STUDY OF DIFFERENT TREATMENT SCHEDULES AGAINST PLANT AND TUBER DAMAGE CAUSED BY SOIL PESTS ON POTATO

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ABSTRACT

Bio-efficacy of various treatment schedules, viz T_1 (thiacloprid + thiamethoxam), T_2 (spiromesifen + thiamethoxam), T_3 (thiacloprid), T_4 (imidacloprid), T_5 (imidacloprid + thiamethoxam), T_6 (metasystox) and T_7 (control) were evaluated against Agrotis ipsilon (Hufner) and mole cricket, Gryllotalpa africana, P.de. Beau. in single potato variety, Kufi Chandramukhi during rabi season of two potato-growing years in 2015-2016 and 2016-2017 from November to February. The percentage of plant (shoot) damage was found low in T_1 (5.82 – 5.87%), than by T_3 (6.12 – 6.49%), T_2 (6.86 – 6.92%), T_5 (7.31 – 7.62%), T_6 (8.21 – 8.81%), T_4 (8.61 – 9.32%) and T_7 (10.70 – 11.13%) respectively. Similarly percentage of tuber damage of potato was noted highest in T_7 (34.29 – 43.90 %) and it was lowest in T_2 (13.15–15.66 %). Maximum marketable yield (t/ha) of potato tubers was obtained in T_2 (26.28–26.80 t/ha), which was succeeded by T_1 (26.19 – 26.92 t/ha) than other treatments and it was recorded minimum in control T_7 (11.17–12.69 t/ha). Maximum cost-benefit ratio (CBR) was recorded in T_5 (1:2.03 – 1:2.04) while it was found minimum in T_6 (1:1.11 – 1:1.17). Among the different treatment schedules T_5 and T_2 were most effective in increasing marketable yield of potato tubers and reduction of soil pest incidence over control T_7 and also over other treatments.

KEYWORDS: Damage, Effectiveness, Insecticidal treatment, Potato, Soil pest, Yield.

INTRODUCTION

Among the vegetable crops, the family solanaceae, which includes potato (*Solanum tuberosum* L.) along with other essential vegetables of our daily diet. Potato is the fourth most important food crop in the world after wheat, rice and maize in terms of production and grown in about one hundred and forty countries (Haase, 2008). The potao originated from the mountains of South America, in recent years potao has

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spread in many countries with warmer and drier climates and it has become important in regions such as the plains of India, Bangladesh, Pakistan, Central America and Argentina (Ahmad *et al.*, 2011). It contributes about 22% of the total vegetables and about 40% of the root and tuber crops produced in the world (Ghosh and Chakraborty, 2012). In India among the states, Uttar Pradesh, West Bengal and Bihar accounted for nearly 66 per cent area and 73 per cent production of the country (Indian Horticulture Database, 2013). In West Bengal, potato is the most important food crop, next to cereals and the states ranks second position in area (386.61 m. ha) and production (11591.30 m. tonnes), but first in productivity (30.00 t/ha) in the country (Indian Horticulture Database, 2013). Earlier, its cultivation was largely confined to the districts of Hooghly, Burdwan and Midnapore, but with the increasing facilities of irrigation, introduction of high yielding early maturing varieties and development of suitable agronomic practices, potato cultivation is gradually being extended to other districts of West Bengal (Anonymous 2013b). It is estimated herbivorous insects eat about 26% of the potential food production and India loses about 30% of its crops every year due to pests and diseases (Sharma and Rao, 2012). The insect pests inflict crop losses to the tune of 40 per cent in vegetable production (Gaurav, 2011). More than 100 insect pest and non-insect pest generally infest potato crop from different parts of World (Simpson, 1977). Among these insect pests, cutworm, *Agrotis ipsilon* (Hufner) (Noctuidae: Lepidoptera); Mole cricket, *Gryllotalpa africana*, P.de. Beau. (Gryllotalpidae: Orthoptera) and potato tuber moth (PTM), *Phthorimaea operculella* (Zeller) (Gelechiidae: Lepidoptera) are the most important soil pests cause tuber damage, as a result to reduce more than yield of potato tubers. In addition to tubers, they also cause damage to the foliage of the crop (Konar *et al*. 2003; Konar and Paul, 2005). They cut the tender shoots near the ground level and feed on the cutted leaves. Therefore, to minimize shoot damage and tuber damage caused by soil pests on potato, a number of synthetic insecticides are applied randomly, but with limited success. Therefore, keeping in view, the present investigation was conducted to assess the efficacy of different treatment schedules against soil pests of potato.

