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EVALUATION OF NEEM (*AZADIRACHTA INDICA*) DERIVATIVES FOR MANAGEMENT OF SORGHUM STEM BORERS (BUSSEOLA *FUSCA* (FULLER) AND *CHILO PARTELLUS* (SWINHOE))

[1] *Adane Tesfaye , and* [2]*Asmare Dejen*
[1]*Bahir Dar University, Faculty of Agriculture and Environmental Science, P.O.Box. 79, Bahir Dar, Ethiopia Email: adane126@Yahoo.com*
[2]*Sirinka Agricultural Research Center, P.O.Box 74, Woldia*

Abstract: Neem (*Azadirachta indica A.* Juss) is the most potential plant for solving the multidimensional problems of the rural people. Neem, *Azadirachta indica* and Persian lilac, *Melia azedarach*, with different formulations were tested against stalk borers on sorghum at Sirinka and Chefa in 2002/03 and 2003/04 cropping seasons. This field evaluation experiment was arranged in complete randomized block design with three replications. Sorghum varieties 'Gambella 1107' and local land race 'Jigurty' were used at Chefa and Sirinka, respectively. Two lepidopterous stem borer species, *Busseola fusca* and *Chilo partellus* were important at Sirinka and Chefa, respectively. Three treatments were tested: a water extract from neem seeds, a powder form from neem seeds and Persian lilac leaves. Synthetic chemicals, Cypermethrin 1% granules and Karate 5% emelsifaible concentrates and an untreated control were included for comparison purpose. Infestation and damage levels of stalk borers were reduced using each botanical at different formulations in both locations and years as compared to untreated control. Among treatments, powder forms of neem seeds and Persian lilac leaves were effective in reducing percent head chaffiness and infested plats. Moreover, the percentage of grain yield increase of 7 to 18 and 8 to 15 were obtained over untreated check using neem seeds and Persian lilac leaves, respectively. High yield advantages over untreated plots were also recorded using Karate 5% emelsiafiable concentrates and Cypermethrin 1% granules with the range of 6 to 27 % and 13 to 40 %, respectively in each location and year.

Key words: *Azadirachta indica, Melia azedarach, Stem borers, Busseola fusca, Chilo partellus.*

INTRODUCTION

Neem (*Azadirachta indica* A. Juss) is a member of Meliacae family and a botanical cousin of mahogany, and native to tropical Southeast and Southern Asia. It is a tall, fast growing, evergreen tree, which can reach a height of 25 m and 2.5 m in girth. Neem is bitter in taste. The bitterness is due to the presence of an array of complex compounds called "triterpens" or more specifically "liminoids". The most important bioactive principal is azadirachtin, however at least 10 other neem liminoids exist (Saxena, 1994). Neem has grown well in plantations in the Sahalian zones as well as non-Sahelian zones areas in Ghana (Cobbina, 1998). In Ethiopia, it is widely planted from hot arid to hot semi-arid regions of Dire Dawa,

Afar and Metema; these areas classified as Acacia woodland and Savannah vegetation covers (Solomon, 2004).

Almost every part of neem tree has pesticide value. In addition to pesticide value, neem trees provide shade, green the world, purify air, conserve water and soil, protect forest-fire and ameliorate soil. It is used as timber for construction works and as fodder and food. The trees posses medicinal value and can be used to produce industrial products. Various neem extracts are known to repel various insects. During the last 25 years, it is discovered that the main active principles in neem seed kernels and leaves, the azadrachtin, is able to influence insects in various mode of action. The most important mode of actions are antifeedancy, reduction/prevention of settling and oviposition, disturbance of metamorphosis, sterility, reduction of activity (fitness) and effects on the molecular level. Some insect species, such as the desert locust, *Schitocera gregaria*, are totally repelled by neem residues; this is only a primary (gustatory) effect. Some others try to feed on treated hot plants but leave after discovering that the food is not palatableand this is called phagodeterrent effect (Schmutterer, 1998).

