Journal of Agriculture and Veterinary Science
ISSN: 2959-1198 (Print), 2959-1201 (Online)

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Research Article

Varietal Preference of Black Bug *Cavelerius excavatus* Distant (Hemiptera: Lygaeidae) on Sugarcane in Field

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ABSTRACT

Black bug, *Cavelerius excavatus* is a serious pest of sugarcane that causes huge losses under favorable conditions. Considering its recent losses in Sindh, Pakistan, this experiment was carried out at Sugarcane Research Institute, Agriculture Research Center, Tandojam to determine their population preference of *Cavelerius excavatus* on nineteen sugarcane varieties. The sugarcane varieties used in the study were NSG-45, B-46-364, BO 14, B-6705, B-6518, CO-419, CP-68-1059, CO-474, CO-616, CO-557, CO-235, B-54-142, CO-475, CO-620, LRK-2001, Raja-14, Q-88, PSTj-41 and LAmTj-76/803. The experiment was conducted in a RCBD design, and each variety was replicated five times. Weekly data was collected from both ratoon and newly grown crop of each variety from sowing till maturity. In each replication five randomly selected plants were observed to count *C. excavatus* population from the entire plants. Data on weather factors was also obtained. Results indicated that *C. excavatus* population was not found on all freshly grown varieties, but it attacked on all ratoon varieties grown, as none of the variety was found resistant. Maximum overall mean population of adults was recorded on LAmTj-76/803 variety (4.47±0.22 adults/ plant) followed by B-6705 (4.16±0.23 adults/ plant), PSTj-41 (3.54±0.23 adults/ plant), CP-68-1059 and Q-88 (3.53±0.21 adults/ plant) and BO-14 (3.51±0.23 adults/ plant). Overall, the lowest *C. excavatus* adult population was recorded on CO-475 (0.98±0.12 adults/) followed by CO-235 (1.19±0.13 adults/plant). Overall maximum mean population of nymphs was recorded on BO-14 and PSTj-41 varieties (3.20±0.21 nymphs/ plant) followed by LAmTj-76/803 (3.12±0.20 nymphs/ plant) and B-6705 (2.90±0.20 nymphs/ plant), hence treated as most susceptible. Minimum nymph population was recorded on CO-475 (1.12±0.11 nymphs/ plant) followed by CO-620 (1.38±0.12 nymphs/ plant), and CO-235 (1.43±0.13 nymphs/ plant) varieties. Among abiotic factors, temperature exhibited a significant, positive and moderate effect on the population of both adults and nymphs in sugarcane, whereas wind velocity showed a negative, moderate and significant effect on their population. Based on the findings, it is suggested that growing of sugarcane as ratoon crop should be avoided to save the crop by the losses of *C. excavatus*.

Keywords: Black Bug, Sugarcane, Damage, Dispersion, Genotypes, Losses, Management, Sindh.

OPEN ACCESS

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Article History
Received: September 24, 2024
Accepted: November 29, 2024
Published: December 05, 2024

INTRODUCTION

Sugarcane, *Saccharum officinarum* L. is a major cash crop grown around the world (Azam et al., 2019; Munir et al., 2020; Yao et al., 2017). In Pakistan, sugarcane is a

significant industrial and highly valued cash crop (Afghan et al., 2022). Millions of people work with sugarcane in the agriculture sector and then allied sugar industry (Iqbal and Iqbal, 2014). A substantial segment of the global population depends on this crop for their industrial, economic, medicinal and nutritional purposes (Rehman et al., 2015). A major part of sugarcane is used in producing a variety of valuable products like pulp, biogas, ethanol, brown sugar, refined sugar and jaggery, among other by-products (Prasara-A and Gheewala, 2016).

In Pakistan during 2022-23, sugarcane was cultivated on 1,319 thousand hectares showing an increase of 4.7 percent compared to 1,260 thousand hectares last year (GoP, 2024). The main factor contributing to more area sown were lucrative market prices of last year. Its production increased by 2.8 percent to 91.111 million tonnes over last year (88.651 million tonnes) (GoP, 2024). According to estimates by Taspinar *et al*. (2019), 25% of sugar is produced from sugar beets and 75% comes from sugarcane. Three regions are used to grow sugarcane in Pakistan: the tropical Sindh, the subtropical Punjab and the temperate Peshawar valley (Pakistan Sugar Mills Association, 2019).

Several factors involved , including a lack of water, lower economic returns, greater production costs and poor sugar recovery are causing both yield and area to decline in Pakistan (Morrill et al., 1995). The insect pest infestation on this crop is one of the primary causes of low yield (Ullah et al., 2012). Sugarcane is a long-duration crop planted across a large area is under threat from many insect pests including the sugarcane borer, whitefly, woolly aphid, termites, leafhoppers and bugs (Prasad et al., 2018). It was known that 288 insect pests could attack sugarcane, where twenty-four insect pests cause considerable losses to sugarcane production and quality (Sanskriti et al., 2022). Several insect pest species have been reported from Sindh, Pakistan and various insect pest species from Indo-Pakistan have also been described (Chaudhry and Ansari, 1988).

