Neo-nicotinoids: A biorational approach for managing sucking insect-pests of Groundnut

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ABSTRACT

The bio-efficacy of three neo-nicotinoids *viz*., imidacloprid 17.8 SL, acetamiprid 20 SP and thiamethoxam 25 WG was determined against leafhoppers and thrips compared with two organo-phosphates; profenofos 40 EC and monocrotophos 36 SL, and a carbamate insecticide, carbosulfan 25 EC. The treatments were imposed as one or two sprays at 30 days after emergence (DAE) and at 30 and 45 DAE, respectively. A modified sweep net method was followed to record the population of leafhopper and thrips. Single spray of neo-nicotinoids, acetamiprid 20 SP @ 0.5 g L^{-1} or imidacloprid 17.8 SL @ 0.4 mL L^{-1} or thiamethoxam 25 WG @ 0.4 g L^{-1} at 30 DAE was found effective in reducing leafhopper population whereas, two sprays of any of the three neo-nicotinoids at 30 and 45 DAE was found effective in reducing thrips population.

Key words: *Arachis hypogaea*, Neo-nicotinoids.

Groundnut, *Arachis hypogaea* L. is an important oilseed crop in India grown in an area of 5.31 M. ha. the annual production of groundnut is 6.93 MT while productivity is 1305 kg ha^{-1}. The productivity in India is very low as compared to the world average (more than 1680 kg ha^{-1}) (http://www.fas.usda.gov/) and this is mainly attributed to the abiotic and biotic factors on crop. The key sucking insect-pests that attack groundnut crop are two species of leafhoppers, *Balclutha hortensis* Lindberg and *Empoasca kerri* (Pruthi) and four species of thrips, *Scirtothrips dorsalis* Hood, *Frankliniella schultzei* Trybom, *Thrips palmi* Karny and *Caliothrips indicus* (Bagnall). These pests feed on plant sap from the underside of the leaves, young shoots and floral parts. The leafhopper and thrips population reaches their maximum during the 8^{th} and 4^{th} standard weeks, respectively which coincides with summer sown crop (Harish *et al.*, 2013). The total yield loss due to insect pests of groundnut was worked out to 40.2% as observed by Baskaran and Rajavel (2013). The chemical management of insect-pests is most practiced by the groundnut farmers as they are economical and bring quick reduction in pest load. The present investigation was, therefore, planned to evaluate the bio-efficacy of some alternate insecticides on the sucking insect-pests of groundnut.

Materials and Methods

The present investigation was conducted at Research Farm of DGR Junagadh, Gujarat. The trials were laid out as an irrigated crop during the summer cropping season of 2010 (5^{th} to 23^{rd} SW *i.e.*, February-June) and 2011 (6^{th} to 22^{nd} standard week *i.e.*, February-June) in a R.C.B.D. having plot size of 6.75 m^2 (5 m rows of 3 m length). The groundnut cv., GG-2 (105-110 days to maturity) was sown in the month of February. Bio-efficacy of six insecticidal treatments comprising of three neo-nicotinoids *viz*., imidacloprid 17.8 SL, acetamiprid 20 SP and thiamethoxam 25 WG, two organo-phosphates; profenofos 40 EC and monocrotophos 36 SL, and a carbamate insecticide carbosulfan 25 EC was determined against leafhoppers and thrips during both the years and was replicated thrice. The insecticide treatments were imposed as one and two sprays on the crop with a hand compression knap sack sprayer using 500 litres of spray / ha. The first spray was imposed when the pest population crossed economic threshold level (ETL) *i.e.*, 5 to 10 hoppers / plant and 5 thrips / terminal bud at 30 days after emergence (DAE) and the subsequent second spray at 15 days interval. The application of insecticides was given on 12th and 26th of March in 2010, while it was made on 11th and 28th of March in 2011.

