The Journal of Agriculture and Natural Resources Sciences. 1(2):132-136. 2014

T.J.A.N.R.S

The Journal of Agriculture and Natural Resources Sciences

Journal homepage: http://www.journals.wsrpublishing.com/index.php/tjanrs

ISSN:2383-238X

Original Article

Evaluation of the Efficacy of Different Rates of Vinasse Application for the Control of Mound Forming Termite at Fincha a Sugar Estate

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ARTICLE INFO

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How to cite this article:
Mengistu, L., S. Tegene, M. Bikila and F. Birhanu. 2014. Evaluation of the Efficacy of Different Rates of Vinasse Application for the Control of Mound Forming Termite at Fincha a Sugar Estate. *The Journal of Agriculture and Natural Resources Sciences*. 1(2):132-136.

Article History:
Received: 28 Septber 2014
Revised: 25 October 2014
Accepted: 28 October 2014

ABSTRACT

A trial on the use of factory bi-product vinase application in controlling mound forming termite was accomplished with the objective of evaluating the efficiency of vinasse application in controlling this insect at Finchaa Sugar Estate. To meet this objective field experiment consisting of 11 treatments were accomplished in three replications. Accordingly, it was observed that high volume vinasse application showed superior control potential as compared to others. The overall mean percent efficacy data indicated, all treated plots resulted in significantly reduced termite population as compared to the unsprayed check. Hence, from this trial it could be advisable for the plantation people to use between treatment 4 (Vinasse@65m^3 + Ethiozinon 60 EC@ 2.3L) and treatment 7 (Vinasse@100m^3 + Ethiozinon 60EC@2.3L) for the control of mound forming one by analysing their cost and benefit; and environmental safety to choose between the two. By utilization of vinase, the plantation can save on average 50 % of insecticide cost besides safe disposal of the bi-product via utilization.

Key words: Vinase, insecticides, termites, mound forming.

INTRODUCTION

Termites are very serious Pests in several parts of Ethiopia, particularly in the Western parts of the country. They cause considerable damage on agricultural crops, rangelands, forestry seedlings, and wooden structures such as rural houses, stores, fences and bridges crossing streams. According to the studies conducted in western Ethiopia, thatched roof huts are destroyed in less than five years and corrugated iron roof houses in less than eight years. Termite is one of the most important soil dwelling insect pest in the Sugarcane Plantations of Ethiopia specifically at Fincha a Sugar Estate since 1976 (Tesfay and Solomon, 2007) recently at Beles Sugar Project. The crop is vulnerable to termites attack at all growth stages (i.e. seed setts, young shoots and stools, and stalks) (Harris, 1969; Miranda *et al*., 2004). Major infestation of termites occurred on sets at the time of planting resulted in total failure of germination, if left un-protected. Moreover, in the late growth stages, it could result in heavy damage on cane yield. This damage can be particularly severe in periods of low rainfall or at water stress condition and also more severe on plant cane crop than ratoon fields (Roonwal, 1981). High cellulose content of sugarcane crop also renders it highly susceptible to termite attack. Tesfay and Solomon (2007) reported that termite caused 17, 13 and 10 % of dead setts, chopped shoots and stalks, respectively at Finchaa Sugarcane Plantations fields.

Although termites are excellent decomposers of dead wood and other sources of cellulose, they become a serious problem when they attack standing trees, logs, and crops. Therefore, effective control methods such as physical, chemical and biological methods were extensively studied and exploited by many researchers. Today, there are many safe and simple practices of termite management in sugarcane plantation including cultural practices, biological control, plant resistance, natural product, intercropping, physical barriers and baiting systems but insecticides are still playing a key role for the termite's control (Clowes and Breakwell, 1998; Ahmed *et al.,* 2007). The severity of the risk posed to insects is primarily dependent upon the insecticide applied and their exposure to it and its residues. The different cultural control options include avoiding crop stress by providing adequate irrigation where possible, digging out mounds and removing the queen (for mound-building species only), addition of fish meal and others also plays decisive role. The protein-based baits resulted in greater ant nesting near maize plants and reduction in termite damage (Logan *et al.,* 1990). Other approaches to termite control include the use of entomopathogens and according to Anonymous, (2000) some entomopathogens has resulted satisfactory control of the pest. Termites control in recent past was purely based on chemicals especially synthetic insecticides (Anonymous, 2000), though, many farmers in Asia and Africa had been using plant extracts (neem, wild tobacco, dried chillies, Calotropis and wood ashes) for controlling and repelling termites (Anonymous, 2000). Few research reports indicated that sugarcane bi-product, vinasse, apart improving soil physical, chemical and biological properties, has showed pest control potential.

