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Residual toxicity of insecticides against aphids (*Aphis craccivora*) infesting cowpea under laboratory condition

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Abstract
Residual toxicity of the nine insecticides was evaluated against aphid, *Aphis craccivora* infesting cowpea under laboratory condition. The result revealed that acteamiprid 0.004 per cent, dinotefuran 0.006 per cent and dimethoate 0.03 per cent were comparatively more effective in controlling the adults of aphids than others insecticides under test, both in respect of mortality as well as their prolonged persistances. Taking the RPT values into consideration, they can be arranged in descending order as follows: Acetamiprid > Dinotefuran > Dimethoate > Clothianidin > Chlorfenapyr > Flonicamid > Cyantraniliprole > Spiromesifen > Spinosad.

Keywords: *Aphis craccivora*, cowpea and residual toxicity

Introduction
Pulses have been recognized as a major source of dietary proteins for majority of the population in India and also in the world. Pulse crop also helps in the restoration of soil fertility by fixing the atmospheric nitrogen in to soil through symbiotic nitrogen fixation with the help of bacterium called Rhizobia. Thus, every pulse plant is a mini fertilizer factory itself. Cowpea is one among the major pulse crops in our country which serves the dietary requirement of the most of the vegetarian population on daily basis.

Cowpea [*Vigna unguiculata* (L.) Waip] belongs to family Leguminoceae and sub family Faboidae. It is one of the most important principle pulse crop of tropics. Importance of this crop lies in its versatility being a fodder, a vegetable, a grain legume, green manure crop as well as most versatile *kharif* pulse crop because of its draught tolerant characters, soil restoring properties and multipurpose use. It is consumed as green seeds, green pods and dry grains. Cowpea plays an important role in human nutrition in a predominantly vegetarian country like India because it is considered as vegetable meat due to high amount of proteins. Cowpea grain contains about 60 per cent carbohydrates, 22 to 28 percent proteins and 11.8 per cent fat. Moreover, it is a rich source of calcium and iron (Sharma, 2000) [12].

Cowpea originated in the Savannah region of west and central Africa (Colby and Steele, 1976) [6]. In India it is mainly grown as sole crop both in *kharif* as well as summer season. It is also frequently grown either as inter or mixed crop along with cereals like sorghum, maize, millet or sometimes with cotton. It is mainly grown in the States of Gujarat, West Bengal, Tamil Nadu, Andhra Pradesh, Kerala, Uttar Pradesh, Haryana, Delhi and Punjab.

In India, cowpea is cultivated in about 1.5 million hectare with an annual production of 0.5 million tones and average productivity 608 kg/ha (Swaminathan, 2007) [13]. In Gujarat, cowpea (grain legume) is cultivated in about 30470 ha area with an annual production of 322084 tones and average productivity of 845 kg/ha whereas, vegetable purpose cowpea occupies an area of 760 ha with an annual production of 6460 mt/ha and average productivity of 8.50 mt/ha (Anonymous, 2014) [2].

Even though all the efforts have been made by the scientists for increasing the production, the higher yield potential of various pulses including cowpea could not be able to achieve. Among the constraints responsible for low yield of such an important pulses crop, the losses due to insect-pests are considered to be an important. It is an unfortunate fact that every year about 15 to 20 per cent losses in pulses is due to the ravages of pest infestation (Lai and Sachan, 1997) [9]. The avoidable losses in yield due to insect pests have been recorded in the range of 66-100 per cent in cowpea (Pandey *et al.* 1991) [10]. As many as 21 insect pests of different groups were observed on cowpea during summer and *kharif* season.

Among this, only few of them are considered to be major pest of cowpea. Sucking pests like aphid, jassid and whitefly are important pests limiting profitable cultivation of cowpea not only by direct sap sucking but also by virus transmission.

