International Journal of Advanced Studies in Ecology, Development and Sustainability
Vol. 3, No. 1 January, 2015 ISSN HARD PRINT: 2354-4252 ONLINE: 2354-4260
© www.internationaljournal/Journals/advanced-ecology-dev-sustainability-vol,4No.1
ASEDS: 015:2:4

IMPACT OF SYSTEMIC INSECTICIDE ON STEM BORER INFESTATION ON ESTABLISHMENT AND PRODUCTIVITY OF SOME SORGHUM VARIETIES/CULTIVARS IN BIU; BORNO STATE, NIGERIA

[1]Adamu, H. L., & [2]Malgwi, A. M.
1Department Agricultural Education, College of Education
Waka-Biu, PMB 1502 Waka; Borno state, Nigeria
2Department of Crop Protection, School of Agric. and Agric. Technology, Federal
University of Technology Yola, Adamawa State, Nigeria

Abstract

The stem borer (Busseola fusca, Fuller) infestation of sorghum (Sorghum bicolor) L. Moench varieties/cultivars in naturally infested field causes certain damages on the crop. This experiment was conducted in Biu, Borno state; Nigeria which aimed at identifying varieties/cultivars relative reactions to B. Fusca and efficacy of a systemic insecticide on damages in 2008 and 2009 cropping seasons. The field experiment was a split-plot design (SPD) that consisted of ten sorghum cultivars sourced locally in Biu and its environs and five varieties obtained from Institute of Agricultural Research (IAR), Zaria. The varieties/cultivars were the sub-plots while the untreated and treated (used Chlorpyriphos 10G) plots served as the main-plots replicated three times in 6m2 plots. Six damage parameters; leaf scrapping, 'dead heart', tillers, peduncle and stem breakages, chaffy and unproductive heads were taken into account at 25DAE & 35DAE and at harvest (100DAE). The result has shown that primarily stem borer activities produced tillers after killing sorghum growth points followed by leaf scrapping, then stem and peduncle break, chaffy and unproductive heads are formed, as well as reduction in production. However, the combined interactive results revealed that 'Kwakwai' produced largest number of tillers per plot. 'Yollom' and 'Piltumvwa' suffered most the leaf scrapping damage and percentage leaf feeding damage at 25DAE was higher on 'Tiksha mamza' (48%) and 'Piltumvwa' (24%), while at 40DAE, 'Chaklari' had highest 'dead–heart' (25%). Aggregate percentage damage was highest on 'Tikshamamza' (89%). Of the 15 sorghum varieties/cultivars screened, kwakwai, Tiksha mopu, Samsorg14 and 41, and KL-1 showed relative tolerance to stem borer damages, while 'Shalmadi', 'Yungum', 'chaklari', Samsorg17, and NR-7114 showed moderate tolerance. Meanwhile, Piltum vwa and 'Yollom' were relatively susceptible and Tiksha mamza was highly susceptible. Hence it is concluded that, sorghum varieties/cultivars reacted differently to the stem borer damages and were reduced with just one application of chlorpyriphos. It was recommended that, local farmers adopt the use of tolerant crops, increased application rate of chlorpyriphos, coupled with effective cultural measures (destruction and burning of infested stalks) and to do determine alternate host range of sorghum stem borer in sub-saharan regions of Nigeria.

Keywords: Cultivars; Chlorpyriphos; Effects; Sorghum; Stemborer; Productivity and Establishment.

Background to the Study

Sorghum (Sorghum bicolour L. Moench) is a grain crop which originated in Africa and is grown widely in the savannah regions of West Africa. It is the third most important cereal crop grown in the United States and the fifth most important cereal crop grown in the world. The United States is the world's largest producer of sorghum followed by India, China, Argentina and Nigeria which is a leading cereal grain producer in Africa. Leading exporters are the United States, Australia and Argentina (Hills and Waller, 1999 & U.S. Grains Council, 2010). It is grown on over 45 million hectares of land World wide in semi-aid tropics (SAT) of Africa, Asia and Latin America (FAO, 1984; PROTA 2006). The World annual production of sorghum was 69 million and its World production in 1984 was 66 million metric tonnes (Mt); total area sown in 1999 were 4.4 million hectares and 58 million tonnes respectively (Onwueme & Sinha, 1999; U.S. Grains Council & Wikipedia, 2010).

In 2006, area cultivated was 43.7 hectares with production of about 62.8 million tonnes (Singh et al., 2006). The U.S. harvested approximately 9.7 million acres of sorghum in 2009/2010, representing approximately 89 percent (%) of total production. Africa is the largest producer of sorghum with approximately 21.6 million Mt produced annually. Leading producers around the world during fiscal year 2010 included Nigeria (11.5 million Mts) representing (19.3%), followed by the U.S. with 9.7 million Mt representing16.3% (USDA, Grains: World markets and Trade, 2010).

Malgwi, 1999 and Bello, 2010 considered sorghum as second in importance among cereals in Africa and next in importance after rice and wheat in India. In many parts of the world sorghum has traditionally been used in food products like porridge, unleavened bread, cookies, cakes, couscous and malted beverages. The grain may be ground into flour used in various traditional foods, like "tuwo" in Nigeria and snack food products of Japan. Sorghums are also important animal feeds in countries like the U.S., Mexico, South America and Australia which are further processed to improve its feed value and products are then fed to beef and dairy cattle, laying hens and poultry and swine. As much as 30-40 percent of domestic sorghum production goes to produce ethanol, stalks provide shelter, and its various co-products for renewable fuel sources and other uses such as source of dye, sugar and syrup (FAO, 1984, ICRISAT, 1991, Malgwi, 1999 and (U.S. Grains Council; & Bello, 2010). Athough sorghum has lost part of its traditional value in Africa to maize, which produces better in more favourable environment, it is however anticipated that sorghum remains an important food security crop in less favourable environments in tropical Africa (Taylor, 2003).

There are over 150 insect species which damage sorghum plant from sowing to crop harvest and more than 100 insect pest species have been recorded in Africa (Seshu Reddy and Davies, 1979; Nwanze, 1985; Seshu Reddy, 1991 & Malgwi, 1999). Generally the annual losses of sorghum to pests in the developing world are estimates between 25% and 50% of the expected output and over 1billion US Dollas in the semi-Tropical region (ICRISAT, 1992 & USDA, 2004). Although there are number of reports on different aspects of sorghum insect pests damages and progress has been slow because of the perceived low market value of sorghum in the developing countries (Leuschner, 1989 and Malgwi, 1998).

Stem borers are caterpillars that live in cereal stems. They eventually turn into yellow or light brown moths; usually one larva occurs per tiller and they are nocturnal moths. A female can lay up to three egg masses during her 7 to 10 day life as an adult. Busseola fusca is a pest of maize in Africa and also attacks sorghum, pearl millet and sugar cane and some wild grasses. Larvae feed on young leaves, tunnel into the stems and Cause 'deadhearts' or drying of the central tiller during vegetative stage, loss of crop stands, whiteheads at reproductive stage and peduncles breakages (Harris & Nwanze, 1992 and U.S. Grains Council, 2010).

Chemical control of insect pests will continue to be a major component of integrated pest management. However, control of tissue borers with insecticides is relatively more difficult than control of the insect pests feeding externally on foliage, shoots and stems. The foliar application of dust and spray formulation of most of the available insecticides has generally proved to be unsatisfactory as these cannot penetrate deep inside the tissues in sufficient quantities to kill the borers. The recent advances in pest control technology, placing greater emphasis on use of various pest management components as well as insecticide selectively based on improved application methods has now made the control of stem-borers more effective and economical (Rillon, 2007). Advantage can now be taken of the knowledge of the specific habits of the pests, period of peak activity of the most vulnerable stage and the economic thresholds for determining the appropriate time of application to control these pests. The development of new systemic insecticides and their granular formulation has further contributed towards the effective control of these borers. The recent research findings and recommendations for the control of cereal stem-borers are reviewed and discussed (Malgwi & Adamu, 2013).

(50g) per 10kg of sorghum seeds to provide protection against seed and soil borne organisms. The seeds were sown on 28th July, in both 2008 and 2009 cropping seasons at 5-7 seeds per hole with spacing of 45×75cm respectively (BOSADP,1992; Malgwi, 1998) and regular cultural operations like thinning, weeding and fertilizer application were carried out as recommended (Onwueme & Sinha, 1999 and Enwuezo et al., 1989).

