Pest Management in Horticultural Ecosystems
Vol. 29, No.1 pp 41-46 (2023)
DOI Number:10.5958/0974-4541.2023.00006.1

Evaluation of insecticides against foliage feeding beetles of potato

P. G. SATVIK[1], ARUNDHATI SASMAL[2*], ASHOK MISHRA[3] and ANJAN KUMAR NAYAK[1]

[1]Department of Entomology, College of Agriculture, [3]AICRP on Potato, OUAT, Bhubaneswar-751003, Odisha, India
[2*]Regional Research and Technology Transfer Station (RRTTS), Coastal zone, OUAT, Bhubaneswar

***E-mail**: sasmalarundhati@gmail.com

ABSTRACT: A field experiment was conducted to evaluate the efficacy of insecticides against foliage feeding beetles *viz., Henosepilachna vigintioctopunctata* F. and potato flea beetle, *Epitrix cucumeris* on potato (*Solanum tuberosum* L.) during *Rabi*, 2019-20 and 2020-21 at Odisha University of Agriculture and technology (OUAT), Bhubaneswar, India. The treatments consisted of azadirachtin 0.03% w/w@1500ml/ha, cypermethrin 25% EC @200ml/ha, fipronil 5% SC@1000ml/ha, spinosad 45% SC @187.5ml/ha, cartap hydrochloride 50% SP @1000g/ha, chlorpyriphos 20% EC @2000ml/ha and untreated control. The results revealed that, cartap hydrochloride 50% SP @1000g/ha was found to be most effective against epilachna beetle (0.7beetles/plant) and flea beetle (0.8beetles/plant) with 85.41% and 82.98% reduction over control and also recorded maximum potato tuber yield (14.1t/ha) with 48.42% yield improvement over untreated control.

Keywords: Potato, cartap hydrochloride, cypermethrin, fipronil, epilachna beetle, flea beetle

INTRODUCTION

Potato, *Solanum tuberosum* L. is one of the most widely cultivated food crops in the world. This can be attributed to the fact that it has a wide range of adaptability to both temperate and tropical climates. Potato is also one of the few crops which are grown even at an elevation of about 4000 m. In terms of human consumption, it comes in third place among the food crops behind rice and wheat. Insect pests affect potato productivity and tuber quality. More than 100 distinct types of arthropods attack potatoes over the world (Simpson, 1977). Of them, leaf beetle (The Epilachna beetle), *Henosepilachna vigintioctopunctata* F. and potato flea beetle, *Epitrix cucumeris*, are major defoliators. The pest management programme should incorporate different pest control measures such as cultural practices, bio agents, herbicides, insecticides, and resistant cultivars in order to keep the pest population below the economic threshold. It is difficult to totally ignore the role that insecticides play in pest management, even while we are prioritizing a variety of non chemical based means of pest control. New generation insecticide compounds in particular provide a variety of advantages, including great pest selectivity, outstanding efficacy at low rates or dosage, and less harm to the environment and natural enemies (Kodandaram *et al*., 2010). Therefore, it is a continuous and crucial activity to assess the effectiveness of new generation insecticides against insect pests of potatoes. In light of these considerations, a field experiment was carried out to assess how several pesticides of a new generation affected potato foliage-eating beetles.

MATERIALS AND METHODS

Field studies on the potato variety "Kufri Jyoti" were conducted during *Rabi*, 2019–20 and 2020–21 in a Randomized Block Design with three replications and seven treatments at Regional Research and Technology Transfer Station (RRTTS), Coastal zone, OUAT, Bhubaneswar, Odisha. Standard agronomic procedures were followed to plant at a seed rate of 20q/ha, with each plot measuring (3m x 2m) 6m^2. The healthy potato tubers were arranged in rows at a 60 cm row and 20 cm plant spacing. The insecticide treatments were applied to each replicated plot with a knapsack sprayer at 30 and 45 days after planting. The treatments were included azadirachtin 0.03% w/w@1500ml/ha, cypermethrin 25% EC @200ml/ha, fipronil 5% SC@1000ml/ha, spinosad 45% SC @187.5ml/ha, cartap hydrochloride 50% SP @1000g/ha, chlorpyriphos 20% EC @2000ml/ha and an untreated control. Five numbers of plants were selected randomly to draw an unbiased sample from the treatment plot. From each plant, total number of epilachna beetle and flea beetle were recorded. Average number of epilachna beetle and flea beetle per plant were calculated in each treatment plot. Observations were recorded prior to one day of first spray; three, seven and fourteen days after each spray.

