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STUDY OF CHEMICAL PLANT FACTORS ON *CHILO INFUSCATELLUS* (PYRALIADE: LEPIDOPTERA) INFESTATION FROM SELECTED SUGARCANE VARIETIES

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ABSTRACT

The study was conducted to find out the effects of sugarcane (*Saccharum officinarum* L.) chemical plant factors against the stem borer (*Chilo infuscatellus* L.) infestation. The pest causes major losses in production and quality of sugarcane especially in southern areas of Pakistan. The effect of chemical plant factors on the population of sugarcane stem borer was calculated by processing the data into a simple correlation and multiple linear regression. Correlation analysis showed that nitrogen, phosphorous, magnesium, copper, manganese and zinc contents of sugarcane showed positive and non-significant impact on pest infestation. The influence of potassium, calcium and ferrous had negative and non-significant correlation (P>05) with pest infestation. It is concluded that present finding could be helpful for the management of *Chilo infuscatellus*.

Keywords: Chemical, Factors, Infestation, Lepidoptera, Sugarcane

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is a perennial crop of family Poaceae (Rami *et al.,* 2002). The average yield of sugarcane crop is 47 tons per hectare (Khan and Jamil, 2014) as increasing demand for sugar in future also expected. The average yield of sugarcane is 4 tons per hectare in Pakistan, which is much lower than the average yield in other developing countries of the world (Kumarasinghe, 1999). The average sugarcane producing area is 1.690 million acres, and yield is 39.700 million hectares (Anonymous, 2015-16). Sugarcane is a tropical region crop and requires a high temperature and more sunlight therefore Pakistan is considered as a good location for sugarcane crop production. Pakistan stands 5th position in sugarcane production ranking while 7th and 8th position in term of production and consumption at world level. In Pakistan, 12 species of sugarcane insect pests identified in Pakistan (Chaudhary and Ansari, 1988) and stem borers are the most injurious one (Rami *et al*., 2002). They can reduce the yield by 80% approximately (Ashraf and Fatima, 1980) and During feeding they even may cut the central whorl of leaves that are referred to as "dead-heart" and such plants do not grow further (Shahid *et al.,* 2007). All sugarcane borers destroy or minimize the sugarcane yield throughout the world but sugarcane stem borer, *Chilo infuscatellus* (Lepidoptera: Pyralidae) is most destroying one (Ashraf and Fatima, 1980). Severe infestation of *C. infuscatellus* can reduce yields up to 30% (Anwar *et al*., 2004). Chemical plant factors are helpful to examine the relationship between pest infestations (Khaliq *et al.,* 2005). Objective of the present study was to determine the impact of chemical plant factors of sugarcane against the pest infestations.

MATERIALS AND MEHTODS

The experiments were conducted at Entomology Research Area, University of Agriculture, Faisalabad Pakistan. After preliminary screening, based on the infestation nine varieties of sugarcane Viz., US-676, US-133, US-312, SPF-234, US-1491, US-824, CPF-246, US-718 and CPF-237 were selected for the experiment to examine the effect of chemical plant factors against the stem borer. The varieties were raised with intra and inter row distance of 30cm and 75cm respectively, with five treatments in each block. The research was scheduled for a triplicate randomized complete block design

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(RCBD). The percentage infestation was calculated by counting the no holes in damaged plant and complete damage was determined by using the following formula:

Infestation (%) = [No. To damaged by cane/No. Of total cane] 100

The data were analyzed by analysis of variance (ANOVA) and mean were compared by the Tukey HSD test ($P \leq 0.05$) using software Statistic 8.1.

Studies for the Chemical Plant Factors:

Various biochemical factors (nitrogen, magnesium, copper, manganese, zinc, ferrous, calcium, potassium and phosphorous were calculated in finally selected nine varieties. The method utilised for the determination of chemical factors was taken from AOAC (1990). The methods were briefly described as under;