Data collection

Stem Borer Damage Symptoms on Sorghum Plants

A modified screening system of insect host-plant interaction damage symptoms was used to obtained; The total number of plants per plot; The total number of plants per plot (main and tillers separately); and those with unproductive and productive panicles (main and tiller separately) (Leuschner, 1989) and percentages of infested plants scored based on Visual damage rating scale for B. Fusca infestation on 1-9 scale (Seshu Reddy and Davies, 1979). The data were subjected to Analysis of Variance (ANOVA) (Cox and Cochran, 2003) on SAS Statistical package and means separated using Student-Neuman-Keuls (SNK) test for variables.

Sorghum Grain production and Varietal/Cultivar Performance Assessment

The quantity of sorghum grains produced was assessed based on the weight obtained from the productive sorghum panicles on both untreated and treated plots separately after harvest which was threshed and weighed in kilogram (kg) using weighing scale balance (Leuschner, 1989).

Results

The experiment determined how a systemic insecticide (chlorpyriphos) influenced the activities of stem borer infestation on the establishment, grain production and reactions of some sorghum varieties and cultivars under natural field infestation

Effects of Stem Borer Damage on the Establishment of Some Sorghum Varieties

Stem borers inflict damages on sorghum plants which began with the newly hatched larvae that fed on rolled developing leaves and continued throughout its growth stages, which were characterised by tunnelling into various parts (stem, midrib, peduncle & panicle). These activities manifest in symptoms like 'dead hearts', leaf scrapping, stem and/or peduncle breakages and stunted growth or delayed maturity, loss of stands, chaffy heads and influence productivity.

Effects of Chlorpyriphos Insecticide on the Population of Some Sorghum Varieties and Cultivars at Vegetative Stage due to Stem Borer Infestation

Result has shown that; 'kwakwai' had 40.17 and 'Tiksha mopu' had 23.17 on untreated and total sorghum population at 25 DAE and 40 DAE vary among the varieties/cultivars where 'kwakwai' ranked first at both 25 and 40 DAE (Table 1.1).

However, despite the contributions of sorghum to economic development, infestations of B. fusca of sorghum crop have continued to threaten its commercial production and products and only few works on the types of control and damages it causes to sorghum crop have been made. Most studies reported the screening of sorghum genotypes resistant to the stem borers, for example Chilopartellus (Swinhoe) in China (Marulasiddesha, 2007) and B. Fusca in Zaria, Nigeria (ICRISAT, 1989) and so on, hence the need to study the relative impact of a systemic insecticide on the damages that are caused on the crop at vegetative and reproductive stages that leads low productivity in Biu, Borno state, which utilizes sorghum as staple food.

Objectives of the Study

The study is designed with specific objectives to:

1 Examine the effects of B. fusca damages on the establishment of some sorghum cultivars and varieties.

2 Determine how the damage influences the performance or productivity of each of the varieties and cultivars of sorghum in naturally stem borer infested area.

3 Identify sorghum varieties and cultivars with relative ability to produce better in an infested area.

4 Assess the effectiveness of granulated systemic insecticide in managing B. fusca in a stemborer "hotspot" zone.

Materials and Methods

The impact of stem borer (Busseola fusca) infestations on some S. bicolor cultivars/varieties was conducted at Maraban Ja'ali-Biu, 8 kilometres (km) from Biu, Borno state, Nigeria in 2008 and 2009 cropping seasons. The experiment consisted of fifteen sorghum crops and application of granulated insecticide (Chlorpyriphos 10G) at the rate of 10kg a.i. ha-1, applied in the leaf whorls of sorghum to reduce environmental hazards at 40 days after emergence (DAE) of the crop used for the treated plots (Malgwi and Dunuwel, 2013) in a Split-Plot Design (SPD) replicated three times in 6m2 plots. Application of chlorpyriphos was the main treatment plot (treated and untreated plots), while sorghum varieties and cultivars were the sub-plots. The planting materials of sorghum consisted of five (5) varieties obtained from the Institute for Agricultural Research (1.A.R) Samaru, Zaria, namely; (i) Samsorg41 (ICSV111), (ii) Samsorg17 (SK5912), (iii) Samsorg14 (KSV9), (iv) NR-7114, (v) KL-2 and ten (10) cultivars sourced from Biu local farmers, viz; (i) 'Yungum', (ii) 'Perpelli', (iii) 'Kwakwai', (iv) 'Piltum vwa', (v) 'Shalmadi', (vi) 'Yollom,' (vii) 'Yusuf yazara', (viii) 'Tiksha mopu', (ix) 'Ticksha mamza' and (x) 'Chaklari'.

The experimental field was ploughed and prepared to fine tilth which exposed soil inhabiting organism to predators and desiccation by sunshine three days before sowing. Seeds were dressed with Apron Star 50DS – (Metal-axyl-lott carboxin 60% + Furathiocarb-34%) at the rate of 1 sachet

Table 1.1 Impact Chlorpyriphos on stem borer damages on some sorghum varieties and cultivars Populations at the vegetative Stages in two cropping seasons

	Year 1 (2008)		Year 2 (2009)	
VARIETIES	*25DAE	40DAE	*25DAE	40DAE
Shamadi	32.00[ab]	39.00[a]	29.67[a]	53.33[a]
Yungum	26.67[b]	42.17[a]	27.33[abc]	43.83[bcd]
Yusuf yazara	43.50[ab]	43.83[a]	29.83[a]	55.00[a]
Perpeli	24.00[b]	30.17[a]	19.83[c]	30.50[ef]
Piltum vwa	33.50[ab]	44.83[a]	26.17[abc]	51.67[ab]
Kwakwai	40.17[a]	52.00[a]	28.83[ab]	55.50[a]
Yollom	31.67[ab]	46.17[a]	30.17[a]	47.17[cd]
Samsorg14	27.33[ab]	35.67[a]	23.00[abc]	41.67[cd]
Samsorg17	27.67[ab]	37.00[a]	23.67[abc]	32.83[ef]
Samsorg41	25.50[b]	30.17[a]	04.17[d]	05.83[g]
NR – 7114	29.50[b]	41.67[a]	28.00[ab]	37.67[de]
KL – 1	34.17[ab]	46.00[a]	21.33[bc]	25.17[f]
Tiksha mamza	25.17[b]	49.17[a]	27.17[abc]	54.67[a]
Tiksha mopu	23.17[b]	49.17[a]	27.17[abc]	54.67[a]
Chaklari	35.33[ab]	31.00[a]	24.67[abc]	43.67[bcd]
Mean	30.05	40.37	24.62	40.67
C V (%)	22.15	30.07	16.09	13.15
S E	6.67	12.14	3.96	5.34

Figures followed by the same alphabets are not significantly different at P = 0.05 using (Students Nueman-Kuels) SNK test for variables and * = plant population before chlorpyriphos application. Generally untreated plots had lower plant population across the varieties/cultivars at 25DAE only. But at 40DAE; treated plots contained higher population of sorghum plants throughout the field (Figure 1.1).

