Advances in Entomology, 2014, 2, 81-86
Published Online April 2014 in SciRes. http://www.scirp.org/journal/ae
http://dx.doi.org/10.4236/ae.2014.22014

Effect of Intercropping Pattern on Stem Borer Infestation in Pearl Millet (*Pennisetum glaucum* L.) Grown in the Nigerian Sudan Savannah

M. M. Degri[1*], D. M. Mailafiya[2], J. S. Mshelia[1]

[1]Department of Agronomy, Faculty of Agriculture, Federal University, Kashere, Gombe, Nigeria
[2]Department of Crop Protection, Faculty of Agriculture, University of Maiduguri, Maiduguri, Nigeria
Email: [*]mikedegri@gmail.com, [*]michael4peace@hotmail.com

Received 6 February 2014; revised 15 March 2014; accepted 28 March 2014

Abstract

Fields experiments were conducted at the Department of Crop Protection, Faculty of Agriculture, University of Maiduguri Teaching and Research Farm, Maiduguri during 2010 and 2011 cropping seasons to investigate the effects of intercropping pattern on stem borer pest infestation in pearl millet (*Pennisetum glaucum* L.) intercropped with ground nut (*Arachis hypogea* L.). A split-plot design was used to test the intercrop pattern of 1:0 ratio (sole millet), 1:1 ratio (1 millet row to 1 ground nut row), 2:1 ratio (2 millet rows to 1 ground nut row) and 1:2 ratio (1 millet row to 2 ground nut rows). The results obtained showed that the intercrop pattern of 1:2 ratio and 1:1 ratio yielded less stem borer infestation and abundance in pearl millet, and as well supported high panicle weight and grain yield. In addition to recommending either of these two intercropping patterns to pearl millet farmers for more effective stem borer pest management, results further show the need for identification of effective intercropping patterns in other cropping systems.

Keywords

Pearl Millet, Stem Borer, Intercropping, Sudan Savannah

1. Introduction

Studies carried out in both tropical and temperate zones reported lower crop pest densities in more diversified

[*]Corresponding author.

How to cite this paper: Degri, M.M., Mailafiya, D.M. and Mshelia, J.S. (2014) Effect of Intercropping Pattern on Stem Borer Infestation in Pearl Millet (*Pennisetum glaucum* L.) Grown in the Nigerian Sudan Savannah. *Advances in Entomology*, **2**, **-**. http://dx.doi.org/10.4236/ae.2014.22014

agricultural ecosystems [1]-[3]. In Africa, such crop diversification practices include mainly pest diversion or trap cropping and inter- or mixed cropping [4]. Intercropping, an important cultural practice in crop pest management, primarily involves increasing the plant diversity of a given agro-ecosystem to aid reducing insect pest populations, and consequently, their attack [5] [6]. The practice seeks to alter the environment to support favourable crop growth and yield, rather than encourage insect population increase [7] [8]. Some plant combinations, for instance, with non-hosts lower the spread of pests within crops [9] [10]. Non-host plants in such mixtures may emit chemicals or odours that adversely affect the pests, thereby conferring some level of protection to the host plant [6] [11]. Studies indicate that crop diversification through intercropping, such as cereals with legumes, is effective in reducing insect pest damage [12]-[14]. Even plant diseases are believed to be less in intercropped agroecosystems due to increased crop diversity than those in sole crops [15] [16]. Also, the intercropping of groundnut with pearl millet (*Pennisetum glaucum* L.) has particularly been found to increase the population of *Goniozus* sp., a parasitoid species that effectively manages leaf miner pest populations in ground nut (*Arachis hypogaea* L.) [17].