Sugarcane black bug, *Cavelerius excavatus* (Dist.) is a widely distributed pest which sucks cell sap by residing in the whorls of sugarcane crop (Atwal and Dhaliwal, 2009). Recently it has become a serious pest of sugarcane in some areas in Pakistan. The *C. excavatus* was a minor pest till the late seventies, but now it has attained the status of major pest of sugarcane (Atwal and Dhaliwal, 2009). It was assumed that it was a serious pest of young ratoon crop during pre-monsoon only and during rainy periods. However, some studies suggested that *C. excavatus* is not only a pest of ratoon crops, but it can also cause severe damage to all types of crops viz., planted as well as ratoon crops (Pandey and Singh, 2014).

Both adults and Nymphs cause damage by sucking cell sap from the plants as a result the shoot turns pale yellow in color with brown patches and sickly appearance. These subsequently have an impact on the length, girth and weight of the stem as well as the chlorophyll content of the leaves (Atwal and Dhaliwal, 2009; Hayat Zada et al., 2013). The healthy stalk was significantly longer than the infected stalk and it was noticed that the infected stalk has lower weight than the normal stalk. There are negative effects on the growth of the sugarcane plant and the juices quality because of its damage (Hayat Zada et al., 2013). The young plants cell sap is gregariously sucked by *C. excavatus* adults and nymphs (Atwal and Dhaliwal, 2009). New nymphs emerge in either March-April which is also a peak period of its infection and from June to October as both nymphs and adults can be present together in a particular sugarcane crop. The adults of *C. excavatus* move easily, in this way infestation spread from one plant to other, but nymphs are less mobile. In severe cases of threat, the plant may potentially desiccate and die as feeding of 4 to 6 bugs/plant has a significant impact on the growth of the sugarcane plant within 4-6 days (Morrill et al., 1995).

The management of *C. excavatus* requires use of both cultural control and chemical insecticides in sugarcane. During the initial infestation period of *C. excavatus,* its damage can be reduced by burning the trash and leaves of sugarcane and its associated weeds after the harvest of the main crop, whereas use of synthetic chemicals should be opted as the last option during severe infestation (Jaipal, 1991). It has also been noticed that deficiency of nitrogen fertilizers in sugarcane enhanced the damage potential of *C. excavatus.*

The incidence and intensity of *C. excavatus* in ratoon crop may be reduced from 50 to 70 % simply with the removal or burning of plant crop residue and foliar nitrogen applications (Jaipal, 2000). Among other management options, use of resistant sugarcane varieties can be a good option to manage its losses, as Jaipal (1991) evaluated nineteen varieties of sugarcane among these were found most susceptible, whereas CoS 767 was screened out as least susceptible and showed no signs of damage.

In recent years, the severity of *C. excavatus* has been reported from main sugarcane areas of Sindh, but no systematic work has been yet done its various aspects, particularly evaluating the level of resistance among widely cultivated sugarcane varieties. Therefore, this study was conducted to determine the relative resistance of various sugarcane varieties against *C. excavatus* under field conditions.

MATERIALS AND METHODS

Experimental area

The experiment was carried out at the experimental area of Sugarcane Research Institute, Agriculture Research Center, Tandojam.

Varieties used

The sugarcane varieties used in the study were NSG-45, B-46-364, BO-14, B-6705, B-6518, CO-419, CP-68-1059, CO-474, CO-616, CO-557, CO-235, B-54-142, CO-475, CO 620, LRK-2001, Raja-14, Q-88, PSTj-41 and LAmTj-76/803. All the agronomic practices were used as per the recommendations for the cultivation of sugarcane.

Experimental setup, data collection and analysis

The experiment was conducted under field conditions in a Randomized Complete Block Design (RCBD). Each sugarcane variety was divided into five blocks that were treated as replications. The data was collected from both ratoon and newly grown sugarcane varieties since their sowing till the maturity of crop. The whorls of five plants per replication of each sugarcane variety were randomly observed to count the number of *C. excavatus* nymphs and adults by counting their number from the entire selected plants. Observations were taken on a weekly basis.

The data for weather parameters such as temperature, relative humidity and wind velocity were obtained from the local Meteorological Station, Tandojam to determine their influence on *C. excavatus* populations on sugarcane varieties.

Statistical Analysis

Moreover, Analysis of Variance (ANOVA) along with the Least Significant Difference (LSD) were used to determine the relative preference of *C. excavatus* on different sugarcane varieties. Peason's correlation was performed to determine the impact of various weather parameters on the population fluctuation of *C. excavatus* on various sugarcane varieties of Sindh. All the analysis for the experiment was performed on STATISTIX 8.1 computer software.

RESULTS

The experiment on the population fluctuation of *Cavelerius excavatus* on sugarcane varieties were conducted at Sugarcane Research Institute, Agriculture Research Center, Tandojam. The detailed results for the population fluctuation of *C. excavatus* on sugarcane varieties are discussed below:

Population fluctuation of *Cavelerius excavatus* adults on various sugarcane varieties in Sindh, Pakistan