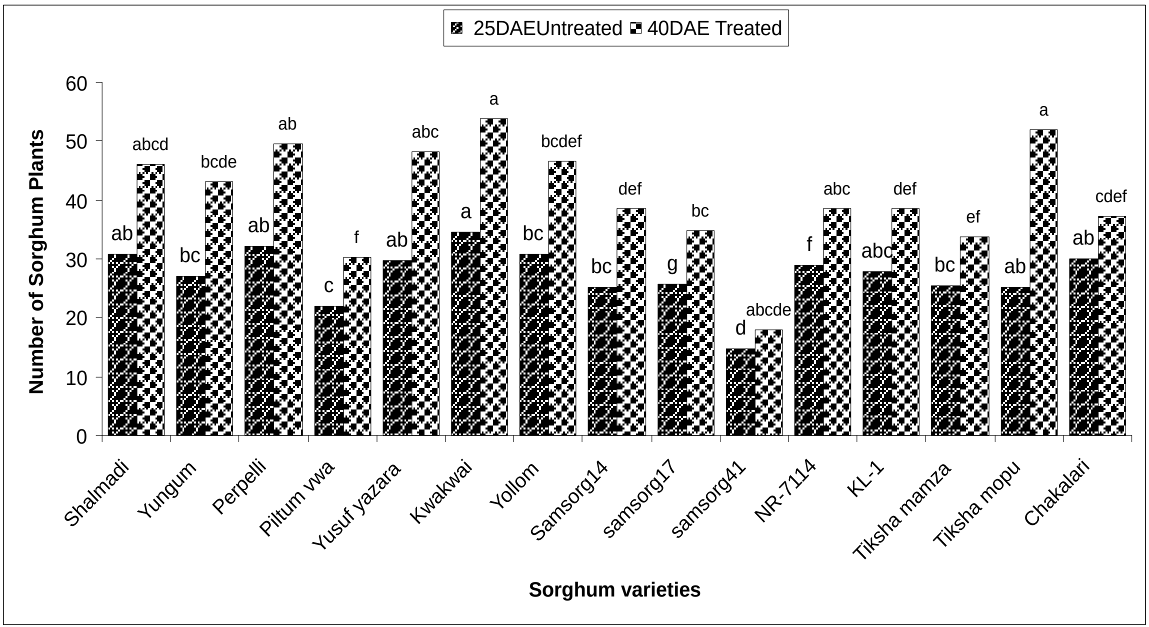

Figure 1.1: Effects of chlorpyriphos on stem borer damages on some sorghum varieties and cultivars population before and after application at the vegetative stage in combined analysis.

Key: Figures followed by the same alphabets are not significantly different at P = 0.05, using Students Newman Kuels (SNK) test at p=0.05. This is an indication of the tiller ability of varieties and cultivars as well as efficacy of the leaf whorl applied systemic insecticide on stem borer infested sorghum.

Assessment of the impacts of stem borer damages parameters before and after application of Chlorpyriphos on some sorghum varieties and cultivars at vegetative stages

The results obtained in evaluating the influence of Chlorpyriphos on stem borer damages indicated varying degree of impacts manifested on treated and untreated plots and were presented below:

Leaf Feeding Damages

Stem borer feeding activities resulted in leaf scrapping with characteristic reduction in photosynthetic areas on the leaves. In a combined result, 'Yollom' scored highest feeding damage of 9.08 as against 'Chaklari' of 1.92. (Tables 1.2) There was significant difference among the varieties in both 2008 and 2009. Feeding symptoms differed significantly on the untreated and treated plots significantly of 7.57 and 2.62 respectively (Figure 1.2).

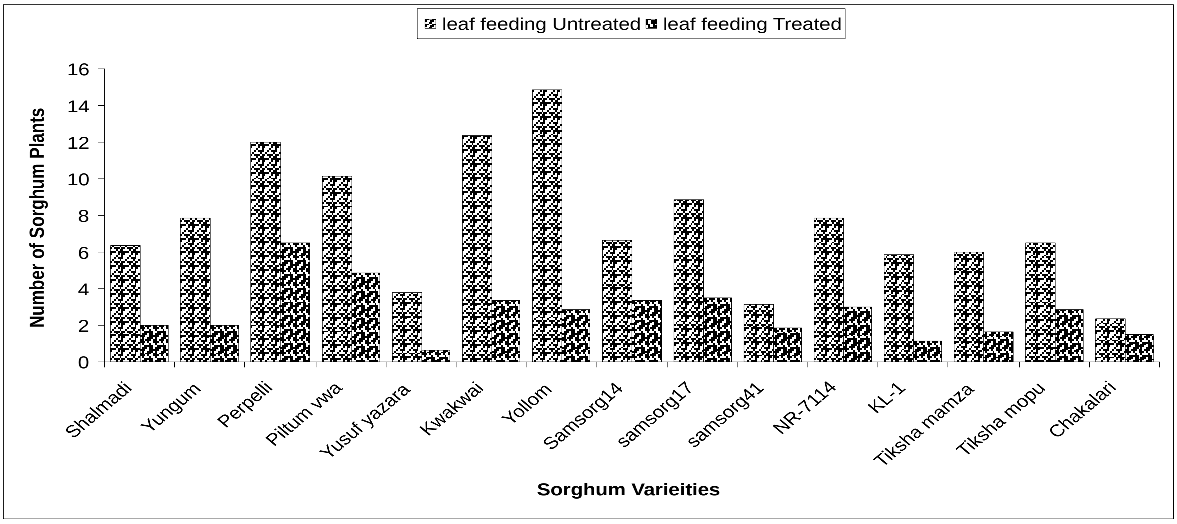

Figure 1.2: Leaf feeding symptoms on the some sorghum varieties and cultivars before and after Chlorpyriphos application in a combined analysis.

'Dead Heart' Symptoms

In the combined values of 'dead heart' has shown that, 'Yusuf yazara' had the highest mean value of 11 and samsorg41 had the lowest of 3.25. There was no significant difference among the sorghum varieties and cultivars (Table 1.3). The sorghum varieties/cultivars were significantly diffferent on both untreated and treated fields at 25 and 40 DAE in their reactions to such damage and ranked at p=0.05 probability. Generally 'dead heart's manifested greater on untreated plots than treated except for 'Tiksha mamza' and 'Tiksha mopu' (Figure 1.3).

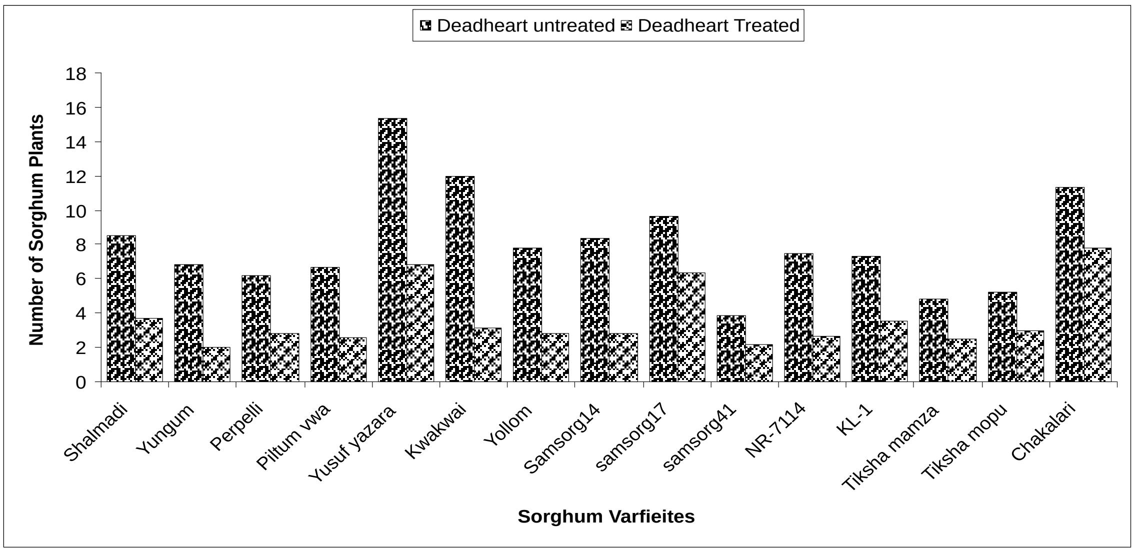

Figure 1.3: 'Dead heart' symptoms on some sorghum varieties and cultivars before and after chlorpyriphos application in a combined analysis.

The stem damage

Severe tunnelling of the stem resulted in weaken and broken stems and number of plants per plot affected ranged from 0.00–6.17, 'Yusuf yazara' had the highest stem damage in combined result and lowest Samsorg17 and Samsorg41 of zero each and there was no significance difference between both 2008 and 2009 cropping seasons (Table 1.3). The numbers of plants with stems broken were extremely higher on untreated when compared to treated plots. Yusuf yazara' was severely damaged and Samsorg17 and 41 had virtually no such damage in a combined result (Figure 1.3).