Elsewhere in the world, Entomologists have found that neem products can affect more than 450 insect species. These include many that are resistant to insects which are inherently difficult to control with conventional pesticides, for instance potato whitefly, green peach aphid, and western floral thrips, diamond back moth, and several other leaf miners. The tree products are a medium to broad-spectrum pesticides of plant – eating (phytophagous) insects. They affect members of insects like; Coleoptera, Diptera, Hetroptera, Homoptera, Hymnoptera, Lepidoptera, Orthoptera, Thysanoptera, one particular species of Ostracod, several species of mites, nematodes, and even noxious snails and fungi, including aflatoxin producing *Aspargillus flavus*. The list continues to expand, as neem derivatives are tested against additional pest species (Vietrneyer, 1992). Neem seems remarkably benign to spiders, butterflies, bees, ladybugs that consume aphids and wasps that act as parasites on various crop pest-insects. Thus, insects that feed on plant tissues succumb, while those that feed on nectar or other insects rarely contact significant concentrations of neem products (Vietrneyer, 1992).

Farmers in the region tries to manage stem borers on sorghum and Welo bush crickets on various cereal crops through crop management practices related to time of planting, crop rotation, tillage, plant spacing, intercropping and field sanitation, as well as the use of synthetic insecticides resistance varieties, bio-pesticides and other biological controls. (Adane and Asmare 2005 and Adane and Guatam, 2003 and Adane, *et al.* 2003). However, synthetic insecticides whilst valued for effectiveness and convenience, can pose problems. This include toxicity to non-target organisms, health hazards, development of pest biotypes resistance to specific pesticidal chemicals and aggravation of pest problems in some situation due to the effect of chemicals on natural control organisms (Harris, 1963 & Schmutterer, 1998). Biological control method is not a new one, rotenone (Derris spp.), nicotine and pyrethrins have been used for considerable time in small-scale subsistence and also in commercial agriculture (Stoll, 2000). The use of pesticides derived from plants increases from time to time not only due to their availability but also they do not require high technical input to prepare, increase quality of a crop in taste and texture. They are not phytotoxic, easy to grow and pose no hazard to non-target organisms, wild life, humans or the environment. These facts brought the need for looking alternative pest control strategies, especially those that are effective, low cost and environmentally friendly. Therefore, the objective of this study was to evaluate the efficacy of neem derivatives for the management of sorghum stem borers to utilize as component of integrated pest management programme in the area.

MATERIALS AND METHODS

The study site is located in Amhara National Region state, North Welo administrative (sirinka) and Oromia Administrative zone (Chefa). The altitude range of Sirinka is 1850 meter above sea level, where as altitude of Chefa is about 1600 meter above sea level. The major crop grown in the area are Sorghum, teff and millets. This trial was conducted at Sirinka and Chefa trial sites where *Busseola fusca* and *Chilo partellus* were important, respectively in 2002/03 and 2003/04 cropping seasons. *Sorghum bicolor*, Sorghum varieties, "*Gambella 1107*' and local land rice 'Jigurty' were used at Chefa and Sirinka, respectively.

The experimental design was randomized complete block with three replications and plot size of each treatment was 3.75 m X 5 m. The replications were considered as blocks and the spacing between block were 2 m and spacing between treatments were 1 m.

The treatments were water extracts and powder form of neem seeds and Persian lilac leaves. Two insecticides, Cypermethrin 1 % granule (G) and Karate 5 % Emelsifiable concentrates (E.C.) (300 ml/ha) and untreated checks were used as controls. The neem seeds, yellow in color, were collected from Kobo. The husk of the seeds were removed and washed, and dried under shade. Hand gloves were used during spreading on canvas to avoid contamination. The dried seeds were ground using local mortar and pestle up to fine powder form. Likewise, leaves of neem were collected from middle twinges, to avoid collecting, young and old leaves and dried under shaded condition. The dried leaves were ground with local mortar and pestle up to fine powder form. Similarly, Persian lilac leaves, which were collected from Sirinka, were dried under shade and ground with local mortar up to fine powder.