Cowpea aphid, *Aphis craccivora* causes significant yield losses of 20-40 per cent in Asia and up to 35 per cent in Africa. The nymphs and adults suck the cell sap from host plant. The damage to the crop results in profuse draining of plant sap and development of honey dew leading to black sooty mould on leaves and leaf shedding (Kotadia and Bhalani, 1992) [4, 7]. A virus "rosette" is known to be transmitted by this aphid (Atwal, 1976) [3].

Now- a- days, a large number of newer insecticides are available in market. Residual toxicity of these insecticides needs to be studied for comparatively safer to environment and economical management strategies of any insect pest. Very less amount of work has been made in safer to environment and economical management strategies of aphid, *A. craccivora* infesting cowpea especially in South Saurashtra and North Saurashtra Agro-climatic Zone of Gujarat.

Materials and method

The culture of *A. craccivora* was maintained in the laboratory for experimental purpose. Initial culture was raised by collecting the adults of *A. craccivora* from the untreated cowpea field located at the Vegetable Research Station, Junagadh Agricultural University, Junagadh. The cowpea seeds were sown in earthen pots containing black cotton soil. They were allowed to grow for 30-40 days in laboratory and 2-3 leaves per plant were allowed to retain while rest were pinched off. Such plants were covered with the glass chimney measuring 4.7 cm diameter at top and 7.2 cm diameter at the bottom with bulging shape in the middle and 21 cm in height. The chimney was gently pressed into soil of plot to hold it firmly. Forty to fifty adults of aphids were introduced into the chimney. The top was closed with black muslin cloth and kept in position with the help of rubber band. After 24 hours of exposure, the adults were removed from the plants, again covered with chimney and kept under laboratory. On hatching the nymphs move on leaves in such of suitable feeding site. The nymphs thus developed in laboratory were used for further study. For transferring nymphs, they were slightly disturbed initially by touching with camel hair brush so as to withdraw their mouth parts from the tissues, after that nymphs of aphids were transferred to fresh leaves with help of a wet camel hair brush and then they were used for laboratory studies.

Application of treatment

With a view to determine the residual toxicity of different insecticides against aphid, ten rows of cowpea crop of five meter length was sprayed with different insecticides under test. The spray solution was used @ 500 lit / ha with the help of knapsack sprayer. The leaves from the respective treatments were brought into the laboratory at an interval of two days and kept in the specimen tubes. The one day starved third instar ten nymphs of aphids were released into each specimen tube containing the treated leaves of cowpea. The nymphs were provided with fresh untreated food after 24 hours of feeding on treated food. Observation on the mortality were recorded 48 hours after the release of the nymph and continued till no mortality is observed. The percentage mortality was corrected by using Abbott's formulas (Abbott, 1925) [1] given below.

$$P = \frac{P^1 - C}{100 - C} \times 100$$

Where

P = Corrected mortality percentage in the test insects.

P^1 = Observed mortality percentage in the test insects.

C = Percent mortality in the control.

The zero and per cent values was removed by using the formula 1/4n × 100 and (1- 1/4n) × 100, respectively (Bartlett, 1947) [5], where, n= number of nymphs per treatment. The data, thus obtained were transformed by using angular or sine inverse transformation and subjected to statistical analysis. Relative persistent toxicity (RPT) for each insecticide was worked out as suggested by Sarup *et al.* (1970) [11].

Residual toxicity of different insecticides

A field cum laboratory study was carried out to assess the residual toxicity of some insecticides against the third instar nymphs of *A. craccivora* on cowpea crop. The mortality data obtained at different intervals are included in Table.

Two days after spray

The results presented on mortality percentage in population (Table 1 and Fig.1) of *A. craccivora* revealed that dinotefuran 0.006 per cent was found superior over rest of the insecticides and gave 98.00 per cent mortality of aphids. It was found to be statistically at par with the treatments acetamiprid 0.004 per cent, spiromesifen 0.08 per cent and dimethoate 0.03 per cent as they had registered 96.00, 92.55 and 90.23 per cent mortality values, respectively. The treatments flonicamid 0.02 per cent and clothianidin 0.003 per cent registered 87.33 and 85.66 per cent mortality in population, respectively. The rest of treatments, chlorfenapyr 0.0075 per cent and cyantraniliprole 0.02 per cent gave 79.25 and 75.56 per cent mortality in population, respectively. The treatment spinosad 0.009 per cent registered the lowest (46.69 per cent) mortality value.