The result of the study confirmed a highly significant difference ($F = 39.50$; $P < 0.001$) among various sugarcane varieties regarding the population occurrence of *C. excavatus* adults on weekly basis. It was observed that the population trend of *C. excavatus* adults was observed on sugarcane varieties since the growth as ratoon (Figure 1). However, population of *C. excavatus* was not recorded on all the freshly cultivated sugarcane varieties. According to the initial population recorded during the first week of observation on 15th February 2023, the highest *C. excavatus* adult population was recorded on LAmTj-76/803 variety (2.1±0.43 adults/ plant), followed by B-6705 (1.9±0.38 adults / plant), CP-68 1059 (1.7±0.42 adults / plant), Q-88 (1.3±0.40 adults / plant), LRK-2001 (1.3±0.30 adults / plant) and PSTj-41 (1.1±0.28 adults / plant) varieties. Moreover, the lowest *C. excavatus* adult population was recorded on CO-620, B-54-142 and CO-475 (0.1±0.10 adults / plant) variety that was followed by CO-557 (0.2±0.13 adults / plant), B-46-364 and CO-616 (0.3±0.15 adults / plant), CO-419 (0.4±0.16 adults / plant), CO-474 (0.5±0.22 adults / plant) B-6518 (0.6±0.27 adults / plant), BO-14 (0.9±0.28 adults / plant), NSG 45 (1.0±0.21 adults / plant), Raja-14 (1.0±0.37 adults / plant) and whereas no population was recorded on CO-235 variety.

Afterwards, *C. excavatus* adult's population showed a rapid increase in various varieties that gradually decreased towards maturity of the crop. Weekly, the highest mean population of *C. excavatus* was observed during the 7^{th} to 9^{th} week of observation on different sugarcane varieties. Among varieties, the highest weekly mean population (6.9±0.78 adults / plant) was recorded on LAmTj-76/803 and B-6705 varieties, followed by PSTj- 41(6.0±0.37 adults / plant) and LRK-2001 (5.9±0.38 adults / plant) varieties. Moreover, on remaining varieties, the highest weekly mean population was recorded as BO-14 (5.8±0.36 adults / plant), Q-88 (5.4±0.60 adults / plant), NSG-45 (5.4±0.48, adults / plant), CP-68-1059 (5.2±0.88 adults / plant), Raja-14 (5.1±0.85 adults / plant), B-6518 and CO-474 (4.9±0.66 adults / plant), B-46-364 (4.6±0.65 adults / plant), CO-419 (4.5±0.69 adults / plant), CO-616 (4.1±0.62 adults / plant), CO-557 (3.2±0.49 adults / plant), B-54-142 (2.9±0.38 adults / plant), CO-475 (2.8±0.40 adults / plant), CO-620 (2.7±0.37 adults / plant) and CO-235 (2.3±0.40 adults / plant) as shown in (Figure 1).

Overall, the highest (4.47±0.22 adults / plant) mean population of *C. excavatus* adults was recorded on LAmTj-76/803 variety, followed by B-6705 (4.16±0.23 adults / plant), PSTj-41 (3.54±0.23 adults / plant), CP-68-1059 and Q-

88 (3.53±0.21 adults / plant), BO-14 (3.51±0.23 adults / plant) and LRK-2001 (3.43±0.19 adults / plant). Moreover, overall, the lowest *C. excavatus* adult population was recorded on CO-475 (0.98±0.12 adults / plant), followed by CO-235 (1.19±0.13 adults / plant), CO 620 (1.39±0.14 adults / plant), B-54-142 (1.51±0.15 adults / plant) and CO-557 (1.71±0.17 adults / plant) as shown in (Figure 2).

