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Evaluation of some granular insecticides against white grub, *Lepidiota mansueta* B. in potato (*Solanum tuberosum* L.)

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Abstract
Field efficacy of six different insecticides were evaluated against the grubs of *L. mansueta* in potato at the farmer's field of Pohadiya village, Majuli, Assam during 2013-15. The required amount of insecticides was applied in seed furrows by incorporating with pulverized soil before sowing of the potato tubers. Experimental results indicated that all the insecticidal treatments were significantly superior in respect of per cent reduction of tuber damage as well as reducing the number of grubs per square meter over the untreated control. However, the plots treated with chlorpyriphos 10 G @ 2 kg *a.i.*/ ha recorded lowest per cent of tuber damage (3.11 and 2.74 % both in weight and number basis) as well as least number of grubs (3.50) resulting in a marked increase in tuber yield of 119.91 q/ ha. On the other hand, untreated control recorded lowest yield (91.80 q/ ha) with a very high levels of infestation (28.79 and 28.94 based on weight and number, respectively) of tubers caused by the grubs of *L. mansueta*. Highest B: C ratio was registered in chlorpyriphos 10 G @ 2.0 kg *a.i.*/ha (2.69:1) treated plots followed by clothianidine 50 WDG @ 120 g *a.i.*/ ha (1.50:1) and imidacloprid 70 WG @ 300 g *a.i.*/ ha (1.44:1).

Keywords: White grub, efficacy, insecticide, potato

1. Introduction
Potato (*Solanum tuberosum* Linnaeus.) is an important tuber crop belonging to the family solanaceae and is native to South America. It is one of the four major staple food crops of the world [1] playing a major role in human nutrition and produces highest dry matter per unit area and time [2]. In India, potato is cultivated in almost all the states under diverse agro-climatic conditions. The crop has great export potential besides huge domestic requirement. However, during the recent past various limiting factors (biotic and abiotic) has led to the decrease in the production and productivity of potato, among the various factors, ravages caused by the insect pests associated with this crop are major ones and annually several crores of rupees are lost, accounting for 10-20 per cent of total potato production [3]. The subtropical conditions of North-East region of India favours potato cultivation both in hills and plains [4] round the year [5]. The area under potato in in this region is about 70,000 hectares, but production in these areas suffers heavily due to infestation of many soil insect pests, out of which white grubs are major ones [6]. About 24 species of white grubs are associated with potato crop throughout India [7]. An endemic white grub species, *Lepidiota mansueta* has emerged as a key pest in Majuli river island of Assam, and is the foremost one causing substantial damage to potato crop varying from 42-48 per cent [8, 9]. *L. mansueta* has a biennial life cycle, and the second as well as third instar grubs are the most destructive stage, found throughout the year due to overlapping generations [9]. Grubs feed on the fibrous roots of young plants as well as tubers making shallow, circular cavities which render infested tubers unfit for marketing [10] the damage becomes evident only when the plant dries up. The infestations are spotty, localized and impossible to predict [11]. The management of *L. mansueta* have become thought-provoking as the grub spends most of their lifespan underground and emerge abruptly [12]. Since the species is endemic to majuli information's regarding the insecticidal management of this grub species are scanty. As chemical control would be the first line of defence against these pests under the outbreak conditions, therefore exigencies to evaluate certain chemical insecticides which are ecosafe, economic and effective at low application rate to suppress the grubs of *L. mansueta* is imperative.

2. Materials and Methods

2.1 Study area

The experiment was conducted in the farmers' field of Pohadiya village of Majuli river island (27.0016° N and 94.2243° E), Assam during 2013-15. The experimental site was known to be previously infested by the grubs of *L. mansueta* in potato.

2.2 Experimental layout

The experiment was laid out as 4RBD (Randomized Block Design) and the size of individual plot was 4 × 3 square meter. The variety "*Kufri Jyoti*" was grown as it is a commonly cultivated potato variety of Assam and is partially tolerant to late blight disease, following all recommended agronomic package of practices of Assam [13].

