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Development of Integrated Management Approaches against *Spodoptera litura* in Tropical Sugarbeet of Bangladesh

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ABSTRACT

The experiment was conducted at Bangladesh sugarcrop research institutional farm during 2014-2015 cropping season with a view to find out the best integrated management approaches against *Spodoptera litura* Fab on tropical sugarbeet cultivation. The experiment was laid out in a Randomized Complete Block Design with three replications and comprised of eight treatments viz. T_1 - Pheromone trapping, T_2 - Hand picking (Feb.-April), T_3 - Bio-neem plus @ 1ml L^{-1} (Feb.-April) at 15 days interval, T_4 - spraying NPV @ 0.2 gm L^{-1} (Feb.-April) at 15 days interval, T_5 - T_1 +Release of *Bracon hebetor* @ 1,000 at 15 days interval (Feb.-April), T_6 - T_2 + T_3 + T_4 + T_5 and T_0 - Control plot were tested in eight different IPM packages against sugarbeet caterpillar. The highest 84.48% efficacy was observed in Nitro treating plot followed by 74.62% efficacy was found in combination plot compared to three cropping season of 2013-16. The highest pol 15.51% was found in Nitro treating plot followed by 14.42% was found in combination plot and the lowest was 11.82% in the control plot. From pol% increased over control, the highest pol increase 31.22% was found in Nitro treating plot and the lowest was 8.12% in the control plot. The highest yield 70.64 t ha^{-1} was observed in Nitro treated plot followed by 63.33 t ha^{-1} in combination plot where as the lowest yield was 44.41 t ha^{-1} in control plot. The yield increase over control ranging from 5.13- 59.06 t ha^{-1}. The sugarbeet caterpillar infestation is dependent on the total beet yield. It indicates that the sugarbeet caterpillar infestation increased with the decreased the beet yield.

Key words: Tropical Sugarbeet, integrated pest management, *Spodoptera litura*

INTRODUCTION

Tropical sugarbeet, *Beta vulgaris* L. is a temperate crop. It is a biennial sugar producing tuber crop growing in temperate countries. Now sugarbeet varieties are being produced successfully in tropical and subtropical countries including India, Bangladesh and Pakistan. Bangladesh is a wide agro-climatic diversity suitable for sugarbeet cultivation. Tropical sugarbeet is second to sugarcane as the world's sugar and recently it is used as an important material for ethanol production as bio-fuel. Sugarbeet can be successfully cultivated in salien area of Bangladesh (Rahman, 2006). There was no adverse effect on beet yield and pol percentage in saline prone area, where salinity level was 4-14 ds/m during growing period. According to FAO (1982) recommendation per capita 13 kg sugar is required for human diet. The total requirement of white sugar is 1.95 million tons and 2.55 million tons of brown sugar calculated for 150 million people in the country to be

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expected by 21st century. Present production of sugar is 0.10 milliom tons and goor is about 0.50 million tons respectively. The average beet and sugar yields in major growing countries were found 82.0 and 7.7 tons per hectare respectively (Encyclopaedia of Agril. Sc. V.4, 1994).

Population increase as well as urbanization, demands of sugar is being increased, while acreage of sugarcane cultivation is being gradually decreased due to higher demand for food, vegetables etc. and utilization of crop lands for houses, roads, industries etc. Therefore, there is no scope to increase sugarcane acreage to meet the higher demand of increasing population in Bangladesh. To fulfill our sugar shortage, Bangladesh will be importing about 3-5 million tons of sugar annually which will not only be a huge financial liability on the national exchequer but also an emerging threat to the sugar industry and related beneficiaries i.e. mainly farmers and indirect stake holders in the country. Sugarbeet can produce almost 2-3 times higher sugar yields per hectare in a short period (4-6 months) as compared to sugarcane needs 12-16 months (Baloach *et. al.,*2002).

Being a new crop in India several constraints are noticed in cultivation of sugarbeet and severe incidence of insect pests and disease is a major (Patil *et. al.,* 2007). Sugarbeet insect pests can cause yield loss of 18 t ha^{-1} (Annual Report, 2011-12). Insect pests are the main problem for sugarbeet production in Bangladesh. Eight insect pests i.e., sugarbeet caterpillar, cutworm, aphids, red mite, grass hopper, hairy caterpillar, flea beetle and webworm etc. Sugarbeet caterpillar, *Spodoptera litura*, is one of the most destructive pests of sugarbeet. Female moths lay eggs in masses on the lower surface of leaves. The eggs hatch in about 6- 8 days. Soon after hatching, the young larvae start feeding on the epidermis of the leaves. Initially, the caterpillars are a translucent green with a dark thorax. They feed gregariously in the early stages and damaged leaves appear skeletonized. The larger caterpillar is voracious feeder 10-15 gm per day and the crop may be completely defoliated within a week.