Water extract of neem seed was prepared by mixing 1500 g powders with 400 lts. water for one hectare farm land and kept as such for 24 hours. Little 70% alcohol was added in the admixture for more extraction of the active ingredient. Finally, the admixture was allowed to pass through a cloth with very fine sieve so as to make the residues remain on the cloth and filtrate easily pass through nozzle during spray using knapsack sprayer. This filtered extract was sprayed into sorghum leaf funnel in the afternoon when daily temperature falls to prevent volatility of the active ingredient. Powder of Persian lilac leaves and neem seeds were applied into the funnel or leaf whorl using hand pinch. The powder was placed in the young leaf funnel of sorghum to make the powder reach where larvae fed in the young leaf. Approximately one hand pinch, which is equivalent to one teaspoon, was applied per plant shoot. Both chemicals and bio-pesticides were applied three times starting at 2 weeks after the crop emergence (WAE).

Data on percent infested plants; dead hearts and leaf damage scores at 4 and 6 WAE, chaffy heads (complete and partial), tillers number /plot, number of harvestable heads, 1000 seed weight and grain yield (kg/ha) were recorded at harvest. Avoidable losses per each treatment as compared to the untreated check (control) in each trial site were estimated using the

following formula. Yield loss (%) = $\left[\frac{X-Y}{X}\right]x100$, where X= Mean grain yield of treated plots and Y= Mean grain yield of untreated plots (Krishnaiah, 1980).

RESULTS AND DISCUSSION

Results

At Sirinka study area of 2002/03 cropping season, the dead heart count both at 4WAE and 6WAE were non – significant but tiller numbers per plot (18.75m2) at harvest and number of harvestable heads were significantly different in accordance with the treatments. In addition to that, the numbers of infested plants, leaf damage score, number of chaffy heads, 1000 seed weight and yield in kg/ha were highly significant between different treatments. Plots treated with neem water extract and Persian lilac leaf powder were causing lower dead heart, reducing the number of infested plants, leaf damage score and chaffy heads but higher in number of harvestable heads, 100 seed weight and yield in kg/ha as compared to untreated check. Even though bio pesticides are better in reducing sorghum stem borers damage, synthetic chemicals highly reduced percent-infested plants, number of dead hearts, leaf damage scores and chaffy head numbers and there was a high increase in 1000 seed weight and grain yield in kg/ha. Thus, Percent infestations of sorghum plants were reduced by 15-20 % using bio-pesticides and 34.5 % using synthetic chemicals as compared to the check. Moreover, the grain yield in kg/ha Head chaffiness was also reduced by 13 % and 26 % using bio-pesticides and chemicals, respectively in both years (Table 1).

In the crop season 2003/04 at Sirinka trial site, the incidence of stalk borer at Sirinka was less than that in the previous year (2002/03). As a result, numbers of dead heart count and number of infested plants at 4WAE and 6WAE were not significantly different among treatments. Due to these phenomena, there were no significant differences of chaffy head numbers and grain yield in Kg/ha both between synthetic insecticides, bio-pesticides and untreated check. Though, grain yield was not significantly differred between synthetic insecticides, botanicals and untreated check, grain yield advantage of 7-18 % and 13 % were recorded using neem and Persian lilac and in the same year, 20 % and 10 % yield advantages over untreated check were recorded using Cypermethrin 1 % G and Karate 5% E.C., respectively (Table 2).

