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S Panda
Department of Entomology, College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

Raghunandan H
Department of Entomology, College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

Corresponding Author:
S Panda
Department of Entomology, College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India

Silicon alleviates resurgence inducing tendency of insecticide against white backed planthopper, *Sogatella furcifera* (Horvath) in rice

S Panda and Raghunandan H

Abstract
Field testing of insecticides like dinotefuran 20 SG, buprofezin 25 SL, their combination (Dinotefuran and buprofezin) 58 WDG and acephate 75 SP sprayed at 30 and 50 days after transplanting at recommended doses either alone or in combination with basal soil application of a silicate fertilizer, diatomaceous earth (DAE) at 300 kg/ha proved their additive effects on *Sogatella furcifera* population and rice grain yield. Acephate sprays resulted in resurgence of hopper with 128% increase in population over control, which was effectively contained by combined use of DAE resulting in 58.0% decline in hopper and 43.8% increase in grain yield.

Keywords: Silicon, *S. furcifera*, resurgence, rice

Introduction

Insect pests are major biological constraints that limit rice crop production throughout the world (Panda and Kush, 1995) [1] amongst which, the xylem and phloem sap feeders are the important ones. White backed planthopper (WBPH), *Sogatella furcifera* (Horvath), is one such serious and economically important sucking pest of rice (Xiao & Tang, 2007; Normile, 2008) [2, 3]. In Asian countries, farmers prefer to go for blanket application of insecticides against this key pest, which eventually disrupt the ecological balance of rice ecosystem (Gorman *et al.*, 2008) [4] resulting in insecticide resistance, resurgence and secondary pest outbreak. Complete devastation to local rice by sucking pests due to insecticide resistance has been reported by Liu *et al.* (2010) [5].

In order to get rid of such problems, farmers are advised to adopt eco-friendly approaches such as use of safer molecules and non-chemical means of pest management. Dinotefuran, a new molecule belonging to third generation neo-neonicotinoid group and buprofezin, a chitin inhibitor are used as selective insecticides for controlling the plant hoppers in rice (Hegde and Nidagundi, 2009) [6]. Dinotefuran 20 SG was found quite effective against BPH at 25 g a.i./ha and was also very safe to the important predators recorded to be present in rice field (Ghosh *et al*., 2014) [7].

Now-a-days, combination product of these molecules is available in the market, which is expected to delay the process of developing resistance because of combined action of two different mode of action. Silicon on the other hand is a beneficial element and reported to have a role in inducing resistance against insect pests in rice (Panda *et al*, 1975) [8]. As such silicon uptake is beneficial in overcoming various biotic stresses leading to increased crop productivity (Jawahar *et al*., 2015) [9]. The present study was undertaken with the hypothesis that combined use of insecticide and silicon can effectively arrest hopper population growth and increase rice productivity in endemic pockets.

Materials and Methods

A replicated field trial was conducted in the Central Farm of Odisha University of Agriculture and Technology during *Kharif* 2017 to determine the effects of insecticides alone and in combination with silicon in tackling the hopper problem in rice. Twenty- five- day old seedlings (var. Swarna) was planted at the rate of two seedlings per hill in 20 m^2 sub plots at 15 cm x 20 cm spacing and crop was raised following local recommended practices. The treatments comprising insecticides like dinotefuran 20 SG, buprofezin 25 SL, their combination (dinotefuran and buprofezin) 58 WDG and acephate 75 SP sprayed alone and in combination with diatomaceous earth (DAE), an organic source of silicon containing 63.7%.

SiO2. This beneficial element was supplemented through soil broadcast of DAE just before transplanting, whereas prophylactic application of insecticides was done using a high volume knapsack sprayer at 30 and 50 days after transplanting (DAT). Performance of each treatment was compared with that of DAE alone and an untreated control. Due care was taken to avoid inter plot mixing effect by separating each plot with bunds and channels. To know the impact of treatments, WBPH population buildup were recorded through visual count of nymphs and adults at one day before 3, 7, 14 and 21 days after second spraying (DAS) from ten randomly selected hills and plot wise grain yield was recorded leaving two border rows from all sides.

Result and Discussion

Immigrating population of WBPH appeared at late vegetative stage of the crop and started slowly building up attaining its peak at about 70 days after transplanting (DAT). Impact of exogenous basal application of silicon and prophylactic sprays of insecticides could be observed only at panicle initiation stage, which provided favorable environment for hopper build up. Treatment variations were significant at 3 and 7 days after second spraying (DAS) with a distinctly lower population in plots receiving both DAE and insecticides. The variation became more conspicuous at 14 DAS with graded level of efficacy of various treatments (Table 1). Unlike other molecules which were highly effective against the WBPH (with 2.20 to 7.37 /hill), acephate resulted in a flared-up population of 52.7 hoppers/hill as against 12.8 /hill in control exhibiting the hopper resurgence inducing ability of this molecule resulting in 127.78% population growth over control. However, in combination with DAE this molecule effectively contained the population and restricted to 8.75 /hill exhibiting the utility of silicon application in rice. This change explains positive interaction of silicon with insecticide in successfully altering the toxicity of acephate inhibiting its resurgence inducing tendency against WBPH in rice. At the peak activity (21 DAS) of WBPH, there was a marked increase in hopper population in all the insecticide treated plots with a record of 14.47 to 62.00 hoppers/hill, highest being in acephate treatment confirming the hopper inducing ability of acephate molecule. However, the hopper build up could effectively be contained when combined with basal application of silicon. All the insecticides except the combination product showed an additive effect with DAE registering 8.2-17.7 hoppers/hill as against 25.53 hoppers /hill in control. This beneficial effect of silicon was more pronounced when combined with acephate sprays preventing resurgence of *S. furcifera*, The lowest population of 8.2 and 8.73 /hill were recorded in plots receiving dinotefuran and acephate along with DAE and remained on par with that of DAE alone (11.4/hill). From the mean data the utility of combined action of silicon and insecticide is well established with a record of distinctly lower hoppers 3.23-6.75 /hill as against 4.17.-23.37 /hill in plots receiving insecticides alone. Silicon application alone contributed to 59.97% decline in hopper population over control. Amongst the test insecticides, dinotefuran 20 SG was proved the most efficacious insecticide when used alone or in combination with DAE with a record of 59.35 and 68.51%.