2.3 Treatments

Six insecticidal treatments *viz*., chlorpyriphos 10 G @ 2.0 kg *a.i.*/ ha, carbofuran 3G@ 750 g *a.i.*/ ha, clothianidine 50 WDG @ 120 g *a.i.*/ ha, thiamethoxam 25 WG@ 80 g *a.i.*/ ha, emamectin benzoate 5 SG@ 12.5 g *a.i.*/ ha and imidacloprid 70 WG@ 300 g *a.i.*/ ha were incorporated with pulverized soil and thereafter, these were applied in seed furrows before sowing of the potato tubers. In case of untreated control, water was sprayed in respective plots.

2.4 Observations

The efficacy of each treatment was assessed on the basis of per cent tuber damage caused by grubs both in weight and number basis also on the number of grubs per square meter at the time of harvest and tuber yield. The tuber damage (weight and number basis) was calculated by following the methodology [14] as delineated below:

Tuber damage by weight (TD %) = (Wd/Wt) × 100
Where,
Wd = weight of damaged tubers in a plot; Wt = total weight of tubers in same plot
Tuber damage by number (TD %) = (Nd/Nt) × 100
Where,
Nd = Number of damaged tubers in a plot; Nt = total number of tubers in same plot

2.5 Statistical analysis

Data on per cent tuber infestation for both weight and number basis were transformed into angular values (arcsin √x). Data on grub population was transformed using square root transformation √(x+0.5) and finally all the transformed values were analyzed by using analysis of variance (ANOVA) for Randomized Block Design [15].

3. Results and Discussion

The effect of six different insecticidal treatments against the grubs of *L. mansueta* based on per cent tuber damage and yield of potato is presented in Table 1. Experimental results indicated that all the insecticidal treatments were significantly superior over the untreated control in reducing per cent tuber damage and number of grubs per sq. meter resulting in a significant increase in tuber yield.

The pooled analysis of data for two consecutive seasons revealed that, chlorpyriphos 10 G@ 2 kg *a.i.*/ha recorded lowest per cent of tuber damage on weight basis (3.11 %) and showed statistical parity with clothianidine 50 WDG @ 120 g *a.i.*/ ha (3.64%), imidacloprid 70 WG @ 300 g *a.i.*/ ha (3.92%) and thiamethoxam 25 WG @ 80 g *a.i.*/ ha (5.45%) treated plots followed by carbofuran 3G @ 750 g *a.i.*/ ha (6.11%) and emamectin benzoate 5 SG @ 12.5 *a.i.*/ ha (10.36 %). The untreated control on the other hand registered highest *i.e* 28.79 per cent of tuber damage (Table 1). Considering the per cent tuber damage on number basis, all the insecticidal treatments were found to be significantly superior over the untreated control. However, chlorpyriphos10 G @ 2.0 kg *a.i.*/ ha maintained its superiority over all other treatments and recorded the lowest tuber damage of 2.74 per cent (Table 1) followed by clothianidine 50 WDG @ 120 g *a.i.*/ ha, thiamethoxam 25 WG @ 80 g *a.i*/ ha, imidacloprid 70 WG @ 300 g *a.i./* ha, carbofuran 3G @ 750 g *a.i.*/ ha and emamectin benzoate 5 SG @ 12.5 g *a.i.*/ ha which resulted in 4.17, 4.62, 4.70, 5.22 and 9.05 per cent of tuber damage which was significantly superior over the untreated control i.e 28.94% (Table 1).

The data recorded on number of grubs per square meter at the time of harvesting of potato revealed significant superiority of all the treatments over untreated control. However, it is vivid that the soil application of chlorpyriphos 10 G @ 2.0 kg *a.i.*/ ha proved to be the most effective in reducing the grub population (3.50) followed by clothianidine 50 WDG @ 120 g *a.i.*/ha (4.00) and imidacloprid 70 WG @ 300 g *a.i./*ha (4.17) treated plots whereas the grub population recorded in the untreated control plot was 8.83 per square meter. The records of tuber yield suggested superiority of all the insecticidal treatments over the untreated control. However, the highest pooled tuber yield was registered in chlorpyriphos 10 G @ 2.0 kg *a.i.*/ha (119.91 q/ha) treated plots and it was found to be *at par* with the tuber yield recorded in thiamethoxam 25 WG @ 80 g *a.i.*/ha (117.46 q/ha), clothianidine 50 WDG @ 120 g *a.i.*/ ha (117.37 q/ha) and imidacloprid 70 WG @ 300 g *a.i.*/ ha (116.47 q/ha) as against 91.80 q/ha in the untreated check. Highest B:C ratio (2.69:1) was obtained in chlorpyriphos 10 G @ 2.0 kg *a.i.*/ha treated plots followed by clothianidine 50 WDG @ 120 g *a.i.*/ ha (1.50:1) and imidacloprid 70 WG @ 300 g *a.i.*/ ha (1.44:1) (Table 1).