Table 1. Effect of botanicals on incidence of stem borers and yield component at Sirinka in 2002/03 cropping season

Treatments	Dead heart		Number of infested plants		Leaf damage score (1- 9 scale)		Tillers/ plot at harvest	No. of chaffy heads		Harvest. heads	1000 seed weight	Yield (kg/ha)
	4WAE	6WAE	4WAE	6WAE	4WAE	6WAE		Complete	Partial			
Neem seeds water extract	1.4	0.3	2.5	15.0b	0.5abc	2.8ab	9.3	5.3abc	11.5b	83.8	31.6cd	1844.2bc
Neem seeds powder	0.8	0.5	2.8	17.8ab	1.0ab	3.0ab	7.0	5.8ab	9.8b	78.0	31.8cd	1633.3c
Persian lilac leaves powder	0.8	0.0	4.5	10.3bc	0.8abc	2.5b	8.3	5.0bc	8.8b	83.3	33.1bc	1728.0c
Cypermethrin 1G	1.3	0.0	0.6	0.5c	0.0c	0.2c	9.3	0.0d	1.0c	93.0	35.5a	2221.7a
Karate 5% E.C.	1.1	0.3	0.5	0.5c	0.3bc	0.5c	7.8	1.8cd	5.5bc	95.8	34.8ab	2067.5ab
Control	1.3	1.0	8.8	26.3a	1.3a	3.5a	9.8	8.8a	18.0a	71.75	30.97d	1511.69c
LSD at $\partial = 0.05$	NS	NS	NS	**	**	**	*	**	**	*	**	**
CV (%)	36.0	40.7	38.5	32.4	38.9	28.21	24.0	32.2	24.31	16. 82	3.90	11.12

WAE= Weeks after crop emergence NS = Non significant between treatments

** = highly significant level * = significant level

a, b, c= indicate the level of treatment difference using Duncan multiple range test (DMRT)

Values in each column followed by the same letter(s) are not significantly different ($P<0.05$)

CV= coefficient of variation LSD = List significant level at 5%

Table 2. Effect of botanicals on dead heart, number of infested plants, leaf damage score and Chaffiness at Sirinka in 2003/04 cropping season.

Treatments	Dead heart		Number of infested plants		Leaf damage score (1- 9 Scale)		No. of tillers /plot at harvest	No. of chaffy partial heads	Yield (kg/ha)
	4WAE	6WAE	4WAE	6WAE	4WAE	6WAE			
Neem seeds water extract	0.7	0.7	4.6	6.0ab	1.5bc	2.3b	36.3ab	5.3	3399.1
Neem seeds powder	0.7	0.8	5.1	5.0b	1.8b	2.3b	25.8b	4.3	3321.7
Persian lilac leaves powder	0.8	0.7	5.4	6.2ab	2.0ab	3.0ab	38.5a	5.8	3316.4
Cypermethrin 1G	1.1	0.7	5.0	1.5c	2.0ab	0.5c	2.3c	3.8	4037.5
Karate 5% E.C.	1.0	0.8	4.6	2.6bc	1.5bc	1.0bc	7.3c	3.8	3770.1
Control	0.8	-0.8	5.3	7.1a	2.3a	3.8a	40.8a	10	3526.2
LSD at $\hat{c}$ = 0.05	NS	NS	NS	**	**	*	**	NS	NS
CV (%)	28.6	23.2	26.4	20.2	48.5	34.6	38.2	30.5	13.1

In the cropping season of the year 2002/003 at Chefa trial site, dead heart count was not significantly different between different treatments. The number of infested plants, leaf damage score, number of chaffy heads, number of harvestable heads, 1000 seed weight and grain yield in Kg/ha were significantly different between plants treated with synthetic insecticides and untreated check. Bio-pesticides treated plots are on the intermediate point of stalk borer effects and gain of yields. In my over all observation, the level of infestation and damage of sorghum by stalk borer was reduced by using synthetic chemicals and bio-pesticides. Though, there was no significant difference among treatments in percent-infested plants, relatively less infested plants were recorded in plots treated with synthetic chemicals and bio-pesticides. In addition to that, there were no significant differences among plants treated with bio-pesticides and untreated control but a yield advantage of 15 % was obtained using application of neem seed and Persian lilac extracts. (Table 3).

