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TERMITE SPECIES AND THEIR MANAGEMENT THROUGH *VETIVER, VETIVERIA ZIZANIOIDES* L. AND IRRIGATION IN MAIZE, *ZEA MAYS* L.

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ABSTRACT

Field studies were conducted to record the termite species and asses the interaction effect of *Vetiveria zizanioides* Linnaeus and irrigation against termite population in maize at Nakemte, Ethiopia. Seven termite genera, *Coptotermes, Microtermes, Odontotermes, Psedocanthotermes, Macrotermes, Microcerotermes* and *Trinervitermes* were identified causing damage to roots, stem and cobs of maize; among them, *Odontotermes and Microcerotermes* were most dominant. Termite management through three levels of vetiver (10, 15 & 20 % and no treatment as control) and irrigation (irrigation & hoeing, only irrigation and no irrigation as control) was evaluated in a randomized block design in factorial arrangement with three replications and effectiveness was recorded after 60 days post-treatment. Vetiver (20%) and irrigation together with hoeing significantly reduced the number of termites (29.77) in comparison to control (154) using bamboo bait method. The maximum yield (22.63 q/ha) was recorded from vetiver (20%) and irrigation with hoeing, followed by that from vetiver (20%) and only irrigation (21.4 q/ha), both being statistically at par. Vetiver (20%) and irrigation & hoeing or vetiver (20%) and only irrigation are recommended for the management of termites in maize.

Key words: Hoeing, irrigation, maize, termites, *Vetiveria zizanioides* L.

INTRODUCTION

Maize is considered a promising option for diversifying agriculture in upland areas of India. It now ranks as the third most important food grain crop in India (Joshi *et al*., 2005). Termites are the primary insect group adapted to consume wood and lignocelluloses. Among the 2700 termite species, about 83 were considered as pests and have severe impact in tropical and subtropical regions (Hussenederk *et al*., 2003). *Macrotermes subhyalinus* was observed to cause up to 30 per cent stand loss in maize in Western Ethiopia (Abdurahman, 1990) and 15–25% estimated loss in maize in India (Joshi *et al*., 2005). Djirata *et al.* (2007) reported five genera, *Ancistrotermes, Macrotermes, Microtermes, Odontotermes, Pseudacanthotermes* from sub-family Macrotermitinae and one genus, *Trinervitermes* from sub-family Nasutitermitinae of Termitidae family causing damage *to Zea mays* L., *Eragrostis tef* (Zuccagni Trotter), *Sorghum bicolor* L. and rangelands in western part of Ethiopia forcing farmers to abandon their crop fields and move to the lowlands, searching new land for crop cultivation.

Effectiveness of several botanicals and their products have been assessed against termites by many research workers for instance neem, *Azadirachta indica* (Singh and Singh, 2002; Nwilene *et al*., 2008; Himmi *et al*., 2013); and vetiver, *Vetiveria zizanioides* (Zhu *et al.*, 2001; Maistrello, 2001; Hendersen *et al*., 2005; Nix *et al.,* 2006; Su, 2005). Tizazu (2011) found that vetiver (20%) was effective up to 60 days post-treatment under field conditions in Metekel zone of Ethiopia. Management of termite population was achieved effectively through irrigation and hoeing at one and two month's interval in mango orchard (Singh and Singh, 2003). Kumarasinghe and Ranasinghe (1988) and Logan and El Bakri (1990) reported that frequent irrigation reduces termite attack in crops. As no scientific evidence was documented on the effectiveness of botanicals against termite fauna in Western Ethiopia, this field study was undertaken to identify the pest termite fauna and their management combining the effects of vetiver and irrigation.

MATERIALS AND METHODS

The field experiments on the management of termites in maize were conducted at Green Focus Ethiopia Ltd**.,** Nakemte, Western Ethiopia during monsoon 2012**.** Termite specimens were collected from the maize fields comprising 30 workers and 10 soldiers in the ratio of 3:1 that were preserved in ethyl alcohol (80%) and identified up to generic level with the help of

an identification manual (Harris, 1964; Thakur, 1989**;** Pearce, 1997) and under Stereo Microscope in Biology Department of Ambo University.

The active mounds were selected from maize fields to assess the efficacy of the combined effect of two factors (vetiver grass root extract and irrigation). The activeness of mounds was confirmed by placing dried grass and wooden sticks on the mound to forage by workers and by digging 10-20 cm deep to see live termites. The three concentration levels (10, 15, & 20%) of vetiver, a control; irrigation with three levels (irrigation and hoeing, only irrigation and no irrigation as control) were used to assess the efficacy of management. The vetiver concentrations were prepared by boiling the root of 'vetiver' grass; the root extracts were prepared on w/v basis in 5 litres of water. The prepared solutions were sprayed into the mound through main galleries using knapsack sprayer (nozzle was detached from the sprayer) and opened galleries were covered with soil immediately after application in order to prevent evaporation from direct sunlight and birds to eat poisoned dead termites. The maize field was irrigated after 30 days of sowing and hoeing was done after 7 days of irrigation, which was used as a first level and only irrigation after 30 days of post-sowing as a second level and no irrigation as control of the second factor were used.