The present data's provides a foundation for establishing that chlorpyriphos is highly effective in suppressing the infestation of white grubs. Lingappa and Giraddi,[16] reported chlorpyriphos 20 EC was effective in successfully managing potato white grubs in Karnataka. The present finding also corroborates the findings of Allsopp *et al*. [17], Anjana and Bhagat, [18] Rahama *et al*. [19] and Zaki *et al*. [20] specifying that Chlorpyriphos was the best chemical treatment in reducing the infestation and numbers of other white grub species in different crops. The neonecotinoid group of insecticides *viz*., clothianidine 50 WDG, thiamethoxam 25 WG and imidacloprid 70 WG also proved promising in reducing tuber infestations caused by the grubs of *L. mansueta*. The ability to manage many soil arthropods in different crops by using neonicotinoid insecticides was also supported by the earlier findings of Annon, [21]. The less effectiveness of emamectin benzoate 5 SG as compared to the other treatments against the grubs of *L. mansueta* is similar to the findings of Adarsha *et al.* [22] where they reported emmamectin benzoate was least effective against arecanut white grub.

Table 1: Evaluation of some granular insecticides against *Lepidiota mansueta* in potato at Majuli during 2013-15 (pooled)

Treatments	Dose (*a.i.*/ha)	Per cent tuber damage						Number of grubs per sq.m			Yield (q/ha)			B:C ratio		
		Weight basis			Number basis											
		2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
Chlorpyriphos 10 G	2.0 kg	3.65 (11.02)	2.57 (8.95)	3.11	3.16 (10.23)	2.31 (8.73)	2.74	3.33	3.67	3.50	123.22	116.61	119.91	2.50	2.87	2.69
Carbofuran 3G	750 g	6.93 (15.19)	5.30 (13.31)	6.11	6.31 (14.54)	4.13 (11.73)	5.22	4.33	5.33	4.83	111.64	111.90	111.77	0.85	1.09	0.97
Clothianidine 50 WDG	120 g	4.01 (11.55)	3.26 (10.40)	3.64	5.19 (13.18)	3.15 (10.19)	4.17	4.00	4.00	4.00	119.43	115.31	117.37	1.25	1.74	1.50
Thiamethoxam 25 WG	80 g	7.85 (16.25)	3.04 (10.03)	5.45	6.30 (14.53)	2.94 (9.88)	4.62	4.33	4.33	4.33	117.53	117.38	117.46	1.11	1.32	1.22
Emamectin Benzoate 5 SG	12.5 g	9.68 (18.09)	11.04 (19.39)	10.36	7.66 (16.07)	10.45 (18.86)	9.05	7.00	7.00	7.00	101.89	101.74	101.82	0.25	0.48	0.37
Imidacloprid 70 WG	300 g	4.49 (12.19)	3.36 (10.56)	3.92	5.82 (13.97)	3.57 (10.89)	4.70	4.00	4.33	4.17	119.86	113.08	116.47	1.21	1.67	1.44
Control	Water spray	32.07 (34.36)	25.51 (30.28)	28.79	30.11 (33.29)	27.77 (37.78)	28.94	9.33	8.33	8.83	95.49	88.11	91.80			
S.Ed ±		1.74	1.11	1.11	0.52	0.84	0.48	0.61	0.64	0.52	2.89	1.93	1.96			
CD(0.05)		3.66	2.33	2.34	1.09	1.76	1.01	1.28	1.34	1.10	6.07	4.05	4.13			

Data are mean of four replications

Data in parenthesis are angular transformed values

4. Conclusion

The results of the present findings clearly indicate that chlorpyriphos 10G @ 2kg/ ha registered a low incidence of *L. mansueta* grubs leading to a marked increase in tuber yield. The cost benefit ratio of chlorpyriphos was also much higher as compared to the other treatments. Therefore, chlorpyriphos may be recommended for application against the *L. mansueta* infestation in potato which could effectively help in managing this pest

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