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Journal of Advanced Studies in Agricultural, Biological and Environmental Sciences (JABE) www.jabe.in

A Peer Reviewed & Refereed, International Open Access Journal

Vol.2.Issue.3.2015 (July-Sept.) **ISSN:2394-2606**

EVALUATION OF THE EFFICACY OF DIFFERENT RATES OF VINASSE APPLICATION FOR THE CONTROL OF SUBTERRANEAN TERMITE AT FINCHAA SUGAR ESTATE

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ABSTRACT

A trial on the use of factory bi-product for sugar cane insect management was accomplished with the objective of evaluating the efficiency of vinasse application in controlling subterranean termite at Finchaa Sugar Estate. To meet this objective field experiment consisting of 14 treatments was accomplished in three replications with RCBD design. Accordingly, it was observed that high volume vinasse application showed superior control as compared to others. On the other hand, the low vinasse application rates such as treatment 4, 6 and 7 in spite of numerically lower in terms of insect control as well as improving cane and sugar yield, they showed significantly at par with the high rates in most parameters considered. Hence, from this trial it could be advisable for the plantation people to use among treatment 4 (Vinasse@45m^3+ Pyrinex48EC@1.5L), treatment 6 (Vinasse@90m^3) and treatment 7 (Vinasse@90m^3 + Pyrinex 48 EC@ 1.5L) for the control of subterranean termite by analysing their cost and benefit; and environmental safety to choose among the three. As a result, the plantation can save nearly 50 % of insecticide cost in addition to safe disposal of vinase via utilization.

Key words: Vinase, insecticide, termite, subterranean

Cite this article: **LEUL MENGISTU et al.,** ***"EVALUATION OF THE EFFICACY OF DIFFERENT RATES OF VINASSE APPLICATION FOR THE CONTROL OF SUBTERRANEAN TERMITE AT FINCHAA SUGAR ESTATE"****. Journal of Advanced Studies in Agricultural, Biological and Environmental Sciences,* 2(3): 2015, 12-19

INTRODUCTION

Termite is one of the most important soil dwelling insect pest in the Sugarcane Plantations of Ethiopia specifically at Finchaa 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 setts 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.

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

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Vol.2.Issue.3.2015 (July-Sept.) **ISSN:2394-2606**

barriers and baiting systems but insecticides are still playing a key role for the termite's control (Clowes and Breakwell, 1998). The severity of the risk posed to insects is primarily dependent upon the insecticide applied and their exposure to it and its residues. 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 Milner et. al. (2003) 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). Grace (1988) reported that there were few fungicides having toxicity and behavioural effect on subterranean termites. Compounds modifying subterranean termite behavior may play an important role in future pest control strategies (Grace, 1987; Rust et al, 1988). Few research reports indicated that sugarcane bi-product, vinasse, apart improving soil physical, chemical and biological properties, has showed pest control potential. In support of this fact, Goettel and Hajek (2000) reported that vinasse has showed a suppressing potential of some fungal disease like *Fusarium oxysporum* fsp *melonis*, *Sclerotinia sclerotiorum, Pythium aphanidermatum* and *Phytophthora parasitica*.

Currently, at Finchaa 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. 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 (Gilpatrick, 1969; Huber and Watson, 1970; Mian and Rodriquez, 1982; 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 (Martin and Martin 1978; 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 (Penatti et al., 2005). 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 subterranean termite at Finchaa Sugar Estate.

MATERIALS AND METHODS

Effect of vinasse for the control of subterranean termite

Evaluation of vinasse for the control of subterranean termite at field condition was conducted in 2012/13 cropping season on luvisols at Finchaa Sugar Estate. The experiment has fourteen combined treatments including free check and chemical control (Table 1). Treatments application was made within the

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Vol.2.Issue.3.2015 (July-Sept.) **ISSN:2394-2606**

furrow at the time of planting and soil band (dyke) was made between plots in order to avoid any mix up of treatment while apply irrigation.

