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INVESTIGATING THE PERFORMANCE OF LEPIK MACHINE FOR MANAGING POPULATION DENSITY OF SPOTTED BOLLWORM (*EARIAS* SPP.) IN COTTON CROP

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ABSTRACT

Current study was conductedin two consecutive years i.e. 2013 and 2014 on cotton crop for evaluating the performance of LEPIK (Light Equipped Power Insect Killer) technology at three application intervals (3, 6 and 9 days) against spotted bollworm as compared to spinosad(chemical control measure) and control treatment. LEPIK technology applied at 3, 6 and 9 days interval exhibited population densities of spotted bollworm in the range of 1.89-1.95, 4.94-5.32, 6.89-7.91larvae/plant in both years. The chemically treated plots showed a population density of less than 1.0 larvae/plantboth years. The highest and statistically similar population reduction for *Earias*spp.was recorded in those plots which were treated with spinosad (95.9 and 97.5% in 2013 and 2014, respectively) and LEPIK technology applied at 3 days interval (84.3and 86.0% in 2013 and 2014, respectively). The plots where LEPIK technology was applied at 6 and 9 daysinterval exhibited 55.6-58.8% and 29.1-31.1% reduction in spotted bollworm population in both years. LEPIK technology applied at 3, 6 and 9 days interval demonstrated 4.7-4.9, 14.1-15.1 and 19.9-20.9 times less reduction in the spotted bollworm population than spinosad in both years. The highest and statistically similar population reduction for *Earias*spp. (> 80% but < 100%) was recorded in those plots which were treated with spinosad and LEPIK technology applied at 3 days interval.In conclusion, the application of LEPIK technology at three days interval proved at par with chemical control but better than non-chemical control measure and hence can be recommended for spotted bollworm management after evaluating its cost of application and cost benefit ratio.

Keywords: Chemical control, Cotton, Mechanical control, Population density, Spotted bollworm,

INTRODUCTION

Among the various low yield factors in cotton, the insect pests are one of the major threatsto cotton production in Pakistan and cause varying level of damage depending on the season and crop variety(Abro*et al.* 2004; Khan *et al.,* 2014).The bollworm complex (*Earias* spp., *Pictinophoragossypiella*and*Helicoverpaarmigera*) was responsible for the plant stress and fruit abscission which demonstrate 29% reduction in harvestable bolls yieldand 1328 kg/ha reduction in seed cotton yield (Gupta *et al.,* 2000). According to Abro*et al.* (2004), bollworm complex cause 30-40% reduction in cotton yield. Among bollworms, American bollworm and spotted bollworm can cause complete destruction of the crop. Spotted bollworm species (*Eariasinsulana*and*Eariasvitella*) are considered as major deleterious pests for cotton all over the world. They damage the tender shoot tip by boring at initial stage of the crop and at later stages to squares, flowers and immature bolls. The feeding larvae inside the bolls result in spoilage and poor quality of cotton lint and consequently reduction in the lint yield (Shah and Saleem, 2002).

In Pakistan, farmers are completely dependent on insecticide application for the control of bollworms (Rao, 2007a, b;

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Arshad *et al*., 2009). According to an estimate, approximately US$300 million are spent on pesticides export annually and more than 80% of these exported insecticides is used on cotton, especially for control of bollworms in Pakistan (Rao 2007a, 2007b). According to Banerjee *et al*. (2000) and Gogi *et al*. (2006), 30-40 application of pesticides are exercised by the farmers on calendar basis in cotton to control pest attack in Pakistan and India. The continuous and unselective use of insecticides to control the population of insect pests creates problems of health hazards not only in human and animal life but also speed up environmental pollution, appearance of new pests, outbreak of secondary pest and development of resistance against insecticides (Sarfraz and Keddi, 2005; Gogi*et al*., 2006). In order to minimize such effects of insecticide usage, economical and health friendly control measures should be adopted.

Mechanical control is considered as one of the safest tolls for insect pest control in various crops and has great potential in IPM program of any crop. LEPIK (Light Equipped Power Insect Killer) technology can be used for small, medium and large size flying insects which are attracted towards light. The insects attracted towards light are sucked, captured and crushed in LEPIK. This mechanical insect killer can be operated in the field by the operator specifically hanging it on his shoulder just like knapsack sprayer or can be mounted in front of the tractor while operating different agronomic practices or spraying work in the field by tractor. LEPIK technology has been evaluated for the management of whitefly in cotton and proved very effective and economical as compared to insecticides and control treatment (Khan *et al.,* 2012). In the present study, the effectiveness of LEPIK technology was determined at its different application intervals against spotted bollworm species.

