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Efficacy of imidacloprid seed treatment for the control of leafhoppers and thrips in groundnut

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ABSTRACT

The bio-efficacy of imidacloprid seed treatment against leafhopper and thrips of groundnut was studied during *kharif* (23rd to 42nd standard week) and summer (5th to 23rd standard week) cropping seasons of 2010 and 2011. The six different concentrations *viz.*, 0.5, 1.0, 2.0, 3.0, 4.0 and 5.0 g a. i. kg^{-1} were tested for their bio-efficacy. A modified sweep net method was followed to record the leafhopper and thrips populations. Seed treatments with imidacloprid @ 2.0 to 5.0 g a. i. kg^{-1} were found most effective in reducing the insect population. However, seed treatment with imidacloprid @ 2.0 g a. i. kg^{-1} may be included in integrated pest management (IPM) package for groundnut from environmental safety point.

Key words: *Arachis hypogaea*, Imidacloprid, Leafhopper, Seed treatment, Thrips.

INTRODUCTION

Groundnut, (*Arachis hypogaea* L.) productivity in India (≈1105 kg ha^{-1}) is very low compared to world average (≈1562 kg ha^{-1}) (anonymous 2013) mainly due to the abiotic and biotic factors. The biotic factors that are hindering the groundnut cultivation are insect-pests, diseases and weeds wherein the former may inflict yield losses up to 30%, but severe crop losses may occur under epidemic situations. In groundnut, two species of leafhoppers, *Balclutha hortensis* Lindberg and *Empoasca kerri* (Pruthi) (Nandagopal and Reddy, 1987) and four species of thrips, *Scirtothrips dorsalis* Hood, *Frankliniella schultzei* Trybom, *Thrips palmi* Karny and *Caliothrips indicus* (Bagnall) (Nandagopal and Vasanta, 1991 and Rao and Wightman, 1993) are known to occur as major sucking insect-pests. They feed on plant sap from the underside of the leaves, young shoots and floral parts. The yield reduction is up to 22% due to leafhoppers (Vyas, 1984) and up to 40% due to thrips (Ghewande, 1987) when infestation occurs during the early stages of crop growth *i.e.*, vegetative and flowering stages (Amin, 1980). Recently due to increasing development of resistance to conventional insecticides in sucking insects, intensive research is carried out to evaluate novel insecticides as seed treatment chemicals.

The neonicotinoid, imidacloprid (1-[(6-chloro-3-pyridinyl) methyl]-N-nitro-2-imidazolidinimine) is most widely used insecticide and has both contact and systemic properties (Yamamoto, 1999 and Makkouk and Kumari, 2001). It acts by binding to nicotinic acetylcholine receptor sites of insect neurons and when applied as seed dresser, it protects the crop up to 45%60 days from leafhoppers, thrips, aphids and whiteflies (Altmann, 1991, Fluckiger *et al*, 1992, and Vadodaria *et al*, 2001) with minimal adverse effects on non-target organisms (Krauter *et al*, 2001). However, the high volume spray of imidacloprid is harmful to the beneficial insects like, green lacewing, European honey bee, bumble bees etc. (Ishaaya *et al*, 2007 and Incerti *et al*, 2003). Though imidacloprid as foliar spray has been tested against insect-pests of various crops but only few studies have been carried out with seed treatment application in groundnut crop, a highly self pollinated crop with < 2% out crossing affected by honey bees. Therefore, the present study was undertaken to test the bio-efficacy of imidacloprid seed treatment for controlling leafhoppers and thrips in groundnut.

MATERIALS AND METHODS

Bio-efficacy of imidacloprid seed treatment against sucking pests of groundnut was studied during *kharif* (23rd to 42nd standard week) and summer (5th to 23rd standard week) seasons of 2010 and 2011, at (ICAR) Directorate of Groundnut Research farm, Junagadh (70. 36° E longitude and 21. 31° N latitude and at an altitude of 60 m above mean sea level). The groundnut variety, GG-20 (120-125 days to maturity) was sown in the *kharif* season (2nd week of June) in