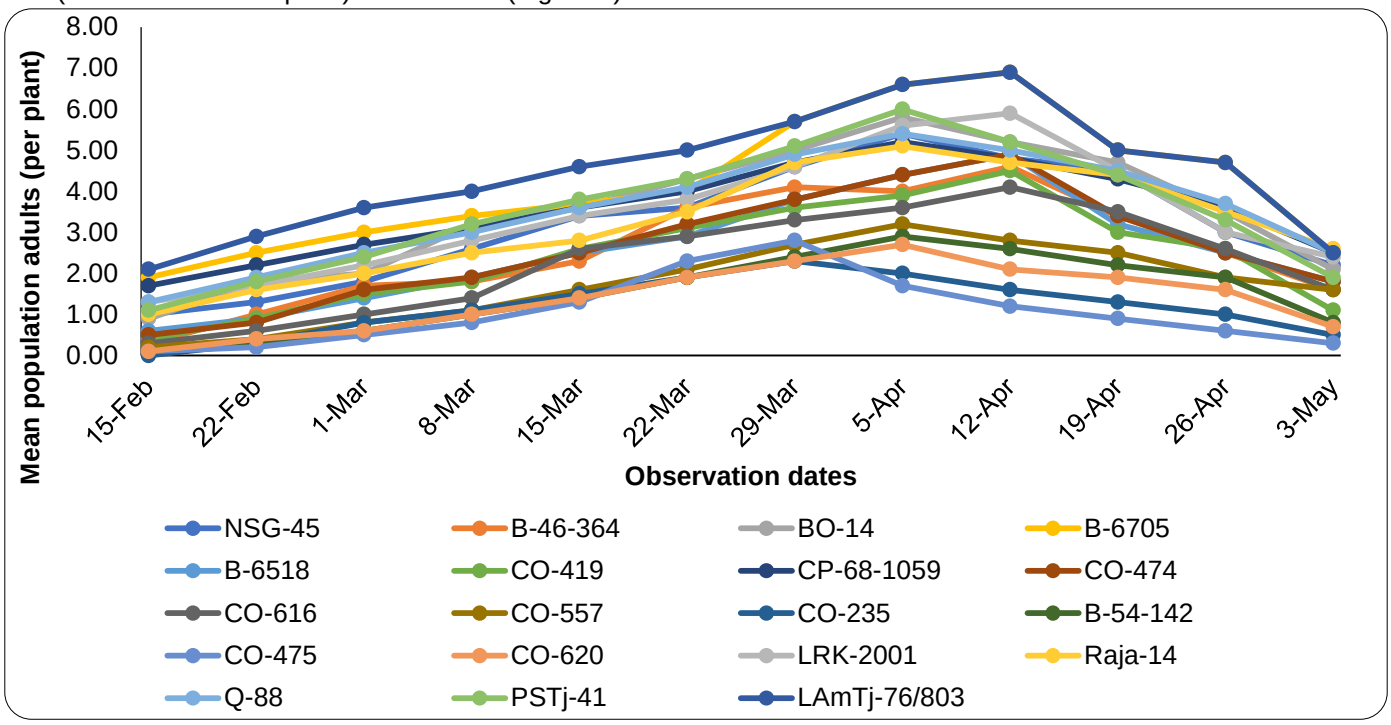

Figure 1. Weekly mean population of *Cavelerius excavatus* adults on different sugarcane varieties of Sindh, Pakistan.

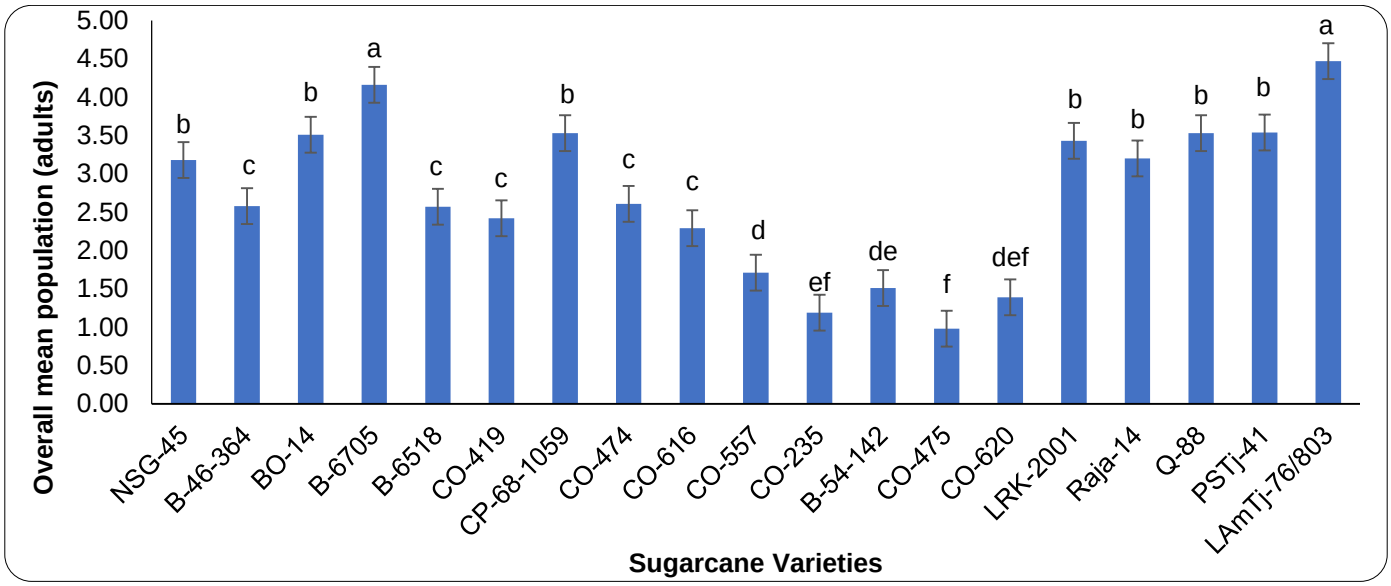

Figure 2. Overall mean population of *Cavelerius excavatus* adults on different sugarcane varieties of Sindh, Pakistan. *Means followed by same letters not significantly different from each other (LSD = 0.4493, P <.0.05)

Population fluctuation of *Cavelerius excavatus* nymphs on various sugarcane varieties in Sindh, Pakistan

The result of the study confirmed a highly significant difference (F = 18.58; P = 0.001) among various sugarcane varieties regarding the population occurrence of *C. excavatus* nymphs on weekly basis. According to the results, the population of *C. excavatus* nymphs were observed on sugarcane varieties since the sowing of crop. Thus, during the first week of observation on 15th February 2023, the highest *C. excavatus* nymph population was recorded on LAmTj-76/803 variety (1.5±0.34 nymphs / plant), followed by LRK-2001 (1.3±0.40 nymphs / plant), B-6705 (1.0±0.33 nymphs / plant), CP-68-1059 and Raja-14 (0.9±0.35 nymphs / plant), Q-88 (10.9±0.31 nymphs / plant) and PSTj-41

(0.8±0.29 nymphs / plant) varieties. Moreover, the lowest *C. excavatus* nymph population was recorded on CO-475 (0.1±0.10 nymphs / plant) variety that was followed by CO-235 & B-54-142 (0.2±0.13 nymphs / plant), CO-474 & CO-557 (0.3±0.15 nymphs / plant), B-6518 (0.4±0.16 nymphs / plant), CO-616 (0.4±0.22 nymphs / plant), CO-419 (0.6±0.22 nymphs / plant), BO-14 (0.6±0.27 nymphs / plant), NSG-45 (0.7±0.26 nymphs / plant), B-46-364 (0.7±0.30 nymphs / plant) and whereas no population was recorded on CO-620 variety.

