Tropical and Subtropical Agroecosystems, 13 (2011): 91 - 97

PEST STATUS OF BEAN STEM MAGGOT (*OPHIOMYIA* SPP.) AND BLACK BEAN APHID (*Aphis fabae*) IN TAITA DISTRICT, KENYA

[SITUACIÓN DE LAS PLAGAS DEL FRIJOL: GUSANO DEL TALLO (*OPHIOMYIA* SPP.) Y AFIDO DEL FRÍJOL NEGRO (*Aphis fabae*) EN EL DISTRITO DE TAITA, KENIA]

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SUMMARY

On-station and on-farm studies were carried out in Taita district, Kenya, to assess the effect of various soil fertility regimens on bean stem maggot (BSM) (*Ophiomyia* spp.) and black bean aphid (BBA) (*Aphis fabae*) incidence. These studies aimed at gathering information useful in the development of an IPM programme for the project on conservation and sustainable management of below-ground biodiversity (CSM-BGBD). Field survey of bean stem maggot and black bean aphid was conducted in both the on-station and on-farm plots four weeks after bean emergence. From each plot forty bean plants were sampled. The parameter assessed included stems, leaves and flowers and the percent numbers of plants having bean stem maggot and black bean aphid were expressed as the percentage incidence for that particular plot. The incidence of bean stem maggot and black bean aphid were significantly higher in the on-farm plots than in the on-station plots. On the other hand, influences of integrated soil fertility management (ISFM) interventions and location on bean stem maggot and black bean aphid incidence were minimal. These findings point to the fact that, soil fertility management interventions alone are not effective in mitigating the challenge of insect pest. Instead, there is a strong need to adopt a holistic management approach that incorporates both pest management (IPM) and soil fertility management (ISFM).

Key Words: Black bean aphid (*Aphis fabae*); Bean stem maggot (*Ophiomyia spp*); Soil fertility management practices

INTRODUCTION

Over the past ten years, crop yields in parts of Africa have declined significantly. This is attributed in part to low soil fertility since in these regions crops are grown in marginal environments where soils are impoverished, with minimal external inputs being used to improve crop growth (Singh, 1990; Okoko *et al*,, 2005; ASARECA, 2007; SCRIPTORIA, 2009; Ampofo, *et al*., 1998). Additionally, food crops such as beans are grown by small-scale farmers, whose land sizes often do not exceed 1 ha and as such do not rotate crops or allow fallow periods (Ampofo, *et al*., 1998). This leads to a build up of pests and diseases. Bean stem maggot (BSM), also known as bean fly (*Ophiomyia* spp., Diptera: Agromyzidae) and black bean aphid (*Aphis fabae*, Homoptera: Aphidadae), are the most important pests of beans in such systems. They account for yield losses ranging from 8 to 100% and 37 to 90% respectively (Ampofo, *et al*., 1998; Okoko, *et al*., 2005; Alford, 1999; Abate, *et al*., 2000; Abate, *et al*., 1996).

Bean stem maggot adult oviposits in leaves, stems and hypocotyl of young seedlings. Emerging maggots mine their way to the root zone where pupation takes place and where feeding becomes concentrated between the woody stem and the epidermal tissue. Such feeding interfere with nutrient transport and creates avenues for entry of disease organisms (Ampofo, *et al*., 1998).

To establish the relation between soil fertility and crop yield, CSM-BGBD project evaluated the influence of various soil fertility regimens on soil biodiversity and yield of selected crops in Embu and Taita districts, Kenya. The study also examined the pest status of bean stem maggot (*Ophiomyia spp*) and black bean aphid (*Aphis fabae*) in Taita district to provide information for Integrated Pest Management to complement Integrated Soil Fertility Management interventions.

MATERIAL AND METHODS

Experimental Layout

On-station and on-farm experiments were conducted in 2008 during the long rains (March – May), in Taita Taveta District, Wundanyi location. The area is situated southeast of Kenya, 300 km east of Nairobi at latitude 03^0 20’ S, longitude 38^0 15’ E, and a mean altitude of 2,228m. The area is under the influence of Inter-Tropical Convergence Zone, receiving an annual rainfall of 1,500mm in the highlands and 250mm in the lowlands.