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5 m rows of 3 m wide plots, with spacing of 30 cm between the rows and 10 cm between the plants. Similarly, the groundnut variety, GG-2 (105-110 days to maturity) was sown in the summer season (1st week of February). The seeds were treated with six different rates of imidacloprid 70 WS @ 0.5, 1.0, 2.0, 3.0, 4.0 and 5.0 g a. i. kg^{-1} seeds. The foliar spray of monocrotophos 36 SL @ 0.04% on 30 and 45 days after crop emergence (DAE) was used as standard check along with an untreated control. The required quantities of imidacloprid were dissolved in water (1:1 v/w of seeds) and smeared over the seed surface (stirring was done for 2 minutes). Treated seeds were dried in shade for few hours and next morning used for sowing. The treatments were arranged in a randomized complete block design (RCBD) with three replications.

A modified sweep net method (Nandagopal *et al*, 2007) was used to record the leafhopper and thrips populations. From each experimental plot, 5 sweeps were taken randomly using the sweep net. The adults of leafhoppers and thrips caught in the sweep net were transferred to zip-lock bags, allowed to settle down in laboratory and then counted. The observations on insect populations were recorded at ten days interval starting from 30 DAE. At harvest, observations were recorded on pod yield from each experimental plot. The data on insect counts were subjected to square root transformation and the pod yields per plot were converted to the pod yield per hectare. The pooled values of the pod yield were statistically analyzed for ANOVA of simple RCBD built on Microsoft Excel format developed by M. R. Srinivasan (https://sites.google.com/site/mrsrini/). Mean values were calculated along with standard errors and 95% confidence limits (P=0.05) were determined. Means were separated with the Duncan's Multiple Range Test (DMRT). Cost-benefit analysis was also done.

RESULTS AND DISCUSSION

Efficacy of seed treatments on leafhopper population during kharif and summer seasons: During the *kharif* cropping season, (Table 1) seed treatment with imidacloprid 70 WS @ 2.0, 3.0, 5.0, 4.0 and 0.5 g a. i. kg^{-1} recorded least number of hoppers *i.e.,* 0.5, 0.5, 0.5, 0.6 and 0.8 per 5 sweeps, respectively at 30 DAE. All the doses of imidacloprid seed treatment were found superior over the untreated control (3.6 hoppers/5 sweeps) and standard check (3.2 hoppers/5 sweeps). Whereas, at 40 DAE, the leafhopper population ranged from 0.8 to 4.9 hoppers per 5 sweeps wherein, all the seed treatments differed significantly with standard check (3.8 hoppers/5 sweeps) and untreated control (4.9 hoppers/5 sweeps).

The leafhopper population ranged from 4.9 to 12.4 and 6.4 to 16.0 hoppers per 5 sweeps at 30 and 40 DAE, respectively during the summer cropping season (Table 1). At 30 DAE, seed treatment with imidacloprid @ 5.0 g a. i. kg^{-1} recorded least number of leafhoppers (4.9 hoppers/ 5 sweeps) and was statistically at par with imidacloprid seed treatment @ 4.0 g a. i. kg^{-1} (5.7 hoppers/5 sweeps) and 3.0 g a. i. kg^{-1} (6.6 hoppers/5 sweeps) and differed significantly with standard check (11.4 hoppers/5 sweeps) and untreated control (12.4 hoppers/5 sweeps). Whereas at 40 DAE, all the doses of imidacloprid seed treatment along with standard check were found at par with each other but differed significantly with untreated control (16.0 hopper/5 sweeps). The seed treatments in the decreasing order of their efficacy are imidacloprid @ 4.0, 5.0, 0.5, 2.0, 3.0 and 1.0 g a. i. kg^{-1}

TABLE 1: Effect of imidacloprid seed treatment on the population of leafhoppers in groundnut (average of 2010 and 2011 years).