The experiment was laid out in Randomized complete block design with three replications. The size of plot was six furrows by eight meter length (69.8 square meters) and two furrows were left between replications. Data on number of dead/wilted shoots and chopped stalks were taken from each plot at fifteen days interval starting from 1.5 to 3 months after planting for sixth months. Percentage chopped shoot and stalk were calculated using the formula used by Ahmed et al, 2007.

$$\text{Percentage chopped (dead) shoot} = \frac{\text{No. of damaged shoots per plot}}{\text{Total No. Shoots per plot}} \times 100$$

$$\text{Percent chopped stalk} = \frac{\text{No. Of chopped stalk per plot}}{\text{Total No. Of stalks per plot}} \times 100$$

In the course of the experiment, data on germination, tiller count, stalk count, cane and sugar yield was taken at 45 days, 4 months, ten months, and at harvest, respectively. Finally, data were subjected to statistical analysis using SAS software package and treatment mean separation were made with Duncan Multiple Range Test (DMRT). Data on percent chopped shoot and stalk were subjected to square root transformation before analysis. 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

Table 1. Treatments for field applications on subterranean termites

No.	Treatments	Rate ha^{-1}
1	Free check	-
2	Pyrinex 48 EC	3 lt
3	Vinasse alone	$45m^3$
4	Vinasse + Pyrinex 48 EC	$45m^3$ + 1.5lt
5	Vinasse + Pyrinex 48 EC	$45m^3$ + 3lt
6	Vinasse alone	$90m^3$
7	Vinasse + Pyrinex 48 EC	$90m^3$ + 1.5lt
8	Vinasse + Pyrinex 48 EC	$90m^3$ + 3lt
9	Vinasse alone	$180m^3$
10	Vinasse + Pyrinex 48 EC	$180m^3$ + 1.5lt
11	Vinasse + Pyrinex 48 EC	$180m^3$ + 3lt
12	Vinasse alone	$270m^3$
13	Vinasse + Pyrinex 48 EC	$270m^3$ + 1.5lt
14	Vinasse + Pyrinex 48 EC	$270m^3$ + 3lt

RESULTS AND DISCUSSION

Effects of vinasse application on sugarcane germination

This study upholded the effectiveness of vinasse and insecticide (alone and/or in combination) in checking bud damage and increasing germination of sugarcane. Plots that received treatments showed significant variation ($P<0.05$) in percentage germination as compared to the unsprayed check. The variation in

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Vol.2.Issue.3.2015 (July-Sept.) **ISSN:2394-2606**

percent germination between unsprayed and treated ranged from 13.42 and 27.77. The highest germination (89.81%) was found on plot received vinasse at a rate of 270 cubic meters and the lowest (62.04%) was recorded on unsprayed plots (Figure 1). In support of this, Ahmed *et al*, (2008) indicated that plots receiving a treatment combination of blood and molasses prevented bud and seedling damage due to termites effectively. Furthermore, Alam *et al.* (2012) also revealed that variation in percentage germination between insecticide treated plot and unsprayed control was observed to be in the range of 6.11-13.42%. Similarly, Singh and Singh (2002) reported the bud damage up to 30-35 % due to termites attack.