Sugarbeet caterpillar is a cosmopolitan and polyphagous pest, affecting several crops like cotton, pulses, oil seeds, vegetables, ornamental plants. Two, four and eight larvae per plant reduced sugarbeet yield by 24, 44.2 and 50.4%, respectively (Patel, *et al.,*1971). Different pest management practices like resistant varieties, cultural practices, mechanical control, biological and chemical control methods have so far been recommended to control sugarbeet caterpillar. But no single method had so far been proved to be completely successful and reliable. Among all these methods, the chemical control method is still popular to our farmers because of its quick and visible results. Frequent and the large-scale use of synthetic pesticides in agriculture have developed pesticide resistance, frequent pest out breaks, emergence of new pests, environmental pollution and human health hazards.

The Integrated Pest Management (IPM) is the most desired approach because it is the management of the pests by using more than one possible technique in such a way that the damage is kept below the economic injury level through least affecting the environment. The comparative efficacy of different management tactics including some non-chemical and selected insecticides for development of suitable integrated pest management approach using safer components are not properly addressed in Bangladesh. Therefore, integrated pest management (IPM) strategies will be developed to control insect pests of sugarbeet resuting high sugar and goor production in sugarbeet.

MATERIALS AND METHODS

The field experiment was conducted at the experimental farm of Bangladesh Sugarcrop Research Institute (BSRI) Ishurdi, Pabna during the three cropping seasons of 2013-16. The experiment consisted of eight treatments. The experiment was laid out in Randomized Complete Block (RCB) design with three replications. The individual plot size was 4m 5m. Block to Block distance was 2m apart with a border of 1.5 m. Line to line spacing and seed sowing was 50 cm 20 cm. The experiment was located in High Ganges River Flood Plain soils under Agro-ecological Zone-11 with medium high land of typical sandy loam soil having p^H 7.6.

The experiment comprised of eight treatments was:
T_1: Pheromone trapping was commonly practices in all treatments on February
T_2: Hand picking (Feb.-April)
T_3: Bio-neem plus @ 1ml L^{-1} (Feb.-April) at 15 days interval
T_4: spraying NPV @ 0.2 gm L^{-1} (Feb.-April) at 15 days interval
T_5: T_1 + Release of *Bracon hebeto*@ 1,000 at 15 days interval (Feb.-April)
T_6: $T_2 + T_3 + T_4 + T_5$
T_7: Spraying of Nitro 505 EC @ 4.5 L ha^{-1} (Feb.-April) at 15 days interval
T_0: Control (untreated)

The experimental plot was prepared with plowing thoroughly because sugarbeet being deep-rooted crops requires a good tilth of soil free from clods for its proper growth. Fertilizer dose of MOC, Urea, TSP, MoP, Gypsum, Zinc Sulphate and Boric Acid were applied at the rate of 450 kg, 250 kg, 120 kg, 22 5kg, 100 kg, 10 kg and 20 kg per hectare respectively (Anonymous, 2005). Total MOC was applied at the time of final land preparation. TSP, MOP, Gypsum, Zinc sulphate, Boric Acid and 1/3 Urea was applied in the line before ridge preparation. Rest amount of Urea was applied in two installments at 30 and 60 days after sowing. Seed of tropical sugarbeet genotype (Shubhra) was sown on light ridge soil at 3-4 cm depth on month of November, 2014-16 with the spacing of 50 cm 20 cm. Light irrigation was done immediately after sowing to ensure uniform sugarbeet seed emergence. Sex pheromone trap was also placed @ 45 traps per hectare in the field to male insect attacked. Parasitoid *Bracon hebetor* was also released at 15 days

interval in the field to control *Spodoptera litura.* To ensure optimum soil moisture, irrigation was done twice in a month continued up to March. All types of intercultural operation like weeding, mulching and fertilizer application were done timely. To control of *Spodoptera litura* an integrated approaches was rendered. Nitro 505 EC@ 4.5 liter ha^{-1} at 15 days interval applied in March and April. Five plants were randomly selected in each plot. Larval population was randomly collected in each line for beet harvested. Beet pol% was recorded after 150 DAS (days after sowing). Data on *Spodoptera litura* infesting sugarbeet leaves and roots were recorded in the month of March, April and May Total weight was calculated (ha^{-1}) from each plot and statistically analyzed with the help of MSTAT-C program with LSD test at 5% level of significance.

