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SHORT COMMUNICATION

FIELD EVALUATION OF SOME INSECTICIDES AGAINST WHITE GRUB, *Lepidiota mansueta* B. (COLEOPTERA: SCARABAEIDAE), ON POTATO (*Solanum tuberosum*) IN ASSAM (INDIA)

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ABSTRACT

Field studies were conducted to evaluate the efficacy of six insecticides against white grub, *Lepidiota mansueta*, in potato in 2012 and 2013 at Majuli river island in Assam (India). All the insecticide treatments significantly reduced tuber damage as against untreated control. Of the insecticides tested, fipronil 5 SC @ 150 g *a.i.* ha^{-1} showed low tuber damage on weight basis (5.24 and 4.57%) and was at par with fipronil 5 SC @ 100 g *a.i.* ha^{-1} (5.91 and 5.09%), chlorpyriphos 20 EC @ 400 g *a.i.* ha^{-1} (5.55 and 6.2%) and quinalphos 25 EC @ 400 g *a.i.* ha^{-1} (6.14 and 6.72%). On number basis, fipronil 5 SC @ 150 g *a.i.* ha^{-1} showed lowest tuber damage (4.2%), followed by chlorpyriphos 20 EC @ 400 g *a.i.* ha^{-1} (5.25%) and quinalphos 25 EC @ 400 g *a.i.* ha^{-1} (5.66%). All insecticide treatments were at par in tuber yield, except emamectin benzoate 5% SG @ 12.5 g *a.i.* ha^{-1}. Highest cost benefit ratio was observed in chlorpyriphos 20 EC @ 400 g *a.i.* ha^{-1} treatment (2.50 and 2.62), followed by quinalphos 25 EC @ 400 g *a.i.* ha^{-1} (2.23 and 1.85). Chlorpyriphos 20 EC @ 400 g *a.i.* ha^{-1} and quinalphos 25 EC @ 400 g *a.i.* ha^{-1} seem better alternatives than fipronil to reduce infestation of *L. mansueta* in potato.

Key words: Insecticides, potato, white grub, *Lepidiota mansueta*

INTRODUCTION

Potato (*Solanum tuberosum* L.) is an important staple food crops both in developed and developing countries. India is 3rd largest producer of potato in world (Anon., 2015). The subtropical climatic condition of North-East favours potato cultivation round the year (Gupta *et al*., 2004), both in hills and plains covering an area of 98,000 ha (Anon, 2014). Potato crop is attacked by many insect pests right from transplantation to harvest and their damage is considered a major threat for potential crop yield. The insect pests associated with potato are potato tuber moth (*Phthorimaea operculella*), cutworm (*Agrotis ipsilon*), aphid (*Myzus persicae*), epilachna beetle (*Epilachna viginatioctopunctata)*, jassid (*Empoasca fabae*), red ant (*Dorylus orientalis*), thrips (*Helicothrips indicus*) and a wide array of white grub species. The crop loses several crores of rupees annually due to pest damage, which account for 10-20% of total production (Kishore and Misra, 2001).

