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Effect of Intercropping and Organic Matter on the Subterranean Termites Population in Sugarcane Field

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ABSTRACT

The effect of intercropping and addition of organic matters on subterranean termites in a field of sugarcane was determined. Garlic (*Allium sativum* L.), linseed *(Linum usitatissimum* L.), oliseed (*Brassica compestris* L.) and Methi (*Trigonella foenumgraecum* L.) were intercropped with sugarcane on ridges at the time of setts placement in the furrows. Organic matters (blood, sugarcane trash & fresh cattle dung) were added to the soil 15 days before sowing and mixed well within the soil with the help of a hand hoe. Data were recorded for germination, bud damage and termites' counts. Garlic and sarson intercropped plots had significantly high germination, less bud damage and non-significant termites' counts in comparison with other intercrops and sugarcane alone. Addition of blood caused minimum bud damage (20.32 to 35.20%) as compared to control (43.13 to 58.20%). Termites' count was numerically less in blood added plots (0.00 to 12.5%) than in control (0.00 to 34.0%) at different time points. It is suggested that intercropping with garlic and addition of blood can be suitable in integrated pest management program of subterranean termites in agroecosystem of sugarcane.

Key Words: Sugarcane; Organic matters; Intercropping; Termites

INTRODUCTION

Sugarcane (*Saccharum officinarium* L.) is an important cash crop of Pakistan. Many factors affect the yield of this important crop including insect pests and diseases, which have significant role in this regards. Among insect pests of sugarcane, stem borers, leafhoppers and termites are the most important. Subterranean termites are considered to be the major problem, which can affect the sugarcane germination as well as quality of cane at harvest. Losses by termite may be 90-100% at the germination stage. Five species of *Odontotermes* and two species of *Microtermes* were reported from sugarcane field at Nowshehra and Charsadda Tehsils (Salihah *et al*., 1988). In Punjab, information on termites' population and damage to the sugarcane crop is available only from one locality (Manga Mandi, District Lahore, Pakistan). Maximum activity (235 individuals m^{-2}) of the termites in a sugarcane field was noticed in the month of July. The cumulative damage for sugarcane crop was up to 34.8% and damage increased with the height of the plant (Akhtar & Shahid, 1990).

For controlling the termites many methods have been adopted, among, which chemical, cultural and biological methods are important. The generally accepted method of termite control over the years has been pesticides. However, pesticides are not only expensive but also have many harmful effects. The control of the termites in the sugarcane was largely conducted with the application of insecticides in Pakistan (Sattar & Salihah, 2001; Ahmed *et al*., 2007). These insecticides in liquid or dry formulations such as chlorypyrifos, imidacloprid and fipronil have been suggested as setts treatment in furrows before the first irrigation (Singh & Singh, 2002). The success of such treatment is highly variables. Little information is available on the use of biological and cultural control methods of termites. A cultural method for controlling sugarcane termites using poplar woods have been suggested (Sattar *et al*., 1993; Sattar & Salihah, 2002).

Control methods, other than pesticide, should also be tried to save sugarcane from termites' attack. These methods should aim at (i) preventing termites' access to plants, (ii) reducing termite numbers in the vicinity of plants, or (iii) reducing susceptibility/increase resistance of the plants themselves. However, research on any of these methods is scarce, although numerous cultural procedures have been suggested, including measures to enhance plant vigour and to manipulate termite numbers and behavior (Logan *et al*., 1990).

Intercropping is one of the suggested controls to refrain termites' access to the sugarcane setts and seedlings. Intercropping has been studied in maize against termites and was found effective not only for reduction of damage but also to enhance the efficiency of the predatory ants ((Umeh & Ivbijaro, 1999; Sekamatte *et al*., 2003; Anonymous, 2004; Sileshi *et al*., 2005). Intercropping is useful to

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improve the economics of sugarcane crop. The intercrops of moong, mash, mentha in spring cane was successful in fetching additional income to the farmers, in addition to that from sugarcane. Sunflower can also be grown as intercrop in spring cane without any adverse effect on sugarcane (Bhullar *et al*., 2006). Moreover, the addition of organic matter in many forms in the soil can help to prevent the damage to the crop (Mando *et al*., 1999; Mando & Stroosnijder, 1999; Gould *et al*., 2001; Bokhtiar & Sakurai, 2005). None of these practices has been experimented in the sugarcane. Present studies were carried out to determine the impact of intercropping of sugarcane with Garlic (*A. sativum*), linseed (*L. usitatissimum*), oilseed (*B. compestris*) and Methi (*T. foenumgraecum*) and addition of organic matters (Blood + Molasses, sugarcane trash & cattle dung) to soil on the foraging of the termites in the sugarcane fields.