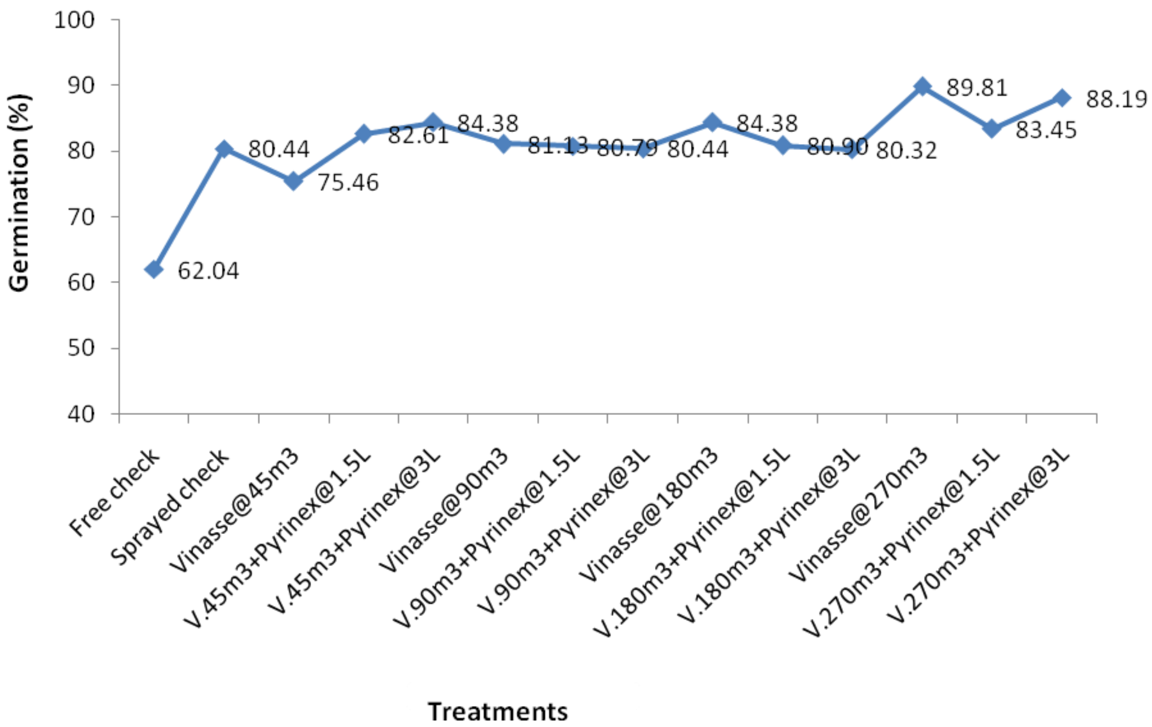

Figure 1. Percentage germination of sugarcane in different treatments and their combinations

Effect of vinasse on sugarcane shoot and stalk damage

The study revealed there was significant difference (P<0.05) among treatments in terms of percent chopped shoot except at 90 days after planting (Table 2). Forty five days after planting, the maximum shoot damage was recorded on treatment 3 (8.32%) and the minimum was on treatment 9 (2.89%). All plots receiving treatments except venase alone(treatment 3) resulted in significantly reduced shoot damage as compared to the unsprayed check both at 60 and 45 days after planting(Table 2). Moreover, this study revealed that the maximum cumulative shoot damage of 28.18% that was observed on unsprayed check plot. The minimum stalk damage was recorded on treatment 5 (1.01%) and treatment 7 (0.68%) at 6 and 7 months, respectively (Table 2). On the other hand, the maximum cumulative stalk damage (6.8%) due to termite was recorded on unsprayed check plot(Table 2). In line with this, Madan and Singh (1998) reported maximum incidence of termite on unsprayed plot and minimum in chlorpyrifos received plot. Similarly, Akhtar and Mushtaq, (1997) reported that cumulative damage for sugarcane crop was up to 34.8% due to termite attack at early young stage and damage increased with the height of the plant. Their study indicated that there was significant difference (P<0.05) among treatments in percent chopped stalk both at 6 and 7 months after planting.

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Vol.2.Issue.3.2015 (July-Sept.) **ISSN:2394-2606**

Table 2. Termite attack on young shoots and stalks of sugarcane crop

Treatments.	Percent chopped shoot				cumulative % shoot damage	Percent chopped stalk			cumulative % stalk damage
	45DAP	60DAP	75DAP	90DAP*		6MAP**	7MAP	8MAP	
1	7.48a	6.10a	8.35a	6.25	28.18	3.77a	2.09a	0.94	6.8
2	3.21b	1.74b	3.86c	4.39	13.2	1.19c	0.83b	0.71	2.73
3	8.32a	4.85a	7.09ab	5.74	26	1.16c	0.9b	0.65	2.71
4	3.69b	2.16b	4.49c	5.59	15.93	1.38bc	0.84b	0.58	2.8
5	4.17b	1.94b	5.21bc	5.29	16.61	1.01c	0.77b	0.59	2.37
6	3.39b	1.98b	3.89c	4.41	13.67	1.55bc	1.07b	0.59	3.21
7	3.09b	2.56b	3.31c	6.21	15.17	2.23b	0.68b	0.57	3.48
8	3.21b	2.23b	4.37c	4.56	14.37	1.32bc	1.34b	0.54	3.2
9	2.89b	2.25b	3.23c	3.64	12.01	1.66bc	0.78b	0.52	2.96
10	3.59b	2.21b	2.73c	6.46	14.99	1.67bc	0.92b	0.58	3.17
11	3.50b	1.65b	3.38c	2.56	11.09	1.25c	0.69b	0.56	2.5
12	3.74b	1.59b	4.69bc	2.89	12.91	1.52bc	0.87b	0.63	3.02
13	3.98b	2.00b	4.24c	4.5	14.72	1.64bc	0.76b	0.68	3.08
14	2.91b	1.99b	3.71c	3.13	11.74	1.23c	0.72b	0.77	2.72
CV(%)	**34.49**	**40.72**	**28.79**	**-**		**11.30**	**12.15**	**8.24**	

