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Studies on Varietal Reaction and Loss Estimation of Yield and Yield Related Parameters Due to *Holotrichia Serrata* (Fabricius) Infestation in Sugarcane

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ABSTRACT

Soil pests that attack crop roots are amongst the most economically damaging pests. Investigation was conducted on varietal reaction and loss estimation of yield and yield related parameters due to *Holotrichia serrata* (Fabricius) *infestation* in sugarcane during 2021-23 in farmer field of Kerur village, Chikkodi taluka, Belagavi district of Karnataka, India with different sugarcane varieties. Among the five sugarcane genotypes screened against *H. serrata* grub both under protected and unprotected conditions, variety CoM 265 emerged and proved as tolerant to white grub attack followed by CoSnk 13374 and yielded significantly more cane yield in spite of white grub attack. Irrespective of varieties the grub population recoded was less in *M. anisopliae* applied plot resulting in better NMC and cane yield.

Keywords : Sugarcane, soil pest, varietal reaction, loss estimation, white grub

INTRODUCTION

White grubs (Coleoptera : Scarabaeidae) are soil inhabiting and root feeding immature stages of scarab beetles. The white grub family, scarabaeidae is the second largest family within the order coleoptera. The world fauna of white grub exceeds 30,000 species (Mittal, 2000) and there are about 1300 North American species (Borror et al. 1975).

Above and below ground herbivory represents a major challenge to crop productivity and sustainable agriculture worldwide. Root herbivory are especially damaging to crops, particularly when combined with abiotic stresses (Zvereva and Kozlov, 2012; Erb and Lu, 2013), which leads to substantial losses in crop yields. Plants often cannot tolerate root herbivory to the same extent as they can shoot herbivory, not because their damage is acute but also because many root-feeding pests are extremely persistent, with damage to plant tissues lasting for many months or even years. This persistence frequently results in prime agricultural land being taken out of production. Sugarcane crop is infested with more than 200 species of pests. Among the different pests of sugarcane, white grubs assumed the status of “National Pest” during the 1960s with the emergence of modern agriculture. The white grub family, Scarabaeidae is the second largest and omnipresent family within the order of Coleoptera (Mishra and Singh, 1999). The immatures of scarabaeid beetles are known as ‘white grubs’ for their white larvae that are found under the soil where they feed on the roots and rootlets of plants and are the most serious pests of almost all cultivated crops (Veeresh, 1977). Among the pests, the subterranean, white grub has the potential to cause 80-100 per cent damage to sugarcane crops (Chelvi et al. 2011).

White grubs are polyphagous pests having a wide range of hosts which are damaged by both adult and larval stages and of these the larvae are of a greater nuisance. Beetles are defoliating pests and damage a large number of horticultural and forest species by

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feeding on apical buds and tender leaves, whereas, the grubs feed on sugarcane plant roots causing yellowing. They cause wilting which is characterized by initial yellowing of the leaves, followed by drying resulting in the death of affected plants and reduced vigour or lodging of canes in sugarcane crop. Larvae feed by making circular holes into lower internodes rendering them unfit for marketing. Some plants wilt and ultimately die; such plants can be easily pulled out. The extent of damage caused by white grubs solely depends upon the species involved, the numbers of pests present and the host crop.

Stebbing (1902) for the first time reported the occurrence of white grub in India. Gupta and Avasthy (1965) reported white grub as a pest of sugarcane in India. Further, there are about 1500 species recorded from India, out of which 40 species are reported to be serious pests. In India, white grub is one of the five pests of national importance (Yadava and Vijayavergia, 1994).

Belagavi district is considered the sugar bowl of Karnataka. Traditionally, sugarcane was cultivated in this area under transitional belt, receiving well distributed rainfall. But in subsequent decades sugarcane cultivation has come up even in non-traditional belts owing to availability of various sources of irrigation such as river, borewells and open wells. Shift from traditional belt to non-traditional belt has resulted in increased white grub menace year after year paving way for the establishment of the pest throughout the sugarcane growing areas. This has also enabled the white grub spread on to non-traditional areas affecting both agricultural and horticultural crops increasing its host diversity.

