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Research Paper

Field Efficacy of few Insecticides as Soil Application against Potato White Grubs in Assam

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Abstract: *A field experiment was conducted during winter (rabi) seasons of 2006-09 to find out the effectiveness of six insecticides as soil application against Lepidiota mansueta, a severe key pest of potato at Majuli river island of Jorhat, Assam. Experimental results indicated all the insecticides were found to be significantly superior in respect of per cent reduction of damage based on both weight and number basis over the untreated control. However, quinalphos 25EC @ 400 gm a.i. /ha recorded lowest tuber damage (10.22 %) and highest tuber yield (86.72 ql/ha) with B:C ratio of 10.11:1. The pesticide residue analysis did not showed any detectable amount of quinalphos in potato samples collected at harvest. Based on the superiority of quinqlphos 25EC @ 400 gm a.i. /ha over other insecticides tested against L. mansueta grubs in potato, an on farm trial (OFT) was conducted at Dhubri in 2009-10 in collaboration with KVK, Dhubri, Assam. The OFT results indicated that the quinalphos 25 EC @ 400 gm a.i /ha treated plots recorded 3.91 and 2.26 per cent tuber damage (based on weight basis) as against 16.04 and 15.00 in untreated control plots respectively in Kufri Megha and Kufri Giridhari varieties. The tuber yield was found to be 225.67 q/ha & 233.33 q /ha (quinalphos treated plots) and 196.44 and 209.70 q /ha (in control plots) respectively in Kufri Megha and Kufri Giridhari varieties.*

Keywords: *Lepidiota mansueta*, potato, insecticides, soil treatment, quinalphos.

Introduction

Potato plays a major role in human nutrition and makes substantial contribution to strengthen food security among the non cereal crops. It is a high volume crop and yields substantially more edible energy protein and dry matter per unit area because of its short vegetative cycle[1]. In India, potato is cultivated in almost all states under very diverse agro-climatic conditions from October to March during winters under short-day conditions[2]. Among the major constrains to potato production, white grubs are one of the most destructive and troublesome soil insects causing up to 85% of tuber damage. There are nearly 20 species of white grubs which attack potato in different parts of India [2]. Among these white grub species, *Lepidiota mansueta* has recently been observed to cause substantial damage to many field crops in Majuli, Assam, North East India with the extent of damage varying from 42-48% in potato [3]. The third instar grubs has a prolonged developmental period (545 to 563 days) and as such, cause heavy damage to the potato tubers. *L. mansueta* could be regarded as a rare species, because it spends its entire life cycle under the ground except for a short period during which adults emerge from the ground for mating [4]. In a similar trend, another white grub species, *Adoretus* sp. was also observed to cause considerable damage to potato in Dhubri district of Assam (personal observation). Grubs of both the species make large, shallow, circular or irregular cavities into potatoes. Such infested tubers with scooped out holes or half eaten tubers are rendered unfit for marketing [5].

As already mentioned, both *L. mansueta* and *Adoretus* sp. cause serious damage to a variety of crops, especially potato and hence, suitable control is urgently needed. However, as the grubs spend most of their lifespan underground, it makes effective control of these insects difficult[6]. One typical aspect of management can be the application of soil insecticides [2]. Efficacy of different soil insecticides against other species of white grubs in agricultural crops had been previously detailed by many researchers from India [2]. But in case of *L. mansueta* and *Adoretus* sp., practically no information is available in regards to insecticidal management of the grubs as both the species are endemic to Assam and their incidence and severity of damage is localized within two districts. Consequently, considering the severity of damage to potato crop, field experiments were initiated against both *L. mansueta* and *Adoretus* sp., at Majuli and Dhubri district of Assam, respectively to evaluate the bioefficacy of some soil insecticides in managing these obnoxious pests of potato.

Material and Methods

Site description

For *L. mansueta*, the study was initiated at farmers' fields at Juginidhari (26° 57' 0" N, 94° 10' 0" E) of Majuli river island in Jorhat district. The experiment was conducted for three consecutive winter (*rabi*) seasons in potato. Similar experiment was also initiated as an "on field trial" (OFT) in Bilasipara sub division (110 92' 41" N, 780 11' 917" E), Dhubri against *Adoretus* sp. However, in this case only one treatment *i.e*. Quinalphos 25EC was taken for the experiment. The experiment was conducted for one winter (*rabi*) season in potato. The site was selected based on the high relative abundance of the grubs in those areas.