The pest population of leafhopper and thrips was recorded by following a modified sweep net method given by Nandagopal *et al.* (2007). . Five sweeps were taken randomly using the sweep net from each experimental plot. The adults of leafhoppers and thrips caught were transferred to zip-lock bags, allowed to settle down and counted in laboratory. The pre-spray observations on insect populations were recorded at one day before spray and the post spray observations were recorded on 3, 7 and 15 days after spray (DAS). Similarly, the observations were recorded for the second spray also wherein, the observations on 15 DAS, after first spray will serve as pre-spray observation for second spray. The post-spray observations on insect population were also recorded for single spray treatments along with two spray treatments after the application of second spray at 45 DAE. The observations on pod yield were recorded from each plot after harvesting. For statistical analysis the two years (2010 & 2011) data on the insect population and pod yields were pooled. The original data on insect populations were square root transformed and the pod yield data / plot was converted to the pod yield / ha. Cost-benefit analysis was used to evaluate the economic benefits of the spray treatments in terms of benefit-cost ratio (BCR), which indicates the amount of Indian National Rupee *i.e.*, INR (₹) gained / INR (₹) spent.

Results and Discussion

The leafhopper population before spray at 30 DAE ranged from 7.9 to 12.4 hoppers / 5 sweeps and it was found to be non-significant (Table 1). After the first spray, significant results were observed for treatment means at 3 and 7 DAS except at 15 DAS. The overall mean leafhopper population from all treatments after the first spray ranged from 3.3 to 8.8 hoppers / 5 sweeps and it differed significantly within the treatemnts. The lowest (3.3 hoppers/5 sweeps) overall mean leafhopper population was recorded in the treatment, Acetamiprid 20 SP @ 0.5 g L^{-1} single spray at 30 DAE which differed significantly with that of standard check (6.6 hoppers/5 sweeps) and untreated control (8.8 hoppers/5 sweeps). The treatments which showed on par results with the former were, two sprays of acetamiprid 20 SP @ 0.5 g L^{-1} at 30 and 45 DAE, imidacloprid 17.8 SL @ 0.4 mL L^{-1} at 30 and 45 DAE and one spray of thiamethoxam 25 WG @ 0.4 g L^{-1} at 30 DAE with the overall mean leafhopper populations, 4.3, 4.5 and 4.6 hoppers / 5 sweeps, respectively. The similar observations were recorded on cotton by Rajeswaran *et al.* (2005), Suganya Kanna *et al.* (2007) and Rohini *et al.* (2012); on rice by Misra (2009); on okra by Dhanalakshmi and Mallapur (2008) and on brinjal by Sinha and Nath (2012).

Mean leafhopper population at 15 days after the second spray was non-significant in all treatments. The lowest overall mean leafhopper population (1.3 hoppers/5 sweeps) two sprays of thiamethoxam 25 WG @ 0.4 g L^{-1} at 30 and 45 DAE and differed significantly with the standard check (3.0 hoppers/ 5 sweeps) and untreated control (4.9 hoppers/5 sweeps). The following treatments that showed on par results with the later were, two sprays of acetamiprid 20 SP @ 0.5 g L^{-1} at 30 and 45 DAE, imidacloprid 17.8 SL @ 0.4 mL L^{-1} at 30 and 45 DAE, carbosulfan 25 EC @ 2.0 mL L^{-1} at 30 and 45 DAE and profenofos 40 EC @ 1.2 mL L^{-1} at 30 and 45 DAE and one spray of thiamethoxam 25 WG @ 0.4 g L^{-1} at 30 DAE and acetamiprid 20 SP @ 0.5 g L^{-1} at 30 DAE with 1.4, 1.6, 1.7, 1.9, 1.9 and 2.0 hoppers / 5 sweeps, respectively. It was

Table 1. Efficacy of insecticides in managing leafhoppers on summer groundnut (pooled results of 2010 & 2011).

