International Journal of Farm Sciences **6(4):** 95-103, 2016

Management of leaf hopper infesting cowpea by seed treatment and foliar spray with neonicotinoid insecticides

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ABSTRACT

Field experiments were conducted during summer and Kharif 2013 to study the bioefficacy of neonicotinoid insecticides (imidacloprid, thiamethoxam and acetamiprid) as seed treatment alone and in combination with one (30 days after germination, DAG) or two (30 and 45 DAG) foliar sprays against the leaf hopper, *Empoasca kerri* Pruthi infesting cowpea. Neonicotinoid insecticides (imidacloprid, thiamethoxam and acetamiprid) as seed treatment combined with two foliar sprays at 30 and 45 DAG effectively managed the leaf hopper. Significantly greater efficacy against *E kerri* and higher green pod yield in cowpea were observed due to thiamethoxam (0.58 leaf hopper/3 leaves) followed by imidacloprid (0.82 leaf hopper/3 leaves) and acetamiprid (1.06 leaf hopper/3 leaves).

Keywords: Neonicotinoids; seed treatment; foliar spray; leaf hopper; cowpea

INTRODUCTION

Cowpea, *Vigna unguiculata* (L) Walp is one of the major pulse crops grown widely in India. The seedlings of cowpea are severely attacked by many early and late season sucking insect pests resulting in stunting of the crop. Neonicotinoid insecticides as seed treatment and in combination with foliar spray can be effective option for the control of both early and late season sucking insect pests of cowpea. Leaf hopper, *Empoasca kerri* Pruthi is one of the major sucking pests appearing in the early crop stages of cowpea. Several researchers have proved the efficacy of neonicotinoids as either seed treatment alone (Nakat et al 2002, Nault et al 2004, Patel et al 2012) or foliar spray alone (Rabari, 2006, Rohit 2012, Patel 2009, Sutaria et al 2010) against leaf hoppers infesting various pulse crops.

However the information on the effect of the combination treatments of seed treatment and foliar spray against leaf hopper, *E kerri* infesting cowpea is very less. The present research was therefore

conducted to find out the efficacy of various neonicotinoid insecticides viz imidacloprid, thiamethoxam and acetamiprid as seed treatment alone and in combination with foliar spray for the management of the leaf hopper, *E kerri* infesting cowpea.

MATERIAL and METHODS

Bioefficacy of three neonicotinoid insecticides (imidacloprid, thiamethoxam and acetamiprid) as seed treatment alone and in combination with foliar spray was evaluated against leaf hopper, *E kerri* infesting cowpea (variety Gujarat Cowpea-1) by conducting field experiments in randomized block design with ten treatments and three replications during summer and Kharif 2013 at the agronomy farm of Anand Agricultural University, Anand, Gujarat.

The treatments evaluated were T_1 (seed treatment (ST) with imidacloprid 600 FS @ 5 ml/kg seed, 3 g ai/kg seed), T_2 (T_1 + foliar spray of imidacloprid 17.8 SL, 0.008%, 40 g ai/ha at 30 days after germination (DAG), T_3 (T_1 + foliar spray of imidacloprid 17.8 SL, 0.008%, 40 g ai/ha at 30 and 45 DAG), T_4 (ST with thiamethoxam 35 FS @ 5 ml/kg seed, 1.5 g ai/kg seed), T_5 (T_4 + foliar spray of thiamethoxam 25 WG, 0.01%, 50 g ai/ha at 30 DAG), T_6 (T_4 + foliar spray of thiamethoxam 25 WG, 0.01%, 50 g ai/ha at 30 and 45 DAG), T_7 (ST with acetamiprid 20 SP @ 20 g/kg seed, 4 g ai/kg seed), T_8 (T_7 + foliar spray of acetamiprid 20 SP, 0.01%, 50 g ai/ha at 30 DAG), T_9 (T_7 + foliar spray of acetamiprid 20 SP, 0.01%,50 g ai/ha at 30 and 45 DAG) and T_{10} (untreated control, water spray).

Five plants were randomly selected and tagged for recording the observations. Observations on leaf hopper were recorded by taking counts from three leaves (top, middle and bottom region) of each tagged plant. Based on these observations mean number of leaf hoppers per three leaves was calculated. The observations were recorded prior as well as 1, 3 and 7 days after spray (DAS). Green pod yield of cowpea (kg/ha) in each treatment was recorded during every picking. Recommended dosages of fertilizers were applied and other agronomic practices were done. The data on leaf hopper population and green pod yield of cowpea were analysed by ANOVA technique (Steel and Torrie 1980).