Currently, at Fincha a Sugar Estate, about 8 million liters of Ethanol produced per production season and out of it about 80 million liters of vinasse were produced as a waste (Personal communication). With regard to chemical composition, vinasse is rich in organic matter and among the minerals potassium is outstanding (Silva and Orlando Filho, 1981). Soil properties were usually improved through vinasse application, nevertheless, the possibility of polluting of N compounds (NO_3, NH_4 and others) leaching in the soil profile must be considered. Considerable evidence support that ammonia liberation following application of high N-amendments is responsible for killing pathogens (Shiau *et al*., 1999; Stirling, 1991).

There are termite groups having symbiotic association with fungus. These fungus-growing termites originated in Africa (Aanen and Eggleton, 2005) and are affiliated in a single subfamily, the Macrotermitinae, which has been divided into 12 genera and ca. 330 species (Eggleton, 2000). The fungus mainly serves as an additional protein rich food source (mainly the fungal nodules); a role in lignin degradation (which facilitates the access to cellulose); decreases the C/N ratio of foraged products (by metabolising carbohydrates); and provisions cellulases and xylanases to work synergistically and/or complementarily with endogenous termites enzymes (Rouland-Lefèvre *et al.,* 1991; Bignell, 2000). The success of termite fungi culture is expected to rely on the termites effectively defending both themselves and their cultivar fungus from invading competitors, diseases and others.

Disposal of vinasse, the major effluent from the ethanol industry, represents a major environmental problem. Rational organic waste management is necessary in order to reduce the environmental impact of human activities. As a solution several countries install expensive vinasse treatment plant and others directly used vinasse as soil amendment, since it contains important amounts of plant nutrients and organic matter (Resende *et al.,* 2006; Parnaudeau *et al.,* 2008). Usage of such effluent as a pest management option for large scale commercial sugarcane production system is not yet tested and verified. Thus, this study was initiated to evaluate the effect of vinasse for the control of termite both subterranean and mound forming termite at Finchaa Sugar Estate.

MATERIALS AND METHODS

Effect of Vinasse for the Control of Mound Forming Termite

Evaluation of vinasse application for the control of mound forming termite was made by selecting of active and nearly equal sized termite mounds within sugarcane plantation fields. A mound was considered as a plot and a total of 33 active mounds were used. The trial had eleven treatments (Table 1) including unsprayed and chemical controls. Before treatment application mound destruction was made both manually and mechanically. Treatment application per mound was made after adjusting the rate per plot simply by measuring the above ground/topical surface area of the mound. Insecticide treatment was applied using 300 litres of water per hectare for evenly distribution of the solution within the mound.

Table 1: Treatments for mound applications

No	Treatments	Rate ha^{-1}
1	Free check	-
2	Ethiozinon 60 EC	4.5 litre/ha
3	Vinasse alone	65 m3
4	Vinasse + Ethiozinon 60 EC	65 m3 + 2.3lt
5	Vinasse + Ethiozinon 60 EC	65 m3 + 4.5 lt
6	Vinasse alone	100 m3
7	Vinasse + Ethiozinon 60 EC	100 m3 + 2.3 lt
8	Vinasse + Ethiozinon 60 EC	100 m3 + 4.5 lt
9	Vinasse alone	135 m3
10	Vinasse + Ethiozinon 60 EC	135 m3 + 2.3 lt
11	Vinasse + Ethiozinon 60 EC	135 m3 + 4.5 lt

In this experiments mounds in one territory were taken as one replication hence the existing eleven treatments were located at three territories. Data on termite population were taken six times at ten days interval. From each active mound termite population count was made by taking soil sample at the depths of 0-30 and 30-60cm and was counted by spreading the soil on white sheet. Moreover, at the end of the trial each mound was visually (activity of the mound) checked with the group of professionals in order to verify the control potential of each treatments. Finally, data were subjected to statistical analysis using SAS software package and treatment mean separation were made with Duncan Multiple Range Test (DMRT). Percent efficacy of treatments was calculated by the formula adopted from Alam *et al.,* 2012 as:

%Efficacy = (Pu-Pt)÷Pu ×100

Where, Pu = population of termite in untreated and Pt = population of termite in treated plots

RESULTS AND DISCUSSION

Effect of vinasse on mound forming termite

The result indicated that plots (mounds) receiving treatments were found significantly superior in percent efficacy to the unsprayed check (Table 2). The study also confirmed that usage of vinasse (alone and in combination with insecticide) showed promising control potential on mound forming termite. Analyzed data on efficacy of treatments indicated that plots receiving treatments 8, 9, 10 and 11, showed significantly superior value in reducing termite population at 30 days after application. Similarly, efficacy data on treatments showed significantly superior control potential after 40 days onwards on all plots except T2 and T3(Table 2). The overall mean percent efficacy data indicated, all treated plots resulted in significantly reduced termite population as compared to the unsprayed check.