RESULTS AND DISCUSSION

From Table 1 Sugarbeet larval population was collected five plants/plot. The three months data were observed statistically significant among the treatments in every month data. From the pool data, the highest larval population was found (65.67) in control plot and the lowest population was (12.44) in Nitro 505 EC treating plot followed by (16.67) in combination plot.The percent efficacy over control ranging from 30.29% - 81.06%. The highest efficacy percentage over control (81.06%) was recorded in Nitro 505 EC treating plot followed by (74.62%) in combination plot whereas 41.80% was found in bio-agent *Bracon hebetor* release plot.

Table1. Effects of different integrated pest management components against larval population of sugerbeet at BSRI farm, Ishurdi, 2013-14

Treatments	Larval population 5 plants/plot			Pool data	% efficacy over control
	1st data (Marc)	2nd data (April)	3rd data (May)		
T_1- Pheromone trapping commonly used in all treatment	2.33ab	81.33b	29.33bc	37.67	42.64
T_2 - Hand picking (Feb.-April)	2.00ab	100.67b	34.67b	45.78	30.29
T_3 - Bio-neem plus @ 1ml L^{-1} (Feb.-April) at 15 days interval	2.00ab	73.67b	28.67bc	34.78	47.04
T_4 - spraying NPV @ 0.2 gm L^{-1} (Feb.-April) at 15 days interval	1.00ab	74.67b	19.67cd	31.78	51.61
T_5 - T_1 +Releas of *Bracon hebetor* @ 1,000 at 15 days interval (Feb.-April)	1.33ab	83.67b	29.67bc	38.22	41.80
T_6 - $T_2 + T_3 + T_4 + T_5$	1.00ab	35.00c	14.00d	16.67	74.62
T_7 - Sprayingof Nitro 505 EC @ 4.5 L ha^{-1} (Feb.-April) at 15 days interval	0.67b	27.33c	9.33d	12.44	81.06
T_0 - Control (untreated)	3.33a	140.67a	53.00a	65.67	-
LSD (0.05)	2.5456	29.846	12.014	-	-

From Table 2 Sugarbeet larval population was collected five plants from each plot. The three months data were recorded statistically significant among the treatments in every month data. From the pool data, the lowest population was (29.78) in Nitro 505 EC treating plot followed by (64.11) in combination plot whereas the highest larval population was found (191.89) in control plot. The percent efficacy over control ranging from 11.81% - 84.48%. The highest efficacy percentage over control (84.48%) was found in Nitro 505 EC treating plot followed by (66.59%) in combination plot whereas 41.61% was found in bio-agent *Bracon hebetor* released plot.

Table 2. Effects of different integrated pest management components against larval population of sugerbeet at BSRI farm, Ishurdi, 2014-15

Treatments	Larval population 5 plants/plot			Pool data	% efficacy over control
	1st data	2nd data	3rd data		
T_1- Pheromone trapping commonly used in all treatment	131.33ab	275.67bc	15.33bc	140.78	26.64
T_2 - Hand picking (Feb.-April)	134.33ab	356.67ab	16.67b	169.22	11.81
T_3 - Bio-neem plus @ 1ml L^{-1} (Feb.-April) at 15 days interval	80.00bc	297.00bc	14.00bc	130.33	32.08
T_4 - spraying NPV @ 0.2 gm L^{-1} (Feb.-April) at 15 days interval	71.33bc	223.00d	13.33bc	102.55	46.56
T_5 - T_1 +Releas of *Bracon hebetor* @ 1,000 at 15 days interval (Feb.-April)	70.67bc	253.67cd	11.67c	112.00	41.63
T_6 - $T_2 + T_3 + T_4 + T_5$	56.00c	131.33e	5.00d	64.11	66.59
T_7 – Spraying of Nitro 505 EC @ 4.5 L ha^{-1} (Feb.-April) at 15 days interval	33.00c	52.33f	4.00d	29.78	84.48
T_0 - Control (untreated)	143.67a	410.00a	22.00a	191.89	-
LSD (0.05)	72.0339	64.985	4.3968	-	-

From Table 3 raveled that Sugarbeet larval population was collected five plants from each plot. The three months data were recorded statistically significant among the treatments in every month data. From the pool data, the lowest population was (3.48) in Nitro 505 EC treating plot followed by (7.00) in combination plot whereas the highest larval population was found (19.56) in control plot. The percent efficacy over control ranged from 18.76% - 80.67%. The highest efficacy percentage over control (84.67%) was found in Nitro 505 EC treating plot followed by (64.21%) in combination plot whereas 38.65% was found in bio-agent *Bracon hebetor* released plot.

