ISSN 2349-0837

Relative Resistance of Some Maize (Zea mays L.) Genotypes Against Stem Borers (Chilo partellus and Sesamia cretica) In Central Sudan

Mohammedein B. Alhussein[1], Atif E. Idris[2*], Sara A. A. Kehail[3], and Hashim.A.Mohamed[4]

[1]Maize Research Program, Agricultural Research Corporation (ARC), Wad Medani, Sudan.

[2]Department of Agronomy, College of Agricultural Studies, Sudan University of Science and Technology, P.O. Box71, Shambat, Sudan.

[3]Crop Protection Research Centre, Agricultural Research Corporation (ARC), Wad Medani, Sudan.

[4]Maize Research Program, Agricultural Research Corporation ARC, Halfa, Sudan.

E.mail:atifelsadig@gmail.com, atifelsadig@sustech.edu, www.sustech.edu

Abstract

In Sudan maize (*Zea mays* L.) subjected mainly to two Lepidopteran stem borers, *Chilo partellus* and *Sesamia cretica*, causing considerable decrease in yield at the end of the season. In this study, thirteen maize genotypes were evaluated to observe their relative resistance against stem borers. Two field experiments were conducted at Agricultural Research Corporation (ARC), Gezira Research Station Farm, Wad Medani, Sudan, during two consecutive winter seasons of 2011 and 2012. The experiments were arranged in RCBD design with 4 replications. The agronomic and plant infestation (leaves damage and dead heart) were carried out weekly, in addition the existence of natural enemies was recorded. The results showed that the percentage (%) of infestation of the plants and dead heart caused by stem borers were higher in season 2011 than season 2012, the natural enemies observed in the field and in laboratory were complex of predators and parasitoids. In season 2011, the genotype BR TZE- COMP-4 DMRS scored the highest grain yield (1860.2 kg/ha) despite of its obtaining a higher level of the leave damage infestation percentage (93%) and a low percentage of dead hart percentage (17%). In season 2012, the genotypes TZBR COMP2-Y and TZBR COMP2-W scored the highest grain yield of (1626.2 kg/ha) and (1229.6 kg/ha) respectively, despite of their obtaining a higher level of the leaves damage infestation percentage of (47%) and (41%) respectively and a low percentage of dead heart percentage of (15%) and (19%), respectively. These results confirm the higher ability of these genotypes to tolerate and/or to resist stem borer infestation in central of the Sudan.

Key words: Maize; Genotypes; Stem borers; Resistance; Sudan.

Introduction

Maize (Zea mays L.) is a cereal crop that is grown widely throughout the world in a wide range of agro-ecological environments. Maize was introduced into Africa in the 1500s and has since become one of Africa's dominant food crops. Maize is the most important cereal crop in sub-Saharan Africa (SSA) and it is the most staple food for more than 1.2 billion people in SSA and Latin America. All parts of the crop can be used for food and non-food products. Nowadays, there is an increasing interest in maize production in Sudan due to maize adaptation to be cultivated in the agricultural irrigated schemes, especially in the Gezira state. In addition, maize can occupy an important position in the economy of the country due to the possibility of blending it with wheat for making bread (Nour et al., 1997; Meseka, 2000). The production of maize is facing by many constrains including insect pests, there were various species of stem borers rank as the most devastating maize pests, they can cause 20-40 % losses during cultivation and 30-90 % losses post harvest and during storage in SSA. In Sudan maize is subjected mainly to two Lepidopteran stem borers, Chilo partellus and Sesamia cretica. Damage by Chilo partellus and Sesamia cretica to young plants ranges from feeding on the whorl leaves causing dead-hearts, older plants causing longitudinal tunnels into the stems, tassels and ears and severe damage to the infested plants causing considerable decrease in yield by the end of the season (Isa et. al., 1969; El-Wakeil, 1997; Ahmad and Akhtar, 1979 and Awan and Abdul Khaliq, 2003). The density of maize stem borers, especially the adult and egg stages and their parasitoids are affected by weather conditions and agricultural practices. Different methods were conducted to reduce the losses caused by stem borers in maize and other crops such as biological control (Kumar, 1997), intercropping (Degri et al, 2014) and chemical control (Khan and Amjad.2000). It was concluded that climatic factors affects immature borers indirectly via the plant and their parasitoids (Duale and Okwakpam, 1997; El-Wakeil, 1997; and Jiang, 2005). Moreover, the reduction in row width increased the number of larvae able to reach adjacent plant rows through migration, and this in turn resulted in more damaged plants (Van Rensburg et. al., 1988). Maize genotypes characterized with high ability to resist and/or tolerate stem borer incidence can play a great role in maize breeding programs and reducing the economics costs of different pest control methods. (Kumar, 1997 and Kumar and Mihm, 1997). Therefore, the objective of this study is to assess relative resistance of some maize (Zea mays L.) genotypes against stem borers (Chilo partellus and Sesamia cretica) in central of the Sudan.