Among the various species of white grubs, *Holotrichia serrata* (Fabricius) has become a key species by causing 30 to 40 per cent loss in sugarcane alone under irrigated ecosystem of Belagavi district. Apart from sugarcane, *H. serrata* infestation has spread to both *kharif* and *rabi* crops in these areas and *H. serrata* has become a devastating pest causing economic concerns for Belagavi and adjoining districts (Lavanya et al. 2023).

Since the white grub menace has spread across to different crops, over the years it has changed its behavior attaining perennial status. In view of the changed pest behavior, crop diversity and a separate strategy is required for varietal reaction and loss estimation in sugarcane.

MATERIALS AND METHOD

A study was conducted on sugarcane varietal reaction and loss estimation of yield and yield related parameters due to *Holotrichia serrata* (Fabricius) *infestation* in sugarcane during 2021-23 in farmer field of Kerur village, Chikkodi taluka, Belagavi district of Karnataka, comprising of five different varieties of sugarcane *viz.*, CoVSI 08005, CoSNK 13374, CoM 265, CoC 671 and Co 86032 in a single block of 5 acres. All the varieties were planted during November 2021 and November 2022.

Half an acre of each variety was maintained under complete randomized block with four replications by applying *M. anisopliae* @ 10 kg per acre during February and remaining half an acre with four replications was left without taking any protection and maintained as control plot to assess the reaction of varieties both under protected and unprotected conditions.

Grub population per m^2 area was taken during June month which coincided with peak grub incidence in June month in protected as well as unprotected plots following destructive sampling. Various growth and yield related parameters were recorded as described hereunder:

Average cane girth: The diameter of five millable canes in each clump was recorded on the middle internode of the cane by using vernier calipers at the time of harvest and average girth was expressed in centimeters.

Average millable cane height (cm): The height of five millable canes was recorded from ground level to the last internode of millable canes in each clump with the help of measuring scale and the average height was expressed in centimeters.

Number of millable canes (NMC) per clump: All the canes from each clump were cut, dressed, counted and recorded as number of millable canes per clump.

Average single cane weight (SCW): The weight of millable canes in each clump was recorded at harvest and the average weight was worked out and expressed as average single cane weight in kilograms.

Cane yield per clump (kg): All the canes in each clump were cut close to ground level, the tops and trash were removed and cane weight per clump was recorded and expressed as cane yield per clump in kilograms.

Brix per cent: Five randomly selected canes were harvested and brix reading was recorded using the brix hydrometer. The corrected brix reading was worked out using Bur standards. It was used to calibrate / workout per cent juice in cane.

Purity per cent: The ratio of sucrose per cent to the corrected brix was expressed as purity of the juice, which indicates the proportion of the sucrose in the total solids present in juice. It was calculated at the time of harvesting by selecting five canes from each treatment.

Number of roots per clump: From each plot, two randomly selected clumps were uprooted by digging the soil without affecting the roots, washed gently and the number of roots was counted, averaged and expressed as number of roots per clump to know the grub reaction in different varieties.

Root dry weight per clump at harvest: Two clumps per treatment were selected, the roots were cut at the base and were separated and kept for drying at 80^0C till a constant weight was attained and expressed as grams per clump.

Average root length at harvest: The length of all the roots in a clump upto the tip was measured with the help of measuring scale and expressed as average root length in centimeters.

RESULTS AND DISCUSSION

Grub load: Under natural and protected plots grub load recorded in different varieties was CoM 265 (10.93 and 0.59), CoC 671 (11.70 and 0.46), CoVSI 8005 (13.08 and 0.65), CoSnk 13374 (10.67 and 0.71) and Co 86032 (12.12 and 0.63), indicated considerable differences (Table 1).

Number of roots per clump at 240 days after planting: Data indicated that two varieties CoM 265 and CoSnk 13374 were significantly superior over remaining varieties by recording 144.73 and 137.20 roots per clump in unprotected plots, respectively. In protected plots number of roots recorded were 174.79 and 167.39 in case of CoM 265 and CoSnk 13374, respectively (Table 1).