Experimental layout and management

For *L. mansueta*, a randomised complete block design (RBD) with five replications and six treatments was used. Each plot size was 4×3 sq.m. The treatments comprised of quinalphos 25EC, chlorpyriphos 20EC, thiamethoxam 70WS, thiamethoxam 25 WG, imidacloprid 200SL & imidacloprid 0.75G at recommended dilutions for potato along with control. The potato variety, *Kufri jyoti* was grown by following all recommended agronomic practices. A similar setup was laid at Khudmari, Bilasipara sub division of Dhubri by growing two popular varieties of Potato *i.e*. Kufri megha & Kufri giridhari with only two treatments *viz.*, soil treatment with quinalphos 25EC @ 400 gm. a.i/ha and an untreated control. The required amount of insecticides was sprayed with pulverized soil and thereafter, these were applied in seed furrows before sowing of the tubers. Finally, the efficacy of different treatments was recorded on the basis of per cent tuber damage caused by the grubs, number of grubs per plot at the time of harvest and tuber yield.

Residue analysis

Soil samples were also collected at harvest for analysis of quinalphos residues in potato and water. The samples were extracted and cleaned up following the procedures as per protocol. The residues were estimated in Shimadzu Gas Chromatographic column for detecting the presence of residues, if any.

Results and Discussion

The insecticides were applied in endemic localities to bring down the population of both *L. mansueta* and *Adoretus* sp. below the economic threshold level. Experimental results indicated that all the insecticides were found to be significantly superior in respect of per cent reduction of damage based on both weight and number basis over the untreated control. The efficacy of soil application of six different insecticides against the grubs of *L. manseuta* is presented in Table 1. The pooled analysis of data for three consecutive seasons revealed that on number basis, quinalphos 25 EC @ 400 gm a.i. /ha recorded lowest per cent tuber damage (15.07%) and it was significantly superior over all other treatments. The application of thiomethoxam 25 WG @80 gm a.i /ha, imidaclorpid 200SL @48 gm a.i/ha, imidaclorpid 0.75 G @ 90 gm a.i/ha, thiomethoxam 70 WS @80 gm a.i./ha and chloropyriphos 20 EC @ 400 gm a.i./ha recorded 20.15, 20.17, 20.47, 22.24 and 23.78 per cent tuber damage and these treatments were found to be at par with each other, but significantly superior over the untreated control (33.50%).

Considering the per cent tuber damage on weight basis, all the insecticides treated were found to be significantly superior over the untreated control. However, the lowest tuber damage (10.20%) was recorded in quinalphos 25 EC @ 400 gm a.i. /ha treated plots and this treatment was significantly superior over all other treatments. Potato white grubs typically are controlled by applying soil insecticides. Chlorpyriphos, phorate and carbofuran are widely used for preventive control of potato white grubs in India [2]. However, in this case quinalphos was found to be effective against grubs of both *L. mansueta* and *Adoretus* sp. The tuber damage recorded in choloropyriphos 20EC @ 400 gm a.i./ha, thiomethoxam 70WS @ 80 gm a.i./ha, imidacloropid 0.75G @ 90 gm a.i./ha, imidacloropid 200SL @ 48 gm a.i. /ha and thiomethoxam 25 WG @ 80 gm a.i. /ha did not vary with each other and resulted 14.71, 15.01, 16.52, 16.69 and 17.85 per cent of tuber damage on number basis. The untreated control plot recorded 27.73 per cent of tuber damage.

Table 1: Field evaluation of insecticides against *L. mansueta* as soil application in potato crop at Majuli