Material and Methods

The field experiments were conducted at Gezira Research Station Farm, Agricultural Research Corporation (ARC), Wad Medani, Sudan, during two consecutive winter seasons of 2011/12 and 2012/13. The thirteen maize genotypes used in the study were: TZBRID-3-C5, TZBRID-4-CW1, TZBRID-4-YC1, BR9922-DMRSR, BR9928-DMRSR, BR TZE-COMP-4-DMRS, AMATZ BR-WC-3, TZBR COMP1-W, TZBR COMP2-W, TZBR COMP1-Y, TZBR COMP2-Y and two local varieties (Hudiba-2 and Var-113). These genotypes were sown on October of the both seasons (years). The experiments were arranged in Randomized Complete Block Design (RCBD) with 4 replicates. The plot size was maintained in 2 rows x 5m long and 20 cm x 80 cm (8.0 m2) with inter and intra row spacing. All recommended cultural practices and agronomic data for maize production were applied as per ARC procedures. Data were recorded for some yield and yield components included Days to tassel, Plant height (cm), Ear height (cm), Ear length (cm) and Grain yield per Kg/Ha). The counts for leave damage and dead heart and their percentages were carried out weekly and covered all the maize plants in the field. In addition the existed natural enemies in the maize crop were also recorded. The Statistical analysis of variance (ANOVA) was carried out on the combined data of yield and yield components of the two seasons using a general linear model (GLM) procedure for randomized complete block design in SAS (1997). Laboratory work was conducted to identify the collected samples of larvae and pupae (from the stems, leaves and the ears) by rearing them till the adults emerged. The parasitized eggs, larvae and pupae of stem borer were also reared till adults parasitoids emerge.

Results and Discussion

The mean performance of the studied maize genotypes are presented in table,1. A wide range of variation was detected among them for plant height, ear height and grain yield (Kg/Ha), this variation could be of a great value in any maize breeding program aiming for obtaining maize genotypes resistant to stem borer or any other maize breeding object. The variation in maize was reported by many researchers (Idris et al 2012; Abuali et al 2014). In general, these genotypes showed late in flowering time with general mean of 65 days, the flowering ranged between 62 days for genotype TZBRID-4-YC1 to 67 days for TZBRID-3-C5. The general mean of plant height and ear placement was 128.4 cm and 57.9 cm, respectively. However, the lower ear placement were observed for the genotypes TZBR COMP2-W (52.3 cm), TZBR COMP1-Y (57.1 cm) and TZBR COMP1-W(56 cm) as shown in (Table,1). Plant height and ear placement are important traits for obtaining plant vigor, on the other side these two traits (tall plant and higher ear placement) subjected maize genotypes to lodging especially under high infestation of stem borer caused a complete damage to the crop and acute reduction in grain yield. (Ahmad and Akhtar, 1979; De Groote,2002). The maize grain yield is considered as the ultimate object for any maize breeding program, (Hallauer and Miranda, 1988; Ishag, 2004). In this study, the best genotypes with the highest grain yield were TZBR COMP2-Y (1082.5 kg/ha) followed by BR9928-DMRSR (1000.9 kg/ha) and TZBRID-4-YC1(1018.8 kg/ha) respectively, table 1.