Potato growing belt of North Eastern region of India suffer heavily due to infestation of many soil insect pests, out of which cutworms and white grubs are major ones inflicting extensive damaged to potato crops (Singh, 2003). Almost 24 species of white grubs are associated with potato crop throughout India (Chandel *et al.*, 2015). White grubs have become increasingly difficult pests in North East India with their intensifying population every year as evidenced by the several outbreaks that occurred over large areas during recent past (Pujari and Bhattacharyya, 2016). Abrupt emergence of white grubs is a major threat to some economically important crops of this region which has been favoured by intensive cultivation, improvements in irrigation facilities, conversion of fallow lands, deforestation as well as overall changes in climatic scenario. Perusal of literature reveals a wide array of phytophagous scarabaeids comprising of 82 species representing 34 genera and 5 subfamilies with several new records (Bhattacharyya and Dutta, 2014). Despite the fact that the white grubs are gaining status as pests of major economic concern, concerted efforts for quantification of losses, identification of most damaging species, pest biology and eco-friendly management measures are yet in infancy. White grub infestations are highly variable from year to year and from place to place and also the damage is spotty, localized and almost impossible to predict (Bhattacharyya and Dutta, 2014). Of late, a biennial species of white grub has appeared as a severe key pest in Majuli river island of Assam (Bhattacharyya *et al.*, 2010). *L. mansueta* has biennial life cycle which is first of its kind from North East India. Unlike other Indian phytophagous white grub species, the adults of *L. mansueta* were not observed to feed on any host plants and hence this species has got the unique distinction of first Indian phytophagous white grub species with non-feeding adults (Bhattacharyya *et al*., 2011). Severity of this insect in Majuli may be attributed to the presence of abundant grasslands with high organic carbon content in soil. *L. mansueta* infestation is a potential problem whenever low grasslands in Majuli are brought into cultivation for the first time without taking any grub management strategies. Field surveys conducted during 2005-2010 revealed that 3rd instar grubs caused substantial damage to potato (42-48%), colocasia (35-40%), green gram (30-35%) and sugarcane (15-20%) (Bhattacharyya *et al.*, 2015). Since, the outbreak of *L. mansueta* is endemic in nature; therefore, a very scanty information is available about insecticidal management of grubs of this pest species. The problem is so severe that most of the riverine areas are considered as a reservoir of grubs with population far exceeding the economic threshold level as recommended in potato crop (2 grubs per 0.09 m^2 (Sharma *et al*., 2012). Considering the severity of the problem, field experiments were carried out at Majuli, Assam to evaluate six insecticides against *L. mansueta* in potato at the farmers' field of Majuli, Jorhat.

MATERIALS AND METHODS

Six insecticides were tested for their effectiveness against *L. mansueta* in potato at farmer's field in Juginidhari village, Majuli (Assam) during 2012 and 2013. The experiment was carried out in randomized block design with three replications. The individual plot size was 5 m × 4 m. The potato crop cv. Kufri Jyoti was grown as per the recommended package of practices for Assam (Anon., 2010). The crop was sown on 25th and 22nd October in 2012 and 2013, respectively. Fifty tubers were planted in each plot. Of the six insecticides tested, two insecticides (quinalphos 25 EC and chlorpyriphos 20 EC @ 400 g *a.i.* ha^{-1}) belonged to organophosphate group, two from neo-nicotinoids (imidacloprid 200 SL @ 48 g *a.i.* ha^{-1} and clothianidin 50 WDG @ 80 g *a.i.*ha^{-1}) and one from abamectin group (emamectin benzoate 5 SG @ 12.5 g *a.i.* ha^{-1}). The required amount of each insecticide was sprayed in seed furrows before tuber sowing. The efficacy of each treatment was assessed on the basis of per cent tuber damage caused by grubs (weight and number basis), number of grubs m^{-2} at harvest and tuber yield. The tuber damage (weight and number basis) was calculated as per Sharma (2013):

$$\text{Tuber damage by weight (TD\%)} = (Wd/Wt) \times 100$$

where, Wd = weight of damaged tubers in a plot and Wt = total weight of tubers in same plot

$$\text{Tuber damage by number (TD\%)} = (Nd/Nt) \times 100$$

where, Nd = Number of damaged tubers in a plot; Nt = total number of tubers in same plot

The data was subjected to one-way analysis of variance (CPCF software developed by Punjab Agricultural University, Ludhiana, India). Data on grub population was transformed using square root transformation $\sqrt{(x+0.5)}$. Tuber damage data were transformed into angular values (arcsin $\sqrt{x}$), before conducting analysis of variance (ANOVA).

