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Alka Sai

Department of Horticulture,
Institute of Agricultural
Sciences, Banaras Hindu
University, Varanasi, Uttar
Pradesh, India

Anand Kumar Singh

Department of Horticulture,
Institute of Agricultural
Sciences, Banaras Hindu
University, Varanasi, Uttar
Pradesh, India

BK Singh

Department of Horticulture,
Institute of Agricultural
Sciences, Banaras Hindu
University, Varanasi, Uttar
Pradesh, India

Ravinsh Kumar Maurya

Department of Horticulture,
Institute of Agricultural
Sciences, Banaras Hindu
University, Varanasi, Uttar
Pradesh, India

Pushendra Singh

Department of Horticulture,
Institute of Agricultural
Sciences, Banaras Hindu
University, Varanasi, Uttar
Pradesh, India

Corresponding Author:**Alka Sai**

Department of Horticulture,
Institute of Agricultural
Sciences, Banaras Hindu
University, Varanasi, Uttar
Pradesh, India

Efficacy of newer insecticides on plant growth attributes of garden pea (*Pisum sativum* ssp. *Hortense* L.)

Alka Sai, Anand Kumar Singh, BK Singh, Ravinsh Kumar Maurya and Pushendra Singh

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Abstract

A field study was conducted at the Vegetable Research Farm, Banaras Hindu University, Varanasi during rabi season 2016-2017 for the evaluation of newer insecticides (Imidacloprid 600 FS and Thiamethoxam 30% FS) on plant growth characters of garden pea. The two insecticides were applied as seed treatment in different doses. The result of bio-efficiency revealed that the seed treatment with T₃ gaucho (Imidacloprid 600 FS) @ 2 ml/kg was found effective in promoting plant growth and increased germination % (93.84%) and maximum plant stand per metre square(m²) (30.40%). Less number of days to 50% flowering (43.33 days) and maximum plant height at last harvesting stage (91.07 cm) were also recorded in seed treatment with T₃ gaucho (Imidacloprid 600 FS), while there was no significant difference in plant height at 30 DAS and 45 DAS. However, all the seed treatment were found superior over untreated control.

Keywords: Neonicotinoids, garden pea, insecticides, treatment

Introduction

Garden pea (*Pisum sativum* ssp. *hortense* L.) is grown throughout the world for varieties of uses as food and fodder. Garden pea is the world's third most important legume grain after soybean and common beans (Timmerman-Vaughan *et al.*, 2005). Garden pea belongs to the family leguminosae. It is an annual herbaceous plant. The plant is semi-erect, but when a support is available, it has a tendency to climb. The plants grows to a height of about 30-200 cm. In India, during year 2016-17, area and production of pea is 545.9 thousand ha and 5451.60 thousand million tonnes respectively and productivity is 10 MT/ ha. Uttar Pradesh ranks first in area (175.01 ha) and production (1877.93 MT). In Madhya Pradesh pea is covering an area over 53.45 thousand ha with 534.0 thousand million tonnes production and 10.0 MT/ha productivity (Anonymous, 2017) [2]. Being a cool season crop, it is mostly cultivated in states of Uttar Pradesh, Bihar, Haryana, Punjab, Himachal Pradesh, Orissa and Karnataka. It ranks among the top 10 vegetable crops. In tropics and subtropics, its cultivation is restricted to cooler altitude and winter season (Patidar, 2014) [3]. It has a prominent place in human diet. Garden pea is highly nutritive and rich source of protein and carbohydrate along with minerals, vitamin A, B and C (Pandita and Pratap, 1990) [4]. Growth and yield improvements have been reported for a few insecticides. Some insecticides apart from keeping the crop free from pest but they promote growth also. Neonicotinoids (Imidacloprid) and Thiamethoxam) are a group of crop protection agents highly effective against sucking pests which act on receptor protein of insect nervous system. They are acute contact and stomach poisons with translaminar activity and systemic properties. Their selectivity, lower use rate and safety to beneficial insects especially when used as seed dressers make neonicotinoids an ideal component in any integrated pest management (IPM) program resulting in less xenobiotic load in the environment. Neonicotinoids are known to interact with the insect nicotinic acetylcholine receptor (nAChR) (Yamamoto *et al.*, 1995; Matsuda *et al.*, 2000) [19]. However, reports in the literature on the effects of insecticides on plant growth are limited, although there have been some reports of increased plant height and flowering (VanTol and Lentz, 1999) [17]. Plant height was significantly higher in seed treated plots with Imidacloprid and Thiamethoxam in cotton (Vadodaria *et al.*, 2001) [1]. Imidacloprid, the first commercialized neonicotinoid insecticide may possess some plant growth regulating properties also.