Yield reduction due to stem borers occur as a result of leaf feeding, stem tunnelling, direct damage to cereal grain [18]-[20]. Depending on the season and nutritional status of plant, crop yield reduction by stem borer feeding and tunnelling activities in Africa can fall between 10% - 100% [21]-[23]. Three to eight times more stems tunnelling and one to three times more cob damage were recorded in monocropped maize with high stem borer larval densities (21% - 48%) and yield loss (1.8 - 3.0 times greater) than in the intercropped counterparts [23]. In contrast however, work by [23] in West Africa, found a considerably reduced amount of noctuid eggs laid by *Sesamia calamistis* Hampson and *Busseola fusca* Fuller due to reduced host found by the ovipositing adult moths in maize intercropped with grain legumes or cassava than those in the monocrop.

Excessive tillering of pearl millet gives the plant a unique structure for exploitation to manipulate crop ecosystems with different possible intercrops for reduction of insect pests' incidence [24] [25]. Intercropping patterns for example paired row, paired-wider row or skip-row should preferably allow for minimal competition amongst component crops [26]. Although paired row sowing of pearl millet is reported not to alter the yield of component crops [7] [27], it is essential to identify the effect of different intercropping patterns on insect infestation of this crop. Adoption of effective intercrop practices for natural regulation of insect pests including stem borers remains crucial [28] [29], especially by resource-poor farmers that lack the capacity of input-intensive plant protection measures. Groundnut is a short-duration legume crop grown by farmers in the savannah regions of Africa, and is readily intercropped with other medium duration crops such as pearl millet [30].

2. Materials and Methods

2.1. Seed Material Collection

The pearl millet (variety: SOSAT 888) and ground nut (variety: Ex-Dakar) seeds used in this study were obtained from the Lake Chad Research Institute, Maiduguri.

2.2. Location and Experimental Procedures

Field experiments were conducted during 2010 and 2011 cropping seasons at the Department of Crop Protection, Faculty of Agriculture, University of Maiduguri Teaching and Research Farm, Maiduguri (11˚51'N and 13˚15'E) situated in the Semi-Arid region of Nigeria. The experiments were conducted in a split-plot design whereby groundnut was introduced as component crop to pearl millet in the ratios of 1:0 (sole pearl millet); 1:1 (1 row of millet to 1 row of groundnut), 2:1 (2 rows of pearl millet to 1 row of groundnut) and 1:2 (1 row of pearl millet to 2 rows of groundnut). The experimental field was divided into 3 blocks each containing 16 subplots replicated 3 times to give 48 subplots. Each subplot size was 4.0 m by 3.0 m (12 m^2) with 1.0 m space between blocks and 0.5 m space between subplots. The experimental fields were ploughed and leveled before sowing pearl millet and groundnut seeds using a hand hoe. The seeds were sown in June at the recommended spacing of 30 cm × 15 cm for pearl millet, while ground nut seeds were sown at the spacing of 20 cm × 10 cm. The reason for the selection of intercrops is to quantify the impact of intercrops on stem borer infestation. Ground nut is short-duration legume grown by farmers in the area while pearl millet is a medium duration crop grown by farmers. The experimental field was weeded using hand hoe whenever weeds appeared.

2.3. Data Collection

Twelve millet plants attacked by stem borers per plot were counted and recorded. The numbers were then used to calculate the percentage (%) plant infestation. The abundance of stem borers was obtained from 10 randomly dissected plants found infested at harvest in each sub-plot. The numbers of larvae found inside the nodes, internodes and peduncles of each plant were counted and recorded.

The pearl millet panicles (heads) from randomly selected plots were weighed and recorded immediately after harvest using Jenway top loading balanced (2000 model) scale with a maximum capacity of 25 kg.

Following harvest, grain yield was obtained from threshed panicles and winnowed grains placed in well labelled polythene bags. The weight of grains obtained from each subplot was then taken and recorded separately.

Data collected on the number of pearl millet plants infested and percentage plant infestation, abundance of stem borers, panicle weight and grain yield were subjected to the analysis of variance (ANOVA). Means of the intercropping patterns (treatments) were separated using the least significant difference (LSD) at 5% level of probability.