Average root length: Root length recorded in unprotected plots ranged from 13.59 to19.25 cm. The two varieties *viz.,* CoM 265 and CoSnk 13374 were significantly superior to the remaining varieties. In protected plots, CoM 265 and CoSnk 13374 recorded significantly superior root length of 23.11 and 21.20 cm, respectively over rest of the varieties (Table 1).

Average root biomass (dry matter): Higher root biomass / dry matter was recorded in both CoM265 and CoSnk 13374 varieties and were significantly superior over remaining varieties by recording 2.38, 1.83 and 3.27, 3.00 g in both unprotected and protected plots, respectively (Table 1).

Single cane weight (SCW): Results pertaining to single cane weight in unprotected plots ranged from 0.75 to 2.37 kg and higher cane weight was recorded in CoM 265 (2.37 kg) and CoSnk 13374 (1.72kg) and were significantly superior over rest of the varieties. Similar trend was observed in protected plots and the weight ranged from 1.11 to 2.78 kg. CoM 265 and CoSnk 13374 were significantly superior by recording 2.78 and 2.51 kg, respectively (Table 1).

Average cane height (m): Results of pooled data revealed that average cane height ranged from 1.72 to 2.48 in unprotected plots. Three varieties *viz.,* Co 86032, CoSnk 13374 and CoM265 were significantly superior over remaining varieties. However, in protected plots CoM 265 (2.66 m) and CoSnk 13374 (2.54 m) were significantly superior over rest of the varieties (Table 1).

Average cane girth (cm): CoC 671 was significantly superior by recording 2.39 cm girth in unprotected plots followed by CoSnk 13374 (2.37 cm). However, CoC 671, CoSnk 13374 and CoM 265 with cane girth of 2.85, 2.79 and 2.73cm, respectively were significantly superior over other treatments in protected plots (Table 1).

Percent purity: CoC 671 was significantly superior over remaining varieties in protected plots by recording 18.74 per cent, followed by Co 86032 (17.64 per cent) (Table 1).

Percent brix: Results pertaining to this trait ranged from 17.47 to 19.50 in unprotected plots as against 19.87 to 22.15 in protected plots. Among the five varieties tested, CoC 671 was significantly superior over remaining four varieties in both unprotected and protected plots by recording 19.50 and 22.15 per cent brix values. However, other two varieties *viz.,* Co 86032 and CoSnk 13374 were the next best treatments with respect to brix per cent. CoM 265 and CoVSI 08005 were significantly inferior as compared to CoC 671, Co 86032 and CoSnk 13374 (Table 1).

Number of millable canes (000/ha): Variety CoSnk 13374 was superior over remaining varieties in unprotected plots by recording 44.27 NMC's, whereas in protected plots Co 86032 was significantly superior over rest of the treatments with NMC's of 86.34 per ha (Table 1).

Yield (t/ha): Data indicated that irrespective of protection CoM 265 could tolerate white grub damage and was significantly superior overall other varieties. The next best was CoSnk 13374 with 75.92 t/ha cane yield even without protection. However, in protected plots the yield recorded ranged from 99.91 to 203.20 and from 75.92 to181.99 t/ha in case of CoM 265 and CoSnk 13374 respectively (Table 1).

Overall results revealed that CoM 265 and CoSnk 13374 were tolerant to white grub attack. Irrespective of the varieties grub population drastically reduced in protected plots leading to higher yield as compared to unprotected plots (Table 1).