The experiment was laid out in Randomized Block Design (RBD) in factorial arrangement with three replications and each mound was treated as one replication. In order to avoid the biasness in the selection of mound, small, medium and large sized mounds measured in diameter i.e. 1.02-2.84m, 2.85-3.74m and 3.75-4.29m and in height i.e. 0.63-1.50m, 1.51-2.1m and 2.1-2.67m, were selected respectively.

Three methods were used in order to assess the effectiveness of the treatments:

1. Application of bamboo baits. Application and installation method of baits was followed as described by Verkerk and Bravery (2001). Bamboo bait was used instead of scot pine, Pine sylvestris in the present experiment and it was easily available and preferred by the termites in the study area. Bamboo stakes measured 4.5 cm in diameter and 45 cm in length; 4 baits were installed at 3 m radius from the mound in North, South, East and West directions and bamboo stake (22%) was inserted in the soil. Numbers of termites were counted from baits interiorly because termites forage the bamboo stakes interiorly due to hollowed nature of bamboo and might be due to presence of high cellulose content and a more rough surface than the outer surface.

2. Percent Infestation Level. Observations were taken from three sampling units (4x4m) per mound in the standing maize field at the distance of 5-10 meter radius to the mound. Termite infestation was quantified by maize infestation level, which is the proportion of infested plants over the total maize stands.

3. The number of termites. It was counted from six uprooted infested maize plants along with the soil and also from the soil in a depth of 20 cm, the root and the stem of the maize from each mound. The observations on effectiveness of the treatments were recorded after 60 days of treatment in each method.

RESULTS AND DISCUSSION

Seven genera of termite fauna were identified from 75 samples collected from maize cultivated field. Of these, one genera (*Coptotermes*) belongs to family Rhinotermitideae; sub family Coptotermitineae, and six genera belongs to one family Termitideae of three sub families i.e. Macrotermitineae (*Microtermes, Odontotermes, Psedocanthotermes and Macrotermes*), Termitineae (*Microcerotermes*) and Nasutitermitineae (*Trinervitermes*). *Odontotermes* and *Microcerotermes* were found in 67 samples whereas *Trinervitermes* were in only 02 samples. Taxonomic characters of soldier termites from identified genera are given in Table 1. All identified genera were found to cause damage in root zone, stem, cobs and dried parts in standing maize crop. The infestation in some places was too much severe and whole plant was converted into soil.

Management of Termites

The efficacy of the treatments were recorded on seven identified termite genera i.e. *Odontotermes, Microcerotermes*, *Macrotermes*, *Microtermes*, *Coptotermes, Psedocanthotermes* and *Trinervitermes,* which are known to cause damage in root zone, fallen stem and cobs of maize crops in the study area.

Table 2 indicates the interaction effect of vetiver and irrigation using bamboo bait method that vetiver 20% and irrigation and hoeing (29.77 termites/bamboo bait) was most effective to manage the termite population. The next effective treatments were vetiver 15% & irrigation and hoeing (31.33) and vetiver 20% & only irrigation (51.66) which were statistically significant to each other. All the treatments were statistically significant from control (154).

The same treatment vetiver 20% and irrigation & hoeing was observed most effective using the method of per cent maize infestation level and termite numbers per plant (Table 3 and 4). The second most effective treatment was vetiver 15% and irrigation & hoeing considering the methods of bamboo bait method and termite numbers per plant, whereas, vetiver 20% and only irrigation was the second most effective treatment considering the per cent maize infestation level.

Table 1. The taxonomic characters of soldier termites found in the identified genera

Termite genera	Taxonomic characters
Coptotermes	Head capsule oval shaped; fontanelle large, circular and lying medially at the interior margin; Rounded head narrower at front with large opening.
Microtermes	Mandibles short, thin, delicate; soldier smaller than workers. Very small termites, straight mandibles, antennae 12-14 segments, 0.49-0.55 mm left mandible length.
Odontotermes	8.0-10.1mm total body length, 4.5-5.3mm head length with mandible, Antenna 15-16 segments, tooth present at the basal left mandible, mandibles are large and generally strong, soldiers larger than workers.
Psedocanthotermes	Two points on anterior pronotum (on major Soldiers).
Macrotermes	9-18mm total body length, 2.5-4.0 maximum head width, 4.5-8.0mm head length with mandible, 15-16 antennal segment, Large termites, white triangular tips on labrum, no tooth found midway on mandibles.
Microcerotermes	Mandibles well developed, functional, Mandibles with inner margins serrated, 5.0-9.0 mm of total body length, 4.0-5.0mm, 15-16 segmented antenna, rectangular shaped heads.
Trinervitermes	2-3 mm total body length, 1.6-1.8mm head length with mandible, Mandibles degenerated, non functional, head capsule produced into a nasus, small.