3. Results and Discussion

3.1. Effects of Intercropping Pattern on the Number and Proportion of Infested Pearl Millet Plants

Pearl millet plants found infested and percentage plant infestation per plot in this study are presented in **Table 1**. Results showed that plots with the intercropping pattern of 1:2 ratio and 1:1 ratio had significantly lower (6.58 and 9.60 respectively) number of infested plants than in plots with the intercropping pattern of 2:1 ratio (11.41 and 10.17 respectively) and the sole crop (1:0 ratio). The results of percentage plant infestation followed the same trend. The lower number or proportion of infested plants found under 1:2 ratio and 1:1 ratio intercropping patterns than that of the sole crop (1:0 ratio) indicates that two-thirds of the intercropping patterns tested support less stem borer pest incidence in pearl millet [31]-[33]. Thus, concurring with the results of [34], who likewise found the incidence of stem borer pests in the humid forest areas of Cameroon to be lower in maize intercropped with cassava, cowpea and soybean to be lower than in monocropped maize. Less stem borer pest incidence, in turn, should allow for low or negligible crop damage levels [12] [34].

3.2. Effects of Intercropping Pattern on Stem Borer Abundance in Pearl Millet

The results of stem borer abundance per plant (found within the nodes, internodes and peduncles) are presented in **Table 2**. Stem borer abundance in pearl millet intercropped with ground nuts at 1:2 ratio (3.83) and 1:1 ratio (5.75) was significantly lower compared to that obtained from the intercropped pattern of 2:1 ratio (6.08) and the sole crop (1:0 ratio) (9.17). Intercropping has been reported to reduce insect pest populations due to colonization deterrence in crop fields with increased plant diversity that creates unsuitable habitat or unfavourable environment to some pest specis [35]-[38]. Oviposition by adult female stem borers may thus have been seriously reduced as a result of host finding difficulties experienced in pearl millet plots intercropped with ground nut using the above two effective intercropping patterns [34] [39], and thereby limiting their population build up.

Table 1. Percentage of infested pearl millet plants per plot.

Intercropping pattern	No. infested plants/plot N = 20	% plant infestation
1:0	11.41	60.00
1:1	9.60	40.00
2:1	10.17	41.67
1:2	6.58	31.25
tSE±	0.53	-
LSD (0.05)	1.08	-

Table 2. Stem borers per plant in pearl millet.

Intercropping pattern	Stem borers/plant N = 20
1:0	9.17
1:1	5.75
2:1	6.08
1:2	3.83
SE±	0.40
LSD (0.05)	0.82

Table 3. Panicle weight and grain yield of pearl millet.

Intercropping pattern	Mean panicle weight (kg/ha)	Mean grain yield (kg/ha)
1.0	652.41	596.70
1:1	1049.22	975.62
2:1	769.20	681.51
1:2	1249.33	1209.13
SE±	32.51	24.61
LSD (0.05)	66.22	49.32

3.3. Effects of Intercropping Pattern on Panicle Weight and Grain Yield of Pearl Millet

Results in **Table 3** show the effect of intercropping on panicle weight and grain yield of pearl millet intercropped using different patterns. For pearl millet intercropped with ground nut using the pattern of 1:1 ratio and 1:2 ratio panicles weight (1049.20 kg and 1249.33 kg) and grain yield (975.62 kg and 1209.33 kg/ha) were significantly higher than from crops intercropped using the pattern of 2:1 ratio as well as the sole crop (1:0 ratio). Altogether, by giving lower stem borer infestation rates and abundance as well as higher panicle weight and grain yield, the intercrop pattern of one row of pearl millet to one (1:1 ratio) or two (1:2 ratio) rows of ground nut tested in this study proved to contribute greatly in managing the attack and destruction or losses caused by these pests in pearl millet. Stable cereal-legume intercrop systems with adequate or effective feed-back mechanism or synchronization of insect pest populations can maintain good crop yields in spite of pest attacks [36] [40] [41]. As with [17] who found increased numbers of *Goniozus* sp. against leaf miner pest populations in ground nut intercropped with pearl millet, the presence and attack (parasitism and predation) of stem borer pests by natural enemies could also be increased in pearl millet under intercrop conditions [13] [32] [38] [41]. Up to 30% crop pest reduction due to "natural enemy effect" have been observed by [4] in intercropped systems. In addition to natural enemy effects, the groundnut component crop as non-host plants could have further constituted a physical barrier to stem borer pests in pearl millet that possibly inhibits their inter or intra row migration in intercropped systems [1] [34] [42] [43].