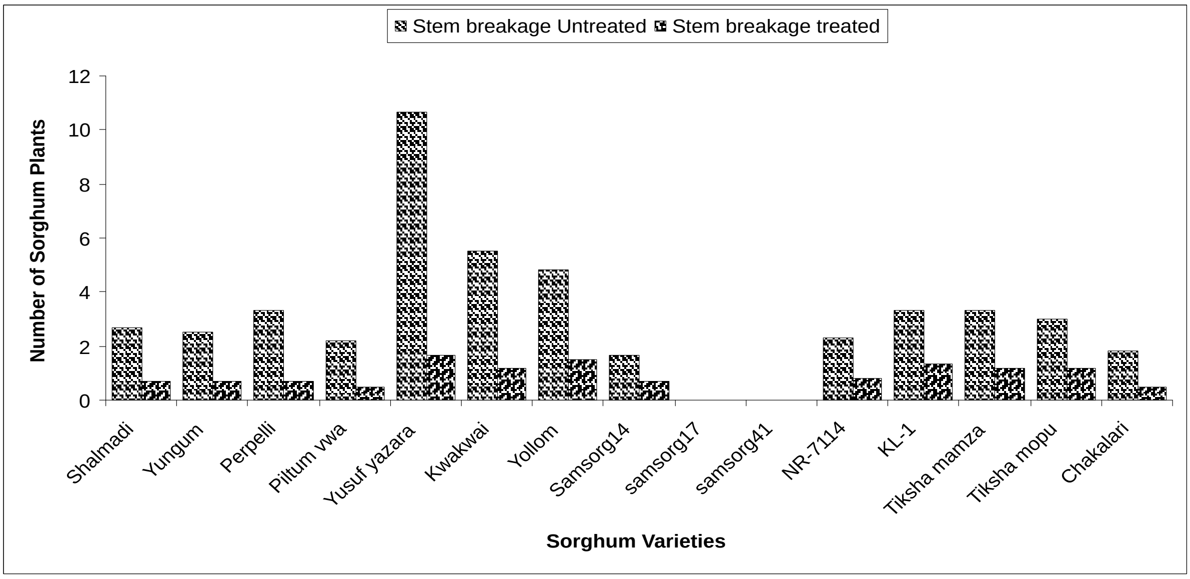

Figure 1.4: Stems damage before and after Chlorpyriphos application on some sorghum varieties and cultivars.

Assessment of the impacts of stem borer infestation damage parameters before and after application of Chlorpyriphos on some sorghum varieties and cultivars at reproductive stages

The peduncle damage

It was observed that stem borer larvae tunnelled the peduncle caused lodges and breakages. Peduncle damages ranged from 0–2.92, 'Shalmadi' and 'Yusuf yazara' recorded the highest number of plants with breakages (2.92), which were followed by 'Chaklari' of 2.83, thus they were relatively susceptible when compared to other varieties. While Samsorg17 had no damage, but

Samsorg 41 had as low as 0.08 mean damages followed by Kwakwai and Yollom of 0.25 each. There was significant difference among the varieties and cultivars on the untreated and treated plots in 2008 and 2009 cropping seasons (Table 1.4).

Table: 3.2 Assessment of stemborer damage parameters on some sorghum varieties before and after chlorpyriphos application in a combined analysis (2008 & 2009 cropping seasons)

Varieties	'Dead heart'	Leaf Feeding	Stem Broken	PedunclBroken	Chaffy Heads	Unproductive Heads	UnprodTillers	Productive Heads	Product Tillers	Grain prodn (kg)
Shalmadi	6.08_{cde}	4.17^{bcde}	1.67^{b}	2.92^{b}	0.25^{a}	2.67^{abc}	5.42^{ab}	20.08^{cd}	9.50^{ab}	152.00^{abc}
Yungum	4.42^{cde}	4.92^{bcde}	1.58^{b}	1.75^{b}	0.25^{a}	0.92^{c}	6.58^{ab}	19.75^{cd}	8.42^{abc}	1617.60^{ab}
Perpeli	4.50^{cde}	9.25^{a}	2.00^{b}	2.17^{b}	0.92^{a}	1.25^{bc}	4.33^{b}	26.33^{ab}	8.92^{ab}	1566.10^{ab}
Piltum vwa	4.08^{de}	7.50^{ab}	1.33^{b}	2.08^{b}	0.42^{a}	1.58^{bc}	3.92^{b}	13.67^{e}	9.42^{ab}	1144.9^{bcde}
Yusufyazar	11.08^{a}	2.25^{de}	6.17^{a}	2.92^{b}	1.50^{a}	2.83^{abc}	7.92^{a}	16.83^{cde}	7.08^{bc}	1170.00^{bcde}
kwakwai	7.58^{bcd}	7.00^{abc}	3.33^{ab}	0.25^{c}	0.75^{a}	0.50^{c}	4.25^{b}	29.25^{a}	10.92^{a}	1911.20^{a}
Yollom	5.25^{cde}	9.08^{a}	3.17^{ab}	0.25^{c}	0.92^{a}	1.17^{c}	4.92^{b}	26.83^{ab}	9.25^{ab}	1609.90^{ab}
Samsorg14	5.58^{cde}	4.75^{bcde}	1.67^{b}	0.50^{c}	0.33^{a}	1.25^{c}	4.33^{b}	19.58^{cd}	8.75^{abc}	1515.10^{abc}
Samsorg17	8.00^{bc}	5.92^{bcd}	0.00^{b}	0.00^{c}	0.08^{a}	2.33^{abc}	4.33^{b}	17.17^{cde}	5.25^{cd}	734.90^{e}
Samsorg41	3.25^{f}	2.50^{de}	0.00^{b}	0.08^{c}	0.33^{a}	2.75^{abc}	4.08^{b}	7.83^{f}	3.17^{d}	690.60^{E}
NR- 714	5.08^{cde}	5.42^{bcde}	1.58^{b}	2.17^{b}	0.58^{a}	3.58^{ab}	4.58^{b}	19.00^{cd}	0.67^{bc}	947.10^{E}
KL- 1	5.42^{cde}	3.25^{de}	2.50^{b}	0.33^{c}	0.92^{a}	1.00^{b}	3.00^{b}	27.00^{ab}	10.25^{ab}	1170.00^{bcde}
Tikshamam	7.17^{cd}	3.83^{cde}	2.25^{b}	2.17^{b}	1.08^{a}	1.92^{b}	5.33^{b}	19.00^{cd}	8.17^{abc}	1008.60^{de}
Tiksha mop	6.50^{cde}	4.67^{bcde}	2.08^{b}	0.25^{c}	0.83^{a}	4.8^{a}	3.33^{b}	22.17^{bc}	7.08^{bc}	1069.30^{cde}
Chaklari	9.58^{ab}	1.92^{e}	1.17^{b}	2.83^{b}	0.67^{a}	1.58^{bc}	4.50^{b}	13.67^{de}	5.33^{cd}	1072.50^{cde}
Mean	6.24	5.12	2.00	1.68	0.66	1.98	4.72	19.73	7.88	1254.53
C V (%)	17.93	14.61	22.76	34.14	39.26	39.70	22.61	10.66	35.08	9.60
S E	1.25	1.30	1.17	0.52	0.53	0.83	1.24	2.40	1.3	382.76

Figures followed by the same alphabets are not significantly different at P = 0.05 using (Students Nueman-Kuels) SNK test for variables in a combined analysis.

However, such severe peduncle damage had been reported from Madhya Pradesh on CSH5 varieties in India (AICSIP, 1975 - 87) and such Peduncle damages were higher on the untreated than on the treated (Figure 3.7).

