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Identification of Termite Infestation Season on Maize (Zea mays L.) BH-540 Variety Growth Stage After Applied by Treatments in Assosa District, Benishalgul Gumuz Region, Western Ethiopia

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Abstract
Termite is one of the most important serious insect pests of maize facing severe problem in western part of Ethiopia. The present study was conducted to evaluate the effectiveness of four different management practices, their combined and their integration. They were examined for evaluation of termite infestation season under maize growth stages in Assosa district of western Ethiopia from mid may 2015 to April 2016. The study was carried out under application of treatments consisted of chemical control (Malathion 50% E.C at rate of 2L/ha), botanical control (Echinops kebericho at rate of 3l/ha), cultural (ash at rate of 2.5kg/plot), and physical soil and water conservation (terrace 30cm in width*60cm in depth) and their integration and untreated control. The experiment was laid out by randomized complete block design with twelve treatments and three replications which is thirty six total observations. The germination emergency of the maize was registered 98.44% to 100% which showed non-significantly difference among plots. The termite infestation was appeared after 20 days of germination emergency within the plots and immediate treatment application was carried out. The infected stand count of maize was taken from seedling stage, late seedling stage, maturity stage and harvesting time after application. The season of infested maize growth stage was registered in integrated treatment, Malathion 50% E.C X Echinops kebericho X Terrace X Ash showed root damage (1%, 1%, no damage, 0.67%) and stem damage (0.67%, 0.67%, 3.67%, 0.67%) and untreated control showed higher number of root damage (6.33%, 6%, 3.67% & 5%), stem damage (6.33%,7%,7% & 9%) and cob damage (4.67%, 9%) were recorded at seedling stage, late seedling stage, maturity stage and harvesting time respectively. Generally, the infestation season was lower at seedling stages while increased at late seedling & maturity and highly increased at harvesting time respectively.
Keywords: - identification, termite, stages, season, infestation, damage

1. INTRODUCTION

Maize (*Zea mays* L.) is one of the most popular crops grown in the world, ranking second next to wheat and followed by rice (Vasal, 2000). It occupies an important position in the world economy as food, feed, and industrial grain crop. It is a staple food for several million people in the developing world where they derive their protein and calorie requirements from it. Termites is one of the most economically important insect pests by eating wood and wood-based cellulosic materials, cause more destruction to crops and paper products and the most difficult and expensive to control in the world than any other insects (Xing *et al.,* 2001). In Ethiopia, identification season of termites infestation of maize at growth stages are one of the major gaps to agricultural crops facing severe problem in lacking of time of pest infestation in western part of the country. Assosa District is one of the termite infested areas and there was no awareness of time of pest prevalence and infestation among farmers. This wide area infestation of termites have brought a multidirectional problem on the livelihood of human beings reside in the area. The main victim of the problem is the farming communities found in the rural areas in this District those depends on agriculture for their livelihood income.

Termites destruct crops on the field starting from the early stage of sowing to the maturity stage and harvesting time of the crops and even at storage, Due to this; it minimizes the agricultural products generally in the region and specifically in the study area. The feeding patterns and time of feedings are the various types of termite, subterranean termites follow the grain, eating the softer areas along the length of the wood and leaving the harder grain skeleton. In contrast, dry-wood and damp-wood termites eat across the grain in any direction (Woodrow *et al.*, 1999).

The research was helped to know the time of termite infestation season at different maize growth stages after with treated and untreated plots separately. Thus, the present study was carried out to conduct identification of growth season of termite infestation at different growth stages of maize cro 2. MATERIALS AND METHODS

2.1 Description of the Study Area

Assosa woreda is located in Benishangul-Gumuz National Regional State, Assosa Zone. The woreda's administrative town is known as Assosa. It is also the Zonal and Regional administrative town. The town is 668 km away from Addis Ababa through the Nekemte road in western direction. Assosa woreda is bordered in the North-western direction by Kurmuk and Komosha woreda, North-eastern direction bordered by Mange woreda,

southern direction by Mao-Komo, Western direction by Sudan and in the Eastern direction bordered by Bambasi woredas of Benishangul-Gumuz Region.