4. Conclusion

Intercropping, particularly with one row of pearl millet to one row of ground nut and one row of pearl millet to two rows of ground nut seems to encourage less stem borer infestation and abundance in pearl millet, whilst additionally support high panicle weight and grain yield. As such, the cultural practice is greatly encouraged over monocropping for stem borer pest management in pearl millet grown in the Nigerian Sudan Savannah. Being an uncomplicated method of control and not capital-intensive, the practice should be readily adopted especially by resource-poor-farmers.

References

[1] Risch, S.J., Andow, D. and Altieri, M.A. (1983) Agro-Ecosystem Diversity and Pest Control: Data, Tentative Conclusions and New Research Directions. *Environmental Entomology*, **12**, 625-629.

[2] Andow, D.A. (1991) Vegetation Diversity and Arthropod Population Response. *Annual Review of Entomology*, **36**, 561-586. http://dx.doi.org/10.1146/annurev.en.36.010191.003021

[3] Thies, C. and Tscharntke, T. (1999) Landscape Structure and Biological Control in Agroecosystems. *Science*, **285**, 893-895. http://dx.doi.org/10.1126/science.285.5429.893

[4] Baliddawa, C.W. (1985) Plant Species Diversity and Crop Pest Control—An Analytical Review. *Insect Science and Its Application*, **6**, 479-487.

[5] Ajayi, O. (1986) Possibility for Integrated Control of Millet Stem-Borer (*Acigonia ignefusalis*) in Zaria. 16th *Annual Conference at IAR*, 16-20 March 1986, 3.

[6] Singh, K.A., Ahlawat, I.P.S. and Mahiendrapal, H. (1986) Cropping Systems Research 1. Concept, Needs and Directions. *Proceedings of the National Symposium on Cropping Systems*, New Delhi, Indian Society of Agronomy, Indian Agricultural Research Institute.

[7] Chatterjee, B.N. and Mandal, B.K. (1992) Present Trends in Research on Intercropping. *Indian Journal of Agricultural Science*, **62**, 507-518.

[8] Songa, J.M., Jiang, N., Schulthess, F. and Omwega, C. (2007) The Role of Intercropping Different Cereal Species in Controlling Lepidopteran Stems Borers on Maize in Kenya. *Journal of Applied Entomology*, **131**, 40-49. http://dx.doi.org/10.1111/j.1439-0418.2006.01116.x

[9] Gautan, R.C. and Kaushik, S. (1980) Studies on Planting Dates and Intercropping of Pearl Millet with Grain Legumes. *Indian Journal of Agronomy*, 25, 441-446.

[10] ICRISAT (1981) *Proceedings of the International Workshop on Intercropping*, Hyderabad, 10-13 January 1979, International Crops Research Institute for Semi-Arid Tropics.

[11] Reddy, S.R. (2012) Agronomy of Field Crops. Kalyani Publishers, New Delhi, 245-264.

[12] Nwanze, K.F. (1989) Insect Pests of Pearl Millet in West Africa. *Acigonia ignefusalis* (Pyralidae: Lepidoptera); Distribution, Population Dynamics and Assessment of Crop Damage. *Tropical Pest Management*, **35**, 137-142. http://dx.doi.org/10.1080/09670878909371342

[13] Polaszek, A. (1986) African Cereal Stem Borers: Economic Importance, Taxonomy, Natural Enemies and Control. CTA/CABI, Wallingford.