The samples were pretreated to destroy the organic matter, because the technique used for metal analysis atomic absorption spectrophotometer required organic matter free and transparent solution. For this purpose, wet digestion is performed. The weight of 50 grams fresh green leaves from each variety from the central shoot of the plant was collected. The sample was washed with distilled water in the laboratory and kept into the open air under the shade for three hours. These leaves were oven dry at 75°C for 12 hours. The oven dry material was cut into pieces and shredded in grinder. Weight 2 gm powder from each variety in separate and treated with 5 ml concentrated nitric acid to oxidize the organic material. For the thermal agitation, the flask were put on the hot plate and covered with crucible lids. The hot plate was at the rate of 70-80°C and slightly boiling of the sample after 2-3 hours. The temperature of the hot plate was subsequently raised to 150°C and then removed the crucible lids to evaporate the digestion mixture and stayed overnight. 5 ml of concentrated sulphuric acid and 3-5 ml of hydrogen peroxide were added. All the digestion procedure was conducted in the fume hood for the prevention of hazardous effects of nitric acid. Continue heating was carried out until complete decomposition of organic matter was took place and clear and transparent solutions were obtained. The contents of flasks were cooled and 10 ml of deionized water was added, then the solution was filtered twice through Whatman Filter paper # 42 and made up to volume 25 ml with deionized water. For the analysis of minerals, two methods were used to atomic absorption spectroscopy and flame photometry. For the analysis of zinc, iron and magnesium atomic absorption spectrometer was used while for the analysis of sodium, potassium and calcium flame photometer was used.

Atomic Absorption Spectrophotometer Analysis

Analysis of samples of sugarcane varieties and standard for the minerals was carried out by atomic absorption spectrophotometer with air acetylene flame. For minerals profile Perkin Elmer analyst 300 atomic absorption spectrophotometer was used. Other parameters, including lamp current and wave length were standard. Hollow cathode lamps of metal ions manufactured by Perkin Elmer that provide narrow spectral lines of moderate intensity with air acetylene system were utilized. The solution containing metal ions was included in the flame through aspiration, the metals ions through dissociation converted into atomic vapors. Atomic vapors were not in grounded state in which electronic arrangements are stable, however part of it absorbed thermal energy emitted from the flame and putting them in an excited state in which energy level was higher. When light beam irradiated from a hollow cathode lamp, atomic vapours in base state absorbed only the spectrum where a wave length was inherited to measure the element and state changes to excite state. The amount of intensity from the spectrum to be absorbed was proportional to the number of atoms in the base state or concentration of the metal ions.

0.5 grams of dry leaf tissue powder from each sample were taken to determine the nitrogen percentage in leaf tissue by Kjeldalh Method (Winkleman *et al*., 1986).

Determination of Nitrogen

Principle

The change of nitrogenous compounds of sample into ammonium sulphate by boiling with sulphuric acid, successive decomposition of ammonium sulphate with fixed alkali (40% NaOH) and collection of ammonia in acid solution, was titrated against acid of known strength and then the nitrogen of the sample was calculated.

N/10 H_2SO_4, 40% sodium hydroxide, distilled water, 2% boric acid methyl red indicator, digestion mixture (K_2SO_4, CuSO4 and $FeSO_4$), sugarcane sample, commercial H_2SO_4, and ethanol.

Preparation of Digestion Mixture:

K_2SO_4 90 parts, $FeSO_4$ 3 parts, $CuSO_4$ 7 parts

Digestion

In total 2 grams' sample of dried sugarcane leaves was taken and 10 grams digestion mixture was added in the Kjeldhal digestion flask (500 ml). The 25-30 ml commercial $H_2SO_4$was then added and heated till it turned a light green.

Digested contents were transferred to a 250 ml volumetric flasks and the volume was made up to the mark with distilled water.

The10 ml of the sample solution was taken in a micro Kjeldhal distillation apparatus flask in which 10 ml of 40% NaOH solution was added. Another flask was taken containing 10 ml of 4% NaOH solution and one drop of methyl red as an indicator was added. The flask was kept to produce fumes of ammonia gas which were trapped in 4% boric acid solution. The end point was a yellow color. After 2 minutes, the flask containing boric acid was removed and the steam was removed. The boric acid solution was titrated with N/10 H_2SO_4, till a golden colour appeared. The volume of acid used was recorded and the nitrogen percentage was calculated using the formula below.

N% = Volume of N/10 H_2SO_4used 0.0014 volume of sample dilution 100

Wt. Of sample volume of sample solution used (10ml)

Table: 1.