For both the flea beetle and the epilachna beetle, the observations on mean leaf damage were recorded. The data were then transformed using the square root using the Gomez and Gomez's methods (1984). The

Table 1. The effect of insecticides on epilachna beetle population (*Rabi*, 2019-20, 2020-21 and pooled mean)

Treatment	Epilachna beetles (adults and grubs)/ plant																		Pooled Mean	Percent reduction over control
	Rabi, 2019-20									*Rabi*, 2020-21										
	First spray					Second spray				First spray					Second spray					
	1 DBS	3 DAS	7 DAS	14 DAS	Mean	3 DAS	7 DAS	14 DAS	Mean	1 DBS	3 DAS	7 DAS	14 DAS	Mean	3 DAS	7 DAS	14 DAS	Mean		
Azadirachtin 0.03% w/w@1500ml/ha	3.50 (2.13)	2.00 (1.73)	2.50 (1.89)	3.00 (2.00)	2.50 (1.88)	1.60 (1.62)	2.50 (1.87)	3.10 (2.04)	2.40 (1.85)	5.50 (2.55)	2.50 (1.88)	2.70 (1.94)	3.20 (2.06)	2.80 (1.96)	1.80 (1.69)	2.60 (1.92)	3.20 (2.06)	2.60 (1.90)	2.60 (1.90)	45.83
Cypermethrin 25% EC @200ml/ha	3.60 (2.16)	0.30 (1.14)	1.00 (1.41)	2.70 (1.94)	1.30 (1.54)	0.50 (1.21)	1.30 (1.54)	2.50 (1.88)	1.40 (1.57)	5.00 (2.46)	0.50 (1.25)	1.10 (1.46)	2.80 (1.96)	1.50 (1.58)	0.70 (1.32)	1.50 (1.59)	2.70 (1.93)	1.60 (1.63)	1.50 (1.58)	68.75
Fipronil 5% SC@1000ml/ha	3.80 (2.17)	1.80 (1.69)	1.60 (1.62)	2.00 (1.73)	1.80 (1.68)	1.50 (1.58)	1.30 (1.53)	1.70 (1.66)	1.50 (1.59)	5.20 (2.51)	1.90 (1.71)	1.80 (1.67)	2.10 (1.78)	1.90 (1.72)	1.60 (1.64)	1.50 (1.58)	1.80 (1.67)	1.60 (1.63)	1.70 (1.63)	64.58
Spinosad 45% SC @187.5ml/ha	3.70 (2.59)	1.00 (1.41)	1.20 (1.50)	1.80 (1.69)	1.30 (1.54)	1.10 (1.47)	1.00 (1.41)	2.00 (1.73)	1.30 (1.54)	5.30 (2.52)	1.10 (1.47)	1.40 (1.57)	2.00 (1.73)	1.50 (1.59)	1.30 (1.53)	1.20 (1.50)	2.10 (1.77)	1.50 (1.60)	1.40 (1.55)	70.83
Cartap hydrochloride 50% SP @1000g/ha	3.70 (2.64)	0.50 (1.24)	0.50 (1.24)	0.60 (1.29)	0.60 (1.26)	0.30 (1.15)	0.50 (1.25)	1.00 (1.41)	0.60 (1.28)	5.40 (2.54)	0.70 (1.32)	0.60 (1.27)	0.80 (1.36)	0.70 (1.31)	0.20 (1.11)	0.40 (1.18)	1.10 (1.46)	0.60 (1.25)	0.70 (1.28)	85.41
Chlorpyriphos 20% EC @2000ml/ha	3.80 (2.61)	1.30 (1.52)	1.80 (1.69)	2.60 (1.90)	1.90 (1.71)	1.00 (1.41)	1.50 (1.60)	2.20 (1.80)	1.60 (1.62)	5.10 (2.49)	1.50 (1.60)	1.70 (1.66)	2.70 (1.94)	2.00 (1.74)	1.10 (1.47)	1.80 (1.68)	2.40 (1.86)	1.80 (1.68)	1.90 (1.69)	60.41
Control (Untreated check)	3.70 (2.63)	3.80 (2.20)	3.90 (2.22)	4.00 (2.24)	3.90 (2.22)	3.80 (2.20)	3.70 (2.17)	3.50 (2.13)	3.60 (2.17)	5.20 (2.50)	5.80 (2.62)	5.70 (2.60)	5.30 (2.52)	5.60 (2.58)	5.90 (2.63)	5.90 (2.63)	5.70 (2.59)	5.80 (2.62)	4.80 (2.39)	
SE(m)±	0.022	0.068	0.032	0.029	0.033	0.063	0.029	0.019	0.029	0.032	0.028	0.028	0.025	0.020	0.035	0.044	0.019	0.055	0.047	
C.D (p=0.05)	NS	0.21	0.10	0.09	0.10	0.20	0.09	0.06	0.09	NS	0.09	0.09	0.08	0.06	0.11	0.14	0.06	0.17	0.10	