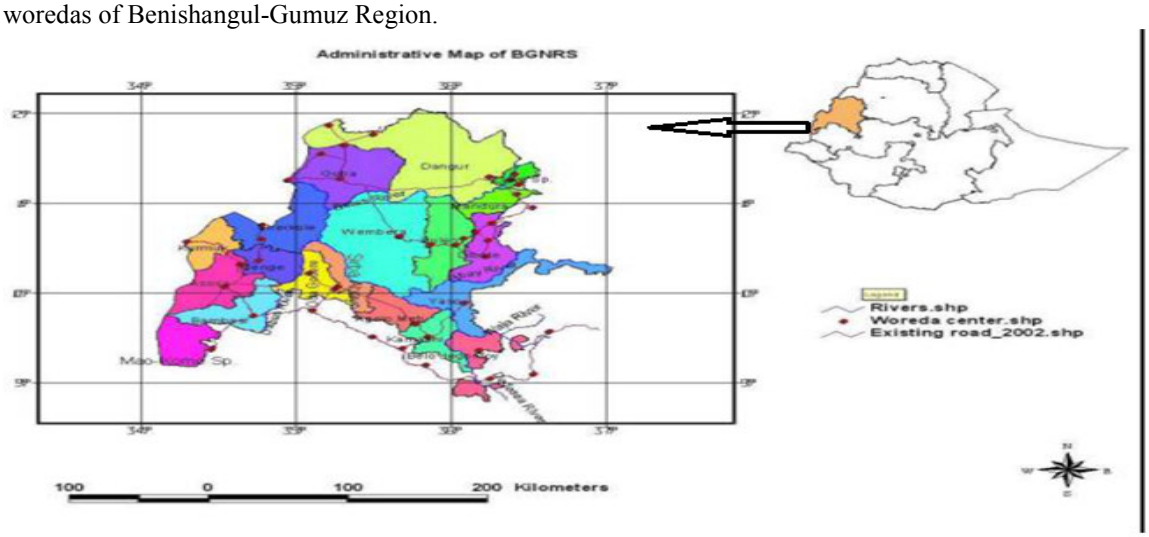

Figure 1: Map of Benishangul-Gumuz Region in Ethiopia

Figure 2: Map of Assosa woreda in Benishangul-Gumuz Region

2.1.1 Climate

The average temperature of the woreda is 27^0C. The rainfall pattern is mono-modal rainfall distribution. The rainy season starts in May and extends to October; and the dry season starts in November and extends to end of April. The dry seasons have a wider temperature differences mainly on the onset it is too cold in the morning and at the night; and too hot in the midday. The annual rainfall of the woreda ranges between 900mm to 1400mm by using the moisture available from rainwater most of the crops are cultivated in the woreda.

2.2 Sources of Data

The primary data was collected from the maize infested seasons at seedling stage, late seedling stage, maturity stage and harvesting time from treated and untreated plots by different termite management practices. The untreated plot was served as a control. The secondary data was collected from different sources of reviews, published journal articles (thesis, discertation, reports, and books)

2.3 Sampling Techniques

Assosa woreda is purposively selected for the purposes of potential production of maize and the major termite infestation problem are high in the district. Then the reconnaissance survey was carried out in the PA of kebele from Woreda where severe termite infestation available was identified. From the identified Kebele; two peasants were selected from "Amba hulet" and the peasants' land was selected with the size of 6m x 6m dimension of plot and 1m x1m from one plot to the other which was the total area is 1311m^2 of land for study.

2.4 Maize planting materials

The seed variety used for this research was BH-540 which was taken from Ethiopian Agricultural Research Center (Assosa Agricultural Research Institute). The total weight of seed used for the study was 25kg/ha which were

3.24kg/ha. The maize seed was sowed on a plot size of 6mx6m=36m^2 with the distance between inter row and row to row is 25cm to 75 cm respectively.

2.5 Experimental Design and Treatments

The experiment was laid out in Randomized Complete Block Design (RCBD) with twelve treatments and three replications and the total observations were 36. There were four treatments applied separately, the four treatments were combined and integrated. Control was used to check the effects of the treatments. The treatments include Cultural (ash= 2.5kg/plot) method, applying physical soil and water conservation (terrace= 30cm in width*60cm in depth), botanical methods (*Echinops kebericho* at rate of 3l/ha), chemical application (malathion 50% E.C. at rate of 2l/ha), their combination, integration and control plot).

2.6 Data Collection

The data was collected from damaged root, stem and cob treated by different termite management practices and control from all plots which were taken from different maize growth stage (seedling stage, late seedling stage, maturity stage and at harvesting time).

2.7 Data Analysis

Data was exposed to analysis of variance employing inferential statistics. The least significance difference (LSD) test was used to separate significantly within means. The Statistical Analysis System (SAS 9.2) software was used to analyze the maize. Finally, the analyzed data were mentioned in the form of tables or graphs, figures and interpreted accordingly.

3. RESULTS AND DISCUSSION

3.1 Termite Infestation Status at maize Seedling and Late Seedling Stages

There was significance difference among treatments of termite infestation at seedling stages. At this growth stage, root and stem infestation were recorded and the root infestation was higher under treated plots registered up to (3.33%) and lower under control (2.78%), but stem infestation was lower under treated registered up to (3%) and higher under untreated (3.33). At this season of maize growth stage, the status of maize infestation level was slightly infested and the root parts are partially affected and some of the infested maize were fall down and dried, but some were remained stand even if root parts were infected.