MATERIALS AND METHODS

Cotton cultivar CIM-409 was sown using randomized complete block design with five treatments and each treatment was replicated thrice. Experiment was performed in two consecutive growing seasons 2013 and 2014. Five treatments including LEPIK application at 3 days interval (T_1), 6 days interval (T_2), 9 days interval (T_3), application of spinosad (T_5) and control treatment (T_0) were applied in randomized complete block design with three replications. The application of all treatments were initiated 41 days after sowing and continued till the end of September. Spinosad application was done at fortnightly intervals at its recommended dose rate (80 ml/acre). Plot size was 25m × 15m with plant to plant and row to row distance of 2 ft and 2.5ft, respectively. All of the recommended agronomic practices were carried out uniformly in all plots. Data regarding population of spotted bollworm larvae were recorded from 15 plants in each plot 24 hours before and 72 hours after application using Maryo's method (Atwal and Dhaliwal, 1986) and then transformed into per plant population. The data were collected upto the month of September. At the end of experiment, all collected data on per plant basis 24 hours before and 72 hours after application of treatment for each replication were transferred to an average spotted bollworm larvae/plant using following formula as described by Khan *et al.* (2012):

$$X = [\sum(X_1 + X_2 \text{-----------------------} + X_n)]/N$$

X = Average population of spotted bollworm larvae in each replication of each treatment;

X_1=Population of spotted bollwormlarvae for first observation;

X_2= Population of spotted bollworm larvae for second observation;

Xn = Population of spotted bollworm larvae for last observation;

N= Number of observations made upto September.

From the average population data, percent population reduction after treatment application was calculated for each replication of each treatment by the following formula as described by Khan *et al.* (2012):

$$\text{Population reduction (\%)} = \frac{P_{BT} - P_{AT}}{P_{BT}} \times 100$$

$P_{BT=}$ Population of spotted bollworm larvae before treatment application; $P_{AT=}$ Population of spotted bollworm larvae after treatment application

Population reduction caused by LEPIK application for each interval over control was calculated by the following formulaas described by Khan *et al.* (2012):

$$PRC_{dx}(\%) = \frac{PC - PL_{dx}}{P_C} \times 100$$

PRC_{dx}=Population reduction of spotted bollworm larvae over control for x days interval; P_C= Population of spotted bollworm larvae in control plot; PL_{dx}=Population of spotted bollworm larvae in LEPIK treated plot at x days interval; dx = LEPIK application intervals (3, 6 and 9 days).

Population reduction caused by LEPIK application for each interval over spinosad application was calculated by the following formulaas described by Khan *et al.* (2012):

$$PRI_{dx}(\text{fold}) = \frac{P_I - Pl_{dx}}{P_I}$$

PRI_{dx} = Population reduction of spotted bollworm larvae over insecticide (spinosad) application for x days interval; $P_{I\ =}$ Population of spotted bollworm larvae in insecticide treated plot; $PL_{dx\ =}$ Population of spotted bollworm larvae in LEPIKtreated plot at x days interval; dx = LEPIK applicationintervals (3, 6 and 9 days)

The data regarding population density and percentpopulation reduction of spotted bollworm larvae for each treatment was subjected toANOVA technique and means were compared by Tukey HSDtest (Steel and Torrie, 1997) using Statix 8.1 software.

RESULTS AND DISCUSSION

Population density of spotted bollworms

Population density of spotted bollworm larvae/plantexhibited significant variation in all treatments for 2013 ($df_=$ 4/8; $F_=$1384.61; $P < 0.0001$) and 2014 ($df_=$ 4/8; $F_=$408.5; $P < 0.0001$). The control treatment exhibited the highest densityofspotted bollwormlarvae/plantduring 2013 (10.9larvae/plant) (Fig. 1) and 2014 (10.2larvae/plant) (Fig. 2). LEPIK technology when applied at 9 days interval demonstrateda population densities of 7.1 larvae/plant in 2013 (Fig. 1) and 6.9larvae/plant in 2014 (Fig. 2). The plots where LEPIK technology was applied at 6 days interval demonstrated 4.9 and 5.3larvae/plant in 2013 and 2014, respectively (Fig. 1 & 2)and exhibited better results than control treatment as well as than the treatment where LEPIK technology was applied at 9 days interval. However, the application of LEPIK technology at 3 days interval exhibited a very low population density in 2003 (1.8 larvae/plant) (Fig. 1) and in 2014(1.9 larvae/plant) (Fig. 2). The application of LEPIK technology at three days interval proved better than non-chemical control measure. The chemically treated plots demonstrated a population density of less than 1.0 larvae/plant in 2013 and 2014 (0.3 and 0.3 larvae/plant, respectively) (Fig. 1 & 2)