Table 2. Interaction effect of vetiver and irrigation on number of termites using bamboo bait method

		Number of Termites/Bamboo bait				
		Vetiver 10%	Vetiver 15%	Vetiver 20%	C	Mean
Irrigation	I+H	57.33^{fg}	31.33^{h}	29.77^{h}	129.7^{c}	62^{z}
and	I	83.66^{e}	55.33^{fg}	51.66^{g}	147^{b}	84.41^{y}
Hoeing	C	130.7^{c}	97.66^{d}	60.33^{f}	185.3^{b}	118.5^{x}
	Mean	90.55^{B}	61.44^{C}	47.22^{D}	154^{A}	88.30
CV%=5.73 $LSD_{0.05}$=8.57						

Table 3. Interaction effect of vetiver and irrigation on percent maize infestation level

		Maize Infested Plants (%)				
		Vetiver 10%	Vetiver 15%	Vetiver 20%	C	Mean
Irrigation	I+H	28.6^{g}	15.2^{j}	6.9^{k}	56.3^{d}	26.7^{z}
and	I	40.5^{f}	24.5^{h}	12.2^{j}	70.2^{b}	36^{y}
Hoeing	C	61.3^{e}	46.3^{e}	21.2^{i}	89.4^{a}	54.5^{x}
	Mean	44.2^{B}	27.2^{C}	13.9^{D}	71.7^{A}	39.4
CV%=4.9 $LSD_{0.05}$=9.26						

Table 4. Interaction effect of vetiver and irrigation on number of termites per plant

		Number of Termites/Plant				
		Vetiver 10%	Vetiver 15%	Vetiver 20%	C	Mean
Irrigation	I+H	63^{g}	33.33^{i}	25^{j}	131^{d}	63.4^{z}
and	I	101^{e}	58^{g}	36.66^{i}	181.6^{b}	94.5^{y}
Hoeing	C	145^{c}	83.33^{f}	43.66^{h}	218.3^{a}	122.5^{x}
	Mean	103.2^{B}	58.6^{C}	35.11^{D}	177^{A}	93.5
CV%=4.12 $LSD_{0.05}$=6.52						

Table 5. Interaction effect of vetiver and irrigation on maize yield (q/ha) against termites

		Maize Yield (q/ha)				
		Vetiver 10%	Vetiver 15%	Vetiver 20%	C	Mean
Irrigation	I+H	13.69^{e}	16.38^{b}	22.63^{a}	10.43^{e}	21.04^{x}
and	I	12.15^{d}	13.67^{c}	21.4^{a}	9.42^{ef}	18.88^{y}
Hoeing	C	8.62^{g}	12.93^{cd}	17.07^{b}	8.18^{fg}	15.60^{z}
	Mean	11.49^{C}	14.33^{B}	20.37^{A}	9.34^{D}	13.88
CV%=7.61 LSD $_{0.05}$=1.24						

Data in Table 5 shows the yield performance of maize that the maximum yield (22.63 q/ha) was recorded on vetiver 20% and iIrrigation and hoeing and it was statistically at par from vetiver 20% & only irrigation (21.4 q/ha) and both the treatments were statistically significant from vetiver 15% and irrigation & hoeing (16.38 q/ha). The yield performance in all the combined treatments was statistically significant from control.

In the present study, seven identified termite's genera i.e. *Coptotermes*, *Microtermes, Odontotermes, Psedocanthotermes, Macrotermes*, *Microcerotermes* and *Trinervitermes* were found from maize field in Western part of Ethiopia. Out of them, *Odontotermes* and *Microcerotermes* were dominant in majority of collected samples to cause damage on maize crop. Djirata *et al.* (2007) recorded six genera i.e. *Ancistrotermes, Macrotermes, Microtermes, Odontotermes, Pseudocanthotermes and Trinervitermes to* cause damage on *Zea mays* L., *Eragrostis tef* (Zuccagni) Trotter), *Sorghum bicolor* L. and rangelands in Western part of Ethiopia. Two termite's genera i.e. *Coptotermes* and *Microcerotermes* were recorded more from the study of *Djirata et al.* (2007), whereas, one genus *i.e. Ancistrotermes* was not found from collected samples in the present investigation.

The chemical components *i.e*., nootkatone, a-cedrene, zizanol and bicyclovetivenol from vetiver were found repellent and toxic to termites (Hendersen *et al.,* 2005 and Zhu *et al.,* 2001); disrupt behavior and physiology of *Coptotermes formosanus* as a consequence of direct physical contact, ingestion, or exposure to the vapors (Maistrello, 2001). Present study shows the effectiveness of 20% concentration of Vetiver root extract in interaction with Irrigation & Hoeing and only irrigation was found statistically significant from other treatments. Tizazu (2011) reported that only 20%Vetiver significantly manage the termite population in maize field at Metekel zone of Ethiopia. Vetiver's alkaloids decreased tunneling activity and showed a “lingering behavior”. Application of Irrigation and Hoeing at one and two month's interval in mango orchard was significantly manage of termite population (Singh and Singh, 2003). The present study was also supported by Kumarasinghe and Ranasinghe (1988) and Logan and El Bakri (1990) that frequent irrigation reduce termite's attack in crops.

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