Comparison of means for the data regarding Phosphorous, Potassium, Calcium, Magnesium, Copper, Ferrous, Manganese and Zinc in various chosen varieties of Sugarcane

Varieties	Nitrogen (%)	Phosphorous (%)	Potassium (%)	Calcium (%)	Magnesium (%)	Copper (ppm)	Ferrous (ppm)	Manganese (ppm)	Zinc (ppm)
US-676	1.075±0.035 B	0.237±0.003 AB	0.125±0.001 F	0.240±0.001 B	0.232±0.001 B	4.18±0.025 B	30.40±0.07B	32.57±0.19 E	19.71±0.07 D
US-133	1.147±0.002A	0.213±0.004 D	0.190±0.001 E	0.230±0.001 C	0.216±0.002 C	3.97±0.012 C	29.74±0.04C	35.60±0.11 C	20.51±0.10C
US-312	1.034±0.001 C	0.224±0.002 C	0.217±0.001 C	0.220±0.002 D	0.207±0.002 D	3.84±0.011D	31.70±0.08A	30.73±0.15 F	19.59±0.13D
SPF-234	1.073±0.002 B	0.198±0.003 E	0.243±0.002A	0.181±0.002 F	0.240±0.001 A	3.58±0.011H	30.55±0.10B	37.34±0.07 A	22.60±0.12A
US-1491	1.135±0.002 A	0.191±0.002 E	0.222±0.001 B	0.249±0.002 A	0.234±0.002AB	3.78±0.009 E	29.66±0.07C	36.48±0.20 B	22.51±0.14A
US-824	1.089±0.002 B	0.237±0.002AB	0.210±0.001D	0.181±0.002 F	0.190±0.003 E	3.74±0.010EF	28.49±0.12D	34.56±0.07 D	20.67±0.11C
CPF-246	1.068±0.002BC	0.244±0.001 A	0.192±0.001 E	0.232±0.002 C	0.220±0.002 C	3.65±0.006 G	29.81±0.08C	32.53±0.16 E	19.65±0.25D
US-718	1.064±0.001BC	0.199±0.002 E	0.222±0.002 B	0.196±0.001 E	0.214±0.003CD	3.73±0.021 F	30.59±0.11B	34.29±0.20 D	18.50±0.13 E
CPF-237	1.073±0.002 B	0.230±0.002BC	0.188±0.002 E	0.229±0.002 C	0.230±0.003 B	4.25±0.010 A	31.61±0.17A	36.45±0.04 B	21.65±0.13B

± (SE) = Standard error

Table-2

Correlation between infestation and various chemical plant factors

Factors	Correlation Coefficient Valu e (r)
Nitrogen (%)	0.335
Phosphorous (%)	0.144
Potassium (%)	-0.121
Calcium (%)	-0.209
Magnesium (%)	0.154
Copper (ppm)	0.328
Ferrous (ppm)	-0.170
Manganese (ppm)	0.608
Zinc (ppm)	0.638

Table-3

Regression analysis for Chemical plant factors

Regression Equation	R^2
$Y = 10.8 X_1$	0.348
$Y = X_1 + 14.3 X_2$	0.507
$Y = X_1 + 7.5 X_2 - 9.7 X_3$	0.579
$Y = X_1 + 5.7 X_2 - 12.0 X_3 - 7.3 X_4$	0.620

Y = Infestation, X_1 = Nitrogen, X_2 =Phosphorous, X_3 = Potassium, X_4 = Calcium,
R^2 = Coefficient of Determination

