 days the following ingredients were added and kept for 19 days with regular mixing both in the morning and evening hours daily. The container was always kept covered with a mosquito net or cotton cloth [12].

1. Fresh cows urine – 3 liters
2. Cow's milk – 2 liters
3. Cow's curd – 2 liters
4. Jaggery – 500 gms
5. Water – 3 liters
6. Ripe banana fruit – 1 bunch
7. Tender coconut water – 3 liters

2.7 Monitoring of Pests

After the seedlings emerged, the plants were checked weekly to see if there were any aphid infestations. After the infestation had occurred, the plant extracts were applied. A hand sprayer was used to apply the extracts.

2.8 Observation on Aphids

Observation on population of aphids was recorded in the morning time in the shoots of five randomly selected plants of each plot. The population was recorded just before treatment and one, three and seven days after the spray.

2.9 Statistical Analysis

The per cent reduction of aphid population over control was calculated based on field observations [13].

Per cent reduction in pest population =
$\left(1 - \frac{Ta \times Cb}{Tb \times Ca}\right) \times 100$

Where,

Ta = Population in treated plots after treatment
Tb = Population in treated plots before treatment
Ca = Population in untreated plots after treatment
Cb = Population in untreated plots before treatment

2.9.1 Percent inflorescence infestation by number

The number of infested inflorescence was counted from the total number of inflorescence, and the percentage of infested inflorescence was calculated as follows:

$$\% \text{ Inflorescence infestation} = \frac{\text{Number of the infested inflorescence}}{\text{Total number of inflorescence}} \times 100$$

The data were statistically analyzed with ANOVA and means were separated using Least Significant Difference (LSD) test by using AGRES software package (version 7.01).

3. RESULTS

The sucking pest infestation allowed naturally in lablab during the period of study was aphids (*Aphis craccivora*). The population of aphids ranged from 245.75 to 487.68 numbers per 5 plants before the application of botanicals (Table 2).

3.1 First Day after Spraying

The aphid population in different treatments ranged between 129.42 and 222.17 after first day of treatment. The per cent reduction was found to be significantly different among the treatments. The reduction due to the application of chilli extract ranged from 44.45 to 55.34 per cent on first day after treatment. The maximum reduction was observed in 7.5% chilli extract (55.34 per cent) followed by 5 and 2.5% with 54.69 and 44.45 per cent respectively. This was followed by neem oil treatment with a reduction of 30.13 per cent followed by garlic extract 28.32 per cent. The minimum reduction was observed in panchagavya 21.69 per cent (Table 3).

3.2 Third Day after Spraying

The aphid population in different treatments ranged between 54.08 and 144 third day after treatment. The per cent reduction was found to be significantly different among the treatments. The reduction due to the application of chilli extract ranged from 77.56 to 80.91 per cent on third after treatment. The maximum reduction was observed in 7.5% chilli extract (80.91 per cent) followed by 5 and 2.5% with 80.69 and 77.56 per cent respectively. This was followed by neem oil with a reduction of 66.26 per cent followed by garlic extract 62.61 per cent. The minimum reduction was observed in panchagavya 48.84 per cent (Table 3).

3.3 Fifth Day after Spraying

The aphid population in different treatments ranged between 31.08 and 144.16 fifth day after treatment. The per cent reduction was found to be significantly different among the treatments. The reduction due to the application of chilli extract ranged from 83.74 to 89.65 per cent on fifth day after treatment. The maximum reduction was observed in 7.5% chilli extract (89.65 per cent) followed by 5 and 2.5% with 89.43 and 86.94 per cent respectively. This was followed by neem oil treatment with a reduction of 68.46 per cent followed by garlic extract 72.63 per cent. The minimum reduction was observed in panchagavya 51.92 per cent (Table 3).

3.4 Seventh Day after Spraying

The aphid population in different treatments ranged between 11.91 and 106.75 seventh day after treatment. The per cent reduction was found to be significantly different among the treatments. The reduction due to the application of chilli extract ranged from 91.54 to 95.82 per cent on seventh day after treatment. The maximum reduction was observed in 7.5 % chilli extract (95.82 per cent) followed by 5 and 2.5 % with 95.63 and 91.54 per cent respectively. This was followed by neem oil treatment with a reduction of 83.50 per cent followed by garlic extract 79.74 percent. The minimum reduction was observed in panchagavya 62.81 per cent (Table 3).