Table 3. Effect of different integrated pest management components against larval population of sugerbeet at BSRI farm, Ishurdi, 2015-16

Treatments	Larval population 5 plants/plot			Pool data	% efficacy over control
	1st data	2nd data	3rd data		
T_1- Pheromone trapping commonly used in all treatment	5.33b	27.67b	12.00a	15.00	23.31
T_2- Hand picking (Feb.-April)	6.00ab	29.00ab	12.67a	15.89	18.76
T_3- Bio-neem plus @ 1ml L^{-1} (Feb.-April) at 15 days interval	5.00bc	26.33b	11.67a	14.33	26.74
T_4 - spraying NPV @ 0.2 gm L^{-1} (Feb.-April) at 15 days interval	4.67bc	25.33b	11.33a	13.78	29.55
T_5 - T_1 +Releas of *Bracon hebetor* @ 1,000 at 15 days interval (Feb.-April)	3.67bcd	20.33bc	12.00a	12.00	38.65
T_6 - $T_2 + T_3 + T_4 + T_5$	2.67cd	13.33cd	5.00b	7.00	64.21
T_7- Spraying of Nitro 505 EC @ 4.5 L ha^{-1} (Feb.-April) at 15 days interval	1.33d	7.33d	2.67b	3.48	80.67
T_0 - Control (untreated)	8.00a	36.67a	14.00a	19.56	-
LSD (0.05)	2.6372	8.8049	3.7613	-	-

From Table 4 stated that statistically significant different was observed in the three cropping seasons of 2013-16. The highest pol 14.99% was found in Nitro treating plot and the lowest was 12.25% in the control plot on 2013-14 cropping season. In the cropping season of 2014-15, the highest pol 16.32% was found in Nitro treating plot and the lowest was 12.03% in the control plot. In the cropping season of 2015-16, the highest pol 15.27% was found in Nitro treating plot and the lowest was 11.23% in the control plot. From pool data, the highest pol 15.51% was found in Nitro treating plot followed by 14.42% was found in combination plot and the lowest was 11.82% in the control plot. From pol% increased over control ranging from 8.12-31.22%. The highest pol increase 31.22% was found in Nitro treating plot and the lowest was 8.12% in the control plot.

Table 4. Effects of different integrated pest management components on pol% of sugerbeet at BSRI farm, Ishurdi, 2013-16

Treatments	Pol %			Pool data	Pol% increase over control
	2013-14	2014-15	2015-16		
T_1- Pheromone trapping commonly used in all treatment	13.73abc	12.95de	12.17cd	12.95	9.56
T_2 - Hand picking (Feb.-April)	12.87cd	12.93de	12.53bcd	12.78	8.12
T_3 - Bio-neem plus @ 1ml L^{-1} (Feb.-April) at 15 days interval	13.50bcd	13.13d	12.63bcd	13.09	10.74
T_4 - spraying NPV @ 0.2 gm L^{-1} (Feb.-April) at 15 days interval	13.69abc	14.36bc	13.27bc	13.92	17.77
T_5 - T_1 +Releas of *Bracon hebetor* @ 1,000 at 15 days interval (Feb.-April)	13.77abc	13.28cd	13.53abc	13.53	14.47
T_6 - $T_2 + T_3 + T_4 + T_5$	14.33ab	14.67b	14.27ab	14.42	22.00
T_7 - Spraying of Nitro 505 EC @ 4.5 L ha^{-1} (Feb.-April) at 15 days interval	14.93a	16.32a	15.27a	15.51	31.22
T_0 - Control (untreated)	12.25d	12.03e	11.23d	11.82	-
LSD (0.0 5)	1.3232	1.0938	1.9244	-	-

From Table 5 observed that the yield of sugarbeet was statistically significant among the different treatments. The highest yield 70.64 t ha^{-1} was observed in Nitro treated plot followed by 63.33 t ha^{-1} in combination plot where as the lowest yield was 44.41 t ha^{-1} in control plot. The yield increase over control ranging from 5.13 - 59.06 t ha^{-1}. The highest yield 59.06 t ha^{-1} was found in Nitro treated plot followed by combination plot 42.60 t ha^{-1}. The lowest beet yield increase over control was 5.13 t ha^{-1} recorded in hand picking plot. (Rahman *et. al.,* 2013), reported that variety Subhra (51.87-121.03 t ha^{-1}) found in BSRI farm, Ishurdi , Pabna. The present study reflects their finding related to yield. Development of Integrated Management Approaches against sugarbeet caterpillar, *Spodoptera litura* Fab. in sugarbeet.