The on-farm experiments were carried out on six farms which were distributed in two study areas situated half a kilometre from each other. Window 1 covered mainly annual and perennial cropping on bench-terraced uplands and agroforestry on steep hills with an altitude varying from 1,200 to 1,600 m above the sea level. Window 2 occupied mainly the natural and planted forest as well as mixed cropping and horticulture on the bottomlands with an altitude varying from 1,600 to 2,000 m above the sea level. Within each farmer's field, seven 3m x 3m plots were established and in each plot beans were planted as intercrops with maize and allocated one treatment. These treatments were: T1 = *Trichoderma* inoculums; T2 = Manure (farmyard manure); T3 = Farmer Practice (Triple Superphosphate and Calcium Ammonium Nitrate); T4 = *Trichoderma* inoculums + Manure; T5 = Control; T6 = Mavuno and, T7 = Mavuno + *Trichoderma* inoculums. Maize (hybrid H513) was planted at a spacing of 90cm x 30cm (two seeds per hole) after application of treatment. Beans variety Mwezi moja were planted at a spacing of 90 x 30 cm between maize rows (two seeds per hole).

On-station experiments were conducted at Farmers Training Centre (FTC), Ngerenyi at longitude 38' 20^0 E and latitude 3' 30^0 S. The trial was laid out in a Completely Randomised Block Design (CRBD), with five replications. Within each sub-block (with the exception of sub-block 4 which had five 3m x 3m plots), ten 3m x 3m plots were established, and in each plot; beans were planted in the same manner as in on-farm plots and using the same treatments. Other recommended agronomic practices were undertaken.

Incidence of bean stem maggot on common beans

Field survey of bean stem maggot was conducted four weeks after bean emergence, to determine the incidence and prevalence of bean stem maggot. From each plot 40 bean plants were sampled, of which the number of bean plants showing symptoms such as poor plant growth, leaf chlorosis, premature defoliation and death; stems thicker than normal with crack above soil were taken as percentage of total plants in the plot. 30% of these infected bean plants were uprooted using a shovel and dissected using a scalpel blade from hypocotyls to the root to expose the pupae and larvae. The number of plants in each plot having the pupae or the larvae of bean stem maggot were recorded as the percentage incidence of that plot.

Incidence of black bean aphid on common beans

At four week after emergence, forty bean plants from the individual plots were inspected. The parameter assessed included stems, leaves and flowers and the percent numbers of plants having the black bean aphids were expressed as the percentage incidence for that particular plot. Using a hand lens, the number of black bean aphid per plant was counted and these numbers were scored in the following scale: 0 = No Aphids Present; 1 = <50individuals/plant; 2 = 51 – 100ndividuals/plant; and 3 = >100individuals/plant.

Data obtained was subjected to ANOVA using SPSS version 12 statistical package. Comparisons were made between treated and untreated plots for bean stem maggot and black bean aphid incidence. Differences were tested using the Least Significant Difference (LSD) test at $p \leq 0.05$.

RESULTS

Incidence of bean stem maggot on common beans

Incidence of BSM was higher in the on-farm plots compared to the on-station plots (Figure 1).

In the on-station plots (Table 1), the mean incidence for the untreated control (T5) was 40.3%. While the mean incidence for the treated plots ranged from 20.6 to 40.9%. In contrast, in the on-farm plots, the mean incidence for the untreated control (T5) was 66.9% whilst the mean incidence for the treated plots varied from 53.3 to 70.9%. However, none of the treatments in both the on-station plots [$F (6, 28) = 1.91, p \leq 0.05$] and on-farm plots [$F (6, 35) = 0.49, p \leq 0.05$] exhibited differences that were significant from the untreated control (Figure 2).

Location like the treatments had no influence on the incidence of BSM (Figure 3).

Incidence of black bean aphid on common beans

Incidences were remarkably higher in the on-farm plots compared to the on-station plots (Figure 1). In the on-farm plots (Table 2), the mean incidence for the untreated control (T5) was 83.3%. While the mean incidence for the treated plots ranged from 66.7 to 83.3%. In contrast, in the on-station plots, there was no recorded case of black bean aphid incidence. None of the treatments in the on-station plots [$F (6, 35) = 0.23, p \leq 0.05$] exhibited differences that were significant from the untreated control (Figure 4).