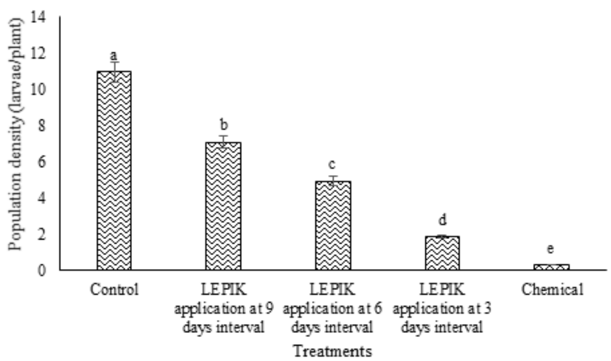

Fig. 1
Population density of spotted bollworm larvae exhibited at 72 hours post-treatment interval on cotton plants in different treatments during 2013. (Bars of the graph indicate the means; Error bars indicate the ±SE; Means bars having different letter are not statistically similar at $\alpha = 5\%$)

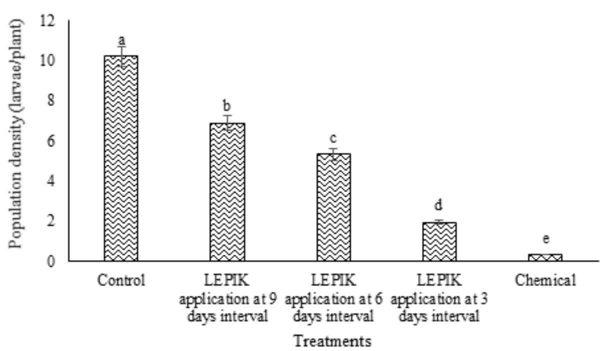

Fig. 2
Population density of spotted bollworm larvae exhibited at 72 hours post-treatment interval on cotton plants in different treatments during 2014. (Bars of the graph indicate the means; Error bars indicate the ±SE; Means bars having different letter are not statistically similar at $\alpha = 5\%$)

Percent reduction in spotted bollworm population

The results reveal that treatments had significant effect on population reduction of spotted bollworm larvae/plant in 2013 (*df* = 4/8; F = 784.61; P < 0.001) and 2014 (*df* = 4/8; F = 224.5; P < 0.01).However, a non-significant variation in population reduction of spotted bollworm larvae/plant was exhibited among years (*df* = 1/29; F = 784.61; P < 0.001). The highest and statistically similar population reduction ofspotted bollworm larvae/plantwas demonstrated by spinosad(95.9 and 97.5% in 2013 and 2014, respectively) and LEPIK technology applied at 3 days interval (84.3 and 86.0% in 2013 and 2014, respectively). LEPIK technology when applied at 6 days interval demonstrated58.8 and 55.6% reduction in population of spotted bollworm larvae/plant in 2013 and 2014, respectively. Similarly, application of LEPIK technologyat 9 days interval confirmed29.1 and 31.1% reduction in population of spotted bollworm larvae/plant in 2013 and 2014, respectively. In control treatment, 21.6 and 27.7% increase in population of spotted bollworm larvae/plant was observed in 2013 and 2014, respectively. These results also depict that application of LEPIK technology at three days interval proved at par with chemical control but better than rest of the non-chemical control measure. (Fig. 3).

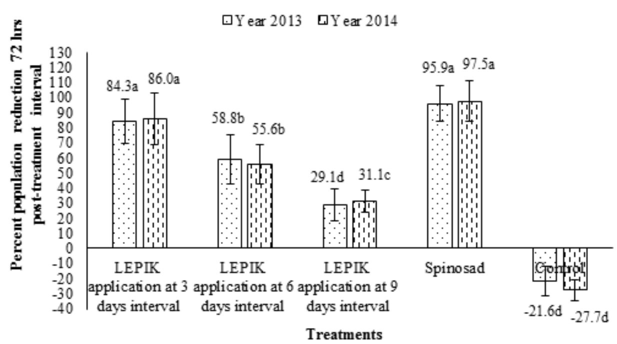

Fig. 3
Percent population reduction of spotted bollworm larvae/plant exhibited at 72 hours post-treatment interval on cotton plants in different treatments during 2013 and 2014. (Bars of the graph indicate the means; Error bars indicate the ±SE; Means bars having different letter are not statistically similar at $\alpha = 5\%$)

Percent reduction in spotted bollworm population over control

Application of spinosad caused 97.0 and 96.8% more reduction in spotted bollworm population than control in 2013 and 2014, respectively. Similarly, application of LEPIK technology at 3 days interval demonstrated82.7 and 80.8% more reduction in the population of spotted bollworm than control in 2013 and 2014, respectively. However, application of LEPIK technology at 6 days interval demonstrated 54.8 and 47.9% more reduction in spotted bollwormpopulation than control in 2013 and 2014, respectively. LEPIK technology when applied at 9 days interval caused 35.22 and 32.5% more reduction in spotted bollworm population than control in 2013 and 2014, respectively (Table 1).