MATERIALS AND METHODS

The field experiment was undertaken to find out the bio-efficacy of different insecticidal treatment schedules against shoot and tuber damage caused by soil pests on potato (Kufri chandramukhi) for two potato growing seasons from November to February in 2015-2016 and 2016-2017, at District Seed Farm (situated at 23.2324° N latitude 87.8615° E longitudes and 30 m altitude above mean sea level), Department of Agriculture, Government of West Bengal, P.O. - Burdwan, Dist. – Burdwan, West Bengal. Potato seed tubers of cv. Kufri chandramukhi was planted in late November in randomized block design (RBD). All standard agronomic practices, recommended for the state, were strictly followed during raising the crop (Anonymous, 2012). The crop was dehaulmed at an age of 85 days and 10 days after dehaulming, potato tuber was harvested from the field.

Seven different insecticidal schedules *viz* T_1 (thiacloprid + thiamethoxam), T_2 (spiromesifen + thiamethoxam), T_3 (thiacloprid), T_4 (imidacloprid), T_5 (imidacloprid + thiamethoxam), T_6 (metasystox) and T_7 (control) (Table 1) were tested against shoot damage caused by soil pests on potato, in an RBD and each treatment was replicated thrice. The schedules were consisting of both chemical and non-chemical insecticides as mentioned in Table 1. During the crop season, after seedling weekly observations were recorded on the shoot damage on potato caused by soil pests in each plot. The percentage of plant damage (on the basis of cutted leaves and shoots) by soil pests (cutworm, mole cricket and PTM) was worked out accordingly. Similarly the extent of infestation in tuber by different soil pests was recorded by counting the number of healthy and damaged tubers in each plot at the time of harvesting. The weight of healthy and damaged tubers for each treatment were also taken and thereafter, the data were analyzed after converting them into necessary forms by DMRT analysis (Duncan's Multiple Range Test). These findings and analysis are in line with the findings of Konar and Mohasin (2002). The cost-benefit ratio (CBR) for respective treatment schedule, i.e. T_1 to T_6 over control T_7, was computed and analyzed with the help of market values of insecticides as well as selling price of potato tubers.

Table 1: Insecticidal treatment schedules against soil pests of potato

Treatment Schedules	Insecticides with dose and time of application
T_1	Foliar spray with thiacloprid @ 48 g a.i./ha at the time of pest appearance and second spray with thiamethoxam 25 WG @ 125g a.i./ha after 15 days of first spray.
T_2	Foliar spray with spiromesifen 240 S.C. after emergence @ 96g a.i./ha (400ml/ha) and second spray with thiamethoxam 25 WG @ 100g a.i./ha after 15 days of first spray and third spray of spiromesifen 240 S.C. after emergence @ 96g a.i./ha (400ml/ha) after 30 days of first spray.
T_3	Foliar spray with thiacloprid @ 48 g a.i./ha at the time of pest appearance.
T_4	Foliar spray of imidacloprid @ 40 a.i./ha at the time of pest appearance
T_5	Foliar spray of imidacloprid @ 40 a.i./ha at the time of pest appearance and second spray with thiamethoxam 25 WG @ 125g a.i./ha after 15 days of first spray.
T_6	Metasystox 25 EC @ 300g a.i./ha as foliar spray at the time of pest appearance and 2^{nd} spray after 15 days of first spray.
T_7	Only water spray and no pesticide (Control)

RESULTS AND DISCUSSION

Per cent plant (shoot) and tuber damage caused by soil pests on potato under different treatment schedules:

In the first year 2015-16 of study, the per cent plant emergence was highest in T_1 (94.32%) and lowest in T_3 (93.21%) in response to different schedules (T_1-T_7) (Table 2). The percentage of shoot and tuber damage by the soil pests like cutworm, mole cricket, potato tuber moth (PTM) was maximum in T_7 (10.70% and 34.29%, respectively) where as shoot damage was minimum in T_1 (5.87%) and tuber damage was minimum in T_2 (13.15%) (Table 2).

In the second year of study during 2016-2017, the percent plant emergence was highest in T_4 (94.07%) and lowest in T_7 (93.17%) in response to different schedules (T_1-T_7) (Table 2). The percentage of shoot and tuber damage by the soil pests was maximum in T_7 (11.13% and 43.90%, respectively) where as shoot damage was minimum in T_1 (5.82%) and tuber damage was minimum in T_2 (15.66%) (Table 2).