Afterwards, *C. excavatus* nymph population showed a rapid increase in various varieties that gradually decreased towards maturity of the crop. Accordingly, weekly, the highest mean population of *C. excavatus* was mostly observed during 8th to 9th week of observation on different sugarcane varieties. Among varieties, the highest weekly mean population (5.7±0.52 nymphs / plant) was recorded on LAmTj-76/803 and B-6705 varieties, followed by PSTj-41(5.2±0.42 nymphs / plant) and BO-14 (5.1±0.66 nymphs / plant) varieties. Moreover, on remaining varieties, the highest weekly mean population was recorded as B-46-364 (4.8±0.76 nymphs / plant), Q-88 (4.8±0.42 nymphs / plant), LRK 2001 (4.6±0.54 nymphs / plant), NSG-45 (4.4±0.60 nymphs / plant), CP-68-1059 (4.2±0.84 nymphs / plant), Raja-14 (4.1±0.80 nymphs / plant), CO-419 (4.0±0.73 nymphs / plant), B-6518 & CO-474 (3.9±0.64 nymphs / plant), CO-616 (3.6±0.70 nymphs / plant), CO-557 and CO-235 (2.8±0.39 nymphs / plant), CO-620 (2.6±0.37 nymphs / plant), B-54-142 (2.6±0.31 nymphs / plant), CO-475 (2.5±0.34 nymphs / plant) as shown in (Figure. 3).

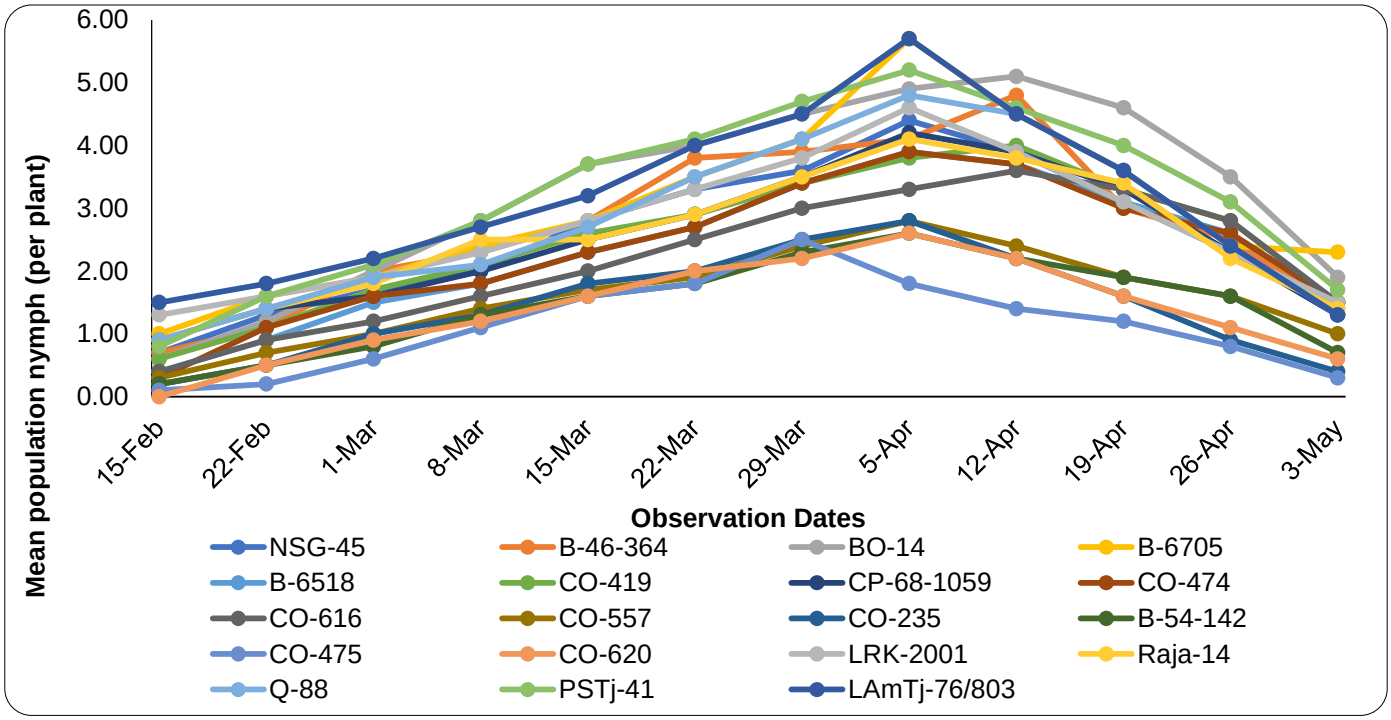

Figure 3. Weekly mean population trend of *Cavelerius excavatus* nymphs on different sugarcane varieties of Sindh, Pakistan.