MATERIALS AND METHODS

Impact of intercropping on termites in sugarcane. Total experimental area of 6000 m^2 was sown with a sugarcane variety HSF-240 at Post Graduate Agriculture Research Station (PARS) Faisalabad. The area was divided into 15 equal plots. The dimension of each plot was 25 x 16 m^2. Each plot consisted of 12 equal rows. In each row number of setts was 65 @ 30,000 per acre. The layout of experiment was Randomized Complete Block Design with three replications. Linseed (*Linum usitatissimum*), garlic (*Allium sativum*), oilseed (*Brassica compestrss*), methi (*Trigonella foenumgraecum*) were sown in the plots as the intercrops. No pesticide was used in this experiment. Crops as intercrop in sugarcane were sown at the time of sowing of sugarcane.

Impact of organic matter as attractant for termites in sugarcane. The dimensions of ex[pereimtal area were 4800 m^2 total area, 12 plots of 16 x 25 m^2 and 12 equal rows in each plot. Layout of the plots were same described above. In this experiment, organic matters, as attractant for the termite to save the sugarcane bud damage, were used. These organic matter included blood (from slaughter house) + molasses, sugarcane trash and fresh cattle dung. A fourth plot was a control, where there was no organic matter addition except mineral fertilizer. All these matters were used at the time of bed preparation before the sowing of crop 15 days before the sowing of sugarcane and mixed with well within the soil with help of hand hoe.

Data Collection

Germination of buds. Data on germination were taken by counting the germinated buds out of 65 setts. The data were taken 20 days after sowing at fortnightly intervals till 80 days. The percenage of buds germination was calculated by using the following formula:

$$\% \text{ Germination of buds} = (\text{Germinated buds}/\text{Total buds}) \times 100$$

Damage to buds. Bud damage by termite was assessed by exposing the setts. The buds in the big gap (>2 m) in the furrows between two seedlings were supposed to be attacked by termites. From each plot 5 sub gaps/places were dug and bud damage was observed. The data was taken from 15 days after sowing fortnightly till 90 days. The buds damage was calculated by using the following formula:

$$\% \text{ Damage of buds} = \text{Damaged buds}/\text{Total buds} \times 100$$

Termite population. For estimating termite population, soil core was taken out with the help of soil sampler having dimension 25 x 25 x 40 cm, from different places in each plot to extrapolate data into termites m^{-2}. The data were taken from 15 days after sowing at fortnightly intervals till cane attained a height of 2 m.

Statistical analysis. Data on germination and bud damage were analyzed statistically by ANOVA and means were compared with LSD at 5% level of probability. Non-parametric Kruskal-Wallis ANOVA was used to test differences between data of termites' counts.

RESULTS

Impact of intercropping on termites in sugarcane. A non-significant difference in the percent germination of sugarcane in different intercropped plots and sugarcane alone was observed on 20 days after sowing. Garlic intercropped with sugarcane was statistically different from other intercrops with 23.57% germination at 40 days after sowing. All other intercrops and sugarcane alone had non-significant different among them at this point. A significant difference ($P<0.05$) was observed in the percent germination of sugarcane in different intercropped plots on 60 days after sowing. Garlic was non-significantly different from sarson at 60 days after sowing but it was significantly different ($P<0.05$) from other intercrops and sugarcane alone at 80 days after sowing (Table I). All treatments showed statistically significant difference ($P<0.05$) with regard to bud damage at all time points (20 to 80 days after sowing.

Highest bud damage (37.50 to 52.2% & 36.00 to 50.10%) was observed in methi and sugarcane alone plots. Linseed plots had significant difference with methi and sugarcane alone on 20 40 and 80 days after sowing. Sarson had non significant difference with garlic at 20 40 and 80 days after sowing (Table I). All treatments had non-significant difference among themselves except on 100, 120 and 140 days after sowing (Table II). Garlic and sarson intercropped plots had less median termites' count as compared to sugarcane alone at 60 to 160 days after sowing. Though garlic had small median termites' count but sarson maintained numerically less median termites' counts as compared to other intercrops as well. All the treatments of organic matters had non-significant ($P>0.05$) difference among themselves regarding the germination percentage on 20 to 80 days after sowing.

