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Chemigation versus foliar application for management of pest complex of cowpea (*Vigna unguiculata* L. Walp) under South Gujarat conditions

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Abstract
Chemigation helps to reduce the labour cost, time and wind drift problems and also give same efficiency in terms of pest management as compared to foliar spray. Out of ten insecticidal treatments at different intervals, data indicated that among foliar spray treatment Imidacloprid 17.8 SL + Cynatraniliprole 10.26 OD was the best in reducing almost all the five major insect pests, recording 0.89 aphid index, 0.42 whitefly/leaf except jassids. Among chemigation treatment Imidacloprid 17.8 SL + Cynatraniliprole 10.26 OD was the best treatment recording 0.54 pod borer and 0.89 spotted pod borer larva per plant.

Keywords: chemigation, cowpea, efficiency, foliar spray, insect pests

1. Introduction
Drip or trickle irrigation can be defined as a method of uniformly delivering water to a plant's root zone through point or line sources (emitters) on or below the soil surface at a small operating pressure (Dasberg and Or, 1999) [3]. Water saving with drip irrigation can be as high as 80 per cent compared with other irrigation methods (Bogle and Hartz, 1986) [2].
The advantages of drip injection of insecticides over ground application methods include a uniform distribution of insecticide throughout the field, a reduction in pesticide application inputs including manpower and vehicle or tractor fuel, reduction in soil compaction, plant disturbance, and applicator exposure to pesticides. Insecticides applied through a drip irrigation system can replace or reduce the number of foliar insecticide sprays, reducing the risks to non-target species. Generally, neonicotinoid insecticides (imidacloprid, thiamethoxam, acetamiprid) are major and extensively used insecticides against almost all the sucking pests like aphids, jassids, hoppers, whiteflies and leaf miners. Clorantraniliprole and cynatraniliprole is a diamide insecticide, it is extremely toxic to lepidopteron pests and discriminative contraction of the larval body occurs after ingestion of this insecticide and it is safe to human beings.
The efforts here were made by using different groups of insecticides which applied via chemigation and foliar application method to check the efficacy and phytotoxicity against insect pests of cowpea and also to reduce the cost of spraying again and again.

2. Materials and Methods
2.1 Experiment details
Cowpea variety (Anand Vegetable Cowpea-1(AVCP-1) was sown with the spacing 45cm × 20 cm by Dibbling line sowing method at SWMRU farm, NAU, Navsari in the year 2018 with the plot size 3.60m×2.40m. In this experiment FRBD (Factorial Randomized Block Design) was followed with 10 (5: Chemigation + 5: Foliar spray) treatments (Table 1) and 3 replications.

2.2 Efficacy of various insecticides over their application methods
In order to evaluate the efficacy of different insecticides, observations on aphid, jassid, whitefly, cowpea pod borer (*H. armigera*) and spotted pod borer (*M. vitrata*) was recorded from five randomly selected plants from each net plot area. Before spray, counts of different pests were recorded from five randomly selected plants per net plot area. Then counts were made at 1, 3, 7 and 14 days after each application. The methodology of recording pest population was to select random 5 plant from each plot and counting of pest was done.

The spraying was carried out with the help of lever operated knapsack sprayer. Proper care was taken during the spraying to obtain uniform coverage of insecticides on each plant in each plot. chemigaion was given by pressure inject technique in drip line with water. Knapsack sprayer was joint in to drip valve and inject the same concentration and same volume as we used in foliar spray. Two sprayings and two chemigation were carried out during experimental period. First foliar spray and chemigation was given at the initiation of pest incidence, second foliar spray and chemigation was given after 15 day of first spray. First spray and chemigation was given for control of sucking pest (Aphid, Jassid and Whitefly) with insecticides (Imidacloprid 17.8 SL and Thiomethoxm 25 WG). Second spray and chemigation was given for the control of borer type of pest (Cowpea pod borer and Spotted pod borer with the given insecticides treatment (Chlorantraniliprole 18.5 SC and Cynatraniliprole 10.26 OD).