Overall, the highest (3.20±0.21 nymphs / plant) mean population of *C. excavatus* nymphs was recorded on BO-14 and PSTj-41 varieties, followed by LAmTj-76/803 (3.12±0.20 nymphs / plant), B-6705 (2.90±0.20 nymphs / plant) and B-46-364 (2.70±0.20 nymphs / plant). Moreover, overall the lowest *C. excavatus* nymph population was recorded on CO-475 (1.12±0.11 nymphs / plant), followed by CO-620 (1.38±0.12 nymphs / plant), CO-235 (1.43±0.13 nymphs / plant), B-54-142 (1.46±0.13 nymphs / plant) and CO-557 (1.59±0.13 nymphs / plant). as shown in (Figure. 4).

The correlation results between the weekly mean capture of *C. excavatus* nymphs and adults with weather parameters i.e., temperature, relative humidity, and wind velocity. According to results, temperature elicited a positive, moderate and highly significant impact on mean population fluctuation of *C. excavatus* nymphs ($r= 0.5431$, $P < 0.001$), where as a positive, moderate and significant impact of temperature was recorded in adults ($r= 0.4871$, $P < 0.001$).

Moreover, wind velocity exhibited a negative, moderate but significant impact on *C. excavatus* adults mean population fluctuation ($r= -0.3651$, $P < 0.05$), whereas it showed a negative, week and non-significant impact on *C. excavatus* nymph population fluctuation ($r= -0.3544$, $P < 0.05$). No significant influence of relative humidity was recorded on the population of *C. excavatus* nymphs ($r = 0.1815$, $P = 0.2318$) and adults ($r= 0.1623$, $P = 0.3541$) describes (Table. 1).

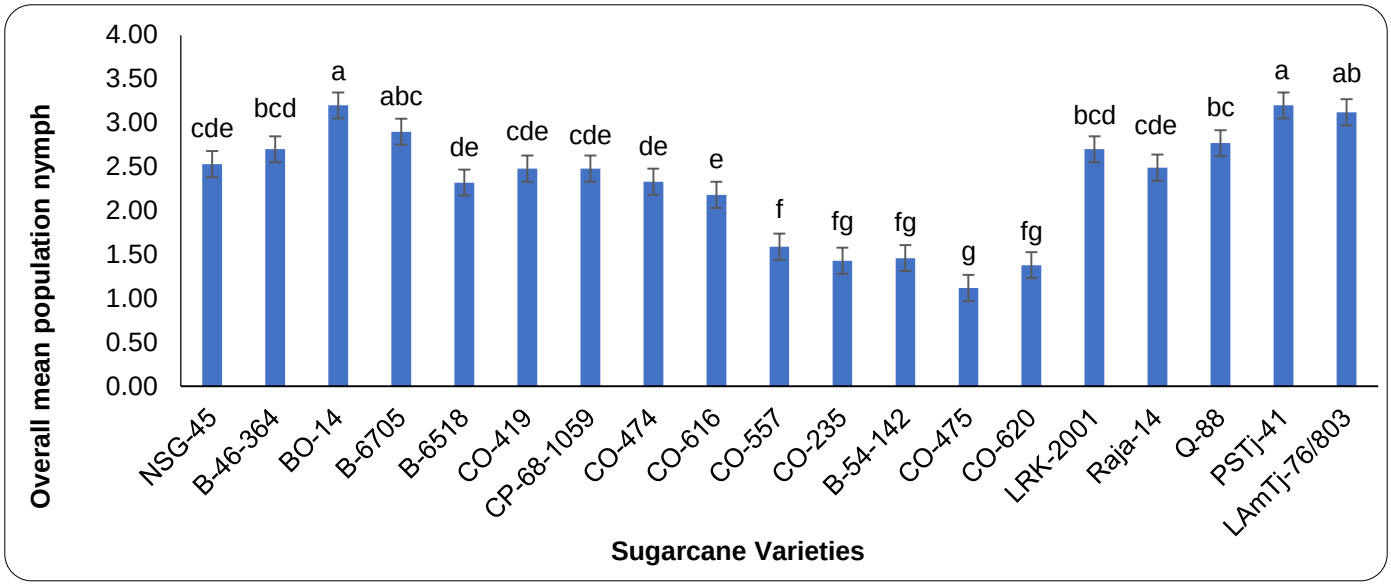

Figure 4. Overall mean population of *Cavelerius excavatus* nymphs on different sugarcane varieties of Sindh, Pakistan. *Means followed by same letters not significantly different from each other (LSD = 0.4168, P <0.05)

Table 1. Correlation coefficient of weekly mean fluctuation population of *Cavelerius excavatus* with weather parameter.

Weather parameter	Nymphs	Adults
Temperature	r= 0.5431, P < 0.001	r= 0.4871, P < 0.001
Relative humidity	r= 0.1815, P = 0.2318	r= 0.1623, P = 0.3541
Wind velocity	r= -0.3544, P < 0.05	r= -0.3651, P < 0.05