DAS: days after spraying DBS: Days Before Spraying NS: Non significant; Figures in the parentheses are √(x+1) transformed values of original data

statistical analysis was done using OPSTAT, online Agriculture Data Analysis Tool created by O.P. Sheoran, Computer Programmer at CCS HAU, Hisar, India (http://14.139.232.166/opstat/index.asp). Treatment means were compared using critical difference (CD). Pooled mean analysis was done taking data of both the seasons.

RESULTS AND DISCUSSION

Epilachna beetle

The pre-spray epilachna beetle population during *rabi*, 2019–20 ranged between 3.50–3.80 beetles/plant. After the first foliar application of insecticides (Table I), the plots treated with Cartap hydrochloride 50% SP @1000g/ha had the lowest mean population of epilachna beetles, (0.6 beetle/plant) followed by Cypermethrin 25% EC @200ml/ha and Spinosad 45% SC @187.5ml/ ha, which had a mean population of 1.3 beetles/plant and were statistically at par with each other. Fipronil 5% SC@1000ml/ha and Chlorpyriphos 20% EC @2000ml/ ha had mean populations of 1.8 and 1.9 beetles/plant respectively, being statistically superior to the untreated check. The plots treated with azadirachtin 0.03% w/w@1500ml/ha recorded the highest epilachna beetle population (2.5 beetles/plant). All treatments showed superiority over untreated control where 3.9 beetles/ plant was noted. After the second foliar spray, same trend of effectiveness was noticed where cartap hydrochloride 50% SP @1000g/ha recorded the lowest mean epilachna beetle population. The plots treated with Spinosad 45% SC at 187.5 ml/ha, cypermethrin 25% EC at 200 ml/ha, Fipronil 5% SC at 1000 ml/ha, and Chlorpyriphos 20% EC were equally effective where 1.30, 1.40, 1.50, and 1.60 beetles/plant were recorded. Azadirachtin 0.03% w/w@1500ml/ha (2.4beetles/plant) showed superiority over untreated control (3.6 beetles/plant).

During the second season *Rabi*, 2020–21, the pre-spray epilachna beetle population ranged from 5.00 to 5.50 beetles per plant. The plot treated with cartap hydrochloride 50% SP @1000g/ha with a mean population of 0.7 beetle/plant had the lowest mean population of epilachna beetles after the first foliar application of insecticides (Table I). The crop treated with cypermethrin 25% EC @200ml/ha and spinosad 45% SC @187.5ml/ha recorded same level of infestation (1.5 beetles/plant). Fipronil 5% SC@1000ml/ ha treated crop had 1.9 beetles/plant statistically equivalent in effectiveness with chlorpyriphos 20% EC @2000ml/ha (2 beetles/plant). In this season also, plants treated with azadirachtin 0.03% w/w@1500ml/ha harbored highest epilachna beetle population (2.8 beetles/plant) among the treated plots. All treatments showed superiority over untreated control where on an average 5.6 beetles/ plant was found. After the second foliar application, the treatment with cartap hydrochloride 50% SP @1000g/ ha performed better with the lowest mean population (0.6 beetle/ plant). Spinosad 45% SC @187.5ml/ha (1.50 beetles/ plant). Cypermethrin 25% EC @200ml/ha (1.60 beetles/ plant), Fipronil 5% SC@1000ml/ha (1.60 beetles/ plant), and chlorpyriphos 20% EC @2000ml/ha (1.80 beetles/ plant) were statistically similar in efficacy against epilachna beetle infestation. All treatments were superior over untreated control (5.80 beetles/ plant).