Treatment	Dose	Number of adult hoppers per 5 sweeps			
		Kharif		Summer	
		30 DAE	40 DAE	30 DAE	40 DAE
Imidacloprid 70 WS	0.5 g a. i. kg^{-1}	0.8 (0.9)ab*#	1.5 (1.2)a	9.6 (3.1)cde	7.3 (2.7)a
Imidacloprid 70 WS	1.0 g a. i. kg^{-1}	1.2 (1.1)b	1.3 (1.1)a	8.3 (2.9)bcd	8.6 (2.9)a
Imidacloprid 70 WS	2.0 g a. i. kg^{-1}	0.5 (0.7)a	1.2 (1.1)a	8.3 (2.9)bcd	7.6 (2.7)a
Imidacloprid 70 WS	3.0 g a. i. kg^{-1}	0.5 (0.7)a	1.0 (1.0)a	6.6 (2.6)abc	8.3 (2.9)a
Imidacloprid 70 WS	4.0 g a. i. kg^{-1}	0.6 (0.8)a	1.2 (1.1)a	5.7 (2.4)ab	6.4 (2.5)a
Imidacloprid 70 WS	5.0 g a. i. kg^{-1}	0.5 (0.7)a	0.8 (0.9)a	4.9 (2.2)a	7.0 (2.6)a
Monocrotophos 36 SL @ 30 & 45 DAE	0.2 kg a. i. ha^{-1}	3.2 (1.8)c	3.8 (1.9)b	11.4 (3.4)de	9.1 (3.0)a
Untreated Control	-	3.6 (1.9)c	4.9 (2.2)b	12.4 (3.5)e	16.0 (4.0)b
	SEm±	0.1	0.1	0.2	0.2
	CD (P=0.05)	0.2	0.4	0.5	0.7
	CV (%)	12.6	19.4	9.5	14.2

* figures within parenthesis are square root transformed values,
# means within a column followed by the same letter do not differ significantly by CD at P=0.05 following DMRT,
DAE= days after crop emergence

which recorded 6.4, 7.0, 7.3, 7.6, 8.3 and 8.6 hoppers per 5 sweeps, respectively.

In both *kharif* and summer cropping seasons all the doses of imidacloprid seed treatment proved effective and were at par in reducing the leafhopper population up to 40 DAE. Similarly, Lobna (2012) observed that cotton seed treated with imidacloprid @ 4.9 g a. i. kg^{-1} resulted in 49.8% reduction in leafhopper (*Empoasca sp.*) population over control. Whereas, the lower dose of imidacloprid (60 g a. i. per 100 kg seeds) was found effective against potato leafhoppers, *Empoasca fabae* (Harris) on snap bean when planted in early June and leafhopper control was lasted between 34 and 42 days after planting (Nault *et al*, 2004).

Efficacy of seed treatments on thrips population during kharif and summer seasons: The mean thrips population at 30 DAE during the *kharif* season ranged from 4.2 to 18.4 thrips per 5 sweeps (Table 2). The lowest thrips population (4.2 thrips/5 sweeps) was recorded with imidacloprid seed treatment @ 5.0 g a. i. kg^{-1} which was statistically at par with imidacloprid 4.0 g a. i. kg^{-1} (5.4 thrips/5 sweeps) and differed significantly with the standard check (14.6 thrips/5 sweeps) and untreated control (18.4 thrips/5 sweeps). Whereas at 40 DAE, the imidacloprid seed treatment @ 5.0, 4.0, 2.0, 1.0 and 0.5 g a. i. kg^{-1} recorded 4.6, 5.7, 6.0, 7.0 and 7.3 thrips per 5 sweeps, respectively and differed significantly with untreated control (11.2 thrips/5 sweeps).

During the summer season, the thrips population ranged from 3.1 to 12.4 and from 8.8 to 22.2 thrips per 5 sweeps at 30 and 40 DAE, respectively (Table 2). All the treatments differed significantly with the standard check (10.2 thrips/5 sweeps) and untreated control (12.4 thrips/5 sweeps) at 30 DAE. The lowest thrips population (3.1 thrips/5 sweeps) was recorded with imidacloprid seed treatment @ 5.0 g a. i. kg^{-1} which was at par with imidacloprid @ 4.0, 0.5, 2.0 and 3.0 g a. i. kg^{-1} which recorded 3.9, 4.0, 4.5 and 4.6 thrips per 5 sweeps, respectively. At 40 DAE, the lowest mean thrips population (8.8 thrips) was recorded with imidacloprid seed treatment @ 0.5 and 4.0 g a. i. kg^{-1} and were at par with imidacloprid seed treatment @ 5.0 g a. i. kg^{-1} (9.5 thrips/5 sweeps), 2.0 g a. i. kg^{-1} (10.5 thrips/5 sweeps) and 3.0 g a. i. kg^{-1} (12.1 thrips/5 sweeps).