Bud damage was non-significant among the treatments on 20 and 40 days but was statistically different on 60 and 80 days after sowing (Table III). All treatments had non-significant ($P>0.05$) difference of median termites' count

Table I. Percent germination and bud damage in the plots of different Intercropping

Crops	Germination			
	Days after sowing			
	20	40	60	80
Garlic	12.43n.s.	23.57a	38.97a	52.17a
Linseed	14.13	18.13b	30.10b	42.00c
Oilseed	13.53	20.27b	33.63ab	45.63b
Methi	11.83	18.60b	27.93b	41.67c
Sugarcane	11.00	18.00b	27.00b	42.00c
LSD value		3.86	7.62	3.28
	Bud damage			
Garlic	22.53c	40.97b	29.53d	25.07b
Linseed	32.77ab	45.93ab	45.63b	38.87ab
Oilseed	26.73bc	45.63ab	37.20c	31.17bc
Methi	37.50a	52.20a	50.30a	43.53a
Sugarcane	36.00a	50.10a	48.00a	39.30a
LSD value	6.68	7.12	1.97	10.1

Table II. Termites' counts (median) in plots of different inter croppings at various days after sowing

Crops	Days after sowing							
	20	**40**	**60**	**80**	**100**	**120**	**140**	**160**
	19/10	9/11	3/12	24/12	8/1	14/1	18/2	11/3
Garlic	95	2.80	0.00	26	113	162	208	185
Linseed	169	1.05	0.00	35	360	425	518	346
Oilseed	19	0.00	0.00	21	212	291	323	305
Methi	72	0.00	0.00	84	481	490	476	382
Sugarcane	90	2.00	0.00	60	375	310	390	360
LSD value	0.28	0.51	0.87	0.21	0.04	0.03	0.02	0.6

Table III. Germination and buds damage (%) in plots of different organic matters

Treatments	Germination			
	Days after sowing			
	20	**40**	**60**	**80**
Control	10.80 n.s.	21.93 n.s.	32.60 n.s.	46.93 n.s.
Blood + molasses	11.70	23.63	36.17	54.40
Sugarcane trash	14.83	24.73	39.80	50.00
Cattle dung	13.63	19.83	32.87	51.10
	Bud damage			
Control	43.13 n.s.	54.40 n.s.	58.20a	54.73a
Blood + molasses	27.00	35.20	22.10c	20.33d
Sugarcane trash	19.87	41.10	46.53b	34.30c
Cattle dung	29.80	44.97	46.67b	43.23b
LSD value	-	-	11.03	7.94

among them. On numerical basis blood + molasses had less termite s counts at most of the time points as compared to control and other treatments (Table IV).

DISCUSSION

Many workers investigating the ways for management of the termites in agriculture and forest plantation have indicated the possibility of using cultural, biological separately or in combination. These are the environments, where the exclusive use of the pesticides can have an effective control of the termites. The difficulty in the use of chemicals is presented by the time and frequency, which may not correspond with the production techniques of the sugarcane. However, chlorpyrifos, imidacloprid and

Table IV. Termites' counts in plots of different organic matters

Treatments	Days after sowing							
	20	40	60	80	100	120	140	160
Control	26	4.70	0.00	0.00	141.00	340.00	310.00	202.00
Blood + molasses	42	6.50	0.00	0.00	30.00	115.00	125.00	125.00
Sugarcane trash	149	3.00	0.00	2.00	132.00	162.00	75.00	109.00
Cattle dung	26	0.00	0.00	4.20	92.00	135.00	25.00	208.00
p-value	0.50	0.79	0.87	0.46	0.09	0.07	0.09	0.67

bifenthrin etc. are being used but with limited success (Madan *et al*., 1998; Anonymous, 2002).

Pearce (1997) reported the use of grasses for the attraction of the termites. Sugarcane being water intensive crop usually have a copious production of the grasses for which the herbicides like Topsin, Dual gold, Stomp and Treflan are used. These grasses are produced in irrigated/riverine lands. The sugarcane grown in the sandy loam soils has the possibility of attack of the termites in the time of water shortage. At this time there should be some kind of plants which can attract the termites. Another possibility can be the repellent action of some plants, which can drive the termites away from the major crop. In both cases the aim is to save the major crop.