When the pooled mean of two seasons is considered (Table I), cartap hydrochloride 50% SP was found to be most effective where lowest mean population (0.7beetle/ plant) was recorded. 85.41% reduction in epilachna beetle population over control was caused in this treatment (Fig. 1). Spinosad 45% SC, cypermethrin 25% EC and Fipronil 5% SC were statistically at par in effectiveness harbored 1.40, 1.50 and 1.70 beetles/ plant causing 70.83%, 68.75% and 64.58% reduction over untreated control. Azadirachtin 0.03% harbored highest epilachna beetle population among the treated plots with 45.83% reduction over control. However, all treatments showed their superiority over untreated control significantly. The present findings about the efficacy of cartap hydrochloride50% SP against epilachna beetle is corroborated with Ghosh and Chakraborty (2012) and Das (2016). Bala *et al*. (2016) came to the conclusion that cypermethrin 25 EC @ 0.4 kg a.i/ha was the most effective treatment against epilachna beetle. Birju *et al*. (2020) tested the efficacy of newer insecticides against epilachna beetle on spine gourd and revealed that spinosad 45 SC was the second-best insecticide amongst the pesticides tested. All the above findings of different scientists are in line with the present findings.

Flea beetle

The flea beetle population prior to the commencement of spray during *Rabi*, 2019–20 varied from 4.80 to 5.40 beetles per plant (Table 2). Against flea beetle, cartap hydrochloride 50% SP @1000g/ha showed maximum efficacy, with lowest mean population (1.10 beetles/plant) followed by spinosad 45% SC @187.5ml/ha(1.60beetles/ plant). Cypermethrin 25% EC @200ml/ha and fipronil 5% SC @1000ml/ha were statistically at par with each other, with mean populations of 2.00beetles/ plant and were superior to the untreated check. Azadirachtin 0.03% w/w@1500ml/ha harbored highest flea beetle population among the treated plots with a mean population of 3.10 beetles/ plant. All treatments showed superiority over untreated control (5.00 beetles/ plant). After the second foliar application, both spinosad 45% SC @187.5ml/

Table 2. The effect of insecticides on flea beetle population (*Rabi*, 2019-20, 2020-21 and pooled mean)