Table 3. Effect of botanicals on stem borer incidence and sorghum yield components at Chefa in 2002/03 cropping season

Treatments	Dead heart		Number of infested plants		Leaf damage score (1-9 scale)		Tellers/ plot at harvest	No. of chaffy heads/ plot	Harvestable heads #	1000 seed weight	Yield (kg/ha)
	4 WAE	6 WAE	4 WAE	6 WAE	4 WAE	6 WAE					
Neem seeds water extract	1.0	0.7	13.3a	25.8ab	2.3a	3.5a	2.5	9.5a	81.5b	32.7c	3193.3b
Neem seeds powder	1.2	0.8	13.8a	30.0a	2.0a	3.8a	1.0	8.8a	84.0b	35.3b	3730.6ab
Persian lilac leaves powder	0.1	0.7	7.5ab	15.8b	1.8ab	3.3a	2.8	8.8a	82.3b	32.9c	3732.2a
Cypermethrin 1G	1.0	0.8	0.8b	0.3c	0.5c	0.3b	1.0	1.0b	92.8a	38.3a	3993.1a
Karate 5% E.C.	1.0	0.7	4.3ab	1.3c	1.0bc	0.5b	2.5	2.0b	87.5ab	37.8a	3552.2ab
Control	1.3	1.0	14.5a	32.5a	2.5a	4.3a	3.8	12.3a	68.3c	31.5c	3157.2b
LSD at alpha 5% level	NS	NS	**	**	**	**	*	**	**	**	**
CV (%)	31.6	17.8	35.8	28.3	28.7	28.2	28.2	36.2	6.1	4.1	9.4

In the crop season 2003/04 at Chefa trial site, Dead heart count, number of infested plants, leaf damage score and number of complete chaffy heads were non- significant. However, highly significant yield differences of sorghum were recorded where synthetic chemicals were used over untreated check. Significantly high grain yield was recorded in plots treated with Cypermethrin 1% G and karate 5%E.C. Although, significant differences were not recorded between bio-pesticides and untreated check, yield advantages of 5% and 9% were recorded in plots treated with neem water extract and Persian lilac, respectively (Table 4).

Table 4. Effect of botanicals on dead heart, number of infested plants and chaffiness at Chefa in 2003/04 cropping season

Treatments	Dead heart		Number of infested plants		Leaf damage score (1- 9 Scale)		N0. of chaffy heads		Yield (kg/ha)
	4WAE	6WAE	4WAE	6WAE	4WAE	6WAE	Complete	Partial	
Neem seeds water extract	1.0	0.0	1.3	2.0	0.8	0.8	2.3	7.5ab	3246.6bc
Neem seeds powder	0.5	0.3	1.0	1.3	0.5	1.0	2.3	5.5b	3075.7c
Persian lilac leaves powder	0.5	0.0	0.3	2.0	0.5	1.0	3.3	4.5b	3343.4bc
Cypermethrin 1G	0.3	0.0	1.0	0.8	0.5	0.5	0.5	0.3c	5137.6a
Karate 5% E.C.	1.0	0.3	1.0	1.0	0.5	0.5	0.5	0.5c	4075.1b
Control	1.3	1.5	2.3	2.8	1.0	2.3	3.5	8.8a	3039.4c
LSD at alpha 5% level	NS	NS	NS	NS	Ns	Ns	Ns	*	*
CV (%)	31.4	24.8	42.3	60.0	82.2	48.7	37.6	30.0	14.2