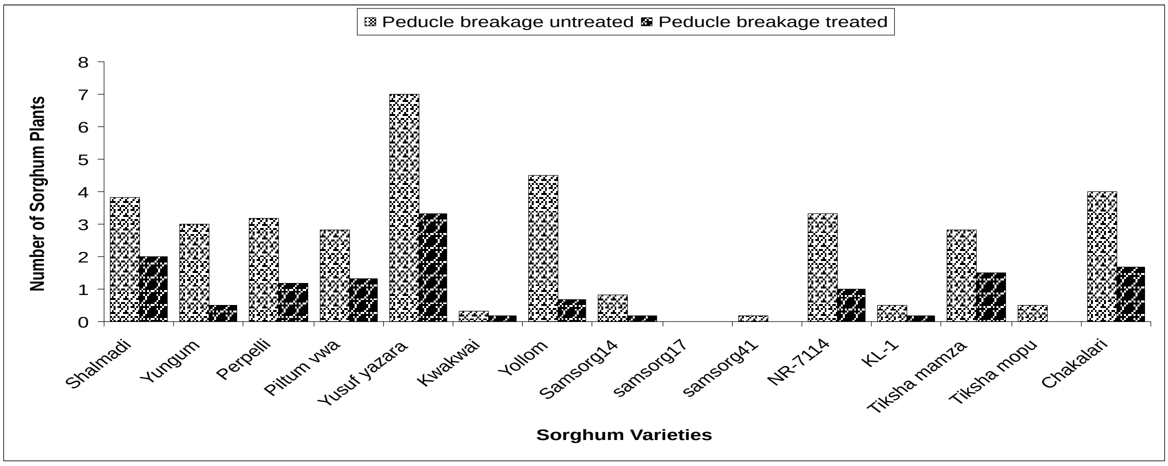

Figure 1.5: Effects of insecticide treatment on stem borer damages on sustainable peduncle of some sorghum varieties before and after Chlorpyriphos application

The chaffy head damage

This result revealed that number of plants with chaffy heads ranged from 0.08 – 1.50, with Yusuf yazara most affected (1.5), followed by Tiksha mamza (1.08), while Samsorg17 had the lowest number of plants with mean unproductive heads of 0.08, followed Shalmadi and Yungum which had 0.25 each (Table 1.5), and thus chaffy heads occurred heavily on the untreated plots and the variety most affected was 'Yusuf yazara' on the untreated plots, while 'Tiksha mamza' was found to be worse affected on the treated. There was no significant difference between varieties and cultivars with chaffy heads in both 2008 and 2009 (Figure 1.5).

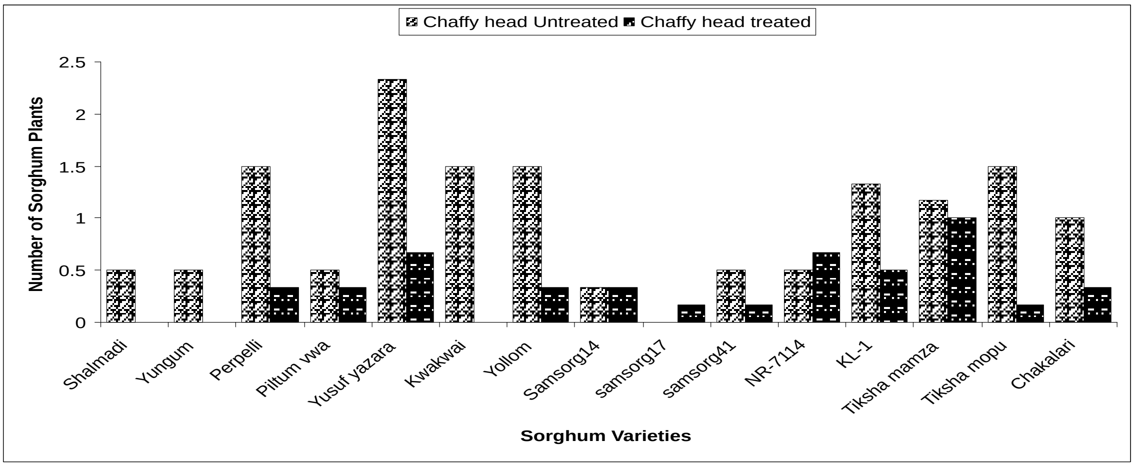

Figure 1.6: Effects of insecticide treatment on stem borer damages on grain filling (chaffy heads) of some sorghum varieties before and after Chlorpyriphos application.

The unproductive heads and Tillers damage

The sorghum heads that fail to produce grains had a mean number that ranged from 0.5 – 4.80, Tiksha mopu was highly affected of 4.8, followed by NR-7114 (3.58). While least affected was Kwakwai (0.5) followed by Yungum (0.92) (Table 1.6). However, 'Tiksha mamza', NR- 7114 and Samsorg17 were heavily unproductive on both untreated and treated. 'Tiksha mopu' was most affected and 'kwakwai' least affected. Combined result has shown that there was significant mean difference between untreated and treated plots, at the probability (p=0.05) SNK (Figure .9). Therefore 'kwakwai' cultivar showed some level of resistance.

Tillers which could not produce harvestable heads at all before harvest were considered unproductive Tillers (UPT); hence cumulative results have shown that UPT ranged from 3.0–7.92, Yusuf yazara had the highest mean of 7.92, followed by Yungum (6.58), while the lowest was recorded on KL-1 (3.0), then followed by Tiksha mamza (3.33) (Table 1.6). 'kwakwai' and KL-1 did not differ from each other significantly, but was significantly different from 'Piltumvwa', at 0.05 SNK probability. Untreated plots differed significantly from the treated (Figure 1.5 &6).

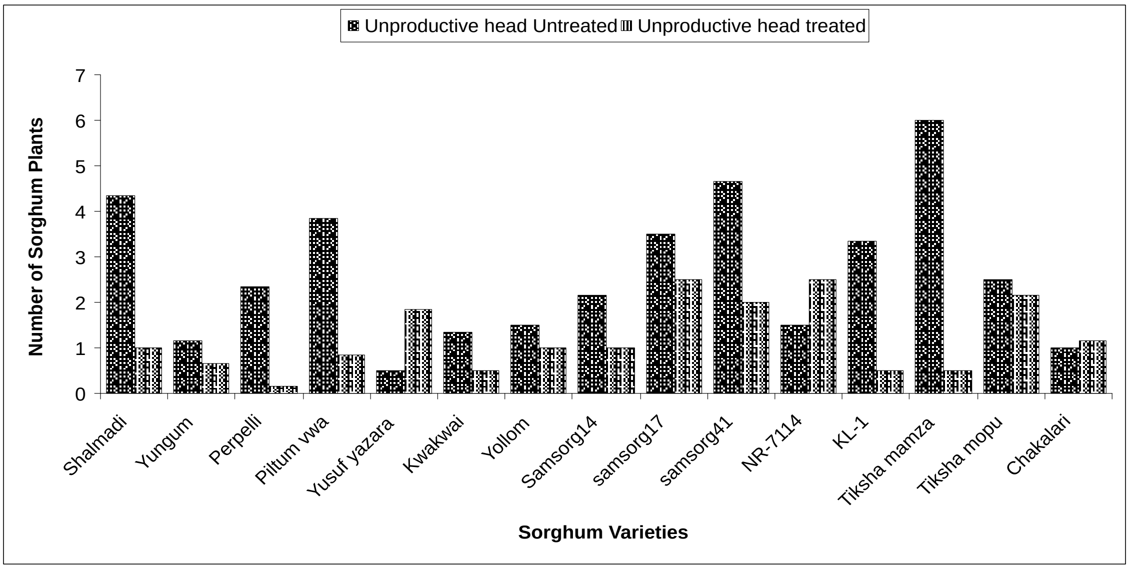

Figure 1.7: Effects of insecticide treatment on stem borer damages on grain filling (unproductive heads) of some sorghum varieties before and after Chlorpyriphos application.

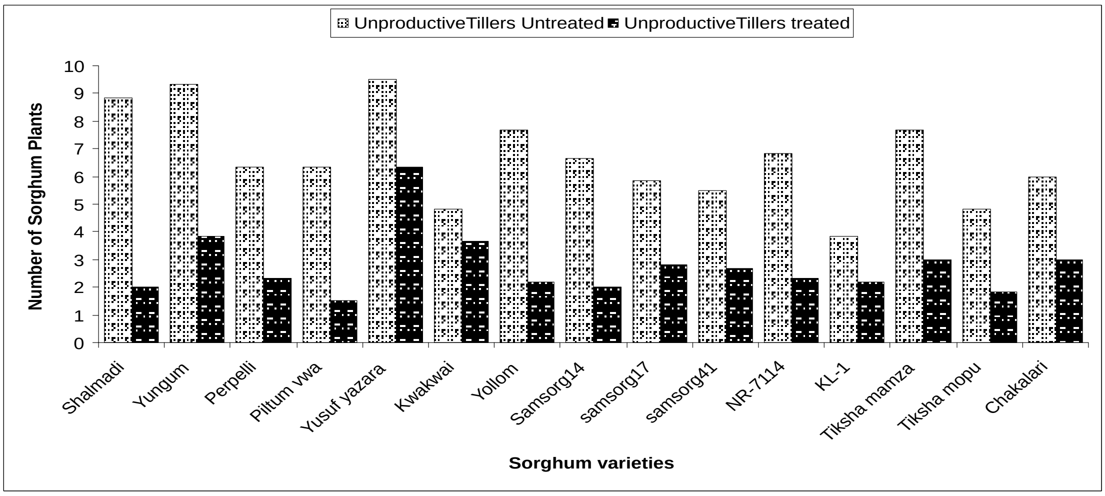

Figure 1.8: Effects of insecticide treatment on stem borer damages on grain filling (unproductive tillers) of some sorghum varieties before and after Chlorpyriphos