Treatment	Flea beetles (adults and grubs)/ plant																			Pooled Mean	Percent reduction over control
	Rabi, 2019-20									*Rabi*, 2020-21											
	First spray					Second spray				First spray					Second spray						
	1 DBS	3 DAS	7 DAS	14 DAS	Mean	3 DAS	7 DAS	14 DAS	Mean	1 DBS	3 DAS	7 DAS	14 DAS	Mean	3 DAS	7 DAS	14 DAS	Mean		
Azadirachtin 0.03% w/w@1500ml/ha	5.20 (2.49)	1.40 (1.55)	3.00 (2.00)	5.00 (2.55)	3.10 (2.02)	1.00 (1.41)	2.80 (1.95)	3.60 (2.14)	2.50 (1.87)	3.60 (2.14)	3.20 (2.05)	3.20 (2.05)	5.20 (2.49)	3.40 (2.10)	1.60 (1.61)	3.00 (2.00)	4.00 (2.24)	2.90 (1.97)	3.0 (2.00)	36.17
Cypermethrin 25% EC @200ml/ha	5.00 (2.45)	0.00 (1.00)	2.20 (1.79)	3.80 (2.19)	2.00 (1.73)	0.00 (1.00)	2.00 (1.73)	3.00 (2.00)	1.70 (1.64)	4.00 (2.23)	2.00 (1.73)	2.00 (1.73)	4.20 (2.28)	2.30 (1.82)	0.00 (1.00)	2.40 (1.84)	2.80 (1.95)	1.70 (1.64)	2.0 (1.72)	57.45
Fipronil 5% SC@1000ml/ha	4.80 (2.41)	0.80 (1.34)	2.00 (1.73)	3.20 (2.05)	2.00 (1.73)	0.60 (1.26)	1.40 (1.55)	2.80 (1.95)	1.60 (1.61)	3.80 (2.19)	1.60 (1.61)	1.60 (1.61)	2.80 (1.95)	1.80 (1.67)	0.80 (1.34)	1.80 (1.67)	3.00 (2.00)	1.90 (1.70)	1.9 (1.69)	59.57
Spinosad 45%SC@187.5ml/ ha	5.00 (2.45)	0.60 (1.26)	1.40 (1.55)	2.80 (1.95)	1.60 (1.61)	0.20 (1.09)	0.80 (1.34)	2.20 (1.79)	1.10 (1.45)	4.20 (2.28)	1.00 (1.41)	1.00 (1.41)	2.20 (1.79)	1.30 (1.51)	0.00 (1.00)	1.20 (1.48)	2.60 (1.90)	1.30 (1.52)	1.40 (1.53)	70.12
Cartap hydrochloride 50%SP@1000g/ha	5.40 (2.53)	0.00 (1.00)	1.40 (1.55)	2.00 (1.73)	1.10 (1.45)	0.00 (1.00)	0.40 (1.18)	1.80 (1.67)	0.70 (1.30)	3.80 (2.19)	0.60 (1.26)	0.60 (1.26)	1.60 (1.61)	0.70 (1.30)	0.00 (1.00)	0.80 (1.34)	1.20 (1.48)	0.70 (1.30)	0.8 1.34)	82.98
Chlorpyriphos 20% EC @2000ml/ha	5.20 (2.49)	0.40 (1.18)	3.00 (2.00)	4.00 (2.24)	2.50 (1.87)	0.00 (1.00)	2.00 (1.73)	3.20 (2.05)	1.70 (1.64)	4.00 (2.23)	2.60 (1.90)	2.60 (1.90)	4.60 (2.37)	2.60 (1.90)	0.00 (1.00)	2.40 (1.84)	3.00 (2.00)	1.80 (1.67)	2.2 (1.77)	53.19
Control (Untreated check)	4.80 (2.41)	5.00 (2.45)	4.60 (2.36)	5.40 (2.53)	5.00 (2.45)	5.20 (2.45)	4.80 (2.41)	4.60 (2.37)	4.90 (2.43)	4.20 (2.28)	4.00 (2.24)	4.00 (2.24)	4.80 (2.41)	4.50 (2.35)	5.00 (2.45)	4.20 (2.28)	4.00 (2.24)	4.40 (2.32)	4.7 2.39)	
SE(m)±	0.038	0.047	0.041	0.035	0.047	0.048	0.058	0.044	0.048	0.049	0.064	0.057	0.041	0.037	0.024	0.044	0.039	0.059	0.055	
C.D (p=0.05)	NS	0.15	0.13	0.11	0.15	0.15	0.18	0.14	0.15	NS	0.2	0.18	0.13	0.11	0.08	0.14	0.12	0.18	0.11	

DAS: days after spraying DBS: Days Before Spraying NS: Non significant; Figures in the parentheses are √(x+1) transformed values of original data

Table 3. The effect of insecticides on potato tuber yield (*Rabi*, 2019-20, 2020-21and pooled mean)