All the doses of imidacloprid seed treatment were found effective and at par in reducing the thrips population on groundnut during both the *kharif* and summer seasons. Similarly, Lobna (2012) reported that cotton seed treatment with imidacloprid @ 4.9 g a. i. kg^{-1} resulted in 65.3% reduction in population of thrips, *Thrips tabaci* Lindeman over control. Seed treatment of leek seeds with imidacloprid @ 28 and 42 g a. i. per unit (one unit equalling 250,000 seeds) resulted in lowest thrips per plant *i.e.*, 1.7 and 0.6 (8 weeks after sowing, July) and 13 and 13 (13 weeks after sowing, August), respectively (Ester *et al*, 1997).

Effect of seed treatments on pod yield and economics of groundnut: During the *kharif* season, the pod yield was maximum (2230.9 kg ha^{-1}) with imidacloprid seed treatment @ 5.0 g a. i. kg ha^{-1} which also recorded significantly higher increase in yield over control (62.2%), net returns (Rs. 55,005.2) and the BCR (3.0). However, the standard check recorded highest net returns (Rs. 55,301.9) and the BCR value (3.1). The pod yields of the standard check (2192.1 kg ha^{-1}), imidacloprid seed treatment @ 4.0 g a. i. kg^{-1} (2172.6

TABLE 2: Effect of imidacloprid seed treatment on the population of thrips in groundnut (average of 2010 and 2011 years)

Treatment		Number of adult thrips per 5 sweeps			
		Kharif		Summer	
	Dose	30 DAE	40 DAE	30 DAE	40 DAE
Imidacloprid 70 WS	0.5 g a. i. kg^{-1}	10.0 (3.2)b*#	7.0 (2.6)abc	4.0 (2.0)ab	8.8 (3.0)a
Imidacloprid 70 WS	1.0 g a. i. kg^{-1}	11.7 (3.4)bc	6.0 (2.4)ab	5.7 (2.4)b	14.7 (3.8)bc
Imidacloprid 70 WS	2.0 g a. i. kg^{-1}	10.9 (3.3)b	7.3 (2.7)abc	4.5 (2.1)ab	10.5 (3.2)ab
Imidacloprid 70 WS	3.0 g a. i. kg^{-1}	8.9 (3.0)b	8.1 (2.8)bcd	4.6 (2.1)ab	12.1 (3.5)abc
Imidacloprid 70 WS	4.0 g a. i. kg^{-1}	5.4 (2.3)a	5.7 (2.4)ab	3.9 (2.0)ab	8.8 (3.0)a
Imidacloprid 70 WS	5.0 g a. i. kg^{-1}	4.2 (2.0)a	4.6 (2.2)a	3.1 (1.7)a	9.5 (3.1)a
Monocrotophos 36 SL @ 30 & 45 DAE	0.2 kg a. i. ha^{-1}	14.6 (3.8)c	9.4 (3.1)cd	10.2 (3.2)c	15.6 (3.9)c
Untreated Control	-	18.4 (4.3)d	11.2 (3.3)d	12.4 (3.5)c	22.2 (4.7)d
	SEm±	0.1	0.2	0.1	0.2
	CD (P=0.05)	0.4	0.5	0.4	0.6
	CV (%)	8.1	11.0	8.8	9.7

* figures within parenthesis are square root transformed values,
# means within a column followed by the same letter do not differ significantly by CD at P=0.05 following DMRT,
DAE= days after crop emergence

TABLE 3: Pod yield and economics of the treatments imposed on groundnut (average of 2010 and 2011 years)