The productive Heads and Tillers

Sorghum crop plants that reached maturity and were grain filled are referred to as Productive heads. Their mean ranged from 7.83 – 29.25, 'Kwakwai' (29.25) recorded highest followed by Yollom (26.83), while Samsorg41 had lowest PH (7.83) and was followedby Piltum vwa and Chaklari of 13.67 each. Meanwhile mean productive tillers (PT) ranged from 0.67 - 10.92 with Kwakwai having the highest record of 10.92 which was followed by KL-1, and NR-7114 (0.67), followed by Samsorg41 (3.17) 'kwakwai' and KL-1 had the highest (Table 3.2) and differed from the rest of the varieties significantly at p=0.05. This result indicates also that,'kwakwai' produced highest and differs significantly from others. However, cumulative results had shown that productive tillers were less on the untreated than treated (Figure 3.12 & 13).

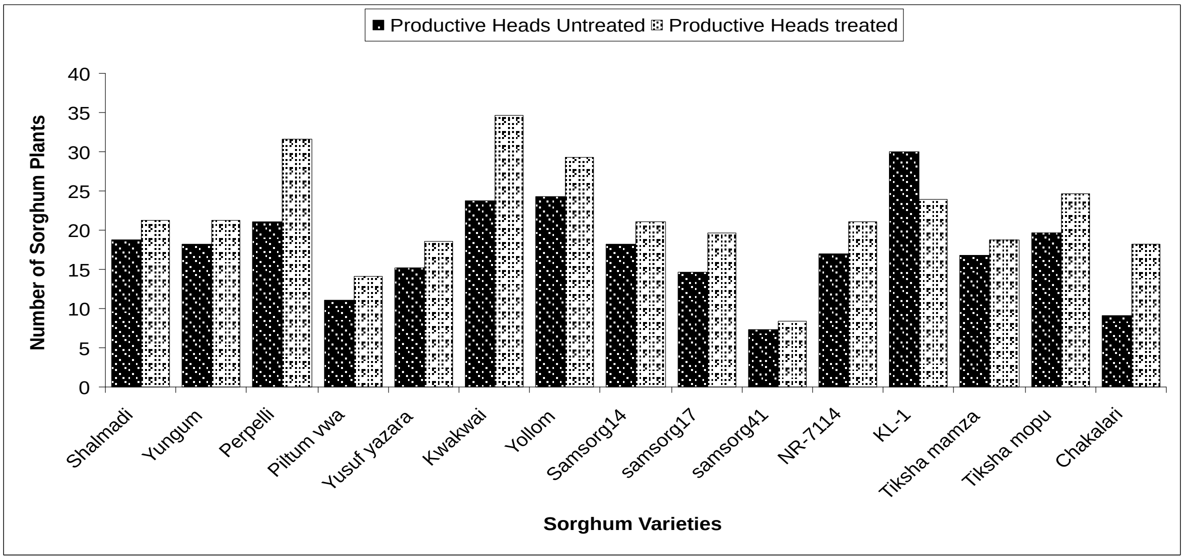

Figure 1.9: Effects of insecticide treatment on stem borer damages on grain filling (productive Heads) of some sorghum varieties and cultivars before and after Chlorpyriphos application.

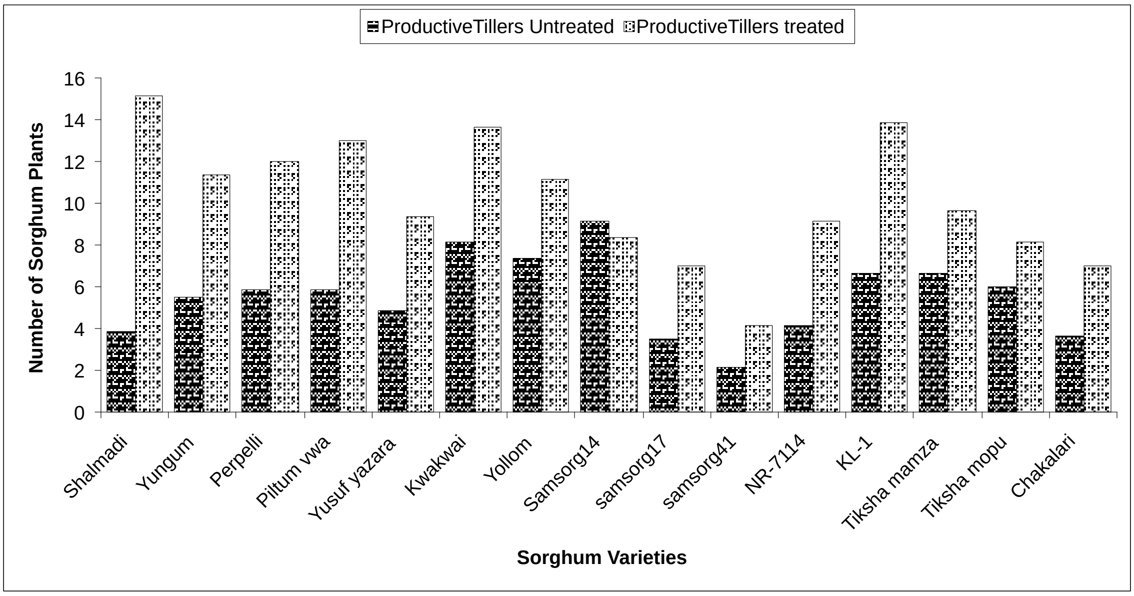

Figure 1.10: Effects of insecticide treatment on stem borer damages on grain filling (productive tillers) of some sorghum varieties before and after Chlorpyriphos application.

Impact of the application Chlorpyriphos on the Damages Caused by Stem Borer on the Production of some Sorghum Varieties and Cultivars under field Infestation

The experimental sorghum grain production ranged from 690.60 – 1911.20 kg per plot. Kwakwai performed highest (1911.20) and Samsorg41 & 17 gave lowest of 690.60 and 734.90 respectively. Varieties and cultivars were significantly different from each other at 0.05 probabilities (Table 3.2). The overall result have shown that damage symptoms were reasonably controlled by the application of chlorpyriphos 5G insecticide on sorghum infested with stem borer naturally in field. Mean number of productive heads were recorded highest on the treated plots which was significantly different from that of untreated, this followed by productive tillers with also marked difference between the untreated and the treated plots. Impact of chlorpyriphos on chaffy heads was significantly low because numbers of plants on the untreated plots were higher; a situation which is similar in 'deadheart', leaf feeding, and stem/peduncle breakages and unproductive heads/tillers (Figure 3.14).

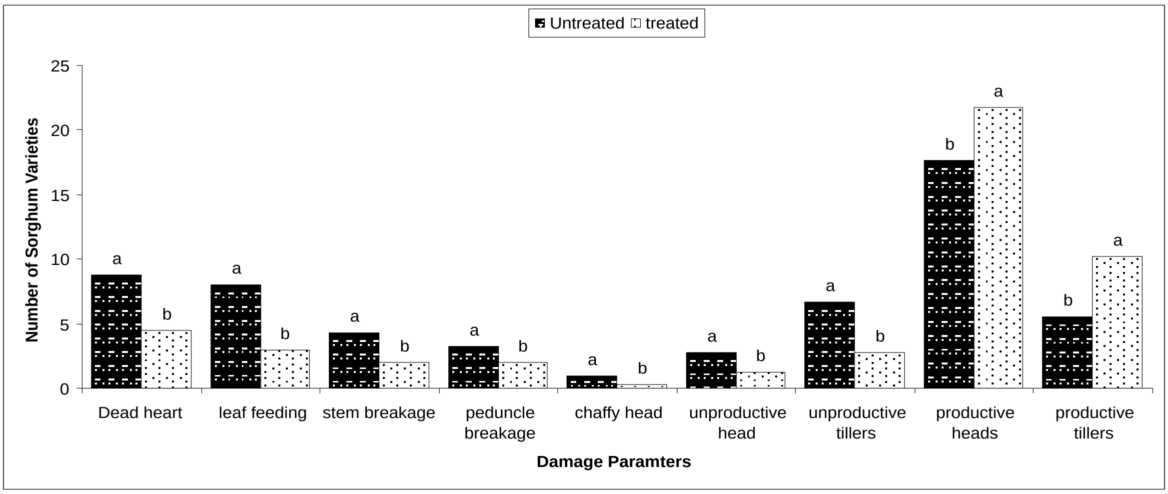

Figure 1.11: Effects of Chlorpyriphos on stem borer damages on sorghums before and after application for in a combined analysis.

