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Development of efficient integrated management package against sweet potato weevil (*Cylas formicarius* [Fabricius, 1798])

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Abstract: The sweet potato weevil (*Cylas formicarius*, 1798) is one of the most damaging sweet potato pests. To prevent an economic crop loss, it is very important to develop a suitable and efficient integrated pest management strategy. A field experiment was set up with three replications at Jamalpur to select the best integrated management package from eight different treatments against sweet potato weevil. The results showed that the lowest percentage of infestation by number (2.94 %) and mass (3.22 %) was found when the crop was planted on November 01; earthing-up for two times, Carbofuran 5G was sprayed @ 15 kg ha^{-1} at 60 days after planting with irrigation and tuber was harvested at 130 days after planting. The marketable yield (23.75 kg) and percent increase of yield than control (50.86 %) performed the highest in the same combination. These findings suggested an effective integration of different management strategies to reduce sweet potato weevil infestation in Bangladesh successfully.

Key words: sweet potato; sweet potato weevil; integrated management; marketable tuber yield

Razvoj učinkovitega integriranega načina zatiranja hrošča *Cylas formicarius* (Fabricius, 1798) na sladkem krompirju

Izvleček: Hrošč *Cylas formicarius* (Fabricius, 1798) je najpomembnejši škodljivec sladkega krompirja. Za preprečitev izpada pridelka je potrebno razviti ustrezen in učinkovit način integriranega zatiranja škodljivca. V ta namen je bil v Jamalpurju izveden poljski poskus s tremi ponovitvami za izbor najustreznejšega načina integriranega zatiranja škodljivca med osmimi obravnavanji. Rezultati so pokazali, da je bil najmanjši odstotek napada, tako v številčnosti škodljivca (2,94 %) kot v masi pridelka (3,22 %) ugotovljen v obravnavanju, ko je bil sladki krompir posajen prvega novembra in dvakrat osipan, poškropljen s karbofuranom 5G 15 kg ha^{-1} 60 dni po saditvi, z namakanjem in spravilom gomoljev 130 dni po saditvi. Tržni pridelek (23,75 kg) in odstotek povečanja pridelka v primerjavi s kontrolo (50,86 %) sta bila največja v istem obravnavanju. Te ugotovitve nakazujejo učinkovito vključevanje različnih načinov zatiranja za učinkovito zmanjšanje napada sladkega krompirja od hrošča *Cylas formicarius* v Bangladešu.

Ključne besede: sladki krompir; škodljivec sladkega krompirja; integrirano varstvo; tržni pridelek gomoljev

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1 INTRODUCTION

The sweet potato (*Ipomoea batatas* (L.) Lam.) has an important role in transforming the nutrition and food security for developing countries significantly in recent years (Korada et al., 2010). The scientific information developed in the sweet potato research has enabled the growers to boost productivity and quality. There are some fundamental needs facing farmers in all major sweet potato producing countries, but there are other significant needs specific to certain regions. The sweet potato weevil (SPW) (*Cylas formicarius* [Fabricius, 1798]) has become widely dispersed, mainly in tropical and subtropical areas of the world (Hue and Low, 2015), and it recently has been found in higher latitude areas as well. It is the most severe pest of sweet potato in Bangladesh. It causes damage both in the field and in storage. The larvae mine the sweet potato tuber and damage the inside tissue. The tuber becomes spongy in appearance, riddled with cavities, and dark in color (Uritaini et al., 1975; Kyereko et at., 2019). The sweet potato larvae make a tunnel inside the root tissue, which is the primary cause of inviting several soil-borne pathogens. Once these pathogens enter the tuber, they become responsible for causing further damage like secondary infection by different pathogenic bacteria and fungi (Onwueme and Charles, 1994). Besides, the sweet potato weevil larvae have an ability to cause damage to the vascular system of the plant. As a result, the number and size of tuber roots those are stored for the future become drastically reduced (Hue and Low, 2015). Sweet potato weevil is causing about 50 to 100 % yield loss in the field (Sorensen, 2009).