Treatment details	Potato tuber yield (t/ha)			yield increase over control (%)	B: C Ratio
	Rabi, 2019-20	*Rabi*, 2020-21	Pooled Mean		
Azadirachtin 0.03% w/w@1500ml/ha	9.5	11.0	10.2	7.36	2.21
Cypermethrin 25% EC @200ml/ha	10.5	12.1	11.3	18.94	2.48
Fipronil 5% SC@1000ml/ha	11	12.6	11.8	24.21	2.35
Spinosad 45% SC @187.5ml/ha	11.8	13.5	12.6	32.63	2.98
Cartap hydrochloride 50% SP @1000g/ha	13.2	15.0	14.1	48.42	3.03
Chlorpyriphos 20% EC @2000ml/ha	10.2	11.6	10.9	14.73	2.35
Control (Untreated check)	8.9	10.2	9.5		2.11
SE (m)±	0.27	0.073	0.14		
C.D (p=0.05)	0.8	0.2	0.4		

ha and cartap hydrochloride 50% SP @1000g/ha were at par where 1.10 and 0.70 beetles/plant were recorded, respectively. The treated plots with fipronil 5% SC@1000ml/ha, cypermethrin 25% EC @200ml/ha, and chlorpyriphos 20% EC@2000ml/ha were statistically equal in efficacy against the flea beetle and harbored 1.60, 1.70, and 1.70 beetles/plant respectively. With a mean population of 2.50 beetles/ plant, azadirachtin 0.03% w/w@1500ml/ha was significantly superior to the untreated control (4.90 beetles/plant).

During *rabi*, 2020-21, the pre spray population of flea beetle ranged between 3.60-4.20 beetles/ plant (Table 2). After the first foliar application of insecticides, the lowest mean population of flea beetle was observed in plot treated with cartap hydrochloride 50% SP @1000g/ ha with a mean population of 0.70 beetle/ plant, followed by spinosad 45% SC @187.5ml/ha with mean population of 1.30 beetles/ plant and fipronil 5% SC@1000ml/ ha with mean population of 1.80 beetles/ plant. This is followed by cypermethrin 25% EC @200ml/ha (2.30 beetles/ plant) and chlorpyriphos 20% EC @2000ml/ha (2.60 beetles/ plant). Azadirachtin 0.03% w/w@1500ml/ ha harbored highest flea beetle population among the treated plots with a mean population of 3.40 beetles/ plant. All treatments showed superiority over untreated control (4.5 beetles/ plant). The treatment with cartap hydrochloride 50% SP @1000g/ha showed the lowest mean flea beetle population of 0.70 beetle/plant after the second foliar spray. Second best performer was Spinosad 45% SC at 187.5 ml/ha (1.30 beetles/plant) followed by cypermethrin 25% EC (1.70 beetles/plant), chlorpyriphos 20% EC at 2000 ml/ha (1.8 beetles/ plant) and Fipronil 5% SC (1.90 beetles/plant). The Azadirachtin 0.03% w/w could not compete with the chemical insecticide treatment, where highest flea beetle population (2.90 beetles/plant)was noticed and the untreated control, had 4.40 beetles/plant.

The pooled mean of two seasons data (Table 2) indicated the superiority of cartap hydrochloride 50% SP in flea beetle management where least population (0.80 beetle/plant) was recorded causing 82.98% reduction over control. Spinosad 45% SC @187.5ml/ha had a mean population of 1.40 beetles/ plant showed 70.12% reduction. Fipronil 5% SC (1.90 beetles/ plant) was the third best treatment where 59.57% population reduction was recorded. All treatments were superior to untreated control. Azadirachtin 0.03% w/w harbored highest flea beetle population among the treated plots (3.00 beetles/ plant).

The results of the current field study are comparable to those of the study conducted by Mahato (2017), who found that cartap hydrochloride 50% SP @ 375 g a.i./ ha was superior in suppressing flea beetle populations during both seasons of the study and exerted a reduction of 72.25 and 83.83% compared to control. In a field experiment, Mahato and Mishra (2019) assessed the bio-efficacy of eight insecticides against the flea beetle, which infested cucumbers (*Cucumis sativus* L). They discovered that spinosad 45 SC and cartap hydrochloride 50% SP recorded the lowest populations of flea beetle adults/5 leaves. According to a field trial conducted by Shanmuga *et al*. (2019), fipronil was the best chemical for controlling flea beetles since it resulted in an 81.6–87.1% decrease in flea beetle population. The results of the present experiment are consistent with those of the experiments conducted by the aforementioned scientists.