The infestation percentages caused by the two stem borers (Seasamia cretica and Chilo partellus) in the two seasons are presented in tables (2 and 3) and Figures (1 and 2). These results showed that the range of the percentage (%) of infestation of leave damage (68-96%) and dead heart (14-40 %) in season 2011 were higher than their correspondence in season 2012 which revealed the range of (25-47 %) for leaves damage and the range of (7-19 %) for dead heart. These results reflect the effect of stem borer, genotypes and the environment conditions and their interactions. The damage caused by stem borer in maize was reported by many researchers (Ahmad and Akhtar, 1979; De Groote,2002; and Ouma et al 2010). In season 2011, the lower infestation percentage for leaves damage (67%) was obtained by the genotype BR9928-DMRSR while the lower percentage of dead heart (14%) was detected by genotype TZBR COMP1-Y (Table 1 and Fig1). The genotype BR TZE- COMP-4 DMRS performed well in season 2011 and scored the highest grain yield (1860.2 kg/ha) despite of its obtaining a higher level of the leave damage infestation percentage (93%) and a low percentage of dead hart percentage (17%), this result confirm the higher ability of this genotype to tolerate and/or to resist stem borer infestation. In season 2012 the lower percentage of infestation leaves damage (25%) was detected by the genotype TZBRID-4-CW1 and the lower dead hart percentage (7%) was obtained by the genotype TZBRID-3-C5 (Table 3 and Fig 2). The genotypes TZBR COMP2-Y and TZBR COMP2-W performed well in season 2012 and scored the highest grain yield of (1626.2 kg/ha) and (1229.6 kg/ha) respectively, despite of their obtaining a higher level of the leaves damage infestation percentage of (47%) and (41%) respectively and a low percentage of dead heart percentage of (15%) and (19%), respectively. These results confirm the higher ability of these two genotypes to tolerate and/or to resist stem borer infestation. The tolerance and/or resistance to stem borer coupled with yield superiority of some maize genotypes was reported by (Awan and Abdul Khaliq 2003; Mugo et al 2006; Ouma et al 2010). For the Laboratory experiments, they revealed that the natural enemies observed and collected from the field and emerged in the laboratory were consisted of a complex of predators and parasitoids. Most of the predators found on the leaves were Lacewings, Chrysoperla (Chrysopa carnea), Lady beetles (Cydonia sp.) and Spiders, while, the parasitoids found in immature stages parasitizing were stem borer eggs, larvae and pupae such as(Telenomous sp), larvae (Cotesia (Apanteles ruficrus Hal) and pupae (Pediobius furvus Gahan). few parasitoids adults were also found flying on plant leaves).

Conclusions:

The Farmers prefer to cultivate maize genotypes characterized with high yield and resistant to stem borer. This study aimed to assess relative resistance of some maize (Zea mays L.) genotypes against stem borers (Chilo partellus and Sesamia cretica) in central of the Sudan. The results showed that, in season 2011, the genotype BR TZE- COMP-4 DMRS scored the highest grain yield (1860.2 kg/ha) despite of its obtaining a higher level of the leave damage infestation percentage (93%) and a low percentage of dead hart percentage (17%). In season 2012, the genotypes TZBR COMP2-Y and TZBR COMP2-W scored the highest grain yield of (1626.2 kg/ha) and (1229.6 kg/ha) respectively, despite of their obtaining a higher level of the leaves damage infestation percentage of (47%) and (41%) respectively and a low percentage of dead heart percentage of (15%) and (19%), respectively. These results confirm the higher ability of these genotypes to tolerate and/or to resist stem borer infestation. Therefore, these genotypes can be recommended to be cultivated and/or to be used in any maize breeding program (Selection, Hybridization…etc.) for obtaining maize genotypes characterized with high yield and resistance to stem borer in Sudan.