Percent reduction in spotted bollworm over spinosad

The results reveal that application of LEPIK technology at 3 days interval, exhibited 4.8-4.9 times less reduction in spotted

Table 1

Percent reduction in spotted bollworm population caused by LEPIK technology and spinosadapplication over control in 2013 and 2014.

Treatments	Population reduction over control (%)	
	2013	2014
LEPIK application 3 days interval	82.7	80.8
LEPIK application 6 days interval	54.8	47.9
LEPIK application 9 days interval	35.2	32.5
SpinosadControl	97.0	96.8
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bollwormpopulationthan spinosad in both years. Application of LEPIK technology at 6 days interval demonstrated 14.1-15.1 times less reduction in spotted bollworm population than spinosad in 2013 and 2014. Whereas, LEPIK technology applied at 9 days interval explained 19.9-20.7times less reduction in spotted bollworm population than spinosad in both years.

Table 2

Treatments	Population reduction over spinosad (x-fold)	
	2013	2014
LEPIK application 3 days interval	-4.8	-4.9
LEPIK application 6 days interval	-14.1	-15.1
LEPIK application 9 days interval	-20.7	-19.9
Spinosad	---	---
Control	32.5	29.9

DISCUSSION

Mechanical control of insects can be a better substitute of insecticide application; hence in the present study, LEPIK technology was evaluated for spotted bollworm management in comparison with its chemical control. LEPIK technology applied at 3, 6 and 9 days interval exhibited population densities in the range of 1.89-1.95, 4.94-5.32, 6.89-7.09spotted bollworm larvae/plant as compared to spinosad application which showed a population density of less than 1.0 (0.32-.33 bollworms/plant)in both years. LEPIK technology applied at 3, 6 and 9 days interval demonstrated 4.7-4.9, 14.1-15.1 and 19.9-20.9 times less reduction in the spotted bollworm population than spinosad in both years. The highest and statistically similar population reduction for *E.* spp (>80% but <100%) was recorded in those plots which were treated with spinosadand LEPIK technology applied at 3 days interval. These results can be compared with those of Chu *et al.* (2003) who documented100% reduction of adult cotton insects when plastic cup traps equipped with light-emitting diodes were operated in cotton crop planted in greenhouse. The results of present investigation are also in confirmatory with those of Nowinszkyand Puskas(2004) who reported that large numbers of insects were captured when light traps were exercised in the field. Hartstack, *et al.* (1973) documented 80% reduction in *Heliothis* spp.populations when blacklight traps were placed in corn, grain sorghum, cotton, and pasture. Their results alsoconfirm the present findings and support the use of black light in mechanical devices for the management of insects as was used in LEPIK technology. Other researchers like Birkinshaw and Thomas (1999), Degallier*et al.*(2004) and Spalding and Parson (2004) also reported that light traps would be exploited for capturing the insect and determining the habitat preferences of nocturnal insects. Khan *et al.* (2012) documented that LEPIK technology applied at 3, 6 and 9 days interval demonstrated 74.5-76.3, 55.5-64.5and 39.1-39.8% more reduction in whitefly population than control; whereas, the same explained 0.47-1.2, 1.6-2.3 and 2.5-4.6 times less reduction in whitefly population thanpyriproxifen in both years (2011 and 2012). Their result also confirm the finding of present study. The plots where LEPIK technology was applied at 6 and 9 days interval exhibited comparatively less spotted bollworm population reduction (54.80-47.88 and 35.2-32.5%) in both years. This variation may be attributed to the more prolonged intervals for the application of LEPIK technology. In conclusion, the application of LEPIK technology at three days interval proved at par with chemical control but better than LEPIK technology when applied at 6 and 9 days interval as nonchemical control measure. Khan *et al*. (2012) also documented similar recommendations regarding application of LEPIK technology in cotton but against whitefly control. However, need is to estimate the cost involved in its application at 3 days interval for deciding if LEPIK technology can be a better substitute of insecticides and an economical recommendation for spotted bollworm management.

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