RESULTS AND DISCUSSION

The efficacy of various insecticide treatments on the basis of per cent tuber damage, number of grubs (m^{-2}) at harvest and tuber yield are given in Table 1 & 2. The 3rd instar grubs of *L. mansueta* and their infestation in potato tubers has been shown in Fig. 1 & 2. All the insecticide treatments proved significantly superior over untreated control with respect to tuber damage and tuber yield. The plots treated with fipronil 5 SC @ 150 g *a.i.* ha^{-1} had low tuber damage (5.24 and 4.57%, weight & number, respectively) but was at par with fipronil 5 SC @ 100 g *a.i.* ha^{-1} (5.91 and 5.09%), chlorpyriphos 20 EC @ 400 g *a.i.* ha^{-1} (5.55 and 6.2%) and quinalphos 25 EC @ 400 g *a.i.* ha^{-1} (6.14 and 6.72%) [Table 1]. Tuber damage in imidacloprid 200 SL @ 48 g *a.i.* ha^{-1}, clothianidin 50 WDG @ 160 and 80 g *a.i.* ha^{-1} and emamectin benzoate 5% SG @ 12 g *a.i.* ha^{-1} treated plots were 6.42 and 6.69, 7.06 and 7.00, 7.34 and 6.35 and 8.99 and 9.33%, respectively. The tuber damage (weight basis) in untreated control plots were 30.84 and 30.19%, respectively, in 2012 & 2013.

Considering the tuber damage on number basis, fipronil 5SC @ 150 g *a.i.* ha^{-1} had lowest tuber damage (4.20%) but was at par with the plots treated with chlorpyriphos 20 EC (5.25%) and quinalphos 25 EC (5.66%) in 2012 and chlorpyriphos 20 EC (5.18%), fipronil 5SC @ 100 g *a.i.* ha^{-1} (5.99%) and quinalphos 25 EC (6.43%) in 2013, but significantly superior over rest treatments (Table 1). Tuber damage in imidacloprid 200 SL, clothianidin 50 WDG @ 160 and 80 g *a.i.* ha^{-1} and emamectin benzoate 5% SG treated plots was 6.71 and 7.23, 8.20 and6.79, 7.85 and 7.66, 10.98 and 9.96% in 2012 and 2013, respectively. The untreated control

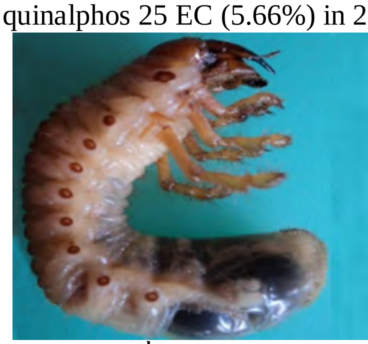

Fig. 1: 3rd instar grub (*L. mansueta*)

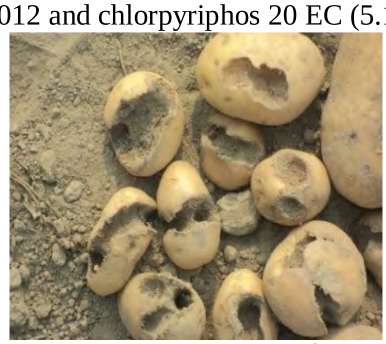

Fig. 2: *L. mansueta* infested potato tubers

Table 1: Tuber damage and grub population of *L. mansueta* affected by various groups of insecticides in potato during 2012 & 2013

Insecticides	Dose (g *a.i.* ha^{-1})	Tuber damage (%) On weight basis 2012	Tuber damage (%) On weight basis 2013	Tuber damage (%) On number basis 2012	Tuber damage (%) On number basis 2013	Grub population (m^{-2}) 2012	Grub population (m^{-2}) 2013
Quinalphos 25 EC	400	6.14 (14.35)	6.72 (14.68)	5.66 (15.03)	6.43 (14.68)	2.67	2.33
Chlorpyriphos 20 EC	400	5.55 (13.63)	6.20 (13.14)	5.25 (14.43)	5.18 (13.14)	1.67	1.00
Fipronil 5 SC	100	5.91 (14.07)	5.09 (14.16)	6.40 (13.05)	5.99 (14.16)	1.33	0.67
	150	5.24 (13.23)	4.57 (12.18)	4.20 (12.34)	4.52 (12.18)	1.00	0.33
Clothianidin 50 WDG	80	7.34 (15.73)	6.35 (16.05)	7.85 (14.61)	7.66 (16.05)	5.00	3.33
	160	7.06 (15.41)	7.00 (15.07)	8.20 (15.35)	6.79 (15.07)	4.00	4.33
Imidacloprid 200 SL	48	6.42 (14.69)	6.69 (15.58)	6.71 (15.00)	7.23 (15.58)	3.33	3.00
Emamectin benzoate 5 SG	12.5	8.99 (17.45)	933 (18.31)	10.98 (17.80)	9.96 (18.31)	3.67	2.67
Control		30.84 (33.73)	30.19 (33.71)	32.38 (33.34)	30.80 (33.71)	4.67	4.00
$CD_{0.05}$		1.09	0.86	1.95	2.68		
CV (%)		3.72	2.95	6.53	9.14		