DISCUSSION

The studies were conducted to determine the relative preference of *Cavelerius excavatus* on nineteen locally and advanced approved sugarcane varieties of Sindh, Pakistan i.e., NSG-45, B-46-364, BO-14, B-6705, B-6518, CO-419, CP-68-1059, CO-474, CO-616, CO-557, CO-235, B-54-142, CO-475, CO-620, LRK-2001, Raja-14, Q-88, PSTj-41 and LAmTj-76/803 under regular and ratoon cultivation system. The infestation of *C. excavatus* was recorded on all the varieties when they were cultivated under ratooning system, with no infestation observed on regular cultivation of all the sugarcane varieties. Moreover, the level of infestation of *C. excavatus* showed highly significant variation among varieties, as none of the sugarcane variety was found to be completely resistant against *C. excavatus* nymphs and adults. Accordingly, the highest mean population of *C. excavatus* adults was recorded on LAmTj-76/803 and B-6705 varieties, whereas CO-475 was relatively less attacked by *C. excavatus* adults, followed by CO-235 and CO-620. Moreover, the highest mean population of nymphs was recorded on BO-14, PSTj-41 and LAmTj-76/803 varieties, whereas CO-475 was found highly resistant against *C. excavatus* nymphs, whereas CO-616, B-6518, CO-474, CO-419, CP-68-1059, Raja-14 and LRK-2001 were found moderately resistant.

It has been generally considered that *C. excavatus* generally preferred to attack on ratoon sugarcane crop than freshly grown sugarcane (Hayat Zada et al., 2013). According, the same was also observed in our studies that no population of *C. excavatus* was recorded on the all the sugarcane varieties when grown afresh. Moreover, studies conducted in different regions of the world also confirmed that *C. excavatus* showed variable preference in their attack on different widely grown sugarcane varieties in the particular countries of the world (Pandey and Singh, 2014).

According to Jaipal (1991), field research on eight commercial cane cultivars CoJ 64, Coil 92, CoS 8436 and Co 7717 (early maturing, high sugared), Coil 99 and CoS 767 (mid maturing, moderate sugared), and Coil 108 and Co 1148 (late maturing, moderate sugared) was done between 1992 and 1997. The studies were conducted at the Regional Research Station, Karnal, CCS-Haryana Agricultural University, on a loamy clay soil. A randomized block design was used for the plots, which were 10 m by 6 m, and each treatment check cultivar had three replications.

Jaipal (2000) reported that cultivar CoS 767 demonstrated the lowest pest number and largest rise in shoot height, leading to a significant drop in the incidence and intensity of *C. excavatus*. All of the cultivars in which the crop residue was removed together with foliar applications of 2.5 % urea twice in May showed a similar decrease *C.*

excavatus population density along with notable increases in shoot length and leaf nitrogen content.

In this regard, research was done by Jaipal (1991) to test the resistance against *C. excavatus* in nineteen sugarcane cultivars that were evaluated in a field experiment in 1989 90 in Haryana, India. The cultivars and sugarcane accessions included CoH 2, CoH 3, CoH 12, CoH 14, CoH 15, CoH 24, CoH 35, CoH 51, CoH 56, CoH 70, CoH 71, CoH 72, CoH 73, CoH 75, CoJ 64, CoS 767, Co 1148, and Co 7717. All showed a drop in shoot height ranging from 2.1 to 53.2%, indicating their susceptibility to the *C. excavatus.* While CoH 2, CoH 3, and CoH 12 were of intermediate sensibility, CoS 767 was the least susceptible and showed no apparent sign of damage. Such host resistance would be an additional technique for the control of *C. excavatus.*

The possible reasons for variable level of resistance among sugarcane genotypes against *C. excavatus* may be attributed due to various varietal characteristics such as presence of trichrome, wax, allelochemicals etc. (Sushil et al., 2020).

Though limited studies have been conducted on the varietal preference of *C. excavatus* in different sugarcane varieties, however due to their damage potential research have also focused on its management using various available tools (Saroj Jaipal, 2000). In this regarding Clothinadion, Malathion Viraat, Marshal, Acephate, Endosulfan, Acetamiprid, Carina, Polytrin, Karate, Chlorpyriphos and Quinolphos have evaluated various synthetic insecticides to manage population of *C. excavatus* under field conditions of sugarcane (Hayat Zada et al., 2013; Jaipal, 1996; Pandey and Singh, 2014; Raza et al., 2020). Moreover, potential of various biological control agents such as *Coccinella undicimpuntata* L., *Menochilus sexmaculatus* F., *Coccinella septumpunctata* L. and *Borumoides saturalis* F were also studied to control its population both under laboratory and field conditions (Hayat Zada et al., 2013).

CONCLUSION

Results of the study suggested that *C. excavatus* only attacked on ratoon crop of all the local and advanced approved varieties of Sindh, Pakistan. Among evaluated varieties, ratoon CO-475 suffered the lowest population of *C. excavatus* nymphs and adults, followed by CO-235 and CO-620 and were found to be relatively resistant. Moreover, LAmtj-76/803, B-6705, PSTj-41, and LAmTj-76/803 varieties suffered maximum population of *C. excavatus* nymphs and adults, hence were classified as highly susceptible. Among abiotic factors, temperature exhibited a significant, positive and moderate effect on the population fluctuation of both adults and nymphs in sugarcane, whereas, wind velocity showed a negative, moderate, and significant effect on their population.

It is recommended that the government and research institute should take serious efforts for the development of resistant sugarcane varieties against major insect pests including *C. excavatus.* Moreover, ratoon sugarcane crops require more attention to monitor and manage insect pests including black bug. However, if growers still want to grow ratoon sugarcane crop, they can grow either CO-475, CO-235, or CO-620.

AUTHOR CONTRIBUTIONS

All authors contributed equally to this research.

COMPETING OF INTEREST

The authors declare no competing interests.