3.5 Effect of Different Plant Extracts in Suppressing Aphids in Terms of Number of Inflorescence per Plot

In Table 4, it is shown that the number of inflorescence infested on plots treated with Chilli extract 7.5% was significantly lower (4.94) but statistically comparable to those of 5% Chilli extract (5.45) and 2.5% chilli extract (5.96) which was followed by neem oil (6.12), garlic extract

(7.24), neem seed kernel extract (7.99) and panchagavya (8.74). On the other hand the highest number of infested inflorescence (10.12) was found in control. The study showed that the performance of T3 (chilli extract- 7.5%) was the best followed by T2 (chilli extract- 5%), T1 (chilli extract- 2.5%), T4 (neem oil), T6 (garlic extract), T5 (neem seed kernel extract) and T7 (panchagavya). The percent of infested inflorescence ranged from 15.59% to 41.37%. The highest percent of infested inflorescence was recorded in control which was statistically

Table 2. Aphid population in lablab before and after spraying of botanicals

Treatments	Mean number of aphid population				
	Before spraying	First day after spraying	Third day after spraying	Fifth day after spraying	Seventh day after spraying
Chilli extract (2.5%)	249.5	142.58	54.08	43	21.33
Chilli extract (5%)	279.58	129.42	55.08	31.08	11.92
Chilli extract (7.5%)	460.58	209.83	91.25	51	19.5
Neem oil	292.83	187.75	105.98	85.17	51.58
Neem seed kernel extract	215.75	161.92	101.33	85.83	59.92
Garlic extract	280.5	174.08	113.33	86.58	63.33
Panchagavya	277.17	200.25	144	144.17	106.75
Control	390.33	401.33	411	442.42	459.33

Table 3. Per cent reduction of aphid population after spraying of botanicals

Treatments	Per cent reduction of aphid population			
	First day after spraying	Third day after spraying	Fifth day after spraying	Seventh day after spraying
Chilli extract (2.5%)	44.45	77.57	83.74	91.54
Chilli extract (5%)	54.69	80.68	89.44	95.63
Chilli extract (7.5%)	55.34	80.91	89.65	95.82
Neem oil	41.95	66.27	75.02	83.50
Neem seed kernel extract	36.37	60.05	68.47	76.94
Garlic extract	41.68	62.61	72.63	79.74
Panchagavya	30.11	48.85	51.92	62.81
SED	3.80	2.67	3.01	2.88
CD(.05)	8.28	5.81	6.56	6.28
CD(.01)	11.61	8.15	9.19	8.80
CV%	10.70	4.80	4.86	4.21

Table 4. Effect of different plant extracts in suppressing aphids in terms of number of inflorescence per plot

Treatments	Total number of inflorescence	No of healthy inflorescence	No. of infested inflorescence	% Infestation
Chilli extract (2.5%)	30.03	24.07	5.96	19.85
Chilli extract (5%)	30.87	25.42	5.45	17.66
Chilli extract (7.5%)	31.68	26.74	4.94	15.59
Neem oil	29.27	23.15	6.12	20.91
Neem seed kernel extract	29.25	21.26	7.99	27.32
Garlic extract	29.59	22.35	7.24	24.47
Panchagavya	27.86	19.12	8.74	31.37
Control	24.46	14.34	10.12	41.37
SED	0.58	0.47	0.09	0.49
CD(.05)	1.23	1.01	0.21	1.04
CD(.01)	1.71	1.40	0.28	1.44
CV%	2.42	2.62	1.66	2.39

SED- Standard error of a difference; CD- Critical Difference; CV- Coefficient of Variation

different from all other treatments. The lowest percent of infested inflorescence (15.59%) was obtained from T3 (7.5% chilli extract) treated plots.

4. DISCUSSION

The result of this study established the potential of chilli extract, neem product, garlic extract and panchagavya to control *A. craccivora* on lablab. The chilli extract was significantly effective in reducing population of *A. craccivora* with the maximum reduction observed in chilli extract powder (7.5%) on seventh day after treatment. Chilli extract was effective in reducing the survival of aphids. Capsaicin is responsible for the pungent principle in chilli. This might be responsible for the reduction in aphid population. Capsaicin has repellent and insecticidal properties, for example, against hemipterans [14,15]. From the results, the chilli extract showed highest efficiency at controlling aphids. The chilli extract has the ability to kill aphids and mites [16].

The efficacy of neem oil was very close to chilli extract against *A. craccivora* on lablab plants. The neem oil against jassids at 3% reduced about 88.48 after 7 days after treatment [17]. The neem has controlled the aphids through its multiplicity of action viz., repellency, antifeedency and ovipositional deterrency [18].

The garlic extract also exhibited prominent efficacy after the neem oil. Garlic extract was the most effective at reducing aphid population by 90.98 per cent as well as leafhopper and plant hopper population by a mean percentage of 68.09 per cent [19]. Garlic is known to have anti-feedent, insecticidal and repellent properties [20] which accounted for reduction of aphid population on the garlic extract sprayed plants.

In the present study, the chilli extracts were observed to be more effective against Aphids (*A. craccivora*) followed by neem oil and garlic extract. From the results, the aphid population was reduced seven days after application of chilli extract. These showed that, aphids can be managed with this treatment.

5. CONCLUSION

The present study revealed that the plant extracts were effective against aphids. Among the different botanicals used, the chilli extract was found to be very effective and compatible in reducing aphid population in lablab. The chilli extract concentration (7.5%) was found to be highly effective against aphids after seven days of spraying. It may be concluded that the chilli extract can be used in controlling aphid population in lablab which is very serious sucking pest. Thus, these botanicals can be used as a better alternative to conventional insecticides for the management of pest attack. Since botanicals are environment friendly and non-toxic to human.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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