RESULTS

The results showed that impact of Potassium. Calcium and Ferrous was negative and non significant. Other factors like Nitrogen, Phosphorous, Magnesium, Copper, Manganese and Zinc showed a positive but non-significant impact on pest infestation. The Nitrogen percentage contributes to 33.5% in pest infestation. With the addition of Phosphorus, this value was increased up to 50.7% followed by Potassium (57.9%) and Calcium (62%). The maximum phosphorus percentage was recorded 0.24% in variety CPF-246 after US-676 with 0.23% which significantly was different from other varieties. The variety US-1491 showed the minimum percentage of phosphorus with 0.19% which similar in varieties SPF-234 and US-718. The variety US-824 possessed 0.23% and was at par with those of recorded in CPF-237, US-312 and US-133. The maximum percentage of Potash was recorded in SPF-234 with 0.24% followed by 0.22% in varieties US-1491 and US718 while 0.21 percent in varieties US-312 and US-824 which significantly different from all other varieties. The minimum percentage of Potash was recorded in a variety US-676 which significantly highly different from other varieties. Varieties US-133 and CPF-234 showed Potash percentage 0.19% while variety CPF-237 showed 0.18% which significantly different from other. The minimum calcium percentage was recorded in variety US-824 with 0.18% similar in SPF-234 after US-718 with 0.19% respectively. The maximum percentage of calcium was found in US-1491 and US-676 with similar 0.24% which significantly different from other. US-133 and CPF-246 varieties showed 0.23% calcium which did not significantly differ from US-312 and CPF-237 with 0.22%. The maximum magnesium percentage was recorded in SPF-234 with 0.24% followed by US-676, US-1491 and CPF-237 with a similar percentage of magnesium 0.23% which significantly different from other. The minimum magnesium percentage was recorded in US-824 with 0.19% which was significantly different from other varieties. The variety CPF-246 showed 0.22% magnesium which was not significantly different from US-718 with 0.21% and US-312 with 0.20%. The minimum concentration was recorded in SPF-234 with 3.58ppm which significantly different from US-718 and CPF-246 with 3.73 and 3.65ppm. The maximum concentration was found CPF-237 with 4.25ppm followed by US-676, US-133 and US-312 with 4.18, 3.97 and 3.84pm which was significantly different from other. The varieties US-1491, US-824 and US-718 showed the intermediate concentration of 3.78ppm, 3.74ppm and 3.73ppm which did not significantly from one another while significantly from other varieties. The maximum concentration of ferrous was recorded in US-312 with 31.70ppm did not significantly from CPF-237 with 31.63ppm. The minimum was recorded in US-824 with 28.49ppm. The US-133 with 29.74ppm showed significant for US-1491 and CPF-246 with 29.66ppm and 29.81ppm. The US-676 with 30.40ppm did not show significant for US-718 with 30.59ppm while significantly from US-824 with 28.49ppm. The maximum contents of manganese were recorded in SPF-237 with 37.34ppm followed by US-1491, CPF-237 and US-133 with manganese contents 36.48, 36.45 and 35.60ppm which significantly different from other. The minimum contents were revealed in US-312 with 30.73ppm. The US-824, US-718, US-676 and CPF-246 showed manganese contents with 34.56, 34.29, 32.57 and 32.53ppm respectively which significantly different from other. The means were compared by Tukey HSD test (P=0.05). The minimum contents of zinc were recorded 18.50ppm in US-718. The maximum contents were recorded in SPF-234 (22.60ppm) which did not significantly from US-1491 and CPF-237 with zinc contents 22.51 and 21.65ppm respectively. The US-824 (20.67ppm) did not significantly from US-133 with 20.51ppm but significantly different from the US-676, CPF-246 and US-312 with zinc contents 19.71, 19.65 and 19.59 respectively.

DISCUSSION

The effects of macro and micro nutrients deficiency slows down the plant growth and development (Fragoyiannis *et al*., 2001; Jansson and Ekbom, 2002). The reduction in proportion of nitrogen in plants, retarded the growth of herbivorous insects (Scriber and Slansky, 1981). Cornelissen and Fernandes (2001) reported that the absorption of sugars in leaves affects the area of leaf damaged by herbivores in *Bauhinia brevipes*. Comes (1916) reported that the accessibility of plants increases with the quantity of reducing sugars, and resistance increases with organic acids. The quantity of reducing sugars was affected by insects which increased the vegetable tissues, caused reduction in the organic acids. The effects of chemical plant factors on the population of sugarcane stem borer were calculated by processing the data into simple correlation and multiple linear regression of variance. It is evident from the results that impact of Potassium, Calcium and Ferrous was negative and non significant while other factors like Nitrogen, Phosphorous, Magnesium, Copper, Manganese and Zinc showed positive and non significant impact on pest infestation. The present findings are partially comparable with those of Khaliq *et al*. (2005) who reported that Copper and Manganese showed non-significant correlation with borer infestation. The present findings show positive relationship with Nitrogen and Magnesium but contradict with Phosphorus, Zinc, Potassium, Calcium and Ferrous showing non-significant correlation with borer infestation. The present findings are comparable with those of Saikia *et al*. (1998) who reported that Copper and Manganese showed non-significant correlation.

CONCLUSION

It is concluded that nitrogen, phosphorous, magnesium, copper, manganese and zinc contents of sugarcane showed positive and non significant impact on pest infestation. The impact of potassium, calcium and ferrous had negative and non significant with pest infestation.

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