RESULTS and DISCUSSION

During summer population of leaf hopper, *E kerri* recorded before the impose of first spray (at 30 DAG) revealed significant differences among treatments (Table 1) owing to the effect of seed treatment at the time of sowing. Significantly lower population of leaf hopper was found in the treatments where seeds were treated

Table 1. Effect of neonicotinoid insecticides on population of leaf hopper, *E kerri* infesting cowpea during summer 2013

Treatment	# leaf hoppers/3 leaves (at different intervals)										Pooled over periods and sprays
	1st spray					2nd spray					
	BS	1 DAS	3 DAS	7 DAS	Pooled	BS	1 DAS	3 DAS	7 DAS	Pooled	
T_1	1.57*	1.62	1.86	2.07	1.85	2.10	2.14	2.11	2.03	2.09	1.97
	(1.96)	(2.12)	(2.96)	(3.78)	(2.92)	(3.91)	(4.08)	(3.95)	(3.62)	(3.87)	(3.38)
T_2	1.60	1.25	1.11	1.21	1.19	2.06	2.11	2.12	2.01	2.08	1.64
	(2.06)	(1.06)	(0.73)	(0.96)	(0.92)	(3.74)	(3.95)	(3.99)	(3.54)	(3.83)	(2.19)
T_3	1.59	1.28	1.10	1.19	1.19	2.04	1.29	1.13	1.05	1.16	1.17
	(2.03)	(1.14)	(0.71)	(0.92)	(0.92)	(3.66)	(1.16)	(0.78)	(0.60)	(0.84)	(0.87)
T_4	1.41	1.44	1.70	1.83	1.66	2.01	2.03	2.06	1.97	2.02	1.84
	(1.49)	(1.57)	(2.39)	(2.85)	(2.25)	(3.54)	(3.62)	(3.74)	(3.38)	(3.58)	(2.88)
T_5	1.43	1.10	1.01	1.04	1.05	2.02	2.05	1.98	1.99	2.01	1.53
	(1.54)	(0.71)	(0.52)	(0.58)	(0.60)	(3.58)	(3.70)	(3.42)	(3.46)	(3.54)	(1.84)
T_6	1.39	1.08	0.99	1.06	1.04	2.00	1.13	1.00	1.04	1.06	1.05
	(1.43)	(0.67)	(0.48)	(0.62)	(0.58)	(3.50)	(0.78)	(0.50)	(0.58)	(0.62)	(0.60)
T_7	1.78	1.92	2.10	2.23	2.08	2.21	2.24	2.21	2.12	2.19	2.14
	(2.67)	(3.19)	(3.91)	(4.47)	(3.83)	(4.38)	(4.52)	(4.38)	(3.99)	(4.30)	(4.08)
T_8	1.79	1.32	1.23	1.36	1.31	2.16	2.16	2.17	2.07	2.13	1.72
	(2.70)	(1.24)	(1.01)	(1.35)	(1.22)	(4.16)	(4.16)	(4.21)	(3.78)	(4.04)	(2.46)
T_9	1.77	1.33	1.25	1.33	1.30	2.17	1.32	1.24	1.13	1.23	1.27
	(2.63)	(1.27)	(1.06)	(1.27)	(1.19)	(4.21)	(1.24)	(1.04)	(0.78)	(1.01)	(1.11)
T_{10}	2.28	2.34	2.33	2.37	2.35	2.39	2.34	2.38	2.22	2.31	2.33
	(4.70)	(4.98)	(4.93)	(5.12)	(5.02)	(5.21)	(4.98)	(5.16)	(4.43)	(4.84)	(4.93)
SEm±											
T	0.12	0.11	0.10	0.13	0.07	0.13	0.12	0.13	0.09	0.06	0.05
P	-	-	-	-	0.04	-	-	-	-	0.04	0.03
S	-	-	-	-	-	-	-	-	-	-	0.02
T x S	-	-	-	-	-	-	-	-	-	-	0.04
T x P	-	-	-	-	0.12	-	-	-	-	0.12	0.07
P x S	-	-	-	-	-	-	-	-	-	-	0.09
T x P x S	-	-	-	-	-	-	-	-	-	-	0.12