It is challenging to deal with sweet potato weevils when they are already in the crop. Cultural practices have proven to be effective control against the sweet potato weevil, but insecticide applications remain the primary basis of control (Muruvanda et al., 1986; Sutherland, 1986). Management of this pest through the shifting of the planting dates could be one of the best ways. The weevil population reaches a peak at the beginning of the dry season because of the high temperature and rainfall (Ladanyi and Hufnagel, 2006; Gomi et al., 2007). So, if it may be possible to harvest two weeks earlier, it may reduce the yield loss. Another way of reducing the sweet potato weevil infestation is to hail-up of soil by re-ridging around the plant-base to fill soil cracks (Beyene, 2015). Pheromone traps are usually used as monitoring, training, and management tools. Many effective traps have been designed by farmers using locally available materials. Different traps are so delicate that they fail to catch weevils make misleading information that the pest is not present (Beyene, 2015). Many insecticides control sweet potato weevil as a foliar spray or basal granular applications. The only chemical method cannot solve the weevil infestation, but good husbandry can control them by preventing spreading. So, management of this pest by using a suitable integrated management strategy is important to save the environment. Yet, no effective integrated management practice against sweet potato weevil has so far been developed or recommended. Therefore, we designed the present study to select the best integrated management package against sweet potato weevil for higher yield.

2 MATERIALS AND METHODS

The study was conducted during the winter season of 2015 at Regional Agricultural Research Station, BARI, Jamalpur, as it was reported to be the hot spot area. Jamalpur is located between 24°55′10″ North and 89°56′53″ East, and the soil is neutral in pH and silty loam in texture. The experiment comprising eight treatments were replicated thrice following RCBD. Eight treatments namely, T_1 (Earthing-up one time + Planting 01 Nov. + Pheromone trap + harvest 130 DAP), T_2 (Earthing-up one time + Planting 15 Nov. + Pheromone trap + harvest 120 DAP), T_3 (Earthing-up two times + Planting 01 Nov. + Carbofuran 5G @ 15kg ha^{-1} at 60 days after sowing with irrigation + harvest 130 DAP), T_4 (Earthing-up two times + Planting 15 Nov. + Carbofuran 5G @ 15kg ha^{-1} at 60 days after sowing with irrigation + harvest 120 DAP), T_5 (Earthing-up three times + Planting 01 Nov. + harvest 130 DAP), T_6 (Earthing-up three times + Planting 15 Nov. + harvest 120 DAP), T_7 (Farmer's practice) and T_8 (Control) were evaluated. BARI SP-8 sweet potato variety was used for this experiment. The spacing between plants was 30 cm and rows 60 cm. The plot size for each treatment was 3 m x 3 m. All plantings were from vine cuttings, and standard horticultural procedures were followed. The roots in each plot were counted and weighed, and evaluated for severity of weevil damage. A sampling of adult weevils using a sweeping-net was carried out six times at 30 days intervals starting from 30 days after planting. The stem and roots were taken as samples from different plants of respective plots and then they were dissected to count the number of adult weevils, pupae, and larvae. The data on the extent of damage on root tubers and stem (vines) was recorded according to the rating scale described by Rangi et al. (1994). The data on the infestation percentage on the stem (vine) and tuber were calculated. Data were statistically analyzed in the MStat program, and means were separated by DMRT.

3 RESULTS AND DISCUSSION

The different integrated treatments were tested for evaluating the efficacy in controlling sweet potato weevil. The effects of all treatment combination on root infestation by sweet potato weevil were presented in Table 1. Significant variation in controlling sweet potato weevil was observed in the combination of various management packages.