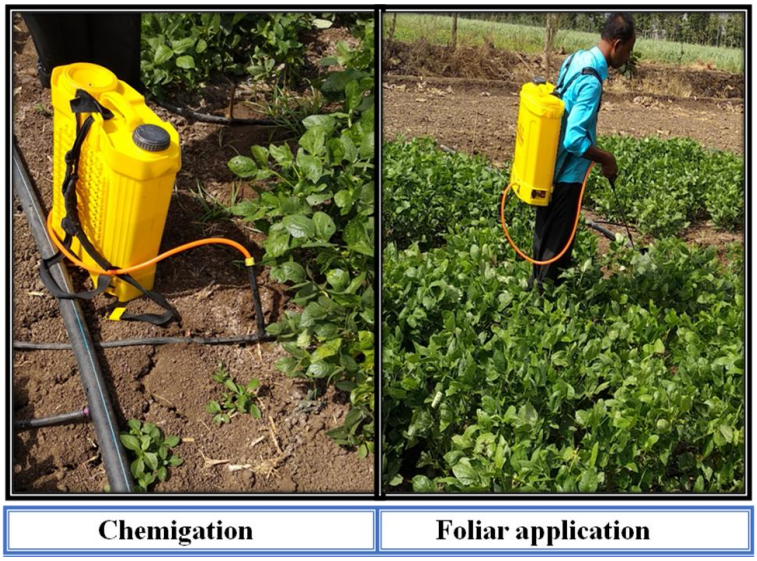

Fig 1: Insecticide Application Methods

3. Results and Discussion

3.1 Sucking pests

3.1.1 Aphid, *A. craccivora*

Pooled over periods data (Table 1) indicated that all the treatments showed significant superiority in controlling the aphid population over control. However, significantly lowest aphid population was recorded in the foliar spray treatment *i.e.*, Imidacloprid 17.8 SL + Cynatraniliprole 10.26 OD (0.89 aphid index) which recorded minimum aphid population than rest of the treatments but it was at par with Imidacloprid 17.8 SL + Chlorantraniliprole 18.5 SC (1.13 aphid index). The remaining treatments *viz*., Thiomethoxm 25 WG + Cynatraniliprole 10.26 OD and Thiomethoxm 25 WG + Chlorantraniliprole 18.5 SC were less effective recorded 1.49 and 1.63 aphid index respectively. Among different chemigation treatments Imidacloprid 17.8 SL + Cynatraniliprole10.26 OD (1.46 aphid index) was found most effective treatment and it was at par with treatment Imidacloprid 17.8 SL + Chlorantraniliprole 18.5 SC (1.66 aphid index). The remaining treatment *viz*., Thiomethoxm 25 WG + Cynatraniliprole 10.26 OD and Thiomethoxm 25 WG + Chlorantraniliprole 18.5 SC were less effective recorded 2.12 and 2.22 aphid index respectively. The highest aphid population was observed in control (3.62 aphid index).

The present findings are in agreement with Gupta *et al.* (1998) [4] they reported that foliar application of imidacloprid 200 SL was highly effective against sucking pests of cotton especially against leaf aphids.These findings can also more or less similar with that of Liu *et al.* (2010) [8] who conducted a field trail using imidacloprid 2.5 EC against cowpea aphid (*A. craccivora*) and found imidacloprid could effectively control cowpea aphid and the efficacy was all above 95.76 per cent during 1 day to 10 days after control.

3.1.2 Jassid, *E. kerri*

With reference to (Table 1) and Pooled data over periods indicated that all the treatments showed significant superiority in controlling the jassid population over control. However, significantly lowest jassid population was recorded in the foliar spray treatment Thiomethoxm 25 WG + Cynatraniliprole 10.26 OD with (0.52 jassid/leaf) significantly minimum jassid population than rest of the tretments but it was at par with Thiomethoxm 25 WG + Chlorantraniliprole 18.5 SC (0.90 jassid/leaf). The remaining treatment *viz*., Iimidacloprid 17.8 SL + Cynatraniliprole 10.26 OD, Imidacloprid 17.8 SL + Chlorantraniliprole 18.5 SC were less effective recorded 1.75, 1.96 jassid/leaf, respectively. Among different chemigation treatments, Thiomethoxm 25 WG + Cynatraniliprole 10.26 OD recorded lower jassid population (1.38 jassid/leaf) and were at par with Thiomethoxm 25 WG + Chlorantraniliprole 18.5 SC (1.66 jassid/leaf). The remaining treatment *viz*., Iimidacloprid 17.8 SL + Cynatraniliprole 10.26 OD, Imidacloprid 17.8 SL + Chlorantraniliprole 18.5 SC were less effective recorded 2.18, 2.26 jassid/leaf respectively. The highest jassid population was observed in control (7.34 jassids/leaf).

The results tallied with Bharpoda *et al.* (2014) who stated that thiomethoxm 25 WG @ 0.0125 per cent (1.22/ leaf) was found significantly superior insecticide in reducing the population of leaf hopper. And, they also reported that the next best group of chemicals was revealed that imidacloprid and thiamethoxam, both belong finding to neonicotinoid group @ 25g a.i./ha provinding significantly superior in controlling aphids and leafhoppers on okra compared to other conventional insecticides. Kumar *et al.* (2001) reported that thiamethoxam 25 WG was on par with imidacloprid (Gaucho, 600 FS) seed treatment @ 12ml/kg of seeds in reducing the leaf hopper infestation.