However, the status of maize stem infestation level was very highly infested and as a result most of the maize were killed and fell down. This indicated that the level of status of termite infestation at seedling stage was very serious if stem of maize is infested than roots parts.

Thus, at the seedling stage, the stem and root infested maize part showed several symptoms such as softening and changing of soil color around infestation, attacking of maize root and stems assisted to expose to the sunlight which led to dried soon and gradually, increase the infestation to pass the stem part. This might be originated from different factors, the populations of termite were lower at seedling stages as can be observed and they were distributed beneath the soil. This could be observed while hoeing and weeding within the plots. Most of the population of termite was occurred around the root of maize seedling and even under weeds.

The reports of Sekamatte, 2001 showed that termite attack maize starts at seedling stages from below root system and turn to stem, the reports showed similar results with the present investigation

Likewise, there was high infestation level at late seedling stages both in root and stem. The status of root infestation was increased lower under treated but highly increased under control (6.33%) at late seedling sage. The infestation status of termite to maize stem was also increased very much than root infestation, but the level of pest infestation under control was (6.33%). As can be observed from the result as the time of maize growth stage increased, the number of infested maize seedlings also increased which means the termite infestation registered were higher at late seedling stage than seedling stage which means the number of infested seedlings both in root and stem were increased under untreated plots. The status of level of infested and damaged were also higher under both stem and root and due to this, most of the crop were dried and fell down. The termite population were distributed over the soil surface especially under the standing crops and produced some castes by approaching to each other.

Abdurahman (1990) reported that greater stand loss of maize due to termite at the vegetative growth stage (and more damage to the seedling stage) of the crop as compared to post-tasselling period in contrary, this finding was not agreed with the reports

Similarly, UNEP (2000) also reported that *Macrotermes* spp. cause to start damage to maize was at seedling stage similarly, the present investigation agreed with this report in which similar result was showed

Table 1: Status of Termite infestation level at seedling & late seedling growth stages after treatment application

Treatments	Seedling Stage		late seedling stage	
	% root damage	% stem damage	% root damage	% stem damage
Malathion 50% E.C	**0.74^{bcd}**	**0.33^{cd}**	**2.00^{b}**	**1.00^{b}**
Echinops kebericho	1.67^{abcd}	0.67^{cd}	3.33^{ab}	2.00^{b}
Terrace	2.22^{ab}	2.00^{abc}	3.33^{ab}	3.67^{ab}
Ash	1.85^{abc}	1.00^{cd}	1.33^{b}	2.33^{b}
Malathion 50% E.C X *Echinops kebericho*	0.56^{cd}	0.33^{cd}	1.00^{b}	1.00^{b}
Malathion 50% E.C x Terrace	0.74^{bcd}	1.33^{bcd}	1.67^{b}	2.00^{b}
Malathion 50 % E. C X Ash	0.93^{bcd}	1.00^{cd}	1.67^{b}	2.33^{b}
Echinops kebericho X Terrace	1.48^{abcd}	3.00^{ab}	3.00^{ab}	2.00^{b}
Echinops kebericho X ash	1.29^{abcd}	1.00^{cd}	2.67^{ab}	1.67^{b}
Terrace X Ash	0.93^{bcd}	1.33^{bcd}	1.00^{b}	2.33^{b}
Malathion 50% E.C X *Echinops kebericho* X Terrace X Ash	0.18^{d}	0.00^{d}	1.00^{b}	0.67^{b}
Untreated control	2.78^{a}	3.33^{a}	6.33^{a}	6.33^{a}
MSE	**0.91**	**1.17**	**5.27**	**4.02**
CV	**35.28**	**27.02**	**2.37**	**24.76**
LSD	**1.61**	**1.82**	**3.87**	**3.38**

*** Means with the same letter in a column are not significantly different at P<0.05**

3.2 Termite Infestation Status of maize at Maturity stage and harvesting time

There was significance difference among treatments of termite infestation at maturity stages. At this growth stage, root, stem and cob infestation were recorded and the infestations were higher under treated plots registered up to (7%) and lower under control (3.67%), but root infestation was lower under both treated and non treated and higher infestation were revealed under stem registering (2.33% to 5.33% from lower to higher respectively). At this maize growth stage, the status of maize infestation level was highly infested and the root parts were completely affected and some of the infested maize was fell down, but some were remained stand even if root parts were infected.

However, the status of maize cob infestation level was the least infested and some of the maize was infested by termite especially those fell down by winds. This indicated that the level of status of termite infestation at maturity stage was the most serious and determinant for yield and showed the significance yield loss directly.