- **NB:** *DAP days after application **MAP Months after application ***Means followed by the same letter along columns are statistically non-significant at 5% probability level according to DMRT

Effect of vinasse on sugarcane yield and yield components

ANOVA result on number of tiller, stalk population, cane and sugar yields revealed that there was a significant variation between plots receiving treatments and unsprayed check (Table 3). In terms of number of tiller, treatment 5 (Vinasse@45m^3 + Pyrinex 48EC@3liters), treatment 12 (Vinasse@270m^3) and treatment 13 (Vinasse@270m3 + Pyrinex 48EC@1.5L) have showed superior value over the other treatments. The increment in tiller population was ranged between 25.85 and 10.83 percent in plots received treatments as compared to the unsprayed check(Table 3). There was also significant difference among treatments with regard to stalk population, cane and sugar yields. The highest stalk population (105.57) was found on treatment 8 (Vinasse@90m3 + Pyrinex 48 EC@3liters) and followed by treatment 12 (95.73). Treatment 8 showed about 18.67 and 28 percent variation as compared to the insecticide sprayed and unsprayed checks, respectively (Table 3). The highest cane yield was obtained on treatment 11 (146.94 t/ha) and it was found to have 26.9 % and 9.1% yield advantage as compared to unsprayed and insecticide sprayed checks, respectively. In terms of sugar yield, treatment 7 (10.15 t/ha) was found to outsmart the other treatments (Table 3).

Ananthaanarayana and David (1986) confirmed our finding in that they revealed as high as 33 % loss in yield due to termite attack. On the other hand, several studies reported that termite foraging habit is enhanced by applying cellulose material or organic matter in the soil (Miranda et al., 2004). Similar studies by Deka et al., 1999 observed that, with different formulations of insecticides (fenvalerate 0.4% dust, malathion 10% dust and sugarcane press mud) against O. obesus, a 10% formulation of malathion was effective. Further more, the addition of organic matter in many forms in the soil can help to prevent the damage to the crop (UNEO, 2000).

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Vol.2.Issue.3.2015 (July-Sept.) **ISSN:2394-2606**

Table 3. Effect of treatments on yield and yield components of sugarcane at Fincha

Treatments	Tiller Count ('000/ha)	Stalk Count ('000/ha)	Cane Yield (ton/ha)	Sugar yield (ton/ha)
T1	170.21c	75.86c	107.38b	7.24b
T2	208.81ab	85.92bc	133.61a	8.79ab
T3	190.89bc	75.81c	105.93b	7.27b
T4	217.66ab	81.98bc	135.75a	8.96a
T5	229.55a	86.67bc	136.63a	8.94a
T6	206.85ab	82.22bc	136.11a	8.81ab
T7	209.81ab	85.35bc	136.21a	10.15a
T8	211.99ab	105.57a	140.00a	9.33a
T9	215.23ab	85.30bc	138.17a	9.49a
T10	209.07ab	83.59bc	137.12a	9.34a
T11	214.22ab	83.76bc	146.94a	9.74a
T12	226.19a	95.73ab	139.48a	9.43a
T13	210.69a	94.63ab	144.87a	9.40a
T14	214.22ab	83.79bc	137.56a	9.33a
CV (%)	**7.64**	**8.17**	**10.46**	**9.88**

- **NB:** * Means followed by the same letter along columns are statistically non-significant at 5% probability level according to DMRT

CONCLUSIONS AND RECOMMENDATIONS

This trial clearly revealed that most plots with vinasse application resulted in a decreased shoot and stalk damage; and better in germination, tiller and stalk population; as well as higher in cane and sugar yields. In general, it was observed that high volume vinasse application showed superior control potential as compared to others. On the other hand, the low vinasse application rates such as treatment 4, 6 and 7 in spite of numerically lower in terms of pest control as well as improving cane and sugar yield, they showed significantly at par with the high rates in most parameters considered. Hence, from this trial it could be advisable for the plantation people to use among treatment 4 (Vinasse@45m^3+ Pyrinex48EC@1.5L), treatment 6 (Vinasse@90m^3) and treatment 7 (Vinasse@90m^3 + Pyrinex 48 EC@ 1.5L) for the control of subterranean termite by analysing their cost and benefit; and environmental safety to choose among the three. Thereby, the plantation can save on average 50 % of insecticide cost besides safe disposal of the bi-product via utilization.

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