Table 1 cont'd

$CD_{0.05}$											
T	0.35	0.33	0.31	0.39	0.18	NS	0.37	0.37	0.28	0.17	0.13
P	-	-	-	-	0.11	-	-	-	-	0.11	NS
S	-	-	-	-	-	-	-	-	-	-	0.06
T x S	-	-	-	-	-	-	-	-	-	-	0.11
T x P	-	-	-	-	NS	-	-	-	-	NS	NS
P x S	-	-	-	-	-	-	-	-	-	-	0.24
T x P x S	-	-	-	-	-	-	-	-	-	-	NS
CV (%)	12.25	13.15	12.32	14.52	13.42	10.73	11.42	11.85	10.01	11.74	12.77

* Figures are $\sqrt{x+0.5}$ transformed values and those in parentheses are re-transformed values, BS= Before spray, DAS= Days after spray, NS= Non-significant, T= Treatment, P= Period, S= Spray

with either imidacloprid, thiamethoxam or acetamiprid (T_1 to T_9).

Pooled over periods' (1, 3 and 7 DAS) data worked out for first spray revealed that minimum (T_5: 0.60 and T_6: 0.58 leaf hopper/3 leaves) number of leaf hoppers were found in the two combination treatments (seed treatment combined with one or two foliar sprays) of thiamethoxam followed by the two combination treatments of imidacloprid (0.92 leaf hopper/3 leaves for both the treatments). With respect to leaf hopper incidence the two combination treatments of imidacloprid were at par with that of acetamiprid (T_8: 1.22 and T_9: 1.19 leaf hopper/3 leaves). The sole treatment (ST alone) proved least effective against the pest but was found to be better than untreated check. Leaf hopper incidence recorded before second spray (45 DAG) indicated same level of the pest in all the experimental plots as it is evident from the non-significant results.

Pooled over periods data worked out for second spray showed the superiority of thiamethoxam, imidacloprid and acetamiprid as ST coupled with two foliar sprays (at 30 and 45 DAG) in controlling the leaf hopper population than ST alone and ST combined with one foliar spray (30 DAG). Pooled over periods and sprays data indicated that minimum incidence of leaf hopper, *E kerri* was registered in the combination treatments of ST coupled with

two foliar sprays at 30 and 45 DAG. Significantly lower population of leaf hopper was found in the treatment of thiamethoxam (T_6: 0.60 leaf hopper/3 leaves) followed by imidacloprid (T_3: 0.87 leaf hopper/3 leaves) and acetamiprid (T_9: 1.11 leaf hopper/3 leaves). These treatments were found significantly more effective over rest of the treatments (ST alone and ST combined with one foliar spray at 30 DAG).

Observations recorded before first spray (30 DAG) during Kharif season (Table 2) also reveal that all the insecticidal treatments exhibited significantly less population of leaf hopper than the untreated plots because of the impact of seed treatment with neonicotinoids. Pooled over periods' data for first spray indicated that least number of leaf hoppers was observed in the combination treatments (ST combined with one or two foliar sprays). These treatments proved significantly more effective in controlling the leaf hopper population in cowpea than rest of the treatments. Leaf hopper counts made before second spray showed non-significant differences among the treatments.

Pooled over periods'data for second spray showed the superiority of the combination treatments of ST + two foliar sprays at 30 and 45 DAG as in case of summer. Pooled data (periods and sprays) showed that least (0.58 leaf hopper/3 leaves) number of leaf hoppers were registered in T_6 (ST with thiamethoxam + two foliar sprays of thiamethoxam at 30 and 45 DAG) followed by T_3 (ST with imidacloprid + two foliar sprays of imidacloprid, 0.80 leaf hopper/3 leaves) and T_9 (ST with acetamiprid + two foliar sprays of acetamiprid, 1.04 leaf hopper/3 leaves).

Overall pooled data computed for both seasons (Table 3) clearly indicate that significantly less number of leaf hoppers was found in T_6 (ST with thiamethoxam + two foliar sprays of thiamethoxam: 0.58 leaf hopper/3 leaves) and T_3 (ST with imidacloprid + two foliar sprays of imidacloprid: 0.82 leaf hopper/3 leaves). Both these treatments proved significantly superior over rest of the treatments. ST with acetamiprid + two foliar sprays of acetamiprid at 30 and 45 DAG (1.06 leaf hopper/3 leaves) was also found to be the better treatment and stood next to above.