Treatments (g or ml L^{-1})	Number of adults / 5 sweeps										
	No. of spray	Pre-first spray	Post first spray				Pre-second spray	Post second spray			
			3 DAS	7 DAS	15 DAS	Overall mean		3 DAS	7 DAS	15 DAS	Overall mean
Imidacloprid 17.8 SL (0.4)	One$^{\$}$	9.6 (3.1)*	5.0 (2.2)$^{ab\#}$	6.1 (2.5)^{b}	3.4 (1.8)	4.9 (2.2)^{b}	3.4 (1.8)	4.5 (2.1)^{de}	3.1 (1.8)^{bcd}	1.8 (1.3)	3.2 (1.8)^{d}
Imidacloprid 17.8 SL (0.4)	Two$^{\$\$}$	10.1 (3.2)	3.8 (1.9)^{a}	5.8 (2.4)^{ab}	3.6 (1.9)	4.5 (2.1)^{ab}	3.6 (1.9)	2.2 (1.5)^{bcd}	1.6 (1.3)^{ab}	0.9 (0.9)	1.6 (1.3)^{ab}
Carbosulfan 25 EC (2.0)	One	10.7 (3.3)	3.7 (1.9)^{a}	7.9 (2.8)^{bc}	4.6 (2.1)	5.4 (2.3)^{bc}	4.6 (2.1)	3.6 (1.9)^{cde}	3.5 (1.9)^{cd}	2.9 (1.7)	3.3 (1.8)^{d}
Carbosulfan 25 EC (2.0)	Two	12.4 (3.5)	5.0 (2.2)^{ab}	7.5 (2.7)^{bc}	4.6 (2.1)	5.9 (2.4)^{bc}	4.6 (2.1)	1.8 (1.3)^{abc}	1.9 (1.4)^{abc}	1.2 (1.1)	1.7 (1.3)^{ab}
Acetamiprid 20 SP (0.5)	One	10.7 (3.3)	4.4 (2.1)^{ab}	3.3 (1.8)^{a}	2.1 (1.4)	3.3 (1.8)^{a}	2.1 (1.4)	2.4 (1.6)^{bcd}	2.5 (1.6)^{abc}	1.1 (1.0)	2.0 (1.4)^{abc}
Acetamiprid 20 SP (0.5)	Two	9.3 (3.0)	4.8 (2.2)^{ab}	5.0 (2.2)^{ab}	2.9 (1.7)	4.3 (2.1)^{ab}	2.9 (1.7)	0.6 (0.8)^{a}	1.5 (1.2)^{a}	1.6 (1.3)	1.4 (1.2)^{ab}
Profenofos 40 EC (1.2)	One	10.4 (3.2)	6.2 (2.5)^{bc}	5.0 (2.2)^{ab}	4.3 (2.1)	5.2 (2.3)^{bc}	4.3 (2.1)	3.0 (1.7)^{bcde}	2.2 (1.5)^{abc}	1.5 (1.2)	2.3 (1.5)^{bcd}
Profenofos 40 EC (1.2)	Two	10.0 (3.2)	5.1 (2.3)^{abc}	6.8 (2.6)^{bc}	2.8 (1.7)	5.0 (2.2)^{b}	2.8 (1.7)	2.2 (1.5)^{bcd}	1.6 (1.3)^{ab}	1.5 (1.2)	1.9 (1.4)^{abc}
Thiamethoxam 25 WG (0.4)	One	11.6 (3.4)	4.4 (2.1)^{ab}	5.1 (2.3)^{ab}	4.1 (2.0)	4.6 (2.1)^{ab}	4.1 (2.0)	2.4 (1.6)^{bcd}	1.4 (1.2)^{a}	1.6 (1.3)	1.9 (1.4)^{abc}
Thiamethoxam 25 WG (0.4)	Two	7.9 (2.8)	3.8 (1.9)^{a}	6.1 (2.5)^{b}	4.1 (2.0)	4.7 (2.2)^{b}	4.1 (2.0)	1.2 (1.1)^{ab}	1.5 (1.2)^{a}	1.3 (1.1)	1.3 (1.1)^{a}
Monocrotophos 36 SL (1.1)	Two	10.3 (3.2)	7.7 (2.8)^{c}	6.3 (2.5)^{b}	5.8 (2.4)	6.6 (2.6)^{c}	5.8 (2.4)	4.4 (2.1)^{de}	2.5 (1.6)^{abc}	1.9 (1.4)	3.0 (1.7)^{cd}
Untreated control		9.2 (3.0)	7.8 (2.8)^{c}	10.3 (3.2)^{c}	8.3 (2.9)	8.8 (3.0)^{d}	8.3 (2.9)	5.3 (2.3)^{e}	5.3 (2.3)^{d}	4.1 (2.0)	4.9 (2.2)^{e}
SEm ±		0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.1
CD (P=0.05)		NS	0.5	0.6	NS	0.3	NS	0.6	0.5	NS	0.3
CV (%)		10.4	13.1	15.4	21.4	8.3	21.4	20.4	18.0	26.8	13.3