Table 2: Efficacy of different treatment schedules against the soil pests causing shoot and tuber damage of potato during 2015-16 and 2016-17

Treatment Schedules	Mean Plant Emergence (%)			Mean Shoot Damage (%)			Mean Tuber damage (%)			Pooled Mea (Shoot+Tube damage)
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	% Reductio Over Control
T_1	94.32 (76.21^{a})	93.21 (74.90^{a})	93.77 (75.55^{a})	5.87 (14.02^{a})	5.82 (13.96^{a})	5.85 (13.99^{a})	14.04 (22.01^{a})	17.11 (24.43^{a})	15.58 (23.25^{a})	133.41
T_2	93.89 (75.69^{a})	92.86 (74.50^{a})	93.38 (75.09^{a})	6.92 (15.24^{ab})	6.86 (15.18^{ab})	6.89 (15.22^{ab})	13.15 (21.51^{a})	15.66 (23.30^{a})	14.41 (22.30^{a})	134.84
T_3	93.21 (74.90^{a})	93.37 (75.08^{a})	93.29 (74.99^{a})	6.49 (14.75^{ab})	6.12 (14.32^{a})	6.31 (14.54^{ab})	19.19 (25.97^{b})	22.46 (28.28^{b})	20.83 (27.15^{b})	84.30
T_4	93.71 (75.48^{a})	94.07 (75.91^{a})	93.89 (75.69^{a})	8.61 (17.06^{c})	9.32 (17.77^{c})	8.97 (17.42^{d})	27.43 (31.57^{d})	25.26 (30.16^{c})	26.35 (30.88^{c})	41.62
T_5	93.97 (75.79^{a})	93.68 (75.44^{a})	93.83 (75.62^{a})	7.62 (16.02^{bc})	7.31 (15.69^{ab})	7.47 (15.86^{bc})	13.31 (21.15^{a})	16.09 (23.64^{a})	14.70 (22.55^{a})	125.62
T_6	93.58 (75.32^{a})	93.88 (75.68^{a})	93.73 (75.50^{a})	8.21 (16.64^{c})	8.81 (17.26^{bc})	8.51 (16.96^{cd})	22.14 (28.06^{c})	32.01 (34.44^{d})	27.08 (31.36^{c})	40.55
T_7	94.17 (76.03^{a})	93.17 (74.85^{a})	93.67 (75.43^{a})	10.70 (19.09^{d})	11.13 (19.48^{d})	10.92 (19.29^{e})	34.29 (35.83^{e})	43.90 (41.48^{e})	39.10 (38.70^{d})	-
SEM	0.46	0.53	0.34	0.43	0.59	0.51	0.55	0.38	0.45	
$F_{Calculated}$ (6,12 df)	2.93^{NS}	2.97^{NS}	2.88^{NS}	3.16*	3.43*	3.29*	3.26*	3.18*	3.33*	

NS: Non-significant at p<0.05; *: Significant at p<0.05; Figures in parentheses indicate angular transformed values In a column, means followed by same letter are not significantly different by DMRT (p<0.05) #: (Control-Treatment) x100/Treatment

Economics of different insecticidal treatment schedules against plant and tuber damage caused by soil pests: The marketable tuber yield (t/ha) of potato in 2015-2016 was found highest in T_2 (26.28 t/ha) and lowest in control, T_7 (12.69 t/ha) (Table

3). Maximum cost-benefit ratio (CBR) was found in T_5 (1:2.02) and was minimum in T_7 (1:1.11) (Table 3). During 2014-15 the highest marketable yield (t/ha) of potato tuber was found in T_2 (26.80 t/ha) and lowest in T_7 (11.17 t/ha) (Table 3). Maximum CBR was found in T_5 (1:1.99) and was minimum in T_7 (1:1.17) (Table 3).

Table 3: Marketable yield and CBR of different treatment schedules against the soil pests causing shoot and tuber damage of potato during 2015-16 and 2016-17

Treatment Schedules	Average Marketable Yield (t/ha)			% Increased Yield Over Control	Cost of Production Including Plant Protection (Rs./ha)		Total Gain (Rs./ha)		Net Gain (Rs./ha)		CBR	
	2015-16	2016-17	Pooled		2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
T_1	25.92^a	25.19^a	25.55^a	114.35	42,207	45,038	110,016	115,950	67,809	70,912	1:1.61	1:1.57
T_2	26.28^a	26.80^a	26.54^a	122.65	41,463	44,228	126,144	134,000	84,681	89,772	1:2.04	1:2.03
T_3	21.67^b	22.33^b	22.00^b	84.56	41,795	44,940	104,016	111,650	62,221	66,710	1:1.49	1:1.48
T_4	19.19^c	19.44^c	19.31^c	62.00	41,139	43,968	92,112	97,200	50,973	53,232	1:1.24	1:1.21
T_5	24.25^a	24.67^a	24.46^a	105.20	41,758	44,538	126,000	133,350	84,242	88,812	1:2.02	1:1.99
T_6	18.14^c	19.17^c	18.66^c	56.54	41,297	44,182	87,072	95,850	45,775	51,668	1:1.11	1:1.17
T_7	12.69^d	11.17^d	11.92^d	-	39,363	41,978	60,912	55,850	21,549	13,872	-	-
SEM	0.51	0.73	0.67									
$F_{calculated}$ (6,12 df)	3.11*	3.27*	3.18*									