Table 1: Residual toxicity of different insecticides against cowpea aphid

Treatments	Concentration	Per cent mortality of cowpea aphids at different intervals after spray (Days)								P	T	PT	RPT
		2	4	6	8	10	12	14	16				
Flonicamid 50 WG	0.02	69.14 (87.33)	54.59 (66.44)	37.01 (36.25)	22.16 (14.23)	13.74 (05.65)	---	---	---	10	41.98	412.80	0.654
Dinotefuran 20 SG	0.006	81.84 (98.00)	77.36 (95.23)	64.26 (81.15)	46.28 (52.25)	32.73 (29.25)	27.66 (21.56)	15.03 (06.73)	12.29 (4.54)	16	48.58	777.28	1.232
Cyantraniliprole 10 OD	0.02	60.36 (75.56)	51.01 (60.59)	40.76 (42.65)	17.70 (09.25)	9.93 (02.98)	---	---	---	10	37.72	377.20	0.598
Clothianidin 50 WDG	0.003	67.74 (85.66)	61.55 (77.32)	51.26 (60.87)	32.34 (28.63)	18.00 (09.56)	---	---	---	10	52.40	524.00	0.830
Chlorfenapyr 10 EC	0.0075	62.89 (79.25)	58.27 (72.36)	42.26 (45.25)	27.66 (21.56)	13.17 (05.20)	---	---	---	10	44.72	447.20	0.709
Spinosad 45 SC	0.009	70.56 (46.69)	38.19 (38.25)	19.04 (10.65)	10.87 (03.56)	---	---	---	---	6	24.78	148.68	0.235
Acetamiprid 20 SP	0.004	78.43 (96.00)	71.97 (90.43)	59.57 (74.36)	51.87 (61.89)	47.99 (55.23)	32.27 (28.52)	28.62 (22.95)	17.99 (09.55)	16	54.61	873.76	1.385
Spiromesifen 48 EC	0.08	74.15 (92.55)	48.65 (56.38)	35.21 (33.26)	28.34 (22.55)	18.65 (10.23)	---	---	---	10	42.99	429.9	0.681
Dimethoate 30 EC	0.03	71.76 (90.23)	62.17 (78.22)	56.57 (69.66)	41.72 (44.29)	25.28 (18.25)	15.98 (07.59)	11.88 (4.24)	09.78 (2.89)	16	39.42	630.72	1.000
S.Em.±		2.34	3.34	2.65	2.35	1.56	1.84	1.32	0.80				
C. D. at 5%		6.98	9.94	7.88	6.98	4.69	6.26	4.59	3.04				
C. V.%		10.08	10.17	10.18	13.13	12.07	12.40	12.43	11.41				

Figures in the parenthesis are retransformed values, those outside are arcsine values
P = Period of time
T = Average toxicity of the insecticides
PT = Persistent toxicity
RPT = Relative persistent toxicity
Dimethoate was taken as unity