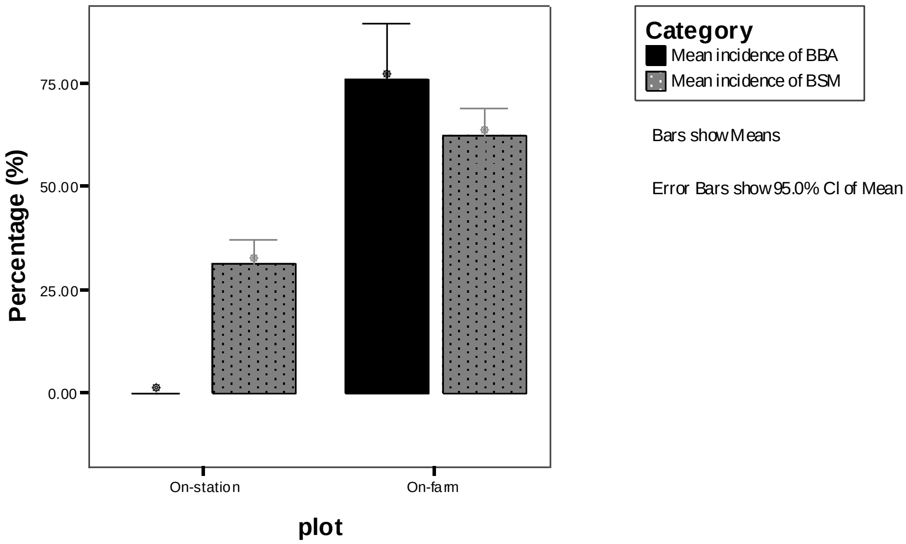

Figure 1: Mean incidence of bean stem maggot and black bean aphid in on-station and on-farm plots in Taita district

Table 1: Least significant difference summary statistic for influence of integrated soil fertility management on incidence of bean stem maggot in on-station and on-farm plots in Taita district

(I) Treatment	(J) Treatment	Mean	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
T5 (On-station)	T1	22.40	17.90	11.02	.12	-4.67	40.47
	T2	26.80	13.50	11.02	.23	-9.07	36.07
	T3	30.70	9.60	11.02	.39	-12.97	32.17
	T4	38.10	2.20	11.02	.84	-20.37	24.77
	T6	40.90	-.60	11.02	.96	-23.17	21.97
	T7	20.60	19.70	11.02	.09	-2.87	42.27
T5 (On-farm)	T1	70.91	-4.00	13.27	.77	-30.93	22.94
	T2	53.67	13.25	13.27	.33	-13.69	40.19
	T3	53.33	13.58	13.27	.31	-13.35	40.52
	T4	62.58	4.33	13.27	.75	-22.60	31.27
	T6	65.00	1.92	13.27	.89	-25.02	28.85
	T7	63.75	3.17	13.27	.81	-23.77	30.10