In similar way, there was high infestation level at harvesting time was almost similar with the maturity stages in root, stem and cob. The status of root and stem infestation was remained constant with maturity stage under treated, but highly increased under control (5% to 9%) respectively. The infestation status of termite to maize cob was increased very much than root and stem under treated condition (5.67%), but the level of pest infestation of cob was almost the same (9%) under control.

As can be observed from the result as the time of maize growth stage increased, the number of infested maize part also increased from root to stem and from stem to cob which means the termite root infestation registered were higher at seedling stage; stem infestation was increased at maturity and harvesting time and termite cob infestation was increased at harvesting time than maturity time. And the number of infested maize parts in root, stem and cob were increased under untreated plots.

Abdurahman (1990) reported that greater stand loss of maize due to termite at the vegetative growth stage (and more damage to the seedling stage) of the crop as compared to post-tasselling period in contrary, this finding was not agreed with the reports

According to the investigation of (Alembrhan, 2008), showed root of maize plants due to termite damage was attacked at all stages, however, increased towards the end of the three months of emergence and high stem damage was recorded after102 days after seedling emergence which showed similar result with the present investigation.

Table 2: Status of Termite Infestation Level at Maturity Stage & Harvesting Time after Treatment Application

Treatments	Maturity Stage			Harvesting time		
	% root damage	% stem damage	% cob damage	% root damage	% stem damage	%cob damage
Malathion 50% E.C	0.67^{b}	3.67^{ab}	0.00^{b}	1.00^{b}	5.00^{ab}	3.67^{bc}
Echinops kebericho	1.33^{ab}	4.00^{ab}	1.00^{b}	2.00^{ab}	4.67^{bc}	4.33^{bc}
Terrace	2.67^{ab}	5.33^{ab}	2.33^{ab}	1.33^{b}	5.33^{ab}	5.67^{ab}
Ash	1.33^{ab}	3.33^{ab}	1.33^{b}	1.33^{b}	3.00^{bc}	3.00^{bc}
Malathion 50% E.C X *Echinops kebericho*	0.33^{b}	2.67^{b}	0.67^{b}	2.00^{ab}	3.33^{bc}	0.67^{c}
Malathion 50% E.C x Terrace	1.67^{ab}	3.00^{ab}	1.33^{b}	1.00^{b}	3.67^{bc}	0.67^{c}
Malathion 50 % E. C X Ash	1.67^{ab}	2.67^{b}	0.33^{b}	2.33^{ab}	2.33^{bc}	1.00^{c}
Echinops kebericho X Terrace	1.00^{ab}	3.33^{ab}	2.33^{ab}	2.67^{ab}	3.00^{bc}	1.00^{c}
Echinops kebericho X ash	2.00^{ab}	5.33^{ab}	1.33^{b}	2.00^{ab}	2.67^{bc}	0.67^{c}
Terrace X Ash	1.67^{ab}	2.33^{b}	0.33^{b}	3.33^{ab}	3.33^{bc}	1.00^{c}
Malathion 50% E.C X *Echinops kebericho* X Terrace X Ash	0.00^{b}	3.67^{ab}	0.00^{b}	0.67^{b}	0.67^{c}	1.00^{c}
Untreated control	3.67^{a}	7.00a	4.67^{a}	5.00^{a}	9.00^{a}	9.00^{a}
MSE	**2.83**	**6.00**	**2.33**	**4.19**	**5.72**	**6.66**
CV	**28.34**	**31.21**	**19.06**	**33.21**	**27.63**	**17.94**
LSD (0.05)	**2.83**	**4.12**	**2.57**	**3.45**	**4.03**	**4.35**

*** Means with the same letter in a column are not significantly different at P<0.05**

4. CONCLUSION AND RECOMMENDATION

Termite infestation was increased from seedling stage of maize growth to the harvesting time. The highest and lowest root and stem infestation were recorded at seedling by control (6.33% & 6.33%) and by integration (1.00% and 0.67%) respectively. Higher mean number of root infestation and stem infestation under untreated plot were (6.00%) and (7.00%) respectively. whereas; lower root infestation (1.00%) and stem infestation (0.87%) was revealed by the integration. There were similar situation of termite infestation and damage both in root and stem at seedling stage and maturity stage.

Generally, the termite infestation was first appeared to infest root part of maize at seedling stage and spread to the stem; and to the cob. The infestation was highly increased under control from the seedling stage to maturity; by root and stems, and highly increased in stem and cob infestation and damage after maturity stage. Generally, it is recommended that using different locally available plant species will be done in the future to reduce termite infestation at any maize growth stage. Maintaining the crop field from seedling stage to harvesting time will be developed by farmers. Thinning and removing of weeds and other crop residues will be carried out within all season in all crop growth stage. Using pest resistance variety and management of crop during growth stage will be done so as to reduce the falling of crop to decrease the cob infestation originating from fall of crop by winds at maturity stage.

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