In the case of percent infestation of the root by number, the lowest percentage of infestation was found in T_3 (2.94%), which was statistically identical with T_6 (3.56 %) and followed by T_1 (5.53 %), T_2 (4.38 %), T_4 (6.71 %) and T_5 (4.42 %), respectively. Correspondingly, the lowest percentage of infestation of the root by mass was also found in T_3 (3.22 %), which was followed by T_1 (8.20 %), T_2 (7.52 %), T_4 (9.81 %), T_5 (5.78 %), and T_6 (5.32 %), respectively. Among all the treatments, marketable yield per plot was ensured significantly the highest in T_3 (23.75 kg), which was followed by T_2 (18.36 kg), T_4 (20.26 kg), T_5 (20.33 kg), and T_6 (21.51 kg), respectively. The lowest yield per plot was found in T_8 (11.67 kg), which was statistically identical with T_7 (13.17 kg) and followed by T_1 (15.04 kg) and T_2 (18.36 kg), respectively. Among all the treatments, the percent increase of yield over control was found the highest in T_3 (50.86 %) and the lowest in T_7 (11.39 %).

Our present study suggested that early planning on November 01, earthing up for two times, applying Carbofuran 5G @ 15kg ha^{-1} at 60 DAP with irrigation and harvesting after 130 days of planting worked the best to manage sweet potato weevil successfully. Bohinc et al. (2019) found combination of calcium cyanamide (1000 kg ha^{-1}), propolis (5 ml 1^{-1} H_2O) and limestone dust (345 kg ha^{-1}) was effective against different potato pests in summer. Hue and Low (2015) described earthing up as an excellent approach that prevented the entry of weevils into tuber and oviposition by female weevils. Palaniswami and Mohandas (1994) also observed that the weevil infestation was significantly reduced by this method. Timely harvesting also reduces weevil infestation at a significant level. Ebregt et al. (2005) found that harvesting 14 days earlier decrease the yield loss of sweet potato by weevil attack. The findings of the present study were strongly supported by Taye and Tadesse (2013), where they reported that carbofuran could efficiently manage sweet potato weevil infestation when this chemical was used with other pesticides.

Table 1: Effect of different integrated treatments against sweet potato weevil infestation at Jamalpur

Treatments	Infestation by number (%)	Infestation by mass (%)	Marketable yield/plot (kg)	Increase/decrease yield over control (%)
T_1 (Earthing-up (One time) + Planting 01 Nov. + Pheromone trap + harvest 130 DAP)	5.53 bc	8.20 bc	15.04 bc	22.41
	(2.32)	(2.78)		
T_2 (Earthing-up (One time) + Planting 15 Nov. + Pheromone trap + harvest 120 DAP)	4.38 bc	7.52 bc	18.36 abc	36.44
	(2.09)	(2.71)		
T_3 (Earthing-up (Two times) + Planting 01 Nov. + Carbofuran 5G @ 15kg/ha at 60 DAP with irrigation + harvest 130 DAP)	2.94 c	3.22 c	23.75 a	50.86
	(1.65)	(1.75)		
T_4 (Earthing-up (Two times) + Planting 15 Nov. + Carbofuran 5G @ 15kg/ha at 60 DAP with irrigation + harvest 120 DAP)	6.71 bc	9.81 bc	20.26 ab	42.40
	(2.46)	(3.01)		
T_5 (Earthing-up (Three times) + Planting 01 Nov. + harvest 130 DAP)	4.42 bc	5.78 bc	20.33 ab	42.60
	(2.09)	(2.40)		
T_6 (Earthing-up (Three times) + Planting 15 Nov. + harvest 120 DAP)	3.56 c	5.32 bc	21.51 ab	45.75
	(1.80)	(2.20)		
T_7 (Farmer's practice)	9.13 b	12.39 b	13.17 c	11.39
	(2.98)	(3.47)		
T_8 (Control)	15.12 a	19.82 a	11.67 c	
	(3.88)	(4.42)		

In a column, treatment means having a common letter(s) are statistically identical by LSD at 5 % level of significance. Figure in the parenthesis indicates square root transformation

4 CONCLUSION

Understanding the insights of sweet potato weevil and their infestation is crucial so that a precise preventive method could be designed. Integrating several cultural practices and chemicals like early planting, earthing up at the proper time, timely harvesting, and appropriate chemical insecticide can manage sweet potato weevil infestation in the crop field. The combination of various IPM strategies that we explained in the study could be an efficient package to prevent the weevil infestation for achieving the nation's fundamental demand of ensuring food and nutrition security.

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