Table 1: Combined effect of insecticides and silicon on population build-up of *S. furcifera* during *Kharif* 2017

Treatments		Dose/ha	Population of *S. furcifera* (Numbers /hill)							Grain yield (q/ha)	% increase over control
			1 DBS	3 DAS	7 DAS	14 DAS	21 DAS	Mean	% Change		
T1	(Dinotefuran + Buprofezin) 58 WDG	320 g	1.10 (1.23)	1.70 (1.48)	2.37 (1.68)	5.30 (2.40)	27.87 (5.32)	7.26	(-) 29.24	39.00	27.74
T2	Buprofezin 25 SC	800 ml	1.20 (1.01)	0.47 (0.97)	1.57 (1.44)	5.30 (2.40)	21.73 (4.70)	6.91	(-)32.65	36.60	19.88
T3	Dinotefuran 20 SG	200 g	1.20 (1.28)	1.23 (1.31)	2.05 (1.58)	4.37(2.20)	14.47 (4.45)	4.17	(-) 59.35	40.10	31.35
T4	Acephate 75 SP	667g	0.97 (1.20)	3.97 (1.88)	2.37 (1.69)	52.70 (7.29)	62.00 (7.90)	23.37	(+) 127.78	33.63	10.15
T5	(Dinotefuron + Buprofezin) 58 WDG + DAE	320 g + 300 kg	1.47 (1.38)	0.20 (2.16)	0.60 (1.02)	5.27 (2.40)	25.33 (5.07)	6.75	(-) 34.21	42.10	37.90
T6	Dinotefuran 20 SG + DAE	200 g + 300 kg	2.27 (1.64)	1.73 1.46)	1.20 (1.30)	7.37 (2.79)	8.73 (3.01)	3.78	(-) 63.15	45.00	47.40
T7	Buprofezin 25 SC + DAE	800 ml + 300 kg	0.80 (1.14)	0.16 (0.81)	1.50 (1.40)	2.20 (1.63)	17.17 (4.19)	4.51	(-) 56.04	36.83	20.64
T8	Acephate 75 SP + DAE	667 g + 300 kg	1.13 (1.24)	0.13 (0.79)	0.40 (0.92)	8.75 (3.02)	8.20 (2.94)	4.30	(-) 58.09	43.90	43.79
T9	Diatomaceous earth (DAE)	300 kg	0.63 (1.02)	1.53 (1.40)	0.87 (1.17)	4.47 (2.21)	11.40 (3.43)	4.62	(-) 59.97	38.33	25.55
T10	Untreated check	-	1.23 (1.32)	4.20 (2.16)	7.53 (2.80)	12.80 (3.64)	25.53 (5.08)	10.26	-	30.53	-
	S. E. (m) ±		0.160	0.220	0.110	0.190	0.260	-	-	1.232	
	C.D. $_{0.05}$		NS	0.64	0.31	0.55	0.76	-	-	3.66	

Figures in parentheses are the √(x + 0.5) transformed values. DBS - Days before spraying, DAS- Days after spraying

Reduction over control respectively. Earlier reports suggest that buprofezin and dinotefuran are effective against plant hoppers with low risks to environment including human beings (Krishnaiah *et al.*, 1996) [10] and predators (Ghosh *et al.*, 2014) [7]. Acephate harboring 128% higher hopper population over control has altered its efficacy when combined with silicon supplements and brought down hopper population by 58% signifying the importance of Si supplements in rice. This may be because of the fact that plants with higher silicon content in their tissues had a higher level of resistance to rice pests (Savant *et al.*, 1997) [11]. According to Panda *et al.* (1975) [8] the sap feeder brown plant hopper unable to attack rice plants because of high silicon content in the stem, which support the present finding.

Combined action of silicon and insecticides not only contained the hoppers effectively but also increased the grain yield markedly. Dinotefuran as such alone or in combination with DAE was the highest yielder with a record of 42-45 q/ha resulting in a maximum of 47% increase in yield followed by combination of acephate and DAE with a record of 43.79% increase. However, statistically both remained on par with each other.

From the overall observations, it may be concluded that the silicon application in rice not only restricted the WBPH population build up but effectively suppressed the resurgence inducing ability of the insecticide highlighting the role of this functional element in population management of *S. furcifera* and increasing the grain yield. Based on the present findings the silicate fertilizer, DAE should be recommended to farmers for use in rice field at the rate of 300 kg/ha for containing hopper population and increasing the grain yield particularly in endemic pockets, which may be considered as an eco-holistic approach for effective integration into the pest management system in rice.

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