REFERENCES

Afghan, S., Arshad, W.R., Khan, M.E., Malik, K.B., 2022. Sugarcane breeding in Pakistan. Sugarcane Technology 24, 232-242.

Atwal, A., Dhaliwal, G., 2009. Agricultural pests of South East Asia and their management. College of agriculture; Ludhiana. India. Kalyani Publishers, New Delhi.

Azam, A., Khan, F.A., Khan, A.A., Ullah, S., 2019. Genetic Diversity Analysis for Economically Important Traits of Sugarcane (*Saccharum officinarum* L.) Ratoon Crop. Journal of Experimental Agriculture International 33, 1-14.

Chaudhry, N., Ansari, M., 1988. Insect pests of sugarcane in Pakistan. Progressive Farming 8, 10-18.

GoP, 2024. Economic survey of Pakistan 2022–2023, Finance Division, Government of Pakistan, Economic Advisor's Wing, Islamabad. www.finance.gov.pk.

Hayat Zada, H.Z., Bashir Ahmad, B.A., Hayat Badshah, H.B., Ahmad-ur-Rehman Saljoqi, A.-u.-R.S., Muhammad Naeem, M.N., Sajjad Anwar, S.A., Muhammad Zamin, M.Z., 2013. A study of comparison of field effectiveness of coccinillid predators and chemical insecticides in the management of sugarcane black bug *Cavelarius excavatus* (Dist.)(Lygaedae: Hemiptera) in Shahpur Sargodha, Pakistan. Pakistan. Journal of Agriculture 29, 213-217.

Iqbal, M.A., Iqbal, A., 2014. Sugarcane production, economics and industry in Pakistan. American-Eurasian Journal of Agricultural & Environmental Sciences 14, 1470-1477.

Jaipal, S., 1991. Infestation and severity of damage by black bug *Cavelerius sweeti* to shoots of nineteen sugarcane accessions and cultivars. Annals of Applied Biology 118, 120-121.

Jaipal, S., 1996. An evaluation of mechanical and chemical methods for the control of black bug (*Cavelerius sweeti* & *C. excavatus*) in sugarcane ratoon crop. Annals of Applied Biology 128, 4-5.

Jaipal, S., 2000. An IPM module for the management of major insect pests of sugarcane in Indian subtropics. Sugarcane Technology 2, 1-8.

Morrill, W., Shepard, B., Rida, G., Parducho, M., 1995. Damage by the Malayan black bug (Heteroptera: Pentatomidae) in rice. Journal of Economic Entomology 88, 1466-1468.

Munir, M., Fiaz, N., Ali, Q., Ahmad, K.J., Sikandar, Z., 2020. Screening of sugarcane *(Saccharum officinarum* l.) varieties/lines for borer's infestation under natural conditions. Journal of Agriculture Research 58, 195-199.

Pandey, S., Singh, M., 2014. Influence of weather parameters on the population dynamics of black bug,(*Cavelerius sweeti* Slater & Mugomoto) in sugarcane in Haryana, India. Indian Journal of Agricultural Research 48, 199-204.

Prasad, K., Doharey, R., Kumar, M., 2018. International Journal of Agriculture Extension and Social Development. International Journal of Agriculture Extension and Social Development 1, 01-04.

Prasara-A, J., Gheewala, S.H., 2016. Sustainability of sugarcane cultivation: case study of selected sites in north-eastern Thailand. Journal of Cleaner Production 134, 613-622.

Raza, I., Nasir, M., Salman, M., Asif, M.U., 2020. Evaluating the toxicity potential of some insecticides against sugarcane black bug, *Cavelerius excavatus* (Hemiptera: Lygaeidae). Pure and Applied Biology 9, 1701-1707.

Rehman, A., Jingdong, L., Shahzad, B., Chandio, A.A., Hussain, I., Nabi, G., Iqbal, M.S., 2015. Economic perspectives of major field crops of Pakistan: An empirical study. Pacific Science Review b: Humanities and Social Sciences 1, 145-158.

Sanskriti, K.A., Chandra, S., Singh, M.K., Prasad, S., 2022. Major pests of sugarcane and their integrated management tactics. Vigyan Varta an International E Magazine for Science Enthusiasts 3, 23-26.

Saroj Jaipal, S.J., 2000. An IPM module for the management of major insect pests of sugarcane in Indian subtropics. Indian Sugarcane Technology 2, 1-8.

Sushil, S.N., Chandra, A., Roy, S., Jaiswal, A.K., Singh, M.R., Pathak, A.D., 2020. Determination of morphological and biochemical basis of resistance against sugarcane black bug, Caveleriuc excavatus Walker in sugarcane. Indian Sugarcane Technology 22, 259-265.

Ullah, F., Shakur, M., Badshah, H., Ahmad, S., Amin, M., Zamin, M., 2012. Efficacy of *Trichogramma chilonis* ishii in comparison with two commonly used insecticides against sugarcane stem borer *Chilo Infuscatellus* snellen (lepidoptera: pyralidae). Journal of Animal and Plant Sciences 22, 463-466.

Yao, W., Ruan, M., Qin, L., Yang, C., Chen, R., Chen, B., Zhang, M., 2017. Field performance of transgenic sugarcane lines resistant to sugarcane mosaic virus. Frontiers in Plant Science 8, 104.