Literature on loss estimation due to *H. serrata* in different varieties of sugarcane (both quantitative and qualitative parameters) is lacking to compare the present finding. However, David et. al., (1984) reported that 17 varieties *viz.*, Co285, Co421, Co453, Co775, Co976, 6304, Co6311, Co6501, Co6512, Co6914, Co7313, Co7626, CoS510, CoL29, CoJ65, CoJ75 and Bo 92 were found resistant/tolerant to *H. serrata* under artificial infestation in pot experiments. Chirame et, al., (2003) also reported that with grub load of 36 per m^2 and 74% crop damage resulted in yield of 23t/ha due to *H. serrata* as against grub load of 1.5 per meter row and 2.5 per cent crop damage in treated plots recording119t/ha. Similarly, Sithanantham (1978) reported that *H. serrata* is predominantly associated with sugarcane causing considerable damage in Tamil Nadu, Maharashtra, Karnataka and Uttar Pradesh. The varieties Co453 and Co6304 was reported to tolerate the damage considerably. In the present investigation number of roots, root length and total dry matter recorded in CoM 265 and CoSnk 13374 varieties both in protected and unprotected plots might have offered the tolerance in spite of grub attack resulting in significantly higher NMC's and cane yield. Present finding are also in agreement with David and Ananthnarayana (1982), who reported one to two grubs per clump of sugarcane is known to have incremental effect on the cane but number more than this will cause damage. Veeresh (1977) noticed that white grubs can feed on any root or underground stem. Similar observations were also recorded by Lavanya et al. (2023), among the eight genotypes screened against *H. serrata* grub CoM 265 (0.00 grubs/m^2) and CoSnk 09293 (0.67 grubs/m^2) recorded a lower number of eggs and grub load coupled with a higher number of roots, maximum root length and high root bio mass. No plant was found completely resistant to white grub attack and certain crops can tolerate more than 50 per cent root damage was observed in the present study for CoM 265 and CoSnk 13374 varieties.

CONCLUSION

Both the tested variety CoM 265 emerged as tolerant to white grub attack followed by CoSnk 13374 and yielded significantly more cane yield in spite of white grub attack. The grub population was recorded less in *M. anisopliae* applied plot resulting in better NMC and cane yield.

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Table 1 : : Varietal reaction and loss estimation of yield and yield related parameters due to *Holotrichia serrata* infestation

Sl. No	Varieties	Grub load per m2		No.of roots		Root length (cm)		Root biomass per clump		Single cane weight (kg)		Cane height (m)		Cane girth (cm)		% Pol		% Brix		NMC (000/ha)		Yield (t/ha)	
		UP	P	UP	P	UP	P	UP	P	UP	P	UP	P	UP	P	UP	P	UP	P	UP	P	UP	P
1	CoVSI 08005	13.08	0.65	69.21	103.99	16.58	19.43	1.56	1.56	0.81	1.45	1.95	1.91	2.05	2.54	15.26	17.12	17.47	20.27	38.36	72.41	30.88	104.63
2	CoM 265	10.93	0.59	144.73	174.79	19.25	23.11	2.38	3.27	2.37	2.78	2.48	2.66	2.39	2.73	15.57	17.55	17.91	19.87	42.16	73.23	99.91	203.20
3	CoSnk 13374	10.67	0.71	137.20	167.79	16.91	21.20	1.83	3.00	1.72	2.51	2.45	2.54	2.37	2.79	16.86	17.48	18.44	20.87	44.27	72.65	75.92	181.99
4	CoC671	11.70	0.46	62.24	96.43	14.04	19.54	0.76	1.40	0.81	1.73	1.72	1.70	2.23	2.85	16.48	18.74	19.50	22.15	40.47	75.91	32.78	130.94
5	Co86032	12.12	0.63	88.43	108.61	13.59	18.72	0.79	1.54	0.75	1.11	2.22	1.64	1.81	2.50	16.41	17.64	18.75	20.79	42.55	86.34	31.91	95.83
SEm. ±		0.07	0.03	1.01	1.29	0.31	0.26	0.04	0.07	0.07	0.07	0.05	0.14	0.06	0.07	0.16	0.21	0.19	0.15	0.82	1.14	3.44	2.82
C.D.at 5%		0.23	0.09	3.10	3.96	0.96	0.81	0.13	0.22	0.23	0.21	0.17	0.42	0.19	0.20	0.50	0.65	0.57	0.46	2.54	3.52	10.60	8.68

NMC = Number of Millable canes P = Protected with Metarhizium anisopliae, UP = Unprotected

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