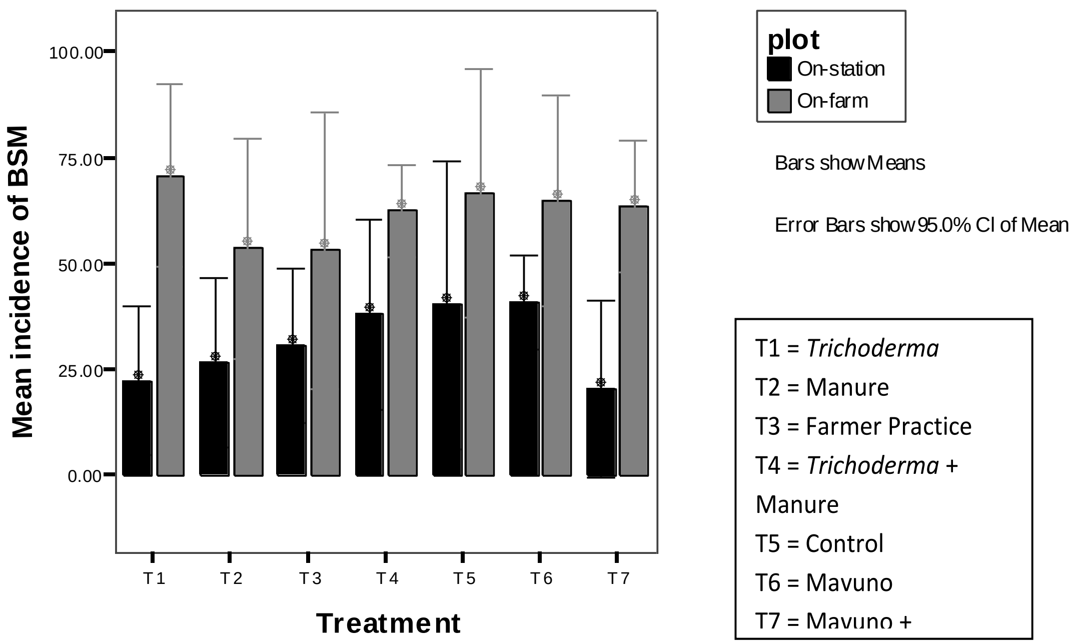

Figure 2: Influence of integrated soil fertility management on incidence of bean stem maggot in on-station and on-farm plots in Taita district

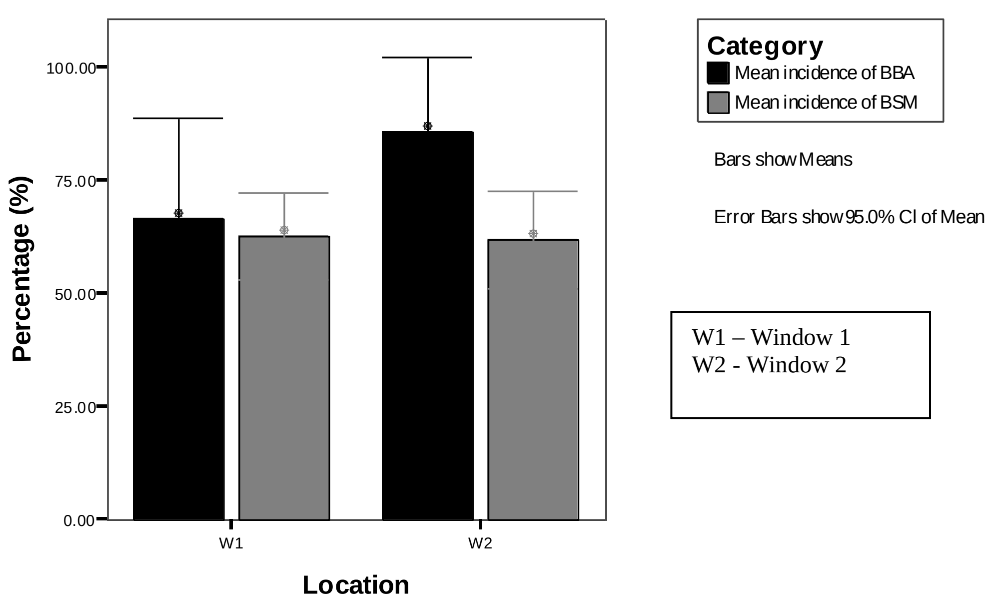

Figure 3: Influence of location on incidence of bean stem maggot and black bean aphid in Taita district

Table 2: Least significant difference summary statistic for influence of integrated soil fertility management on incidence of black bean aphid in on-farm plots in Taita district

(I) Treatment	(J) Treatment	Mean	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
T5	T1	66.67	16.7	26.43	.53	-36.98	70.32
(On-farm)	T2	83.33	0	26.43	1.00	-53.65	53.65
	T3	83.33	0	26.43	1.00	-53.65	53.65
	T4	83.33	0	26.43	1.00	-53.65	53.65
	T6	66.67	16.67	26.43	.53	-36.98	70.32
	T7	66.67	16.67	26.43	.53	-36.98	70.32