Pooled data on cowpea green pod yield (Table 4) worked out for summer and Kharif season revealed that all the plots treated with neonicotinoid insecticides produced significantly higher yields of green pods over untreated check. Maximum (7439 kg/ha) yield was harvested from T_6 (ST with thiamethoxam + two foliar sprays of thiamethoxam) followed by T_3 (ST with imidacloprid + two foliar sprays of imidacloprid) and T_9 (ST with acetamiprid + two foliar sprays of acetamiprid). These treatments

Table 2. Effect of neonicotinoid insecticides on population of leaf hopper, *E kerri* infesting cowpea during Kharif 2013

Treatment	# leaf hoppers/3 leaves (at different intervals)										Pooled over periods and sprays
	Ist spray					2nd spray					
	BS	1 DAS	3 DAS	7 DAS	Pooled	BS	1 DAS	3 DAS	7 DAS	Pooled	
T_1	1.65*	1.72	1.89	2.09	1.90	2.07	2.04	2.01	1.89	1.98	1.94
	(2.22)	(2.46)	(3.07)	(3.87)	(3.11)	(3.78)	(3.66)	(3.54)	(3.07)	(3.42)	(3.26)
T_2	1.67	1.21	1.13	1.18	1.17	2.01	2.01	1.99	1.88	1.96	1.56
	(2.29)	(0.96)	(0.78)	(0.89)	(0.87)	(3.54)	(3.54)	(3.46)	(3.03)	(3.34)	(1.93)
T_3	1.68	1.20	1.10	1.16	1.15	2.03	1.22	1.06	1.04	1.11	1.14
	(2.32)	(0.94)	(0.71)	(0.84)	(0.82)	(3.62)	(0.99)	(0.62)	(0.58)	(0.73)	(0.80)
T_4	1.49	1.54	1.76	1.96	1.75	1.95	1.97	1.94	1.78	1.90	1.82
	(1.72)	(1.87)	(2.60)	(3.34)	(2.56)	(3.30)	(3.38)	(3.26)	(2.67)	(3.11)	(2.81)
T_5	1.50	1.09	0.98	1.04	1.04	1.92	2.00	1.95	1.85	1.93	1.48
	(1.75)	(0.69)	(0.46)	(0.58)	(0.58)	(3.19)	(3.50)	(3.30)	(2.92)	(3.22)	(1.69)
T_6	1.48	1.07	0.99	1.02	1.03	1.91	1.10	0.98	1.04	1.04	1.04
	(1.69)	(0.64)	(0.48)	(0.54)	(0.56)	(3.15)	(0.71)	(0.46)	(0.58)	(0.58)	(0.58)
T_7	1.83	1.92	2.05	2.15	2.04	2.11	2.11	2.06	1.92	2.03	2.04
	(2.85)	(3.19)	(3.70)	(4.12)	(3.66)	(3.95)	(3.95)	(3.74)	(3.19)	(3.62)	(3.66)
T_8	1.86	1.32	1.22	1.36	1.30	2.10	2.06	2.05	1.94	2.02	1.66
	(2.96)	(1.24)	(0.99)	(1.35)	(1.19)	(3.91)	(3.74)	(3.70)	(3.26)	(3.58)	(2.25)
T_9	1.84	1.30	1.23	1.39	1.31	2.08	1.33	1.11	1.10	1.18	1.24
	(2.88)	(1.19)	(1.01)	(1.43)	(1.22)	(3.83)	(1.27)	(0.73)	(0.71)	(0.89)	(1.04)
T_{10}	2.27	2.29	2.28	2.35	2.31	2.23	2.14	2.09	2.02	2.08	2.20
	(4.65)	(4.74)	(4.70)	(5.02)	(4.84)	(4.47)	(4.08)	(3.87)	(3.58)	(3.83)	(4.34)
SEm±											
T	0.13	0.11	0.10	0.09	0.05	0.12	0.14	0.11	0.12	0.06	0.05
P	-	-	-	-	0.03	-	-	-	-	0.04	0.02
S	-	-	-	-	-	-	-	-	-	-	0.02
T x S	-	-	-	-	-	-	-	-	-	-	0.03
T x P	-	-	-	-	0.09	-	-	-	-	0.12	0.06
P x S	-	-	-	-	-	-	-	-	-	-	0.07
T x P x S	-	-	-	-	-	-	-	-	-	-	0.10