CBR: Cost-Benefit ratio; *: Significant at $p<0.05$
In a column, means followed by same letter are not significantly different by DMRT ($P<0.05$)
Selling price of potato was Rs. 4,800/t during 2015-16 & 5000/t during 2016-17.

Percent plant (shoot) and tuber damage caused by soil pests on potato under different treatment schedules: In the first year 2015-16 of study, the percent plant emergence was insignificant with each other [$F_{Calculated}$ (6,12 df) is 2.93] (Table 2). In 2016-17 emergence was also insignificant with each other [$F_{Calculated}$ (6,12 df) is 2.97] (Table 2). In 2015-16, percent shoot and tuber was significant among the treatment schedules [$F_{Calculated}$ (6,12 df) is 3.16 and 3.26 respectively] (Table 2). Similarly in 2016-17, percent shoot and tuber was also significant among the treatment schedules [$F_{Calculated}$ (6,12 df) is 3.43 and 3.18, respectively] (Table 2). It was observed from the both years of study, that the percentage of plant damage was minimum in T_1 (5.82 – 5.87) and maximum in T_7 (10.70 – 11.13). Because in T_1, the crop was protected from planting to harvesting by chemical insecticides which were both (thiacloprid and thiamethoxam) systemic in nature. Next to T_1, T_2 and T_5 were most effective against the soil pests due to application of chemical insecticides during early growth stage, when the intensity of damage by soil pest (cutworm) was high (Konar and Mohasin, 2003). Among the treatment schedules T_2 (6.86 – 6.92 percent plant damage) was slightly better than T_5 (7.31-7.62 per cent plant damage). This is because of the fact that in T_5, the crop was sprayed with both insecticides imdacloprid and synthetic thiamethoxam. Spraying of thiacloprid in T_3 was more effective than treatment with insecticide imidacloprid at planting in T_4. The other treatment schedules, which were

were not so effective in minimizing the plant damage, caused by soil pests. The finding were in agreement with those of reported earlier by Konar *et al.* (2003); Konar and Chettri, (2003).

It can be said from the results of both the years that all the treatment schedules were significantly superior over control in reducing the tuber damage caused by soil pests. Out of seven treatment schedules, T_2 and T_5 were most effective treatment schedules by recording less percentage of tubers damage (13.15 – 15.66 and 13.31 – 16.09 per cent respectively). It was because of the fact that in both the schedules thiamethoxam were applied along with spiromesifen and thiacloprid respectively and it was reported by Konar *et al*. 2003; Konar *et al.* 2005 and Konar and Paul, 2005; that only thiamethoxam plus spiromesifen achieved better result in reducing the tuber damage caused by cutworm and mole cricket.

Economics of different insecticidal treatment schedules against plant and tuber damage caused by soil pests: Among the seven treatment schedules, T_2 and T_5 were most effective treatment schedules by recording the highest tuber yield (26.28 – 26.80 and 24.25 – 24.67 t/ha respectively). The marketable yields was singnificant among the seven treatment schedules [$F_{Calculated}$ (6,12 df) is 3.11 and 3.27, respectively] (Table 3).

From the result of the present field study it might be said that among the different treatment schedules, T_5 and T_2 were most effective in increasing marketable yield of potato tubers and net profit over control than other treatments. The results of Tripathi *et al.* 2003 support the findings of the present study.

CONCLUSION

It can be concluded from the both years 2015-2016 and 2016-2017 of study, that the per cent reduction of plant (shoot) plus tuber damage by the soil pests was highest and most effective in T_2 (134.84%) (Table 3) over control T_7 and also may be concluded from the results of both the years that all the chemical treatment schedules were significantly superior over control and also over the bio-pesticide treatment in reducing the tuber damage caused by soil pests. From the result of the present field study it can be concluded that among the different treatment schedules, T_5 and T_2 were most effective in increasing marketable yield of potato tubers and net profit over control than other treatments.

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