Treatments	Dose (g a.i./ ha)	Tuber damage on number basis				Tuber damage on weight basis				Grub population				Yield (ql/ha)				B:C ratio			
		06-07	07-08	08-09	Pooled Mean	06-07	07-08	Pooled Mean	Mean	06-07	07-08	08-09	Pooled Mean	06-07	07-08	08-09	Pooled Mean	06-07	07-08	08-09	Pooled Mean
Quinalphos 25EC	400	13.00	15.73	16.47	15.07	11.00	9.38	10.22	10.20	2.33	2.00	2.33	2.22	84.37	85.82	86.72	85.64	10.02:1	9.21:1	10.11:1	9.78:1
Chlorpyriphos 20EC	400	25.97	22.32	23.05	23.78	19.50	11.82	12.79	14.71	9.00	9.67	10.33	9.67	79.63	80.41	81.33	80.46	6.50:1	6.79:1	7.54:1	6.94
Thiamethoxam 70 WS	80	23.63	21.18	21.92	22.24	17.61	13.27	14.16	15.01	7.33	8.33	9.00	8.22	73.15	74.00	74.88	74.01	3.38:1	3.18:1	3.54:1	3.36
Imidacloprid 200SL	48	21.36	19.33	19.82	20.17	13.86	17.65	18.57	16.69	4.33	5.67	6.33	5.44	83.37	83.58	84.53	83.83	9.19:1	7.95:1	8.88:1	8.67
Thiamethoxam 25 WG	80	21.13	19.29	20.03	20.15	18.98	16.78	17.80	17.85	8.00	9.00	9.67	8.89	75.00	76.14	77.06	76.07	2.22:1	2.19:1	2.80:1	2.40
Imidacloprid 0.75 G	90	21.84	19.51	20.05	20.47	15.21	16.67	17.68	16.52	6.33	7.33	8.00	7.22	81.11	81.71	82.59	81.80	3.24:1	3.07:1	4.09:1	3.46
Control		33.87	32.37	34.25	33.50	30.24	25.84	27.10	27.73	12.67	13.17	14.00	13.33	65.74	66.93	67.83	66.84				
C. D. at P = 0.05		6.92	2.53	2.70	-	2.17	2.04	1.83	-	3.70	3.18	2.86	-	11.66	6.31	6.93	-				
Pooled S.Ed ±					1.97				1.12				1.53				3.57				
Pooled C.D. (P=0.05)					4.00				2.27				3.10				7.24				

The data recorded on number of grubs per square meter at the time of harvesting of potato revealed that all the treatments were significantly superior over the untreated control. However, it is vivid that the soil application of quinalphos 25 EC @ 400 gm a.i. /ha proved to be the most effective in reducing the grub population (2.22) followed by imidacloropid 200 SL @ 48 gm a.i. /ha treated plot (5.44). The untreated control registered highest number of grubs per square meter (13.33%). In regards to tuber yield, all the insecticidal treatments were found to be significantly superior over the untreated control. However, the highest pooled tuber yield was registered in quinalphos 25 EC @ 400 gm a.i. /ha treated plots (85.64 q/ha) and it was found to be at par with the tuber yield recorded in imidacloropid 200 SL @ 48 gm a.i. /ha (83.83 q/ha), imidacloropid 0.75 @ 90 gm a.i./ha (81.80 q/ha) and chloropyriphos 20 EC @ 400 gm a.i./ha (80.46 q/ha) as against 66.84 q/ha in the untreated check. Highest B:C ratio (9.78:1) was obtained in quinalphos 25 EC @ 400 gm a.i /ha treated plots followed by imidacloropid 200 SL @ 48 gm a.i. /ha (8.67:1). Previously, Das suggested the use of quinalphos 5G at 20 kg/ha for effective management of white grubs in potato [7] while in Karnataka, potato white grubs were controlled by soil application of chlorpyriphos 20EC [8].

The performance of soil application of quinalphos 25 EC @ 400 gm a.i. /ha was also tested as On Farm Trial (OFT) in the Dhubri district of Assam. The OFT results indicated that the quinalphos 25 EC @ 400 gm a.i. /ha treated plots recorded 3.91 and 2.26 per cent tuber damage (based on weight basis) as against 16.04 and 15.00 respectively in *Kufri Megha* and *Kufri Giridhari* varieties. The tuber yield was found to be 225.67 q /ha (in Kufri Mega) and 233.33 q /ha (in Kufri Giridhari) and untreated control plots registered 196.44 and 209.70 q /ha of yield (Table 2).