Field studies on cotton in 2004 in Arkansas have also shown growth and yield enhancement by Imidacloprid (Gonias *et al.*, 2006)^[7].

The present study deals with the influence of neonicotinoid insecticides (Imidacloprid and Thiamethoxam) as seed treatment in different formulations on plant growth parameters like germination %, plant stand per metre square (m²), days to 50% flowering and plant height (cm) at 30 DAS, 45 DAS and at last harvesting stage.

Materials and Methods

The studies were conducted at Vegetable Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh during Rabi 2016 - 2017. The garden pea cultivar 'Azad Pea 3' were planted at a spacing of 30x10 cm. The experiments were arranged in a completely randomized block design with three replications and seven plots per replication. Healthy garden pea seeds, at the recommended seed rate, seed dressing formulations of Thiamethoxam 30% FS @ 1 g a.i./kg (3.3 ml/kg seed) and 1.2 g a.i./kg (4 ml/kg seed). Imidacloprid 600 FS @ 0.6 g a.i. /kg (1 ml/kg seed), 1.2 g a.i. /kg (2 ml/kg seed), 1.8 g a.i./kg (3 ml/kg seed) and 3.6 g a.i./kg (6 ml/kg seed) were done. One kilogram of the seed of garden pea taken in separate polythene bags and chemicals were added and thoroughly mixed until all the seeds were uniformly coated with the formulations. The seeds thus treated were then allowed to dry in the shade for twenty four hours and sown in respective plots in the field. Plants were under care so that there was no pest infestation or disease infection. The plant growth parameters like germination percentage, plant stand per m², days to 50% flowering, plant height (cm) at 30 DAS, 40 DAS and at last harvesting stage, were recorded after the seed treatment.

Experimental Protocol

Germination (%)

Germination % of garden pea plant was recorded from each plot, at 15 DAS. The number of seedling which was emerged counted from each treatment per plot. The germination (%) was worked out.

Plant stand per metre square (m²)

Number of plant were recorded in 1 metre square in five spot in each treatment, quadrant of 1 metre is taken to evaluate the number of plant in 1 metre square area in five spot in each treatment. The mean value of five spot was worked out.

Days to 50% flowering

Number of days taken to initiate 50% flowering in each treatment per plots was observed and recorded the days. The mean number of days for flower initiation of 50% plants of a plot was worked out from the recorded observations.

Plant height at 30 DAS, 40 DAS and last harvesting stage (cm)

Plant height of five randomly selected plants was taken in each treatment per plots by measuring the height from bottom to the shoot tip of the plant by using a metre scale. The mean value of five plants was worked out at different stages.

Statistical analysis

The mean values for all the treatment in each replication were subjected to statistical analysis in the computer program SPAR-II developed by IASRI, New Delhi and the results were computed.

Analysis of variance

The table for analysis of variance (ANOVA) was set as explained by Gomez and Gomez (1984).

Result

Germination %: The data presented in Table 1, revealed the significant differences in the percent germination of garden pea seed recorded at 15 DAS. The percent germination in different treatments varied from 84.53 to 94.83. The highest germination % (94.83%) was recorded in seed treatment with T₃ gaucho (Imidacloprid 600 FS) @ 2 ml/kg which was followed by seed treatment with T₂ gaucho (Imidacloprid 600 FS) @ 1 ml/kg seed (92.37%), T₄ gaucho (Imidacloprid 600 FS) @ 3 ml/kg seed (90.97%). However, all the treatments were superior over the untreated control T₁ which was recorded (85.87%) germination.

Plant stand per metre square (m²)

The data pertaining to the plant stand per metre square (m²) is presented in the Table 1, showed that the plant stand ranged from 25.33 to 30.40. The highest plant stand per metre square was recorded in seed treatment with T₃ gaucho (Imidacloprid 600 FS) @ 2ml/kg seed (30.40 plant stand per m²) which was statistically at par with seed treatment T₂ gaucho (Imidacloprid 600 FS) @ 1ml/kg seed (29.78 plant stand per m²) followed by seed treatment with T₅ (Thiamethoxam 30% FS) @ 3.3 ml/kg seed (25.93 plant stand per m²). However, all the treatments were found significantly superior over the untreated control T₁ which was (25.35 plants per m²).

Days To 50% Flowering

Days to 50% flowering of garden pea presented in table 1, ranged from 43.33 to 48.33 days. The earliest in days to 50% flowering was recorded in treatment T₃ gaucho (Imidacloprid 600 FS) @ 2ml/kg seed (43.33 days) which was statistically at par with T₂ treatment gaucho (Imidacloprid 600 FS) @ 1 ml/kg seed (45.00 days) followed by T₄ gaucho (Imidacloprid 600 FS) @ 3 ml/kg (45.67 days). However, all the treatments were superior over untreated control T₁ which took maximum days for 50% flowering (48.33 days).