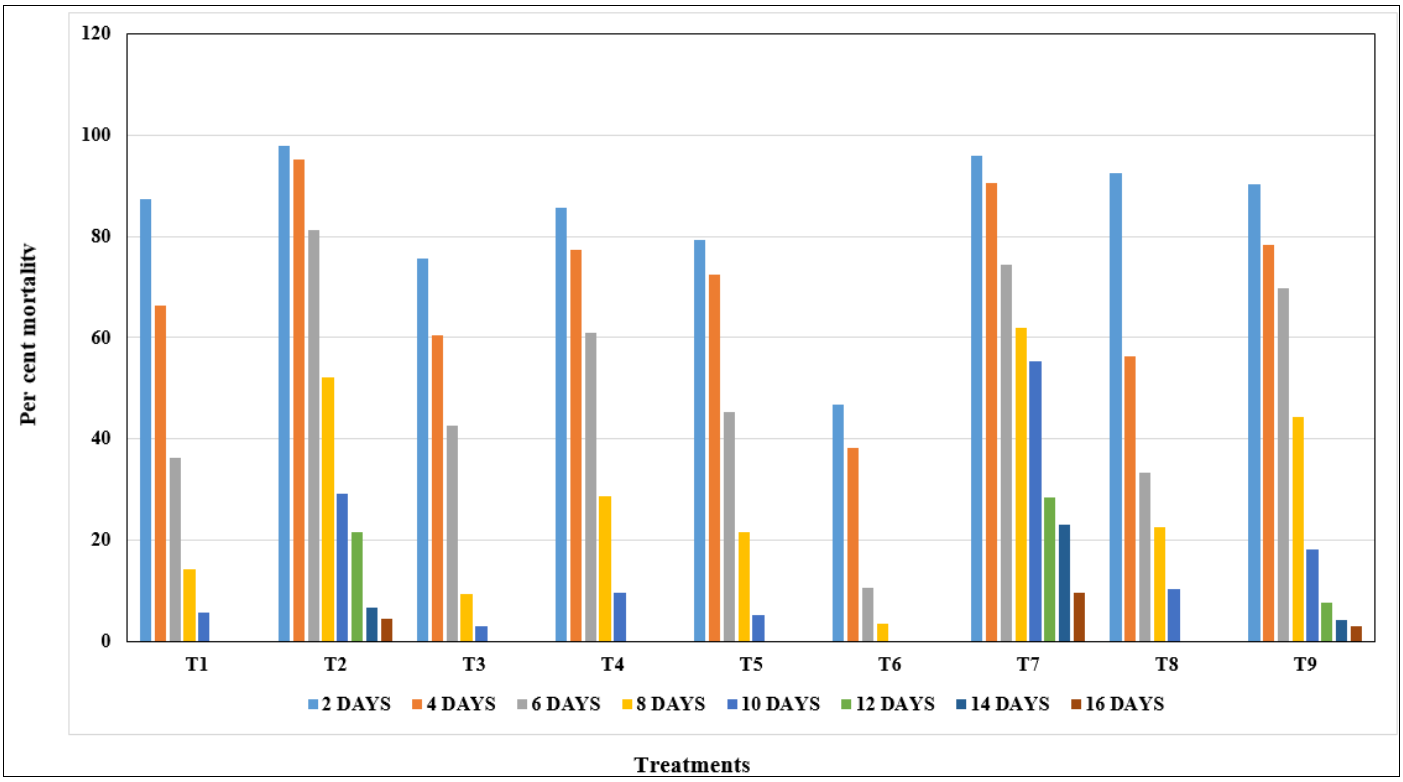

Fig 1: Residual toxicity of different insecticides against cowpea aphid

Four days after spray

The mortality data revealed that dinotefuran 0.006 per cent gave significantly the highest mortality of 95.23 per cent and it was found to be statistically at par with acetamiprid 0.004 per cent as it registered 90.43 per cent mortality. The treatments dimethoate 0.03 per cent, clothianidin 0.003 per cent, chlorfenapyr 0.0075 per cent, flonicamid 0.02 per cent, cyantraniliprole 0.02 per cent and spiromesifen 0.08 per cent registered 78.22, 77.32, 72.36, 66.44, 60.59 and 56.38 per cent mortality values, respectively. The lowest mortality was observed in treatment of spinosad 0.009 per cent which registered 38.25 per cent.

Six days after spray

The treatment of dinotefuran 0.006 per cent gave the highest mortality of 81.15 per cent mortality and it was found to be statistically at par with acetamiprid 0.004 per cent as it registered 74.36 per cent mortality. However, treatments of dimethoate 0.03 per cent and clothianidin 0.003 per cent which had registered 69.66 and 60.87 per cent mortality, respectively proved that next best treatments. The treatments of chlorfenapyr 0.0075 per cent and cyantraniliprole 0.02 per cent registered 45.25 and 42.25 per cent mortality, respectively and were found equally effective and other treatments did not gave effective mortality.