Key: Figures followed by the same alphabets are not significantly different at P = 0.05
Using (Students Nueman-Kuels) SNK test for variables in a combined analysis.

This result is an indicative of the effect of the insecticide to reduce the damages caused by B. fusca feeding during vegetative and reproductive stages of development. Therefore impact of chlorpyriphos is more significant at the reproductive stage.

Percentage (%) Stem Borer Damages on the 15 Sorghum Varieties / Cultivars

Generally percentage damage on the 15 varieties ranged from 44-89%, 'Tiksha mamza' had the highest percentage damage for all the damage symptoms, followed by 'Yollom' and 'Piltum vwa' with 78% each and therefore are relatively susceptible (Figure 3.15).

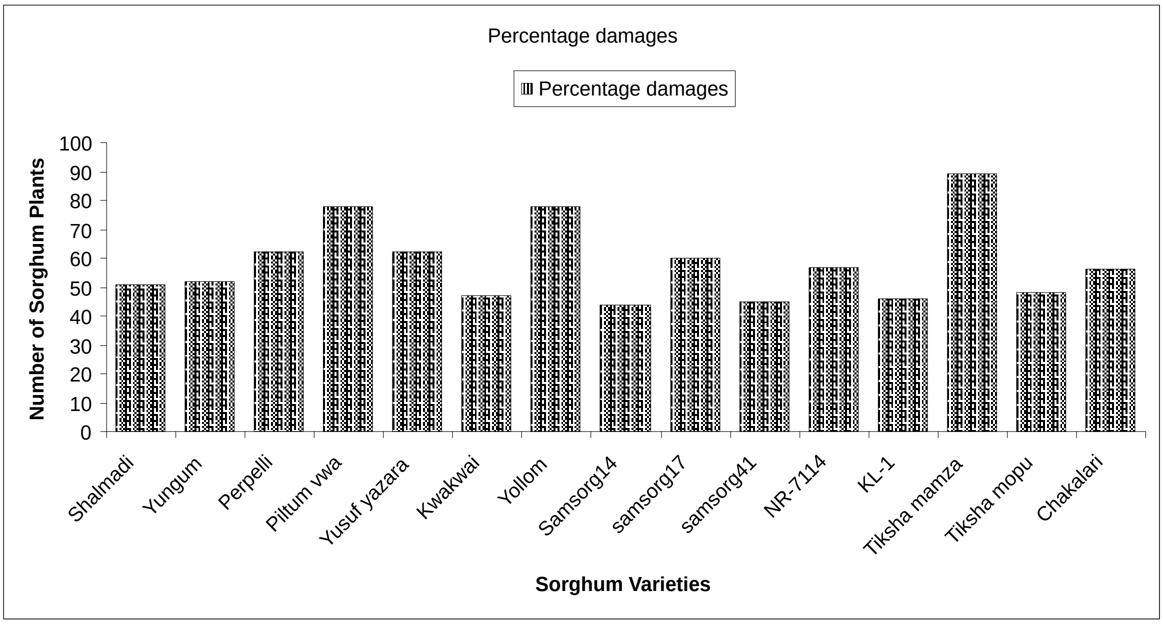

Figure 1.12: Average percentage effects of stemborer damages on some sorghum varieties in 2008 and 2009 cropping seasons.

This result is in agreement with AICSIP (1975 -87) which reported stem borer severity on sorghum had ranged from 54 – 100 % in different locations and is similar to Taneja (1987) in Hisar, India where infestation ranged from 50–100% under field study.

Discussions

Results obtained on the primary reactions of the sorghum varieties and cultivars showed that varieties or cultivars with highest mean number of plants were severely infested which is similar to Taneja (1987) in Hisar, India where infestation ranged from 50–100% under field study. This sharp increase in number of plant per variety per plot is an indication of inherent ability of the varieties to compensate for the damage which could also lead to increased productivity from the tillers that reach maturity. This result was in agreement with Reyes (1989) report, stems tunnelling kills of growth points and may increase the plants population up to the yield. Sorghum plants can compensate for stem borer damage at vegetative stage by producing more tillers; hence, insecticide application may not be necessary during vegetative stage (25DAE). The varieties and cultivars population on untreated plots at 25DAE were higher than that of 40DAE. Conversely significantly number of plants was killed before the application of insecticide.

Cumulative results showed that leaf feeding symptoms on untreated plots were significantly different from the treated plots which agrees with Leuschner, (1989) who suggested that leaf feeding scores should be dropped in favour of the number of plants with leaf feeding symptoms because it wasn't an indicator of loss in production because any decrease in leaf means reduced photosynthetic activities which indicates that chlorpyriphos application was necessary to reduce the feeding damage on the sorghum varieties and cultivars.

'Dead heart' ranged from 3.83 – 12.00 and 'kwakwai' had the highest on the untreated while on the treated the range was from 2 – 9.50 where 'Tiksha mamza' tops the list. There was no significant difference (P=0.05) SNK among the varieties during the first year (2008) but significantly different in the following year. This result signifies that chlorpyriphos application previously on the treated plots caused effective reduction in damage caused by sorghum stem borer in the following year. These could increase the crop production on the untreated plots for the varieties that could tiller profusely, like 'Chaklari'.

Broken stems that ranged from 0.00 – 10.67 and 0.00 – 1.67 on the untreated and treated plots respectively. 'Yusuf yazara' was most affected on the untreated and there was significant difference (P=0.05) SNK between treated and untreated plots. Broken stems were more on the untreated plots, thus application of chlorpyriphos had tremendously reduced stem damages, which corroborates the findings of Reyes et al, (1983) in central and southern America and supported by Sithole (1989) in South Africa and environmentally safer.

It was observed that larvae bored peduncles (closely packed internodes below the fully formed heads), weakened it and led to lodging / breakages. Peduncle damage on the untreated plots ranged from 0–7 with 'Yusuf yazara' and 'Chaklari' most affected, thus they were relatively susceptible. Peduncle damage was higher on the untreated than on the treated plots; however, such severe peduncle damage had been reported from Madhya Pradesh on CSH5 varieties in India (AICSIP, 1975 - 87).

The stem borer activities interfere with the translocation of nutrients and introduce metabolites within the plant which led to malformations called chaffy and unproductive heads as expressed by Sithole (1989). Chaffy heads ranged from 0.00 – 2.33 on the untreated, thus, 'Yusuf yazara' was most affected on the untreated, while 'Tiksha mamza' on the treated plots. Therefore, chlorpyriphos application has tremendously reduced this damage which decreased grain production on untreated plots. However, in 2008 chaffy heads were higher than that of 2009. UPT ranged from 3.83 – 9.50 on the untreated with Kwaikwai highly affected. 'Kwakwai' and KL-1 and differed significantly from 'Piltum vwa', 'Yusuf yazara', samsorg41 and NR-1 in both 2008 and 2009. This is probably because of overlapping generations emerged at the period of panicle emergence or grain filling, or from the previous years since insect resurgence is facilitated by number and doses of the insecticide. This is a pointer towards managing stem borer damages using increased number and quantity of applications at the reproductive stage.

Productive heads were recorded more on the untreated plots over the years, possibly because the untreated varieties and cultivars were tolerant Samsorg41 on the untreated and on treated 'Shalmadi' ranked highest. 'Kwakwai' and KL-1 had the highest and differ from the rest significantly. In cumulative results productive tillers were less on the untreated than treated. This is an indicated ability of chlorpyriphos to reduce stem borer damages.