Table 1: Effect of seed treatment with Thiamethoxam and Imidacloprid on Germination %, Plant stand per metre square (m²), Days to 50% flowering.

Treatment	Dosage/ha a.i.(g)	Formulations (ml or gm)	Germination %	Plant stand per metre square (m)	Days to 50% flowering
T ₁ No spray	-	-	84.53 %	25.33	48.33
T ₂ Gaucho (Imidacloprid 600 FS)	0.6	1	92.37	29.78	45.00
T ₃ Gaucho (Imidacloprid 600 FS)	1.2	2	94.83	30.40	43.33
T ₄ Gaucho (Imidacloprid 600 FS)	1.8	3	90.97	25.93	45.67
T ₅ Gaucho (Imidacloprid 600 FS)	2.4	4	90.60	25.70	47.00
T ₆ Thiamethoxam 30% FS	1	3.3	90.47	25.78	46.33
T ₇ Gaucho (Imidacloprid 600 FS)	6	6	90.17	26.67	47.67
CD 5%			2.24	0.90	2.69

Plant height (cm) at 30 das, 40 das and at last harvesting stage

The data presented in table 2, revealed that the plant height at 30 DAS and 45 DAS in different treatment varies between 27.17 cm to 29.64 cm and 30.16 cm to 32.95. The statistically scrutiny of data showed that there was no significant difference in plant height at 30 DAS and 45 DAS. The maximum plant height at 30 DAS recorded in seed treatment with T₂ gaucho (Imidacloprid 600 FS) @ 1ml/kg seed (29.64 cm). The maximum plant height at 45 DAS was recorded in seed treatment T₂ gaucho (Imidacloprid 600 FS) @ 2 ml/kg

seed (32.95 cm). Plant height (cm) at last harvesting stage in different seed treatments plots were found significantly different and ranged between 83.92 cm to 91.07 cm. Maximum plant height was recorded in treatment T₃ gaucho (Imidacloprid 600 FS) @ 2 ml/kg seed (91.07 cm) which was statistically at par with treatment T₂ gaucho (Imidacloprid 600 FS) @ 1 ml/kg seed (89.87 cm), T₄ gaucho (Imidacloprid 600 FS) @ 3 ml/kg seed (89.40 cm), T gaucho (Imidacloprid 600 FS) @ 4 ml/kg seed (89.27 cm). However, all the treatments were superior over untreated control T₁ which recorded minimum plant height (83.42cm).

Table 2: Effect of seed treatment with Thiamethoxam and Imidacloprid on Plant height (cm) at 30 DAS, 45 DAS and at last harvesting time.

Treatment	Dosage/ha a.i.(g)	Formulations (ml or gm)	Plant height (cm)30 DAS	Plant height (cm)45 DAS	Plant height at last harvesting stage (cm)
T ₁ No spray	-	-	27.17	30.16	83.75
T ₂ Gaucho Imidacloprid 600 FS)	0.6	1	29.64	32.42	89.87
T ₃ Gaucho (Imidacloprid 600 FS)	1.2	2	30.40	32.95	91.07
T ₄ Gaucho (Imidacloprid 600 FS)	1.8	3	28.61	32.08	89.40
T ₅ Gaucho (Imidacloprid 600 FS)	2.4	4	28.48	31.44	83.92
T ₆ Thiamethoxam 30% FS	1	3.3	28.49	31.79	89.27
T ₇ Gaucho (Imidacloprid 600 FS)	3.6	6	28.37	30.99	83.87
CD 5%			NS	NS	2.33

Discussion

Germination (%)

Observation on germination % revealed that there was significant difference in different seed treatments. The seed treatment with T₃ gaucho (Imidacloprid 600 FS) @ 2ml/kg seed recorded highest germination % (94.83%). The next promising seed treatments was T₂ gaucho (Imidacloprid 600 FS) @ 1ml/kg seed (92.37%). The present finding are in agreement with Khandre *et al.* (2017) [11], that there was higher germination percentage (92%) with Imidacloprid 70 WS @ 12 g/kg seed followed by Thiamethoxam 25 WG @ 1.50 g/kg seed (90%). The present finding is in conformity with Kencharaddy (2011) [10], who reported that the germination was higher in Imidacloprid 600 FS @ 10 ml/kg seed (96.00%) followed by Imidacloprid 70 WS @ 5 g/kg seeds (95.1%) and lower in Thiamethoxam 70 WS @ 5 g/kg seed (94.3%). The present finding is in line with Kotlinski (1999) [12] who reported that Vitavax 250 FS and Gaucho 350 FS in all concentrations affected the seed germination and seedling weight in pea.