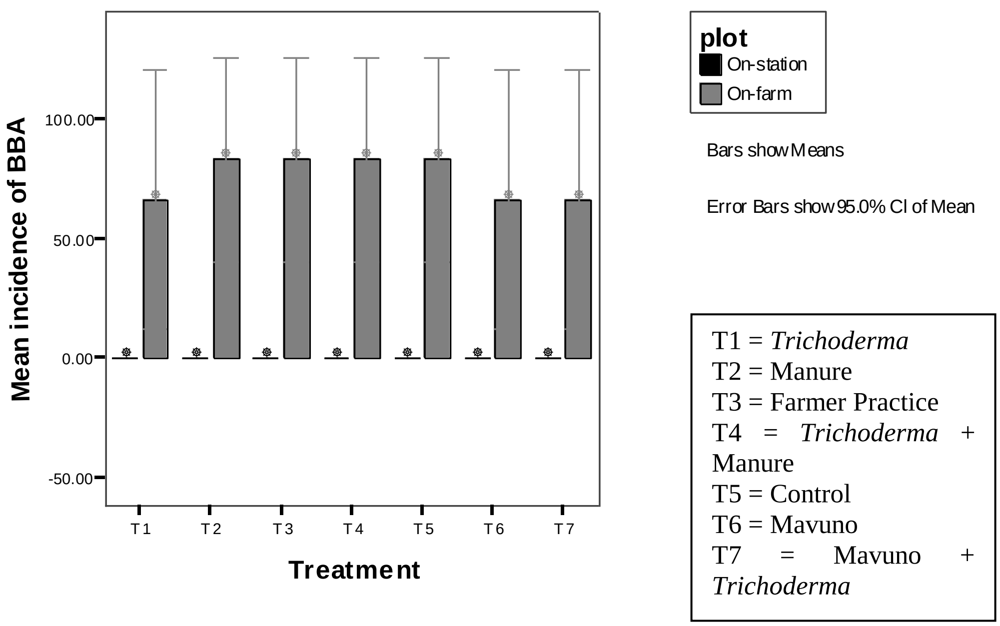

Figure 4: Influence of integrated soil fertility management on incidence of black bean aphid in on-station and on-farm plots in Taita district

DISCUSSION

All on-farm and on-station plots were infested with bean stem maggot. This indicates the importance of BSM as a significant pest of beans in Taita district. In addition, yellowing of the leaves, stunted seedlings, wilt and eventual death manifested BSM presence.

The high incidence of BSM in On-farm plots than in the On-station plots could be attributed to biophysical factors such nutrient deficiencies and imbalances, Autrique (1991 cited in Mwang'ombe *et al.*, 2007); water stress and weed pressures. Weeds and volunteer crops have major implications for pests and diseases, as they act as reservoirs of insects (SAC, 2006; Mwang'ombe, *et al*., 2007). Lack of sufficient water lessens the vigour with which the crop grows; this in turn upsets recovery of the crop by production of the adventitious roots as a result of the pest infestation (Mwang'ombe, *et al*., 2007). On the other hand, location not having a significant effect on BSM incidence; intimates that BSM is a widely distributed pest, common in the upper level uplands (Window 1) as well as in the mountains, hills and foot slopes (Window 2).

The high incidence of BBA in the on-farm trials could be attributed to low standards of husbandry and compounded by the succulent nature of the plant (Nevo, *et al*., 2001; Zelena, *et al*., 2004; Riaz, *et al*., 2007). Sucking insects such as aphids are attracted to succulent foliage, and well fertilised crops may influence populations build up more rapidly. Besides high standards of husbandry, the absence of BBA in the on-station plots could also be partly attributed to location. According to Dixon (1977), locations characterised by high rainfall and low temperatures record lower if any incidence of BBA.

CONCLUSION AND RECOMMENDATION

The study has shown that the impact of integrated soil fertility management (ISFM) interventions on bean stem maggot and black bean aphid incidences is minimal. Likewise, the influence of location on bean stem maggot and black bean aphid incidences - like ISFM interventions - is minimal.

From these results, it is clear that there is a strong need to adopt a holistic management approach that integrates soil fertility and pest management. However, more studies will still be needed on understanding the underlying effects of the soil fertilization regimens on plant health, leading to new and better IPM and ISFM program designs.

As more knowledge regarding the relationship between soil fertility and insect pest attack is accumulated, we will be better placed to change established systems of crop production to those that incorporate agroecological strategies optimizing soil fertilization and pest regulation without incurring yield penalties.

ACKNOWLEDGEMENTS

We acknowledge the project on Conservation and Sustainable Management of Belowground Biodiversity (CSM-BGBD), a UNEP/GEF project number GF/2715-02, for financial support. The University of Nairobi is acknowledged for providing laboratory equipment and space while small scale farmers in Taita District are appreciated for providing free access into their farms.

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Submitted March 1, 2010 – Accepted July 7, 2010
Revised received July 12, 2010