Intercropping usually can serve this purpose. Sattar and Salihah (2001) suggested growing turmeric around the field of sugarcane to repel the termites. However, turmeric may not be successful in the areas of central Punjab, which is characterized by hot and dry winds during the early stage or heavy rains in February and September sown crop of sugarcane, respectively. There are many other alternatives to the choice of intercrops, for example, maize has been recommended as an intercrop in Cassava production. Umeh and Ivbijaro (1999) studied the efficacy of insecticides derived from two local plants on termites infesting maize in maize–cassava–'Egusi' melon intercrops. Cassava and melon plants or cassava tubers were not attacked by termites in any of the trials and their yields were not affected.

Garlic, linseed, sarson and methi were used as intercrops keeping in view the above said conditions. These intercrops were sown on ridges at the same time, when setts were being placed in furrows because the termites usually attack the buds on the setts. In terms of the germination percentage and the bud damage, the garlic intercrop showed significant difference from linseed, sarson and methi. The percent bud damage was significantly lowest (25.07%) and germination was significantly highest (50.17%) at 80 days after sowing in garlic intercropped plots. Ahmed *et al.* (2004) studied effect of intercropping on wheat with different crops sown as intercrop in wheat. Cumin (*Negella sativa*), fennel seed (*Foeniculum vulgare*) and Ajowain (*Trachyspermum ammi*) were sown as intercrops. Median termites' count had non-significant difference in all intercrops with wheat alone, which indicates les effect on the foraing of the termites in the presence of the intercrops.

Mando *et al.* (1999) studied that biological activity (mainly termites) in mulched soil; a key element in the rehabilitation of crusted soil vegetations, which was the best with composite and straw mulches with termites, followed by woody mulch with termites. Mulched plots showed greater vegetation development than bare plots. Uses of agricultural waste viz. woody materials and straws have been used to ameliorate the problem soil by the use of termites in them. However, there is no conclusive scientific report on the use of organic matters in the soil of the field crops, where the termites can be managed or the damage can be prevented by addition of these organic matters. (Khan *et al*., 2001; Khan *et al*., 2002; Sekamatte *et al*., 2003; Anonymous, 2004).

In sugarcane the farm yard manure (FYM) decomposed or un-decomposed is added before the sowing to provide nutrients to this perennial crop for longer time. The under-composed FYM is discouraged in sugarcane at the time of sowing. However, there is no scientific report for the extent of damage to buds on sets and seedling afterwards by the presence of un-decomposed FYM in sugarcane particularly at the time of sowing of sugarcane. The present studies included the use of un-decomposed FYM to determine the bud damage, seedling germination and termites' count. A non-significant germination percentage and significantly high bud damage as compared with other matters was observed at 60-80 days after sowing. Hence, un-decomposed FYM manure may not be a good choice as attractants for the termites.

The blood + molasses showed the lowest bud damage as compared to other treatments, which indicates effect on foraging of the termites in the early stage of the crop. Non-significant difference in termites' count was also observed in the plots where these organic matters were added to the soil. The present findings can not be compared with any other studies due to the lack of literature on this aspect of the management of the termites in sugarcane. Nevertheless, intercropping with garlic and sarson and use of blood + molasses can be an effective way of preventing bud and seedling damage due to the termites.

REFERENCES

Ahmed, S., W. Akbar and M.A. Riaz, 2004. Effect of crop rotation and intercropping on subterranean termites in wheat at Faisalabad. *Pakistan Entomol*., 26: 25–30

Ahmed, S., M.A. Riaz and A. Hussain, 2007. Assessment of the damaged and population of termites (Odontotermes & Unicolor) under various methods of insecticide application. *Int. J. Agri. Biol.*, 9: 125–8

Akhtar, M.S. and S.A. Shahid, 1990. Termite (Isoptera) population and damage in sugarcane fields at Manga Mandi, Lahore, Pakistan. *Proceed Pakistan Congr. Zool*., 10: 43–50

Anonymous, 2002. Finding Alternatives to persistent organic pollutants (POPS) for Termite Management. Global IPM facility Expert Group on termite Biol. Manage. Stockholm Convention. *Food Agric. Org.*, 118–68