*Data in parentheses are angular transformed values

Table 2: Tuber yield (q ha^{-1}) and cost benefit ratio under insecticidal treatments against *L. mansueta* in potato during 2012 & 2013

Insecticides	Dose (g *a.i.* ha^{-1})	Tuber yield (q ha^{-1}) 2012	Tuber yield (q ha^{-1}) 2013	Cost benefit ratio 2012	Cost benefit ratio 2013
Quinalphos 25 EC	400	82.67	76.40	2.23	1.85
Chlorpyriphos 20 EC	400	81.28	81.32	2.50	2.62
Fipronil 5 SC	100	80.33	80.87	1.22	0.96
	150	82.79	83.77	1.11	1.21
Clothianidin 50 WDG	80	78.87	78.78	1.37	1.43
	160	77.42	77.54	1.25	1.08
Imidacloprid 200 SL	48	77.72	78.45	1.21	1.29
Emamectin benzoate	12.5	71.13	72.21	0.25	0.37
Control		64.70	65.68	-	-
$CD_{0.05}$		5.70	5.46		
CV (%)		4.26	4.11		

plots showed 32.38 and 30.8% tuber damage on number basis in 2012 and 2013, respectively.

The mean population of grubs m^{-2} at harvest varied from 1.00 to 4.67 in 2012 and 2013 (Table 1). The tuber yield in all the insecticidal treatments, except emamectin benzoate 5% SG was at par (Table 2). Highest tuber yield was registered in fipronil 5 SC @ 150 g *a.i.* ha^{-1} treated plots (82.79 and 83.77 q ha^{-1}) in both the years. The tuber yield recorded in untreated control plots was 64.70 and 65.68 q ha^{-1} in 2012 and 2013, respectively. Highest benefit cost ratio was recorded in chlorpyriphos 20 EC treated plots (2.50 and 2.62) followed by quinalphos 25 EC (2.23 and 1.85).

The present study revealed that fipronil 5 SC @ 150 g *a.i.* ha^{-1} was best insecticide to reduce *L. mansueta* infestation in potato. However, the ill effects of fipronil to fish and aquatic invertebrates have been reported (Li *et al.*, 2010, Anon., 2012). Majuli is surrounded by river Brahmaputra and the island submerges in flood water almost every year. So, there is every possibility of contamination of water bodies if fipronil is used extensively for grub control. Hence, the use of chlorpyriphos and quinalphos could be better alternative to tackle the menace of this grub in potato field since both the insecticides were at par with fipronil. Almost similar results were obtained by Bhattacharyya *et al.* (2015), wherein they found fipronil as best insecticide to reduce *L. mansueta* infestation in colocasia, followed by chlorpyriphos and quinalphos. Effectiveness of chlorpyriphos and quinalphos in reducing the infestation of other species of white grubs in different crops have earlier been reported (Allsopp *et al.*, 1995, Sharma, 2004; Anjana and Bhagat, 2005; Zaki *et al.*, 2006).

Conclusion: The present study indicates that of the 6 insecticide treatments, fipronil 5 SC @ 150 g *a.i.* ha^{-1} registered a low incidence of *L. mansueta* grubs leading to a marked increase in tuber yield. The treatment was at par with chlorpyriphos and quinalphos treatments. In view of probable leaching properties of fipronil, proper analysis on residual toxicity on aquatic fauna and in ground water is desired. The cost benefit ratio of fipronil was much less than chlorpyriphos and quinalphos treatments. Therefore, chlorpyriphos and quinalphos can be explored as better alternative insecticides to fipronil in reducing the *L. mansueta* infestation in potato.

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