References

1. Abuali,A.I.; Abdelmula, A.A.; Khalafalla, M.M.; Idris, A.E. and Hamza, N.B. (2014). Assessment of genetic variability of inbred lines and their F1- hybrids of grain maize (Zea mays L.) under drought stress conditions. International Journal of Agronomy and Agricultural Research (IJAAR) Vol. 5, No. 2, p. 22-30, 2014.
2. Ahmad, F. and M. Akhtar (1979). Losses caused by weeds and insects to maize crop. M.Sc. (Hons)Thesis, Dept. Agric. Entomol., Uni. Agric. Faisalabad,Pakistan.
3. Awan, N. A. and A.Khaliq (2003). Relative Resistance of Maize Stem Borer, Chilo partellus (Swinoe) Against Some Maize Cultivars. Pakistan Journal of Biological Sciences 6(2): 142-145.
4. De Groote H. (2002). Maize Yield Losses from Stem borers in Kenya. Insect Science and its Application 22:89-96.
5. Duale A. H and Okwakpam B. A. (1997). Inter-larval competition and its subsequent effect on Pediobius furvus (Hym.:Eulophidae) broods for the management of graminaceous stem borers. Biocon Sci Technol 7:239 – 246.
6. 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, 2014, 2, 81-86.
7. El-Wakeil, N.E. (1997). Ecological studies on certain natural enemies of maize and sorghum pests [MSc Thesis]. Egypt:Cairo University. p 212.
8. Idris, A.E.; Hamza,N.B.; Yagoub, S.O.; Ibrahim A.I.A. and El-Amin,H.K.A. (2012). Maize (Zea mays L.) Genotypes Diversity Study by Utilization of Inter-Simple Sequence Repeat (ISSR) Markers. Australian Journal of Basic and Applied Sciences, 6(10): 42-47.
9. Hallauer A.R., JB Miranda (1988). Quantitative Genetics in Maize Breeding. Second edition. Iowa State University Press, Ames, Iowa.
10. Isa, A. L, Awadallah W. H. and Wanas H. N. (1969). Distribution of overwintering corn borers larvae in residues of maize plants. FAO Plant 17:112 – 113.
11. Ishag, A.A., 2004. Estimation of general and specific combining abilities of some maize inbred lines (Zeamays L.), Ph.D.Thesis, Faculty of Agriculture ,University of Khartoum, Sudan.
12. Kumar, H., (1997). Resistance in Maize to Chilo partellus (Swinoe) (Lepidoptera,Pyralidae): a role of stalk damage parameters and biological control. Crop protection, 16: 375-381.
13. Kumar, H. and J.A. Mihm (1997). An overview of research of mechanisms of resistance in maize to spotted stem borer. Insect resistant maize: recent advances and utilization. Proceedings of International Symposium held at the International maize and wheat Improvement Center, 27 November-3 December 1994. Pp: 70-81.

14. Meseka, S.K. (2000). Diallel Analysis for Combining Ability of Grain Yield and Yield Components in Maize (Zea mays L.). M.Sc. Thesis, Faculty of Agricultural Sciences, University of Gezira, Wad Medani, Sudan.
15. Mugo S; Oyoo M., Bergvinson D., DeGroote H., and Songa J. (2006). Evaluation of Open Pollinated Maize Varieties for Resistance to Chilo Partellus in Dryland Mid-Altitudes and Coastal Lowlands of Kenya. To be published as proceedings of the 10th KARI Biennial Scientific Conference 12-17 November 2006, KARI Headquarters Nairobi Kenya.
16. Nour, A.M., I. Nur Eldin and M. Dafalla. (1997). Crop Development and Improvement. Annual Report of the Maize Research Program. Agricultural Research Corporation, Wad Medani, Sudan.
17. Ouma J.O.; M.Odendo ; C.Bett; H. De Groote; S.Mugo; C.Mutinda ; J.Gethi ; S.Njoka; S.Ajanga & J.shuma (2010).Participatory Farmer Evaluation of Stem borer Resistant Maize varieties in three maize growing ecologies of Kenya Contributed Paper presented at the Joint 3rd African Association of Agricultural Economists (AAAE) and 48th Agricultural Economists Association of South Africa (AEASA) Conference, Cape Town, South Africa, September 19-23.
18. Jiang, N. (2005). Effect of the host plant on the survivorship of parasitized Chilo partellus larvae and performance of its larval parasitoid Cotesia flavipes. Biol Cont 32:183 – 190.
19. SAS, Institute (1997). SAS proprietary software, release 6.12 edition, SAS Institute Inc., Cary, NC, USA.
20. Van Rensburg, J. B. J, Walters M. C. and Giliomee J. H. (1988). Plant population and cultivar effects on yield losses caused by the maize stalk borer, Busseola fusca (Lepidoptera: Noctuidae). S. Afr. J. Plant Soil 5:215–18.

Table,1. The mean performance of thirteen genotypes evaluated in Gezira research station farm for two winter seasons 2011 and 2012 combined.