Anonymous, 2004. Soil Biota and Sustainable Agriculture: Challenges and Opportunities.The Systemwide Program on Integrated Pest Management. *IPM Res. Brief*., 2: 11–26

Bokhtiar, S.M. and K. Sakurai, 2005. Integrated use of Organic manure and chemical fertilizer on growth, yield and quality of sugarcane in high ganges river floodplain soils of Bangladesh. *Commun. Soil Sci. Plant Anal*., 36: 1823–37

Bhullar, M.S., A. Kamboj and G.P. Singh, 2006. Weed management in spring-planted sugarcane (Saccharum officinarum)- based intercropping systems. *Indian J. Agron.*, 51: 183–5

Gould, K.A., J. Herrick and H. Lemma, 2001. Refuse to Refuge: Dry Season Use and Modification of Cattle Dung by Subterranean Termites in Guanacaste, Costa Rica'. *Biotropica*, 33: 121–30

Khan, Z.R., J.A. Pickett, L. Wadhams and F. Muyekho, 2001. Habitat Management Strategies for the Control of Cereal Stemborers and Striga in Maize in Kenya. *Insect Sci. Appl*., 21: 375–80

Khan, Z.R., A. Hassanali, W. Overholt, T.M. Khamis, A.M. Hooper, J.A. Pickett, L.J. Wadhams and C.M. Woodcock, 2002. Control of witch weed (*Striga hermonthica*) by intercropping with *Desmodium* spp., and the mechanism defined as allelopathic. *J. Chem. Ecol*., 28: 1871–85

Logan, J.M.W., R.H. Cowie and T.G. Wood, 1990. Termite (Isoptera) control in agriculture and forestry by non-chemical methods: a review. *Bull. Ento. Res*., 80: 309–30

Madan, Y.P., S. Maan and M. Singh, 1998. Evaluation of some soil insecticides for termites and shoot borer control in sugarcane. *Indian Sugar*, 48: 515–8

Mando, A. and L. Stroosnijder, 1999. The Biological and Physical role of Mulch in the the Systemwide Program on Integrated Pest Management. *IPM Res. Brief*, 2: 11–26

Mando, A., L. Brussaard and L. Stroosnijder, 1999. Termites and Mulch Mediated Rehabilitation of Vegetation on Crusted Soil in West Africa. *Restoration Ecol.*, 7: 33–41

Pearce, M.J., 1997. *Termites, Biology and Pest Management*, p: 172. CABI Publishing, Wallingford.

Salihah, Z., M. Shah and A. Sattar, 1988. Survey of sugarcane termites of Nowshehra and Charsadda Tehsils. *In: Proceedings of 8th Pakistan Congr. Zool*., 8: 289–97

Sattar, A. and Z. Salihah, 2001. *Detection and Control of Subterranean Termites*, pp: 195–198. *In: Technologies for Sustainable Agriculture. In: Proceedings of National Workshop*, Sept. 24-26, NIAB, Faisalabad, Pakistan

Sattar, A., A. Khan and Z. Salihah, 1993. Cultural method of controlling termite attack on sugarcane with popular wood. A preliminary study. *In: Proceedings of Pakistan Congr. Zoology*, 13: 71–3

Sattar, A. and Z. Salihah, 2002. Delineation of foraging territories of *Heterotermes indicola* (Isoptera: Rhinotermitidae) by using a dye, Nile Blue A. *In: Proceedings of Pakistan Congr. Zoology*, 22: 10

Sekamatte, B.M., M.O. Latigo and M.R.A. Smith, 2003. Effects of maize-legume intercrops on termite damage to maize, activity of predatory ants and maize yields in Uganda. *Crop Protect*, 22: 87–93

Sileshi, G., P.L. Mafongoya, F. Kwesiga and P. Nkunika, 2005. Termite damage to maize grown in agroforestry systems, traditional fallows and monoculture on nitrogen-limited soils in Eastern Zambia. *Agric. Forest Entomol.*, 7: 61–9

Singh, M. and N.B. Singh, 2002. Bud damage due to termites in sugarcane. *Cooperative Sugar*, 33: 655–8

Umeh, V.C. and M.F. Ivbijaro, 1999. Effects of termite damage to maize of seed extracts of *Azadirachta indica* and *Piper guineense* in farmers' fields. *J. Agric. Sci.*, 133: 403–7

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