$ One spray @ 30 DAE, $$ two sprays @ 30 & 45 DAE, * Figures within parenthesis are square root transformed value, # means within a column followed by the same letter do not differ significantly P=0.05 following DMRT, DAS= days after spraying, DAE= days after emergence.

Table 2. Efficacy of insecticides in managing thrips on summer groundnut (pooled results of 2010 & 2011).

Treatments (g or ml L^{-1})	No. of spray	Number of adults / 5 sweeps									
		Pre-first spray	Post first spray				Pre-second spray	Post second spray			
			3 DAS	7 DAS	15 DAS	Overall mean		3 DAS	7 DAS	15 DAS	Overall mean
Imidacloprid 17.8 SL (0.4)	One[$]	21.7 (4.7)*	3.9 (2.0)[ab#]	15.0 (3.9)[bc]	9.1 (3.0)[a]	9.4 (3.1)[abc]	9.1 (3.0)[a]	4.6 (2.1)[c]	8.4 (2.9)[de]	9.5 (3.1)[de]	7.6 (2.7)[d]
Imidacloprid 17.8 SL (0.4)	Two[$$]	20.3 (4.5)	2.9 (1.7)[a]	10.2 (3.2)[ab]	7.6 (2.8)[a]	7.0 (2.6)[a]	7.6 (2.8)[a]	2.8 (1.7)[bc]	4.5 (2.1)[ab]	4.7 (2.2)[abc]	4.1 (2.0)[ab]
Carbosulfan 25 EC (2.0)	One	22.7 (4.8)	3.9 (2.0)[ab]	14.0 (3.7)[abc]	7.7 (2.8)[a]	8.6 (2.9)[abc]	7.7 (2.8)[a]	4.1 (2.0)[c]	9.3 (3.0)[e]	8.1 (2.8)[cde]	7.2 (2.7)[d]
Carbosulfan 25 EC (2.0)	Two	19.6 (4.4)	4.7 (2.2)[ab]	16.5 (4.1)[bcd]	9.3 (3.0)[a]	10.2 (3.2)[bc]	9.3 (3.0)[a]	2.8 (1.7)[bc]	6.6 (2.6)[bcde]	5.4 (2.3)[abc]	5.0 (2.2)[bc]
Acetamiprid 20 SP (0.5)	One	17.8 (4.2)	3.5 (1.9)[ab]	15.5 (3.9)[bc]	7.7 (2.8)[a]	9.0 (3.0)[abc]	7.7 (2.8)[a]	4.0 (2.0)[c]	8.2 (2.9)[de]	9.8 (3.1)[de]	7.5 (2.7)[d]
Acetamiprid 20 SP (0.5)	Two	20.7 (4.5)	2.9 (1.7)[a]	13.9 (3.7)[abc]	8.8 (3.0)[a]	8.6 (2.9)[abc]	8.8 (3.0)[a]	1.5 (1.2)[a]	5.6 (2.4)[bcd]	4.1 (2.0)[ab]	3.8 (1.9)[ab]
Profenofos 40 EC (1.2)	One	18.7 (4.3)	4.9 (2.2)[ab]	17.9 (4.2)[cd]	10.3 (3.2)[a]	11.1 (3.3)[c]	10.3 (3.2)[a]	3.1 (1.8)[bc]	8.4 (2.9)[de]	7.5 (2.7)[bcd]	6.3 (2.5)[cd]
Profenofos 40 EC (1.2)	Two	24.6 (5.0)	5.2 (2.3)[b]	12.8 (3.6)[abc]	9.7 (3.1)[a]	9.4 (3.1)[abc]	9.7 (3.1)[a]	3.0 (1.7)[bc]	5.0 (2.2)[abc]	4.0 (2.0)[ab]	4.0 (2.0)[ab]