The pooled mean of marketable potato yield of the season 2019-20 and 2020-21 was highest (14.1t/ha) in the treatment cartap hydrochloride 50% SP @1000g/ha with 48.42% increase in yield over untreated control (Table 3). The second highest yield (12.6 t/ha) was obtained from the plots treated with spinosad 45% SC @187.5ml/ ha with 32.63% increase in yield over untreated control followed by Fipronil 5% SC@1000ml/ha (11.8t/ha0 with 24.21% increase in yield over untreated control. The treatment cartap hydrochloride 50% SP @1000g/ha gave the highest monetary benefit resulting in BC ratio of 3.03 followed by Spinosad (2.98) and cypermethrin (2.48). The results of the present experiment are in line with the findings of Deshmukh and Bhamare (2006), Reddy (2015) and Bala (2016) who found these chemicals to be effective against leaf feeding insects and resulted in higher BC ratios. The results indicated that foliar application of cartap hydrochloride 50% SP @1000g/ha at 30 and 45 days after planting was the most effective treatment against foliage feeding epilachna beetle and flea beetle in potato under Odisha conditions.

REFERENCES

Bala, S., Sarkar, A. and Debnath, P. 2016. Efficacy of some insecticides against Epilachna beetle, *Epilachna vigintioctopunctata* and jassid, *Amrasca biguttula biguttula* on brinjal in new alluvial zone of West Bengal. *International Journal of Agricultural Science and Research,* **6** (5): 33-38.

Birju., Painkra, K. L., Bhagat, P. K., Painkra, G. P. and Tiwari, J. K. 2020. Efficacy of newer insecticides againsthaddabeetle(*Epilachnavigintioctopunctata* Fab.) in spine gourd (*Momordica dioica* Roxb.). *Journal of Entomology and Zoology Studies,* **8** (5): 1929-1933.

Deshmukh, R. M. and Bhamare, V. K. 2006. Field evaluation of some insecticides against brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. *International Journal of Agricultural Sciences,* **2** (1): 247-249.

Ghosh, S. K. and Chakraborty, G. 2012. Integrated field management of *Henosepilachna vigintioctopunctata* (Fabr.) on potato using botanical and microbial pesticides. *Journal of Biopesticides,* **5** (suppl.): 151-154.

Kodandaram, M. H., Rai, A. B. and Halder, J. 2010. Novel insecticides for management of insect pests in vegetable crops Review. *Vegetable Science,* **37**: 109-123.

Konar, A. and Mahasin, M. 2002. Incidence of epilachna beetle at different locations of West Bengal. *Journal of the Indian Potato Assoc*iation, **29** (1-2): 95-97.

Mahato, S. 2017. Evaluation of Newer Insecticides on Pest Complex of Cucumber. **In:** M.Sc. (Ag) thesis, College of Agriculture, OUAT, Bhubaneswar, 88.

Mahato, S. and Misra, H. P. 2019. Efficacy of different insecticides against flea beetle, *Podagria* Sp. (Coleoptera: Chrysomelidae) on cucumber (*Cucumis sativus* L). *Journal of Applied Zoological Researches,* **30** (2): 180-184.

OPSTAT, Online Agriculture Data Analysis Tool created by O.P. Sheoran, Computer Programmer at CCS HAU, Hisar, India (http://14.139.232.166/opstat/ index.asp)

Reddy, M. S. Sai. 2015. Seasonal incidence and chemical management of diamondback moth (*Plutellaxylostella* L.) and tobacco caterpillar (*Spodoptera litura* F.) on cabbage. **In:** M. Sc. (Ag.) Thesis, Entomology and Agricultural Zoology. Institute of Agricultural Sciences, Banaras Hindu University.

Shanmuga, P. M., Sridharan, S., Kuttalam, S. and Indhumati, V. S. 2019. Efficacy of novel phenyl pyrazole insecticide fipronil 80WG on flea beetle, *Scelodonta strigicollis* (Motschulsky) in grapes. *International Journal of Chemical Studies,* **7** (6): 2594-2602.

Simpson, G. W. 1977. Potato insects and their control, **In:** Potatoes, Production, Storage and Processing (O. Smith ed.), AVI publishing Co., Westport, Connecticut, USA, 550-605.

MS Received: 03 February 2023
MS Accepted: 09 April 2023