Table 1: Effect of different insecticidal treatments on sucking and borer pests complex

Mean number of *A. craccivora, E. carri, B. tabaci, H. armigera* and *M. vitrata*						
Sr. No.	**Treatment**	**Pooled for aphid**	**Pooled for jassid**	**Pooled for whitefly**	**Pooled for *H. armigera***	**Pooled for *M.vitrata***
Chemigation						
1	Imidacloprid 17.8 SL + Chlorantraniliprole 18.5 SC	1.47 (1.66) *	1.66 (2.26) *	1.35 (1.32) *	1.25 (1.06) *	1.45 (1.60) *
2	Thiomethoxm 25 WG + Chlorantraniliprole 18.5 SC	1.65 (2.22)	1.47 (1.66)	1.60 (2.06)	1.22 (0.99)	1.42 (1.51)
3	Imidacloprid 17.8 SL + Cynatraniliprole 10.26 OD	1.40 (1.46)	1.64 (2.18)	1.25 (1.06)	1.02 (0.54)	1.18 (0.89)
4	Thiomethoxm 25 WG + Cyantraniliprole 10.26 OD	1.62 (2.12)	1.37 (1.38)	1.56 (1.93)	1.08 (0.66)	1.21 (0.96)
5	Control (Drip)	2.02 (3.60)	2.57 (6.13)	2.08 (3.83)	1.89 (3.08)	1.91 (3.14)
	S. Em. ±	0.06	0.07	0.04	0.04	0.06
	C. D. at 5%	0.18	0.21	0.12	0.12	0.18
	C. V. %	6.02	8.41	9.98	8.36	9.35
Foliar spray						
6	Imidacloprid 17.8 SL + Chlorantraniliprole 18.5 SC	1.28 (1.13)	1.57 (1.96)	0.98 (0.46)	1.42 (1.52)	1.63 (2.15)
7	Thiomethoxm 25 WG + Chlorantraniliprole 18.5 SC	1.46 (1.63)	1.16 (0.90)	1.49 (1.72)	1.40 (1.46)	1.61 (2.09)
8	Imidacloprid 17.8 SL + Cynatraniliprole 10.26 OD	1.18 (0.89)	1.50 (1.75)	0.96 (0.42)	1.22 (0.99)	1.42 (1.52)
9	Thiomethoxm 25 WG + Cynatraniliprole 10.26 OD	1.41 (1.49)	1.01 (0.52)	1.38 (1.40)	1.25 (1.06)	1.44 (1.57)
10	Control (Waterspray)	2.03 (3.62)	2.80 (7.34)	2.08 (3.83)	1.87 (2.99)	1.93 (3.22)
	S. Em. ±	0.06	0.07	0.07	0.05	0.05
	C. D. at 5%	0.17	0.20	0.22	0.15	0.16
	C. V. %	10.02	11.31	11.23	11.96	9.35

*Figure in parentheses are retransformed values, those outside parentheses are $\sqrt{x}$ +0.5 Transformed values
DAS Days After Spraying
Poole data were made from before and at 1, 3, 7 and 14 days after each application

3.1.3 Whitefly, *B. tabaci*

Pooled over periods data (Table 1) indicated that all the treatments showed significant superiority in controlling the whitefly population over control. However, significantly lowest whitefly population was recorded in the foliar spray treatment *i.e.*, Imidacloprid 17.8 SL + Cynatraniliprole 10.26 OD (0.42 whitefly/leaf) which recorded minimum whitefly population than rest of the treatments but it was at par with Imidacloprid 17.8 SL + Chlorantraniliprole 18.5 SC (0.46 whitefly/leaf). The remaining treatments *viz*., Thiomethoxm 25 WG + Cynatraniliprole 10.26 OD and Thiomethoxm 25 WG + Chlorantraniliprole 18.5 SC were less effective recorded 1.40 and 1.72whitefly/ leaf respectively. Among different chemigation treatments Imidacloprid 17.8 SL + Cynatraniliprole 10.26 OD (1.06 whitefly/leaf) was found most effective treatment and it was at par with treatment Imidacloprid 17.8 SL + Chlorantraniliprole 18.5 SC (1.32 whitefly/leaf). The remaining treatment *viz*., Thiomethoxm 25 WG + Cynatraniliprole 10.26 OD and Thiomethoxm 25 WG + Chlorantraniliprole 18.5 SC were less effective recorded 1.93 and 2.06 whitefly/leaf, respectively. The highest whitefly population was observed in control (3.83 whitefly/ leaf).