[14] Mailafiya, D.M. and Degri, M.M. (2012) Stem Borers' Species Composition, Abundance and Infestation on Maize and Millet in Maiduguri, Nigeria. *Archieves of Phytopathology and Plant Protection*, **45**, 1286-1291. http://dx.doi.org/10.1080/03235408.2012.673262

[15] Altieri, M.A. and Liebman, M.Z. (1986) Insect, Weed and Plant Disease Management in Multiple Cropping Systems. In: Francis, C.A., Ed., *Multiple Cropping Systems*, Macmillan, New York, 183-218.

[16] Gomez, A.A. (1990) Farming System Research Approach to Identifying Farmers' Production Problems. *Farming System Research Approach*, **8**, 63-70.

[17] Dhaliwal, G.S. and Arora, R. (1996) Principles of Insect Pest Management. National Agricultural Technology Information Centre, Ludhana.

[18] Bosque-Pérez, N.A. and Marek, J.H. (1991) Effect of the Stem Borer *Eldana saccharina* Walker (Lepidoptera: Pyralidae) on the Yield of Maize. *Bulletin of Entomological Research*, **81**, 243-247. http://dx.doi.org/10.1017/S0007485300033496

[19] Cardwell, K.F., Schulthess, F., Ndemah, R. and Ngoko, Z. (1997) A System Approach to Assess Crop Health and Maize Yield Losses Due to Pests and Diseases in Cameroon. *Agriculture, Ecosystem and Environment*, **65**, 33-47. http://dx.doi.org/10.1016/S0167-8809(97)00056-X

[20] Sétamou, M., Schulthess, F., Poehling, H.M. and Brgemeister, C. (2000) Monitoring and Modeling of Field Infestation and Damage by the Maize Ear Borer *Mussidia nigrivenella* (Lepidoptera: Pyralidae) in Benin, West Africa. *Journal of Economic Entomology*, **93**, 650- 657. http://dx.doi.org/10.1603/0022-0493-93.3.650

[21] Ndemah, R. and Schulthess, F. (2002) Yield of Maize in Relation to Natural Field Infestations and Damage by Lepidopterous Borers in the Forest and Forest/Savanna Transition Zones of Cameroon. *Insect Science and Its Application*, **22**, 183-193.

[22] Sétamou, M., Schulthess, F., Bosque-Pérez, N.A. and Thomas-Odjo, A. (1995) The Effect of Stem Borers on Maize Subjected to Different Nitrogen Treatments. *Entomologia Experimentalis et Applicata*, **77**, 205-210. http://dx.doi.org/10.1111/j.1570-7458.1995.tb02002.x

[23] Chabi-Olaye, A., Nolte, C., Schulthess, F. and Borgemeister, C. (2005) Effects of Grain Legumes and Cover Crops on Maize Yield and Plant Damage by *Busseola fusca* (Fuller) (Lepidoptera: Noctuidae) in the Humid Forest of Southern Cameroon. *Agriculture, Ecosystem and Environment*, **65**, 73-83.

[24] Willey, R.W. (1979) Intercropping Its Importance and Research Needs 1. Competition and Yield Advantage and 2. Agronomy and Research Approaches. *Field Crop Abstracts*, **32**, 73-85.

[25] Risch, S.J. (1983) Intercropping as Cultural Pest Control. Prospects and Limitations. *Environmental Management*, **7**, 9-14. http://dx.doi.org/10.1007/BF01867035

[26] Adesiyun, A.A. (1983) Some Effects of Intercropping of Sorghum, Millet and Maize on Infestation by Lepidopterous Stalkborers, Particularly *Busseola fusca*. *Insect Science Application*, **4**, 387-391.