Table 2: Effect of vinasse for the control of mound forming termites at Fincha

Treatment	Termite control efficacy (%)						
	10 DAT*	**20 DAT**	**30 DAT**	**40 DAT**	**50 DAT**	**60 DAT**	**Mean %**
T1	0.00^{d}	0.00^{e}	0.00^{e}	0.00^{d}	0.00^{c}	0.00^{c}	0.00^{e}
T2	35.61^{bc}	43.85^{cd}	41.81^{cd}	43.07^{b}	39.22^{b}	32.30^{b}	39.31^{c}
T3	19.48^{dc}	23.03^{de}	30.02^{d}	20.51^{c}	23.98^{b}	24.34^{b}	23.56^{d}
T4	76.78^{a}	79.78^{ab}	73.53^{ab}	70.74^{a}	69.07^{a}	72.55^{a}	73.74^{a}
T5	79.01^{a}	80.42^{ab}	75.29^{ab}	70.21^{a}	78.70^{a}	68.41^{a}	75.34^{a}
T6	35.46^{bc}	52.36^{bc}	57.60^{bc}	67.99^{a}	65.52^{a}	64.23^{a}	57.19^{b}
T7	65.34^{a}	74.47^{ab}	70.17^{ab}	76.19^{a}	60.76^{a}	68.08^{a}	69.17^{a}
T8	68.27^{a}	89.75^{a}	81.71^{a}	81.58^{a}	75.91^{a}	74.96^{a}	78.69^{a}
T9	61.77^{ab}	80.99^{ab}	79.01^{a}	81.90^{a}	68.45a	78.82^{a}	75.16^{a}
T10	71.74^{a}	75.55^{ab}	78.12^{a}	76.63^{a}	79.63^{a}	82.32^{a}	77.33^{a}
T11	61.21^{ab}	72.49^{ab}	84.66^{a}	71.36^{a}	71.96^{a}	70.53^{a}	72.03^{a}
CV (%)	27.83	25.39	16.62	17.88	20.4	18.69	10.9

NB: * DAT days after treatment

On the other hand, at the end of the trial, visual assessment was made to verify the recovery potential of mounds receiving each treatment after two months. The observation result showed that all treated plots, except treatment 2, 3, 6 and 7, resulted in zero mound repair/recovery followed by treatment 6 and 7 where only one third of the termite mound recovered (Table 3). In support of this trial, Steinbauer and Peveling (2011) reported that after spraying no termites were observed in association with damage mounds whereas the incidence of termites in unsprayed check had remained about the same. Furthermore, it was observed that vinasse application also attract activities of predators like the big black ant. In support of this fact, Ahmed *et al.*, (2008), intercropping and addition of organic matter (blood + molasses) improve activity of predators and refrains termite attack.

Table 3: Effect of vinasse on termite mound recovery (Visual Observation)

Treatment	Visual observation on mound activity after 60DAT			
	Rep. I	**Rep. II**	**Rep.III**	**Mean**
Free check (Unsprayed)	Remained active	Remained active	Remained active	
Ethiozinon 60 EC	re-constructed	re-constructed	controlled	33.33
Vinasse	re-constructed	re-constructed	re-constructed	0.00
Vinasse + Ethiozinon 60 EC	Controlled	Controlled	controlled	100.00
Vinasse + Ethiozinon 60 EC	Controlled	Controlled	controlled	100.00
Vinasse	re-constructed	Controlled	Controlled	66.67
Vinasse + Ethiozinon 60 EC	Controlled	Controlled	re-constructed	66.67
Vinasse + Ethiozinon 60 EC	controlled	Controlled	controlled	100.00
Vinasse	Controlled	Controlled	controlled	100.00
Vinasse + Ethiozinon 60 EC	Controlled	controlled	controlled	100.00
Vinasse + Ethiozinon 60 EC	Controlled	Controlled	controlled	100.00

CONCLUSIONS AND RECOMMENDATIONS

Generally ANOVA of the collected parameters revealed that in most plots except treatment 3 receiving vinasse application resulted in superior control of termite as compared to the unsprayed checks. In addition, visual observation on mound recovery also confirmed that mounds receiving Treatment 4, 5, 8, 9, 10 and 11 resulted in maximum controls of termites (zero mound recovery). Hence, from this trial it could be advisable for the plantation people to use treatment 4 (Vinasse@65m^3 + Ethiozinon 60 EC@ 2.3L) and treatment 7 (Vinasse@100m^3 + Ethiozinon 60EC@2.3L) for the control of mound forming one by analysing their cost and benefit; and environmental safety to choose between the two. By so doing, the plantation can save on average 50 % of insecticide cost besides safe disposal of the bi-product via utilization.

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