Plant stand per metre square (m²)

Different seed treatment showed significant difference with regards to plant stand per m². It is proved from the data that the seed treatment with T₃ gaucho (Imidacloprid 600 FS) @ 2ml/kg seed recorded highest plant stand per metre square (30.40 m²). The next best treatment was T₂ gaucho (Imidacloprid 600 FS) @ 1ml/kg seed (29.78 m²). The above finding is in line with Somasundar (2010) [16], who observed that the seed treatment with thiamethoxam (4.3 g and 8.6 g/kg), Imidacloprid (5 ml and 10 ml /kg) were recorded higher plant stand per 10 metre square ranged from 304.33 to 313.66. Similar finding also reported by Vijay Kumar *et al.* (2007) [18], that the higher plant stand, monopodial and sympodial branches of cotton was found with seed treatment with imidacloprid @ 7.5 g/kg of seed.

Days to 50% flowering

There was significant difference among different seed treatment for days to 50% flowering. It is declared from the data that the seed treatment with T₃ gaucho (Imidacloprid 600

FS) @ 2ml/kg seed recorded less number of days to 50% flowering and earliness in flowering (43.33 days). The next leading seed treatment was T₂ gaucho (Imidacloprid 600 FS) @ 1ml/kg seed (45.00 days). The above findings are in conformity with Dey *et al.* (2005) [6], who reported that Imidacloprid 70 WS @ 5-10 g per kg seed produced less number of days to flower initiation (38.1 days) over control (42.30 days). The above finding is in line with Jijisha (2012) [9], who reported that the seed treatment with Imidacloprid (34.33) exhibited flower initiation in 34 days as against 40 days in untreated control indicating their significant effect in reducing the period for flower initiation. The two season data revealed that days required for flower initiation in okra was significantly reduced by seed treatment with Imidacloprid (34.67) as compared to 40 days in untreated control.

Plant height at 30 das, 40 das and at last harvesting stage (cm)

It is notified from the data that the seed treatment with T₃ gaucho (Imidacloprid 600 FS) @ 2ml/k recorded highest plant height at 30 DAS (29.64cm). The plant height at 45 DAS recorded highest in seed treatment with T₃ gaucho (Imidacloprid 600 FS) @ 2 ml/kg seed (32.95 cm). They are not statistically different from each other. Hence, the plant height at 30 DAS and 40 DAS were found non significant. There was significant difference among the treatment regarding plant at last harvesting stage including untreated control. The plant height in different treatments ranged from 83.92 cm to 91.07 cm with significant differences. The highest plant height was recorded in treatment T₃ gaucho (Imidacloprid 600 FS) @ 2 ml/kg seed (91.07 cm). This was statistically at par with treatment T₂ gaucho (Imidacloprid 600 FS) @1 ml/kg seed (89.87cm). However, all the treatments were superior over untreated control with 83.42 cm. These findings are in conformity with Mote (1993) [14], that an increase of plant height and leaves with Imidacloprid (1 to 5 per cent a.i. w/w) seed treatment of sorghum. These findings are in line with Graham *et al.* (1995) [8] that in cotton, Imidacloprid (Gaucho) seed treatments showed increased plant height over control. Similar finding also reported by Mote *et al.* (1994) [13] that the plant height were found to be

superior in Imidacloprid seed treated plants in okra. These findings are in agreement with Bhargava and Bhatnagar (2001) [5] that the plant height was superior in plots with Imidacloprid 600 FS and 70 WS than the untreated check in okra. Similar finding was also reported by Qureshi *et al.* (2016) [15] with priming method seeds treated with Imidacloprid @ 6g/kg attain maximum plant height 56.94 cm as compared to control which gave minimum plant height which was 45.24 cm in bismarckia palm seed.

Conclusion

It is thus concluded that seed treatment with T₃ gaucho (imidacloprid 600 FS) @ 2ml/kg seed can protect the crop from sucking pests upto 25-30 DAS. There was significant difference in different seed treatment for germination %. Highest germination % (94.83%) was recorded from seed treatment T₃ gaucho (imidacloprid 600 FS) @ 2ml/kg seed. There was significant difference in different seed treatment with regards to plant stand per m². Seed treatment with T₃ gaucho (imidacloprid 600 FS) @ 2 ml/kg seed brought about a reduction from days to 43.33 days to 48.33 days for flower initiation thereby inducing earliness in flowering. Plant height at last harvesting stage (91.07 cm) was found in seed treatment with T₃ gaucho (imidacloprid 600 FS) @ 2 ml/kg seed. All seed treatments were also effective and superior over untreated control T₁. All seed treatments were effective over untreated control and increasing plant growth characters in garden pea.

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