Thiamethoxam 25 WG (0.4)	One	23.3 (4.8)	4.6 (2.1)[ab]	14.1 (3.7)[abc]	8.3 (2.9)[a]	9.2 (3.0)[abc]	8.3 (2.9)[a]	4.0 (2.0)[c]	6.8 (2.6)[bcde]	7.4 (2.7)[bcd]	6.1 (2.5)[cd]
Thiamethoxam 25 WG (0.4)	Two	23.3 (4.8)	5.9 (2.4)[b]	15.6 (4.0)[bcd]	11.1 (3.3)[a]	10.9 (3.3)[c]	11.1 (3.3)[a]	2.3 (1.5)[ab]	3.2 (1.8)[a]	4.2 (2.0)[ab]	3.3 (1.8)[a]
Monocrotophos 36 SL (1.1)	Two	18.4 (4.3)	5.7 (2.4)[b]	7.7 (2.8)[a]	10.0 (3.2)[a]	7.9 (2.8)[ab]	10.0 (3.2)[a]	3.9 (2.0)[c]	7.5 (2.7)[cde]	3.2 (1.8)[a]	4.9 (2.2)[bc]
Untreated control		23.3 (4.8)	14.9 (3.9)[c]	23.9 (4.9)[d]	18.1 (4.3)[b]	19.0 (4.4)[d]	18.1 (4.3)[b]	7.6 (2.8)[d]	15.3 (3.9)[f]	12.6 (3.5)[e]	11.9 (3.4)[e]
SEm ±		0.3	0.2	0.3	0.2	0.1	0.2	0.1	0.2	0.2	0.1
CD (P=0.05)		NS	0.5	0.9	0.6	0.4	0.6	0.4	0.5	0.7	0.3
CV (%)		10.5	14.0	14.0	11.1	8.3	11.1	13.9	10.9	16.8	8.4

$ One spray @ 30 DAE, $$ two sprays @ 30 & 45 DAE, * Figures within parenthesis are square root transformed value, # means within a column followed by the same letter do not differ significantly P=0.05 following DMRT, DAS= days after spraying, DAE= days after emergence.

observed that the mean leafhopper population differed non-significantly at pre-second spray and ranged from 2.1 to 8.3 hoppers/5 sweeps, only in two cases, standard check (5.8) and untreated control (8.3) the leafhopper population found crossing lower limit of ETL *i.e.*, 5 hoppers / plant. When the observations at pre-second spray compared with the overall mean population (1.3 to 4.9 hoppers/ 5 sweeps) after second spray, there was not much variation in population. From this, it can draw inference that the single spray of the neo-nicotinoids like acetamiprid 20 SP @ 0.5 g L^{-1}, imidacloprid 17.8 SL @ 0.4 mL L^{-1} and thiamethoxam 25 WG @ 0.4 g L^{-1} at 30 DAE was effective than two sprays of the same as the population was already below ETL.