Eight days after spray

The acetamiprid 0.004 per cent was significantly found be the most effective treatment and gave 61.89 per cent mortality. The next best effective treatments dinotefuran 0.006 per cent and dimethoate 0.03 per cent recorded 52.25 and 44.29 per cent mortality, respectively. The insecticides clothianidin 0.003 per cent, spiromesifen 0.08 per cent and chlorfenapyr 0.0075 per cent registered 28.63, 22.55 and 21.56 per cent mortality, respectively. The mortality data also revealed that spinosad was found the least persistent as it did not show mortality of the pest at eight days after application.

Ten days after spray

It is evident that mortality among all the treatments drastically reduced after ten days of insecticidal application. Acetamiprid, dinotefuran and dimethoate were found significantly superior to rest of the insecticides and showed 55.23, 29.25 and 18.25 per cent mortality values, respectively. The other treatments gave mortality values ranging from 10.23 to 5.20 per cent. Acetamiprid, dinotefuran and dimethoate were found persistent for sixteen days and exhibited 9.95, 4.54 and 2.89 per cent mortality values, respectively. The other treatments gave mortality values ranging from 10.23 to 5.20 per cent. Acetamiprid, dinotefuran and dimethoate were found persistent for sixteen days and exhibited 9.95, 4.54 and 2.89 per cent mortality values, respectively.

The aphid mortality recorded at different intervals after the application, clearly indicated that there was continuous decline in effectiveness of various insecticides as the exposure of the insecticides was prolonged.

Finally, the relative persistence of the toxicity (RPT) was also worked out on the basis of PT index and it was taken as criterion for the relative persistence of toxicity. Considering the RPT values, it can be seen that acteamiprid 0.004 per cent, dinotefuran 0.006 per cent and dimethoate 0.03 per cent were comparatively more effective in controlling the adults of aphids than others insecticides under test, both in respect of mortality as well as their prolonged persistances. Taking the RPT values into consideration, they can be arranged in descending order as follows: Acetamiprid > Dinotefuran > Dimethoate > Clothianidin > Chlorfenapyr > Flonicamid > Cyantranilipprole > Spiromesifen > Spinosad.

These findings are more or less in confirmation with the earlier research work done by Sinha and Marwaha (2000) in corn and Dhanalakshmi and Mallapur (2008) in okra who also proved that acetamiprid, dimethoate and dinotefuran were the best treatments under the laboratory conditions. Similar result was reported by Kolhe *et al.* (2009) [8] that superiority of acetamiprid 20 SP @ 0.003% and thiamethoxam 25 WG @ 0.005% against aphids gives up to 10 DAT.

Conclusion

Among all the treatments mortality was drastically reduced after ten days of spraying. Acetamiprid, dinotefuran and dimethoate were found significantly superior to rest of the insecticides and show mortality, 55.23, 29.25 and 18.25 per cent respectively. Acetamiprid, dinotefuran and dimethoate were persisted for sixteen days and exhibited 9.95, 4.54 and 2.89 per cent mortality values, respectively.

The aphid mortality recorded at different intervals after the application, clearly indicated that there was continuous decline in effectiveness of various insecticides as the exposure of the insecticides was prolonged. Considering the RPT values, it can be observed that acteamiprid 0.004 per cent, dinotefuran 0.006 per cent and dimethoate 0.03 per cent were comparatively more effective in controlling the adults of aphids than others insecticides under test, both in respect of mortality as well as their prolonged persistances. Taking the RPT values into consideration, they can be arranged in descending order as follows: Acetamiprid > Dinotefuran > Dimethoate > Clothianidin > Chlorfenapyr > Flonicamid > Cyantranilipprole > Spiromesifen > Spinosad.

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