Generally, across all experimental sites and cropping seasons sorghum stem borers incidence were occurred which can cause a loss in sorghum grain yield loss but the insect incidence level and sorghum yield loss amount varies from season to season and place to place depending on agro ecologies and current weather conditions. In both location and cropping season, the incidence of stem borers becomes increasing as the crop phenology progress starting from seedling up to maturity. At both locations and evaluation study seasons, there was no significant difference ($p<0.05$) among treatments in number of dead heart due to stem borers and early infestation of plants. But significantly less number of infested plants was recorded in plots treated with Cypermethrin 1G, Karate 5% E.C. and botanicals (neem seeds powder and Persian lilac leaves) at 6 WAE. Infestation and leaf damage score levels were reduced in those plots treated with bio-pesticides with different

formulations as compared to untreated plots (Table 1, 2, 3 and 4). When we compare the quality of grain yield and environment, the quality of grain yield in my visual observation is almost the same but in environmental aspects the synthetic chemicals have residual effect where as botanicals are eco-friendly. Therefore, applying botanicals rather than conventional insecticides can give safe farm products for the consumer and encourage the population increase of natural enemies (Predators and parasites).

DISCUSSION

Assefa and Ferdu (1999) reported that Persian lilac caused larval mortality comparable with the recommended insecticide. Schmutterer (1998) reported that homemade water extracts of neem seeds or neem kernel are effective provided that the raw material used should be of good quality. Similarly, he also reported that approximately one teaspoon full of neem powder is needed to treat the funnel of one plant and protect the stalk borer very well. Stoll (2000) reported that timely application of neem and Persian lilac seeds and leaves reduced infestation and damage levels of stalk borer and boosted sorghum and maize yields. In our case, both neem and Persian lilac are preferred botanical to suppress sorghum stem borer population.

The reason for better efficacy of neem seed water extract on stem borers' infestation could be due to the addition of little soap that stick the extract to the leaf. Mensah (1998) reported that alcohol extracts were the best method for obtaining liminoids in the extract. The liminoid content in such extract are 50 times more concentrated than for water extracts. The alcohol extracts contain between 300 and 100,000PPM of azadirachtin. Although, alcohol extracts of neem seeds protect more effectively than water extracts, water extract of neem also provided more yield than from untreated plots. The efficacy of powder form of bio-pesticides could increase provided that there was sufficient water or rainfall to moist the powder and reach at the site of action where small size larvae feed on. It is pertinent to note that sufficient powder or spray enters the leaf sheath where the early instar larvae were located. The timing of application is also crucial for the effectiveness of these bio-pesticides. The young larvae rest on the leaves and in the sheath before they bore into the stalk.

Therefore, it is essential to apply during this time, when they are most vulnerable. There is also a need to study application frequency of these bio-pesticides because several generations of the stalk borer over a long period of crop development is expected.

CONCLUSION AND RECOMMENDATIONS

Neem and Persian lilac derivatives proved to reduce stem borers population in sorghum ecosystem as per untreated plot with equivalent efficiency of conventional insecticides like karate 5% & Cyperymethrine 1% G.

Since successful implementation of sorghum stem borers management is required in the region, further evaluation on efficacy, mode of action of various neem derivatives against various stages stem borers and best integration of various management options are necessary.

Considering the lesson of this study and overseas experience, sorghum stem borers and major identified crop-pests of the region can be managed by neem derivatives, and they were spread possibly at neem growing areas, mainly in lowland areas of North Eastern Ethiopia (North and South Wollo, Waghimera, Oromiya and North Shewa zones).

Entomological researches on Neem are the most widely on due; chemical, cultivative, industrial and agro forestry researches have been also undergoing. In pesticide research whenever neem is tested on new nuisance insects, it exhibits a successful result. In Ethiopia, certain undertakings were adapted in its pesticide potential and all results were encouraging for neem introduction.

The pesticide effect results in this research showed a remarkable effect on the studied most important pest-insects of the Region. The tested neem derivatives seem more effective in time course and this may be mainly due to the mode of action of pesticide effect of the derivatives. This may be an additional line of future neem study in the field of insecticides.

Neem can be a powerful entity in agricultural development of the country in general and of the Amhara region in particular. So, following the experience of other developing countries, Neem based national and regional co-ordination staff might be required for its superior importance (environmental friendly & saving money) among the rural people. This staff will

be a key resource for creating awareness about Neem trees, and in promoting information flow, research and development activities in the concerning field.

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