The thirps population was found non-significant at 30 DAE *i.e.*, pre-first spray observation and ranged from 17.8 to 24.6 thrips / 5 sweeps (Table 2). The post first spray observations showed that all the treatment means were significantly differed with that of untreated control means at 3, 7 and 15 DAS and overall mean. The overall mean thrips population after the first spray was recorded lowest (7.0 thrips/5 sweeps, two sprays of imidacloprid 17.8 SL @ 0.4 mL L^{-1} at 30 & 45 DAE) and highest (18.1 thrips/5 sweeps, untreated control), where the former was found to be on par with standard check (7.9 thrips/5 sweeps), one spray of carbosulfan 25 EC @ 2.0 mL L^{-1} at 30 DAE (8.6 thrips/5 sweeps), two sprays of acetamiprid 20 SP @ 0.5 g L^{-1} at 30 and 45 DAE (8.6 thrips/5 sweeps), one spray of acetamiprid 20 SP @ 0.5 g L^{-1} at 30 DAE (9.2 thrips/5 sweeps), thiamethoxam 25 WG @ 0.4 g L^{-1} at 30 DAE (9.4 thrips/5 sweeps) and imidacloprid 17.8 SL @ 0.4 mL L^{-1} at 30 DAE and two sprays of profenofos 40 EC @ 1.2 mL L^{-1} at 30 and 45 DAE (9.4 thrips/5 sweeps). These findings are in line with the observations made on cotton by Rajeswaran *et al.* (2005) and Rohini *et al.* (2012); on chillies by Mandal (2012) and on okra by Dhanalakshmi and Mallapur (2008).

The overall mean after the second spray revealed that the thrips population ranging from 3.3 to 11.9 thrips / 5 sweeps. Two sprays of thiamethoxam 25 WG @ 0.4 g L^{-1} at 30 and 45 DAE recorded lowest mean thrips population (3.3 thrips/5 sweeps) and which found to be on par with two sprays of acetamiprid 20 SP @ 0.5 g L^{-1} at 30 and 45 DAE (3.8 thrips/5 sweeps), profenofos 40 EC @ 1.2 mL L^{-1} at 30 and 45 DAE (4.0 thrips/5 sweeps) and imidacloprid 17.8 SL @ 0.4 mL L^{-1} at 30 and 45 DAE (4.1 thrips/5 sweeps). The mean thrips population differed significantly at pre-second spray and ranged from 7.6 to 18.1 / 5 sweeps, in all the treatments, the thrips population found crossing ETL *i.e.*, 5 thrips / terminal bud. When the observations at pre-second spray compared with the overall mean population (3.3 to 11.9 thrips/5 sweeps) after second spray, there was much variation in population which was in contrary to the earlier inference made for leafhoppers. From this, it can draw inference that the two sprays of the neo-nicotinoids like acetamiprid 20 SP @ 0.5 g L^{-1}, imidacloprid 17.8 SL @ 0.4 mL L^{-1} and thiamethoxam 25 WG @ 0.4 g L^{-1} at 30 and 45 DAE were effective to bring down the population below ETL. Kandakoor *et al.* (2013) reported similar results on groundnut.

The pooled mean groundnut pod yields for the years 2010 and 2011 ranged from 1439.8 kg ha^{-1} to 1876.8 kg ha^{-1} (Table 3). The highest mean pod yield (1876.8 kg ha^{-1}) and highest % increase in yield over control (30.4) was recorded in the treatment with two sprays of imidacloprid 17.8 SL @ 0.4 mL L^{-1} at 30 and 45 DAE and which was statistically on par with the following treatments in decreasing order of their mean pod yields, two sprays of thiamethoxam 25 WG @ 0.4 g L^{-1} at 30 and 45 DAE (1836.1 kg ha^{-1} & 27.5%), standard check (1830.1 kg ha^{-1} & 27.1%), acetamiprid 20 SP @ 0.5 g L^{-1} at 30 and 45 DAE (1823.5 kg ha^{-1} & 26.7%) and carbosulfan 25 EC @ 2.0 mL L^{-1} at 30 and 45 DAE (1775.3 kg ha^{-1} & 23.3%) and differed significantly with that of untreated control (1439.8 kg ha^{-1}). The net returns / ha in INR (₹) was maximum (39,798.0) with acetamiprid 20 SP @ 0.5 g L^{-1} at 30 and 45 DAE which is closely followed by imidacloprid 17.8 SL @ 0.4 mL L^{-1} at 30 and 45 DAE (35,709.7) and standard check