Table 2 cont'd

$CD_{0.05}$											
T	0.39	0.32	0.29	0.28	0.15	NS	0.40	0.32	0.35	0.18	0.14
P	-	-	-	-	0.08	-	-	-	-	0.11	NS
S	-	-	-	-	-	-	-	-	-	-	0.05
T x S	-	-	-	-	-	-	-	-	-	-	0.09
T x P	-	-	-	-	NS	-	-	-	-	NS	NS
P x S	-	-	-	-	-	-	-	-	-	-	0.21
T x P x S	-	-	-	-	-	-	-	-	-	-	NS
CV (%)	12.20	9.90	11.42	10.46	10.61	9.07	13.13	10.79	12.51	12.24	11.23

* Figures are transformed values and those in parentheses are re-transformed values, BS= Before spray, DAS= Days after spray, NS= Non-significant, T= Treatment, P= Period, S= Spray

registered significantly higher yields than the treatments of ST coupled with single spray application at 30 DAG and ST alone with neonicotinoids.

Effectiveness of thiamethoxam, acetamipirid and imidacloprid either as foliar spray alone (Rabari 2006, Patel 2009, Rohit 2012) or seed treatment alone (Patel et al 2012) against the leaf hopper, *E kerri* infesting cowpea has been reported by earlier researchers in the past which is in agreement with the present findings. However it was found that the ST combined with foliar sprays were more superior to the sole treatments (seed treatment alone) in this study.

Khutwad et al (2002) reported that combination treatments of thiamethoxam and imidacloprid (0.2% seed treatment + 0.02% foliar spray) were more effective against the leaf hopper infesting green gram rather than seed treatment and foliar spray alone and recorded maximum yield. It was also found that thiamethoxam was found to be superior to imidacloprid in all respects which was also observed in the present study.

Thus it can be concluded that neonicotinoid insecticides (imidacloprid, thiamethoxam and acetamiprid) as seed treatment combined with two foliar sprays at 30 and 45 DAG effectively manage the leaf hopper, *E kerri* infesting cowpea thereby resulting in increased yields.

Table 3. Effect of neonicotinoid insecticides on population of leaf hopper, *E kerri* infesting cowpea (pooled over seasons)

Treatment	# leaf hoppers/3 leaves		
	Summer 2013	Kharif 2013	Pooled over seasons
T_1	1.97* (3.38)	1.94 (3.26)	1.95 (3.30)
T_2	1.64 (2.19)	1.56 (1.93)	1.60 (2.06)
T_3	1.17 (0.87)	1.14 (0.80)	1.15 (0.82)
T_4	1.84 (2.88)	1.82 (2.81)	1.83 (2.85)
T_5	1.53 (1.84)	1.48 (1.69)	1.51 (1.78)
T_6	1.05 (0.60)	1.04 (0.58)	1.04 (0.58)
T_7	2.14 (4.08)	2.04 (3.66)	2.09 (3.87)
T_8	1.72 (2.46)	1.66 (2.25)	1.69 (2.36)
T_9	1.27 (1.11)	1.24 (1.04)	1.25 (1.06)
T_{10}	2.33 (4.93)	2.20 (4.34)	2.27 (4.65)

*Figures are $\sqrt{x+0.5}$ transformed values and those in parentheses are re-transformed values; NS= Non-significant

	Summer 2013		Kharif 2013		Pooled over seasons	
	SEm±	$CD_{0.05}$	SEm±	$CD_{0.05}$	SEm±	$CD_{0.05}$
T (Treatment)	0.05	0.13	0.05	0.14	0.03	0.09
S (Season)	-	-	-	-	0.02	0.04
T x S	-	-	-	-	0.05	NS
CV (%)	12.77		11.23		12.05	

Table 4. Effect of neonicotinoid insecticides on green pod yield of cowpea

Treatment	Yield (kg/ha)		
	Summer 2013	Kharif 2013	Pooled
T_1	4376	3077	3727
T_2	5635	4311	4973
T_3	7782	6676	7229
T_4	4526	3215	3871
T_5	5682	4596	5139
T_6	7962	6916	7439
T_7	4265	2799	3532
T_8	5558	4098	4828
T_9	7463	6315	6889
T_{10}	3033	1800	2417
SEm±			
T (Treatment)	360.07	330.07	221.19
S (Season)	-	-	109.22
T x S	-	-	345.39
C $D_{0.05}$			
T (Treatment)	1069.82	980.69	630.47
S (Season)	-	-	321.28
T x S	-	-	NS
CV (%)	11.06	13.05	11.94

NS= Non-significant

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Received: 8.3.2016 ***Accepted: 12.7.2016***