No	Entries	DT	PH	EH	EL	GY
1	TZBRID-3-C5	67	134.8	59.8	16.2	760.9
2	TZBRID-4-CW1	67	131.1	66.1	15.2	675.1
3	TZBRID-4-YC1	62	134.1	61.5	15.4	1018.8
4	BR9922-DMRSR	65	140.6	67.3	17.3	833.6
5	BR9928-DMRSR	67	142.8	68.3	16.1	1000.9
6	BR TZE- COMP-4-DMRS	64	130.3	62.3	15.5	598.7
7	AMATZ BR-WC-3	64	130.3	61.8	16	525.7
8	TZBR COMP1-W	64	125.5	56	17.2	800.5
9	TZBR COMP2-W	64	124.8	52.3	16.3	924.6
10	TZBR COMP1-Y	66	127	57.1	16.4	814.5
11	TZBR COMP2-Y	65	139.5	65.1	16.5	1082.5
12	Hudiba-2	63	106.6	39.3	13.8	779.9
13	Var-113	62	103.1	36.1	15.9	680.5
Means		65	128.4	57.9	16	807.4
CV%		7.3	16.1	23.8	11.2	61.7
LSD%		5.4	23.9	15.9	2	574.5
F value		0.76^{ns}	1.98***	3.21***	1.54^{ns}	0.67***

DT= Days to tassel, PH= Plant height (cm), EH=Ear height (cm), EL=Ear length (cm), GY= Grain yield (Kg/Ha).

ns= not significant, *** =Significant at P <0.01.

Table2. The mean percentages (%) of leaves damage and dead heart of stem borer infestation of thirteen genotypes of maize evaluated in Gezira Station Farm Season, 2011.

Entries	Plant stand	leave damage	dead heart	% leave damage	% dead heart	Grain Yield kg/ha
TZBRID-3-C5	37	25	5	79	18	1514.2
TZBRID-4-CW1	37	27	9	89	25	1013.3
TZBRID-4-YC1	31	20	11	80	40	806
BR9922-DMRSR	37	25	6	77	19	1980.5
BR9928-DMRSR	38	24	9	67	27	2073.6
BR TZE- COMP-4-DMRS	38	31	5	93	17	1860.2
AMATZ BR-WC-3	40	31	10	81	28	336.2
TZBR COMP1-W	35	24	5	82	18	1085.7
TZBR COMP2-W	29	18	3	68	17	1497.7
TZBR COMP1-Y	35	26	5	86	14	769.4
TZBR COMP2-Y	36	28	10	87	34	1368.3
Hudiba-2	21	19	5	96	25	75.4
Var-113	36	23	7	71	32	115.5

Table 3 The mean percentages (%) of leaves damage and dead heart of stem borers infestation of thirteen maize genotypes evaluated in Gezira Station Farm Season, 2012.

Entries	Plant stand	leave damage	dead heart	% leave damage	% dead heart	Grain Yield kg/ha
TZBRID-3-C5	11	4	1	31	7	965.5
TZBRID-4-CW1	37	9	6	25	16	993.3
TZBRID-4-YC1	29	12	5	40	18	1670.9
BR9922-DMRSR	37	11	5	29	14	886.8
BR9928-DMRSR	40	12	5	29	11	1379
BR TZE- COMP-4-DMRS	31	12	4	38	11	475.1
AMATZ BR-WC-3	24	9	4	38	15	713.3
TZBR COMP1-W	26	8	3	30	13	1084.4
TZBR COMP2-W	33	11	5	34	14	1229.6
TZBR COMP1-Y	31	13	6	41	19	1090.3
TZBR COMP2-Y	14	7	2	47	15	1626.2
Hudiba-2	33	13	5	38	14	1288.5
Var-113	36	13	4	35	12	1110.9