Table 3. Effect of insecticides on economics of summer groundnut (pooled results of 2010 & 2011)

Treatments	Dose (g or ml L^{-1})	Number of sprays	Pod yield (kg ha^{-1})	Increase in yield over control (%)	Net returns (₹)/ha	BCR
Imidacloprid 17.8 SL	0.4 mL	One$	1590.9[cd#]	10.5	26052.1	1.9
Imidacloprid 17.8 SL	0.4 mL	Two$$	1876.8[a]	30.4	35709.7	2.2
Carbosulfan 25 EC	2.0 mL	One	1605.2[cd]	11.5	22194.5	1.9
Carbosulfan 25 EC	2.0 mL	Two	1775.3[abc]	23.3	28513.0	2.0
Acetamiprid 20 SP	0.5 g	One	1589.2[cd]	10.4	25503.6	1.9
Acetamiprid 20 SP	0.5 g	Two	1823.5[ab]	26.7	39798.0	2.1
Profenofos 40 EC	1.2 mL	One	1605.5[cd]	11.5	22828.2	1.9
Profenofos 40 EC	1.2 mL	Two	1677.3[bc]	16.5	26323.5	1.9
Thiamethoxam 25 WG	0.4 g	One	1681.3[bc]	16.8	24215.8	2.0
Thiamethoxam 25 WG	0.4 g	Two	1836.1[ab]	27.5	27197.4	2.1
Monocrotophos 36 SL	1.1 mL	Two	1830.1[ab]	27.1	30805.7	2.1
Untreated control	–	–	1439.8[d]	0.0	14838.9	1.7
SEm±			65.7			
CD (P=0.05)			192.8			
CV (%)			6.7			

$ one spray @ 30 DAE, $$ two sprays @ 30 & 45 DAE # Means within a column followed by the same letter do not differ significantly by CD (P=0.05), DAE = Days after emergence, BCR: Benefit Cost Ratio.

(30,805.7). Whereas the benefit cost ratio *i.e.*, BCR values also followed similar trend where it ranged from 1.7 to 2.2. The highest value (2.2) for BCR was recorded in the treatment with two sprays of imidacloprid 17.8 SL @ 0.4 mL L^{-1} at 30 and 45 DAE and the lowest value (1.7) was recorded in untreated control.

The three neo-nicotinoid insecticides (imidacloprid, acetamiprid & thiamethoxam) used in this experiment were comparatively more effective in controlling the sucking insect-pests (leafhoppers & thrips) than remaining tested insecticides. Neo-nicotinoid insecticides were some advantages over other traditional pesticides. For instance, they are systemic, water-soluble, and less persistent in environment and enter the plant system through the leaves due to trans-laminar movement and provided protection from insects. Apart from the neo-nicotinoid group of insecticides, the other traditional insecticides groups like, organo-phosphates (profenofos 40 EC, monocrotophos 36 SL) and carbamates (carbosulfan 25 EC) were also found effective in reducing both leafhopper and thrips population due to their residual action.

The following conclusions were made from the above results on bio-efficacy, pod yield and BCR values, that either one (leafhoppers) or two thrips) foliar sprays of neo-nicotinoid molecules at 30 and 45 DAE may be included in the IPM for groundnut. Further, studies may be directed to ascertain the impact and/or effect of neo-nicotinoids on the beneficial insects like natural enemies and pollinators in groundnut ecosystem.

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