Among the 15 sorghum crop screened, five were relatively resistant in both untreated and treated plotss viz; Samsorg14, Samsorg41, KL-1, 'Tiksha mopu' and 'kwakwai', another five were relatively moderate in tolerance which include 'Shalmadi', 'Yungum', 'Chaklari', Samsorg17, 'Yusuf yazara', 'Perpeli' and NR-7114. Meanwhile, four others viz; 'Piltum vwa', Perpelli, 'Yusuf yazara' and 'Yollom' were then relatively susceptible and only 'Tiksha mamza' was found to be highly susceptible. The susceptible varieties/cultivars should not be planted in 'hot spot' zone like Biu, Borno state and neighbouring states like Adamawa, Yobe, Bauchi, Gombe and Taraba where sorghum is a staple food.

Stem borers are difficult to control with insecticides because the larvae and pupae are inside the stem and they have overlapping populations in the field. Proper timing of insecticide application is critical to its control. Chlorpyriphos is a good, easy to apply systemic granulated insecticide in case of emergency field outbreak of stem borers, when applied at vegetative and reproductive stages of sorghum that targets the vulnerable stages as it has overlapping generations. This experiment sets a base for further researches on stem borer control methods which should involve IPM (systemic insecticides with good cultural practices like inter-planting millet with sorghum in alternate stands within the same row to reduce larva infestation of B. fusca on sorghum), since the adult do not effectively utilize millet for oviposition (Adesiyun 1983), in the sorghum growing areas of Nigeria.

References

Adamu, H.L. (2011)" Screening some Sorghum varieties for Stem borer, Busseola fusca Fuller [Lepidptera: Noctuidae] Infection in Biu, Borno State" Nigeria. (Unpublished) M.Sc. Thesis in Crop Protection, Federal University of Technology, Yola.

AICSIP (All India coordinated sorghum improvement project) (1975-87)." Progress reports of AICSIP, Indian council of agricultural Research & cooperative Agencies" New Delhi, India: AICSIP. http://Cropresearch.org/pages/crarchivesvol128no.123.htm

Bello D. (2010)" Combining ability & heteroses for agronomic characteristic & malting quality traits of grain sorghum" (Sorghum bicolor [L] Moench) Adamawa State; a PhD. crop production & Horticulture, Federal University of Technology Yola.

BOSADP (1992)"Cropping recommendation for Borno state. A publication of Borno state Agricultural Development Programme.

F.A.O. (Food and Agricultural Organization). (1984). Production year book-1983: Rome, Italy Food & Agriculture organization of the United Nations.

Fuller, C. (1901). First report on the government entomologist report, department of Agricultural & Natural Resources 1899-1900: 45-48.

Rillon G. S. (2007)."How to manage Stem Borers: Field Operations Manual, PhilRic", www.openacademy.ph accessed 12/08/14.

Harris, K.M. & Nwanze, K.F. (1992). "Review of the Bioecology & management of Busseolafusca" (Fuller): A hand book of information. Information Bulletin no. 33: ICRISAT, (International cereal research institute for semi–arid tropics). Pancheru, Andra Pradesh, 502324, India.

Hills, D.S. & J.M. Waller, (1999). "Pests & Diseases of Tropical Crops" Volume 2, Field Hand Book: Intermediate Tropical Agriculture series. Longman Group, UK Ltd 312p.

ICRISAT, (International Cereal Research Institute for Semi–arid Tropics) (1989). Stem borer Chilopartellus Annual Report, International Crops Research Institutes for Semi Arid Tropics, 1982: 22-23.

ICRISAT, (International Cereal Research Institute for Semi–arid Tropics) (1991). ICRISAT West African programme annual report 1990 International Crops Research Institute for the Semi- arid Tropics (ICRISAT): Sahelian Centre, BP 12404, Niamey, Nigeria.

ICRISAT (International Cereal Research Institute for Semi–arid Tropics) (1992). The Medium Term Plan; Annual Progress Report: Volume II. International Crop Research Institute for the Semi – Arid Tropics: Pantacheru, 502324, Andhra Pradesh, India. 312p.

Leuschner, k. (1989). "A review of sorghum stem borer screening procedures" ICRISAT (International cereal research institute for semi–arid tropics); International workshop on stem borers: 17-20 November, 1987.ICRISATcenter, India, Pancheru, A.P. 502324, India: ICRISAT.

Malgwi, A.M. (1998)" Studies on Sorghum" (Sorghum bicolor [L] Moench) head bugs at Samaru, Zaria. A Msc. Thesis (Unpublished) submitted to the department of crop protection, I. A. R. / A. B. U. Zaria 134pp.

Malgwi, A.M, & Adamu, H. L. (2013) "Effects of Foliar Applied Carbofuran on Damage & Yield of Some Sorghum Varieties/Cultivars Caused by Stem Borer" Busseola Fusca Fuller (Lepidoptera: Noctuidae) in Biu, Borno State, Nigeria. ARPN Journal of Science & Technology VOL. 3, NO. 9, ISSN 2225-7217. http://www.ejournalofscience.org

Marulasidadesha, K.N., Sankar M. & Rama Gouda, G.K. (2007). Screening of Sorghum Genotypes for resistance to damage caused by the stem borer Chilopartellus (Swinhoe). Spanish Journal of Agricultural Research, pp79 – 81.

Nwanze, K.F. (1985). Sorghum insect pest in West Africa PP 37 – 43 in: Proceedings of the international Sorghum Entomology Workshop, 15 – 21 July 1984, College Station Texas, USA. Patancheru, A.P 502 324 India: ICRISAT.

Onwueme, I.C. & T.D. Sinha (1999) "Field Crop Production in Tropical Africa; Principles & Practice"Technical Centre for Agriculture and Rural Cooperation, ACP-EU-Lome Convention.

PROTA ("Plant Resources of Tropical Africa 1"), (2006) "Cereals & Pulses: Eds" M. Brink & G., Belay. Eds: J. M. J. Dewet, O. T. Edje & Westphal. Gen. Eds.R. H. M. J. Lemmens & L.P. A. Oyen: PROTA Foundation/Backhuys Publishers/CTA, Wageningen, Neither Lands.

Reyes, R. (1989) "Sorghum stem borer in central & southern America "ICRISAT (International cereal research institute for semi–arid tropics) International workshop on stem borers: 17-20 November, 1987.ICRISATcenter, India, Pancheru, A.P. 502324, India: ICRISAT.

Seshu R, K.V. (1985) « Relative susceptibility & resistance of some sorghum line to stem borers in Western Kenya" Insect Science & Its Application6 (3):401-404.

Seshu Reddy, K.V. & J.C. Davies (1979) "Pests of sorghum & pearl millet and their parasites & predator" recorded at ICRISAT entomology progress Report No. 2. International Crops Research for the Semiarid Tropics, Pantacheru, AP 502 324 India. 23pp.

Seshu Reddy, K.V. (1991) "Insect pest of sorghhum in Africa. Insect science & its applications" 12 (516):653-657.

Sithole, S.Z (1989) " Sorghum stem borer in southern Africa" Pages 41- 47 in international workshop on sorghum stem borer, 17-20 November 1987, ICRISAT centre, India, Patancheru, A.P. 502-324, India; International Crop Research Institute for the Semi-arid Tropics.

Taylor, J.R.N. (2003)" Overview: Importance of sorghum in Africa" In: Belton, P.S. & Taylor, J.R.N. (Editors) Proceedings of the Workshop on proteins of sorghum & millet; enhancing nutritional & functional properties for Africa & Pretoria, South Africa, 2-4 April, 2003. Afripro (internate) http://www.afripro.org.uk . Accessed April, 2005. 2011/09/19

USDA (United States Department of Agriculture) (2004). National Database for standard reference,release 17 (Internate). Agricultural research service. Nutrient Data Laboratory, Beltsville Md, UnitedStates.http://www.nal.usda.gov/fnic.foodcomp. Accessed June 2005. 2011/09/19

Wikipedia, (2010).”Sorghum bicolor” The free encyclopedia. http://en.wikipedia.org/wiki/ soghum bicolor RHYPERLINK "http://en.wikipedia.org/wiki/soghum%20 bicolor%20%20%20Retrieved%20on%2012/16/2010"etrieved on 12/16/2010.