The findings are match with those of Horowitz *et al.* (1998) [5], they reported that imidacloprid @ 25ml a.i./ha at 2, 7 and 14 days after application, were found effective against whitefly population.

3.2 Pod borers

3.2.1 Cowpea pod borer, *H. armigera*

Pooled over periods of spray data (Table 1) revealed that all the treatments showed significant superiority in controlling the *H. armigera* population over control. However, significantly lowest *H. armigera* population was recorded in the chemigation treatment Imidacloprid 17.8 SL + Cynatraniliprole 10.26 OD (0.54 larvae/plant) was found most effective treatment and it was at par with treatment Thiomethoxm 25 WG + Cynatraniliprole 10.26 OD (0.66 larvae/plant). The remaining treatments *viz*., Thiomethoxm 25 WG + Chlorantraniliprole 18.5 SC, Imidacloprid 17.8 SL + Chlorantraniliprole 18.5 SC were less effective and recorded 0.99, 1.06 larvae/plant, respectively. Among the different foliar spray treatments, Imidacloprid 17.8 SL + Cynatraniliprole 10.26 OD (0.99 larvae/plant) were found most effective treatment and it was at par with Thiomethoxm 25 WG + Cynatraniliprole 10.26 OD (1.06 larvae/plant). The remaining treatments *viz*., Thiomethoxm 25 WG + Chlorantraniliprole 18.5 SC and Imidacloprid 17.8 SL + Chlorantraniliprole 18.5 SC were less effective and recorded 1.46, 1.52 larvae/plant, respectively. The highest *H. armigera* population was observed in control (3.08 larvae/plant).

The present findings are in agreement with Hosamani *et al.* (2013) [6]. They found that at seven days after spray, the lowest numbers of larvae were recorded in cholrantraniliprole 20 SC @ 30g a.i./ha which recorded 0.60 larvae per metre row lenth of chickpea. Mishra (2015) [9] evaluated the bioefficacy of a new anthranilicdiamide, cyantraniliprole (cyazypyr) against *H. armigera* infesting tomato. The results revealed that significantly lowest larval population of (0.3-0.4) and (0.5) per plant at seven days after spray was recorded in the treatments cyantraniliprole (HGH 86) 10% OD @ 90

and 105g a.i./ha with 85.8-89.6 and 84.4-85.95 reduction in larva population over untreated control.

3.2.2 Spotted pod borer, *M. vitrata*

Pooled data computed (Table 1) over periods indicated that all the treatments showed significant superiority in controlling the *M. vitrata* population over control. However, significantly lowest *M. vitrata* population was recorded in the chemigation treatment Imidacloprid 17.8 SL + Cynatraniliprole 10.26 OD (0.89 larvae/plant) was found most effective treatment and it was at par with Thiomethoxm 25 WG + Cynatraniliprole 10.26 OD (0.96 larvae/plant). The remaining treatments *viz*., Thiomethoxm 25 WG + Chlorantraniliprole 18.5 SC and Imidacloprid 17.8 SL + Chlorantraniliprole 18.5 SC were less effective recorded 1.51 and 1.60 larvae/plant, respectively. Among the different foliar spray treatments, Imidacloprid 17.8 SL + Cynatraniliprole 10.26 OD (1.52 larvae/plant) were found most effective treatment and it was at par with Thiomethoxm 25 WG + Cynatraniliprole 10.26 OD (1.57 larvae/plant). The remaining treatments *viz*., Thiomethoxm 25 WG + Chlorantraniliprole 18.5 SC and Imidacloprid 17.8 SL + Chlorantraniliprole 18.5 SC were less effective recorded 2.09 and 2.15 larvae/plant, respectively. The highest *M. vitrata* population was observed in control (3.22 larvae/plant).

The findings are in line with Rachappa, *et al* (2014) [10] who stated that cyantraniliprole 10.26%w/w OD @ 60g a.i./ha was highly effective in controlling pigeonpea pests by registering lowest mean larval numbers of *M. vitrata* (0.13 webs/5 plants). Raghavendra *et al*. (2016) field trails revealed that, cyantraniliprol (90g a.i/ha) provided cross-spectrum control of insect pests as it registering lowest number of fruit damage by shoot and fruit borer (1.09%) at 10 days after application. The same trend was noticed above.

4. Conclusions

The results obtained made is clearly indicated that chemigation of anthranilic diamide group of insecticides like chlorantraniliprole and cyntraniliprole gives better result for the control of borer type pest categories insect pests of cowpea like *H. armigera*,

M. vitrata when compare to the foliar spraying of insecticides and foliar spraying of systemic insecticides like imidacloprid and thiomethoxm gives quick and better result for the control of sucking pest categories insect pests of cowpea like aphid, jassid, whitefly when compare to the chemigation of insecticides.

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