Table 5. Effects of different integrated pest management components beet yield of sugerbeet at BSRI farm, Ishurdi, 2013-16

Treatments	Yield (t ha^{-1})			Pool data	% yield increase over control
	2013-14	2014-15	2015-16		
T_1- Pheromone trapping commonly used in all treatment	57.50cd	45.98b	43.21b	48.90	10.11
T_2 - Hand picking (Feb.-April)	52.50de	44.70b	42.87b	46.69	5.13
T_3 - Bio-neem plus @ 1ml L^{-1} (Feb.-April) at 15 days interval	61.50bc	54.40b	43.78b	53.23	19.86
T_4 - spraying NPV @ 0.2 gm L^{-1} (Feb.-April) at 15 days interval	63.70b	57.87ab	45.13b	55.57	25.13
T_5 - T_1 +Releas of *Bracon hebetor* @ 1,000 at 15 days interval (Feb.-April)	60.73bc	54.40b	48.38b	54.50	22.72
T_6 - $T_2 + T_3 + T_4 + T_5$	65.50ab	59.03ab	65.47a	63.33	42.60
T_7 - Spraying of Nitro 505 EC @ 4.5 L ha^{-1} (Feb.-April) at 15 days interval	70.00a	72.21a	69.72a	70.64	59.06
T_0 - Control (untreated)	48.00e	42.82b	42.41b	44.41	-
LSD (0.05)	5.8564	16.415	7.0733	-	-

Relationship between caterpillar infestations with sugarbeet yield

A positive and linear relationship was obtained between percent sugarbeet caterpillar infestation and beet yield in the cropping season of 2013-14 (Figure 1). This suggested that sugarbeet caterpillar infestation is dependent on the total beet yield and more than 15.80% (R^2 = 15.80) of variation in the caterpillar infestation can be explained by the variation of beet yield. So, it indicates that the sugarbeet caterpillar infestation increased with the decreased the beet yield.

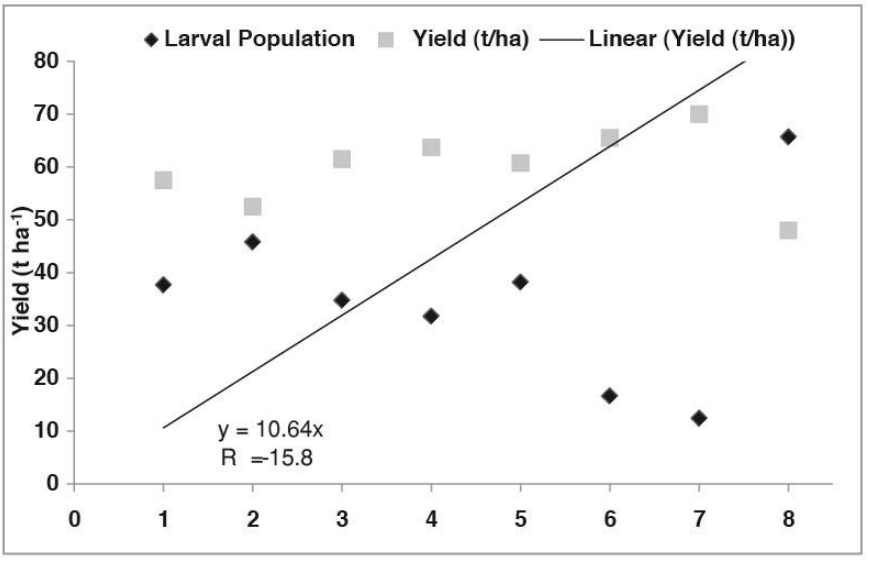

Figure 1. Relationship between larval population and yield, during cropping season 2013-14

A positive and linear relationship was obtained between percent sugarbeet caterpillar infestation and beet yield in the cropping season of 2014-15 (Figure 2). This suggested that sugarbeet caterpillar infestation is dependent on the total beet yield and more than 5.51% (R^2 = 5.51) of variation in the caterpillar infestation can be explained by the variation of beet yield. So, it indicates that the sugarbeet caterpillar infestation increased with the decreased the beet yield.