Treatment	Dose	Pod yield (kg ha^{-1})		Increase in yield over control (%)		Net returns (Rs.)		BCR	
		Kharif	Summer	Kharif	Summer	Kharif	Summer	Kharif	Summer
Imidacloprid 70 WS	0.5 g a. i. kg^{-1}	1759.8b#	1578.5c	28.0	15.5	39028.8	24632.4	2.5	1.9
Imidacloprid 70 WS	1.0 g a. i. kg^{-1}	1839.0b	1670.4bc	33.7	22.2	41795.9	27599.4	2.6	2.0
Imidacloprid 70 WS	2.0 g a. i. kg^{-1}	1970.6ab	1721.7abc	43.3	26.0	46501.3	29002.2	2.7	2.0
Imidacloprid 70 WS	3.0 g a. i. kg^{-1}	2047.7ab	1715.8abc	48.9	25.5	48845.2	28549.6	2.8	2.0
Imidacloprid 70 WS	4.0 g a. i. kg^{-1}	2172.6a	1841.0a	58.0	34.7	53274.6	32388.8	2.9	2.1
Imidacloprid 70 WS	5.0 g a. i. kg^{-1}	2230.9a	1876.0a	62.2	37.2	55005.2	33270.1	3.0	2.1
Monocrotophos 36 SL @ 30 & 45 DAE	0.2 kg a. i. ha^{-1}	2192.1a	1790.6ab	59.4	31.0	55301.9	31136.1	3.1	2.1
Untreated Control	-	1375.3c	1366.9d	0.0	0.0	24922.5	17655.5	1.9	1.6
	SEm±	107.3	53.9						
	CD (P=0.05)	325.5	163.4						
	CV (%)	9.5	5.5						

# means within a column followed by the same letter do not differ significantly by CD at P=0.05 following DMRT,
DAE= days after crop emergence,
BCR= benefit cost ratio.

k g ha^{-1}), @ 3.0 g a. i. kg^{-1} (2047.7 kg ha^{-1}) and @ 2.0 g a. i. kg^{-1} (1970.6 kg ha^{-1}) were found statistically at par with imidacloprid seed treatment @ 5.0 g a. i. kg^{-1} (Table 3).

Similarly, during the summer season; pod yield, increase in yield over control, net return and the BCR were maximum (1876.0 kg ha^{-1}, 37.2%, Rs.33,270.1 and 2.1, respectively) with imidacloprid seed treatment @ 5.0 g a. i. kg^{-1}. This was at par with imidacloprid seed treatment @ 4.0 g a. i. kg^{-1} (1841.0 kg ha^{-1}), @ 2.0 g a. i. kg^{-1} (1721.7 kg ha^{-1}), @ 3.0 g a. i. kg^{-1} (1715.8 kg ha^{-1}) and with standard check (1790.6 kg ha^{-1}). Dhawan *et al* (2011) found that seed treatment with imidacloprid 70 WS @ 3 g a. i. kg^{-1} gave significantly higher fruit yield in okra. However, Singh *et al* (2011) observed higher BCR in mustard when seeds were treated with imidacloprid 70 WS @ 5 g a. i. kg^{-1} for managementof painted bug.

In the present study, seed treatment with imidacloprid @ 2.0 to 5.0 g a. i. kg^{-1} were statistically at par with standard check (monocrotophos 36 SL, 0.2 kg a. i. ha^{-1} at 30 & 45 DAE) in terms of reducing the leafhopper and thrips populations. However, neonicotinoids were considered as safer pesticides compared to conventional pesticides. Seed treatment with imidacloprid improved the plant growth parameters like; leaf area and fibrous root mass (Herbert *et al*, 2008) and also reduced the incidence of viral-disease (bean leaf roll virus, faba bean necrotic yellows virus and soybean dwarf virus) transmitted by aphid, *Acyrthosiphon pisum* (Harris) on faba bean and lentil (Makkouk and Kumari, 2001). The benefits of the seed treatment were, it provided continuous plant protection through most of the growing season, it reduced amount of insecticide required to achieve same levels of insect control through foliar spray and also safer for natural enemies like, predators and parasitoids (Vierbergen and Ester, 2000).

It can be concluded that seed treatment with imidacloprid from 2.0 to 5.0 g a. i. kg^{-1} were found effective in reducing the leafhopper and thrips population and also increases the pod yields during both the cropping seasons. However, by keeping the ecological safety point in mind, seed treatments with imidacloprid @ 2.0 g a. i. kg^{-1} may be included in IPM package for groundnut. Further studies may be directed to ascertain the impact and/or effect of imidacloprid seed treatment on the groundnut plant growth parameters, soil flora and fauna as well as the incidence of peanut bud necrosis disease (PBND) or the peanut stripe virus (PsTV) caused by thrips and also groundnut rosette disease transmitted by aphids.

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