Another feature which was kept in mind was the presence of residue levels of quinalphos which was giving promising results against both the species of white grubs. Even though chlorinated insecticides like aldrin, DDT and heptachlor dusts were standards for grub control during the 1970s and 1980s [10, 11, 12], most of these fast-acting, persistent insecticides were restricted or banned for agricultural usage during the 1990s in response to the environmental concerns and the food safety. Therefore, we also tried to determine the safety levels of quinalphos, both in potato and in ground water. Observing the superiority of quinalphos 25 EC @ 400 gm a.i. /ha in both experiments, the residue analysis of tubers treated with quinalphos 25 EC was carried out. Samples were collected at harvest for analysis of quinalphos residues on potato and ground water of the field and the residues were estimated. However no residues were detected in the samples of Quinalphos treated plots and ground water (Figure 1 A-C). Based on GC analysis, treated water and ground water were found to be free from contamination of quinalphos. These results clearly establish that quinalphos may be recommended against potato white grubs from this region.

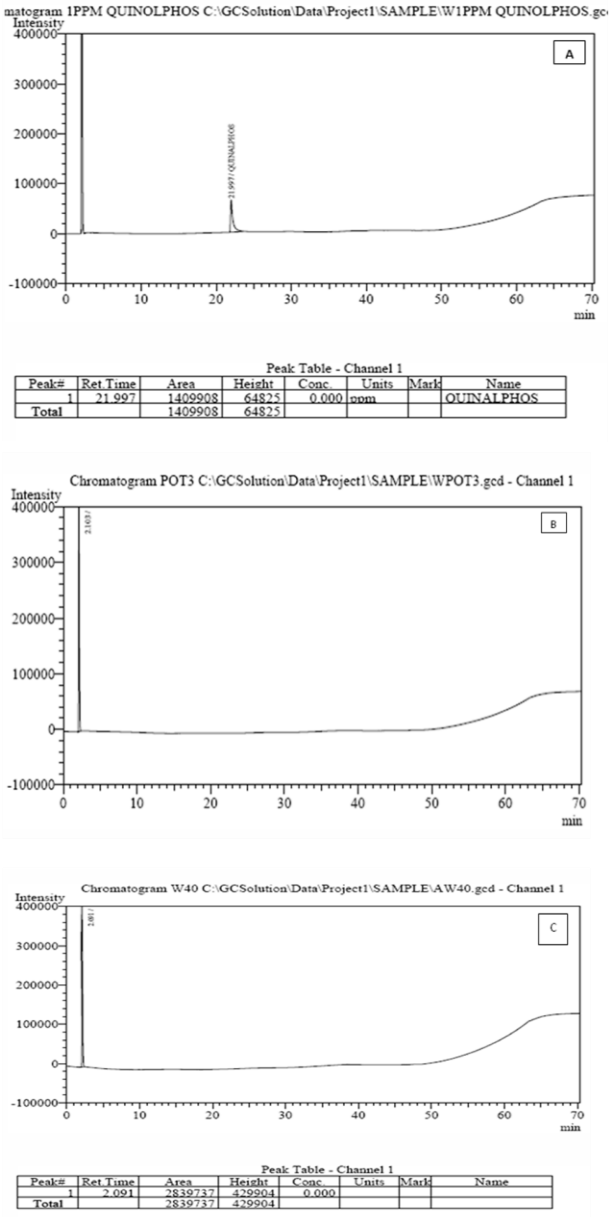

Figure 1: Chromatogram of (A) quinalphos standard, (B) potato samples, (C) water samples tested for quinalphos residues

However, it should be kept in mind that white grubs have a stage of vulnerability when they are most susceptible to an insecticide application. Missing the appropriate time of treatment may lead to little or no insect control [2]. To obtain good results, insecticides application should occur soon after adult emergence and should coincide with egg laying or egg hatching [9].

At this time, most eggs should have hatched, and the small grubs will be feeding near the soil surface where they are more easily controlled. This aspect of timely application was taken into consideration for which a significantly higher control was observed when compared to control.

Conclusion

The results clearly indicate that quinalphos may be safely recommended for application against white grubs in potato which could effectively help in managing these insect pests while also being cost effective for the farmers.

Table 2: On Farm Trial on effect of quinalphos in reducing white grub infestation in potato at Dhubri

Treatments	Dose (g a.i./ha)	Per cent tuber damage (weight basis)	Per cent reduction of infestation over control	Yield (q/ha)
Variety: *Kufri Megha*				
Quinalphos 25 EC	400	3.91	75.62	225.67
Control	-	16.04	-	196.44
Variety: *Kufri Giridhari*				
Quinalphos 25 EC	400	2.26	84.93	233.33
Control	-	15.00	-	209.70

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