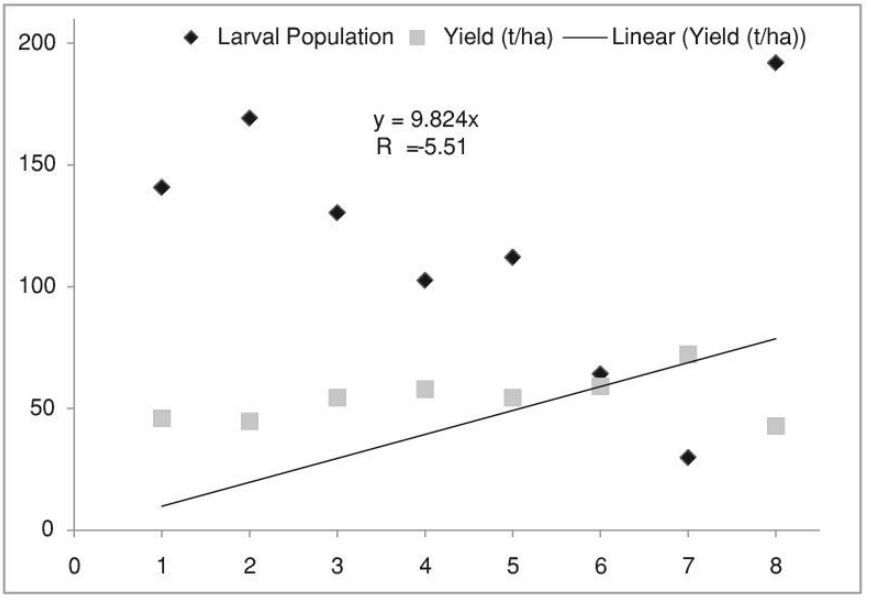

Figure 2. Relationship between larval population and yield, during cropping season 2014-15

A positive and linear relationship was obtained between percent sugarbeet caterpillar infestation and beet yield in the cropping season of 2015-16 (Figure 3). This suggested that sugarbeet caterpillar infestation is dependent on the total beet yield and more than 2.77% (R^2 = 2.77) of variation in the caterpillar infestation can be explained by the variation of beet yield. So, it indicates that the sugarbeet caterpillar infestation increased with the decreased the beet yield.

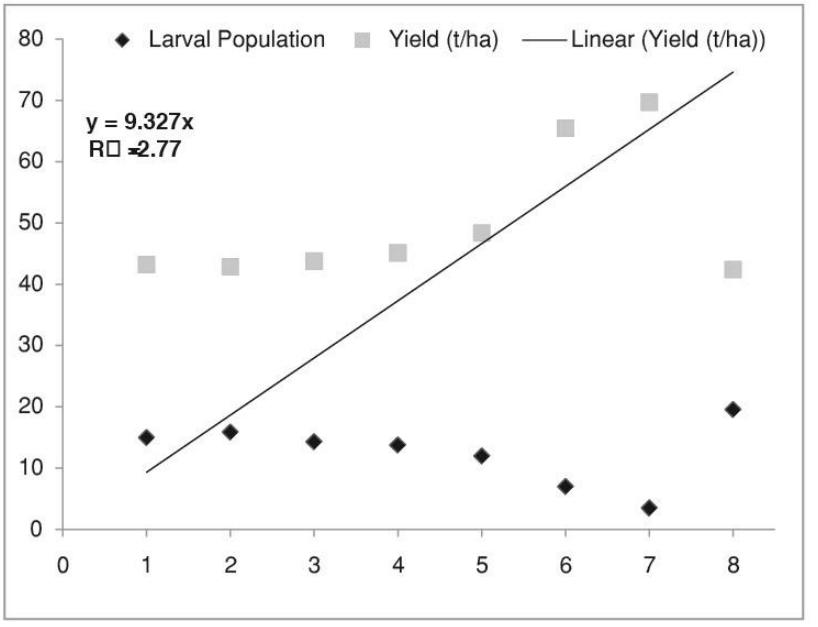

Figure 3. Relationship between larval population and yield, during cropping season 2015-16

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