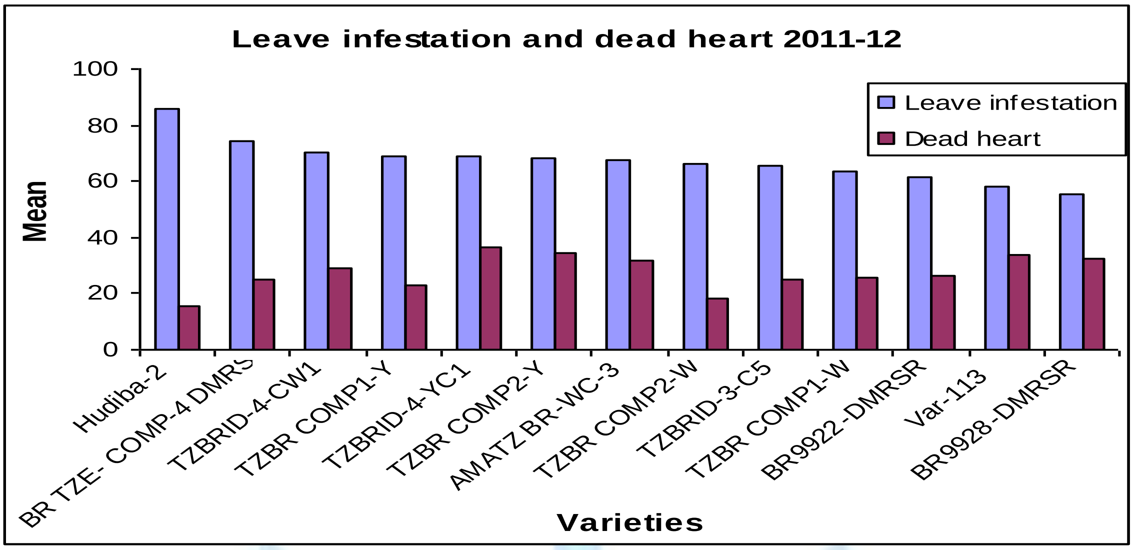

Fig1. The mean percentage (%) of leave damage and dead heart of stem borer infestation of thirteen genotypes of maize evaluated in Gezira Station Farm Season, 2011.

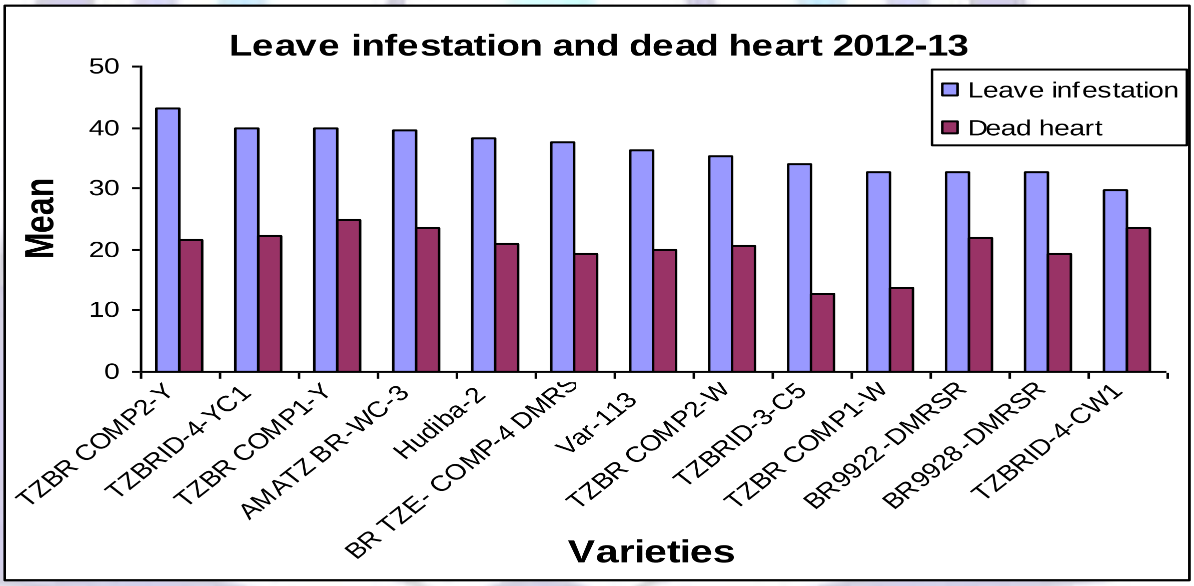

Fig -2 The mean percentage (%) of leave damage and dead heart of stem borer infestation of thirteen genotypes of maize evaluated in Gezira Station Farm Season, 2012.