[27] Ofori, F. and Stern, W.R. (1987) Cereal-Legume Intercropping Systems. *Advances in Agronomy*, **41**, 41-90. http://dx.doi.org/10.1016/S0065-2113(08)60802-0

[28] Rao, M.R. (1986) Cereals in Multiple Cropping. In: Francis, C.A., Ed., *Multiple Cropping Systems*, Macmillan Publishing Company, New York, 34-39.

[29] Verma, A.N. and Singh, S.I. (1989) Cultural Control of Sorghum Stem Borers. In: *ICRISAT, International Workshop on Sorghum Stem Borers*, ICRISAT Centre, Patancheru, 81-87.

[30] Steiner, K.G. (1984) Intercropping in Tropical Small Holder Agriculture with Special Reference to West Africa. GTZ, Eschborn.

[31] Taneja, S.L. and Nwanze, K.F. (1989) Assessment of Yield Loss of Sorghum and Pearl Millet Due to Stem Borer Damage. In: Nwanze, K.F., Ed., *International Workshop on Sorghum Stems Borers*, ICRISAT Centre, Patancheru, 95-104.

[32] Ajayi, O. (1990) Possibilities for Integrated Control of the Millet Stem Borer. *Acigona ignefusalis* Hampson (Lepidoptera: Pyralidae) in Nigeria. *Insect Science Application*, **11**, 109-117.

[33] Kfir, R. (1991) Non-Chemical Control of Grain Stem Borers. *Plant Protection News*, **23**, 4.

[34] Okigbo, B.N. and Greenland, D.J. (1976) Intercropping Systems in Tropical Africa in Multiple Cropping. *ASA Special Publication*, **27**, 63-101.

[35] Lawani, S.M. (1982) A Review of the Effects of Various Agronomic Practices on Cereal Stem Borer Populations. *Tropical Pest Management*, **28**, 266-276. http://dx.doi.org/10.1080/09670878209370720

[36] Youm, O., Mamalo, A.K. and Nwanze, K.F. (1993) Bio-Ecology and Integrated Management of the Millet Stem Borer (Lepidoptera:Pyralidae): A Review and Highlights of Current Research at the ICRISAT Sahelian Centre. *Proceedings of the Regional Pearl Millet Workshop*, Niamey, 19-21 September 1990, 55-63.

[37] Ampong-Nyarko, K., Seshu-Reddy, K.V., Nyagor, R.A. and Saxena, K.N. (1994) Reduction of Insect Pest Attack on Sorghum and Cowpea Intercropping. *Entomologia Experimentalis et Applicata*, **70**, 179-174. http://dx.doi.org/10.1111/j.1570-7458.1994.tb00745.x

[38] Khan, Z.R., Ampong-Nyarko, K., Chiliswa, P., Hassanali, A. and Kimani, S. (1997) Intercropping Increases Parasitism of Pests. *Nature*, **388**, 631-632.

[39] Harris, K.M. (1989) Recent Advances in Sorghum and Pearl Millet Stem Borers Research. In: Nwanze, K.F., Ed., *International Workshop Sorghum Stems Borers*, ICRISAT Centre, Patancheru, 9-16.

[40] Kayumbo, H.Y. (1976) Pest Control in Mixed Cropping System. In: Manyo, J.H., Ker, A.D.R. and Campbell, M., Eds., *Intercropping in Semi-Arid Areas*, 39-47.

[41] Uva, I.I. (1985) Potential of Crops Diversity for Pest Management II. Mechanisms of Influence. *Nigerian Journal of Entomology*, **6**, 14-23.

[42] Trenbath, B.R. (1993) Intercropping for the Management of Pests and Diseases. *Field Crop Research*, **34**, 381-405. http://dx.doi.org/10.1016/0378-4290(93)90123-5

[43] Chabi-olaye, A., Nolte, C., Schulthess, F. and Borgemeister, C. (2005) Relationships of Intercropped Maize Stem Borer Damage to Maize Yield and Land-Use Efficiency in the Humid Forest of Cameroon. *Bulletin of Entomological Research*, **95**, 417-427. http://dx.doi.org/10.1079/BER2005373