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Research Application Summary

Genetic diversity in maize landraces for resistance to *Chilo partellus* in Kenya

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Abstract

Yield losses in maize associated with stem borer damage is estimated at 13% annually in Kenya. New sources of resistance to stem borers are needed to develop germplasm for the diverse maize growing ecologies. This study was conducted to establish new sources of resistance from CIMMYT landrace accessions to *Chilo partellus*. Landraces are expected to provide diverse sources of useful genes that may have been lost during breeding in elite germplasm. Landraces Guan 34, Guat 79, and Guat 1050 were the most resistant, exhibiting lowest tunnel length mean of 8.79 cm compared to the resistant hybrid checks mean of 15.4 cm.

Key words: Exit holes, tunnel length, yield

Résumé

Les pertes de rendement dans le maïs causées par des dégâts des insectes ravageurs des tiges sont estimées à 13% par an au Kenya. De nouvelles sources de résistance aux ravageurs des tiges sont nécessaires pour développer du matériel génétique pour les diverses écologies de croissance de maïs. Cette étude a été menée pour établir de nouvelles sources de résistance à partir des accessions de Landrace CIMMYT au *Chilo partellus*. Les landraces sont censées fournir diverses sources de gènes utiles qui peuvent avoir été perdus pendant la reproduction du matériel génétique d'élite. Les variétés locales Guan 34, Guat 79, et Guat 1050 ont été les plus résistantes, présentant la plus faible moyenne de longueur du tunnel de 8,79 cm par rapport à la moyenne des contrôles des hybrides résistants de 15,4 cm.

Mots clés: Les trous de sortie, longueur du tunnel, le rendement

Background

There have been imbalances between food production and demand as population increases in Kenya. Kenya's population growth of 2.9% is high while arable land remains low. The bulk

of food and cash crop is produced on only 18% of the landmass classified as medium to high potential agricultural land. The mean yield of maize, the major staple is only 1.5 t ha^{-1} compared to a global average of >4.9 t ha^{-1}. This, in part, is responsible for the 56% poverty level of the Kenyan population. Maize production in Kenya has been constrained by abiotic factors including drought and low soil fertility and biotic factors including insect pests, diseases and weeds. *Chilo partellus*,one of the important stem borer species causes maize losses estimated at about 13%. Without increase in arable land, more food can only come through higher yields per unit area of land. New sources of resistance to stem borers are needed to develop germplasm for the diverse maize growing ecologies in Kenya. This study will establish the differences in resistance to the *Chilo partellus* stem borer among maize landraces in Kenya. Landraces are expected to provide diverse sources of useful genes that may have been lost during breeding and selection in elite germplasm.

Literature Summary

Maize is Kenya's staple food and with a per capital consumption level of 125 kg (CIMMYT, 2008). Any threat to maize endanger food security. Stem borers, accounting for about 13% grain yield losses pose such a threat. The major maize stem borer species in Kenya are *Chilo partellus* Swinhoe (spotted stem borers), *Busseola fusca* Fuller (African stem borers), and *Sesamia calamistis* Hampson (pink stem borers) (*Mugo et al.*, 2002). Stem borer injury to maize includes leaf feeding, stalk tunneling and subsequent development of "deadhearts". *Chilo partellus* lays its eggs on the lower surfaces of maize leaves, near the midrib and upon hatching, early instars move into the whorl, where they begin feeding on leaves. Mid and late-instars bore into the midrib and stalk, respectively (Ofomata *et al*., 2000). While the average yield loss attributed to stem borers is 13%, about 33% yield loss has been found in plants with more than one stem borer exit hole (Songa *et al*., 2001). One centimeter of stem borer tunnel reduces yield by about three grams per plant. Damage by the pest reduces the number of ears per plant, plant height and may cause delayed silking (Songa *et al*., 2002).

Stem borer resistance levels in improved varieties is low hence there is need to increase resistance. Landraces have potential to contribute to improved resistance by widening the narrow germplasm base in breeding programs. The objective of this study was to determine the genetic diversity in maize landraces for resistance to *C. partellus* in Kenya. Resistant landraces

identified will contribute towards the development of stem-borer resistant maize varieties.

Study Description

Sixty (68) maize landraces collected from Central and South America were sourced from CIMMYT gene bank in Mexico. Seven hybrid checks developed by CIMMYT which included four with resistance to stem borers (CKIR06009, CKIR07008, CKIR07001, and CKIR07013) were included. The trial was set up at KARI- Kiboko located at 37.75^{o} east, 2.15^{o} south, at an elevation of 975 m above sea level. Kiboko has a minimum daily temperature of 14.3^{o}C and maximum temperature of 35.1^{o}C. It falls under mid-altitude dry agro-ecological zone VI and receives about 530mm rainfall per annum.

The study was an Alpha lattice design with three replications. Plots consisted of 2x5m rows spaced at 0.75m x0.25m, giving a density of 53,333 plants/ha. Two seeds were planted per hill but later thinned to one plant per hill except head hills where two seeds were left to compensate for unfair competition. Ten (10) plants per plot were infested with *Chilo partellus* neonates three weeks after planting. Irrigation was done to ensure no drought stress was experienced.

The traits measured included: leaf feeding damage on a score of 1-9 (1=no damage, 9=extensive damage) at 2 and 4 weeks after infestation, number of plants with dead hearts, cumulative tunnel length (cm), and number of borer exit holes per plant. Others were number of plants showing stem lodging, shoot lodging, ear height, plant height (cm) and grain yield (t ha^{-1}). Data were analyzed using SAS package and means were separated using the least significance difference (LSD) test at 5% level of significance.

Research Application

The landraces evaluated varied significantly in levels of resistance to *Chilo partellus*. The number of exit holes averaged 7.59. Resistant hybrid checks CKIR07013 and CKIR06009 had the lowest number of exit holes means at 2.8 and 3.0, respectively. Tunnel length mean was 21.29cm. Shortest tunnel length was in Guan 34 (8.58cm) while the longest was in Vall 380 (38.55cm). Grain yield mean was 5.3 t/ha. Yields were highest in the resistant check hybrid CKIR07013 (9.57 t/ha) and lowest in landrace Peru 397 (1.85 t/ha) (Table 1).

The resistant landraces were comparably better than the resistant hybrid checks with an overall mean of 12.8 cm tunnel length

Table 1. Variables evaluated at Kiboko during the October - March 2009/2010 season.

Trait	Mean	Range	Pr> F	CV
Leaf damage	2.89	3.88-1.77	0.1793ns	21.88
Exit holes	7.59	14.49-2.8	0.0001	36.73
Tunnel length	21.29	38.55-8.58	0.0054	38.61
Grain yield	5.32	1.85-9.57	0.0005	52.48

Pr= Probability; CV=Coefficient of variation; ns=not significant.

Table 2. Tunnel length for the 10 most resistant, the 10 most susceptible landraces, and the resistant and susceptible hybrid checks after artificial infestation with *Chilo partellus* at Kiboko, Kenya.

Category	Entry no.	Genotypes	Mean tunnel length (cm)	Resistant landraces
Most resistant	1	56	GUAN 34	8.58
	2	9	GUAT 1050	8.65
	3	44	GUAT 79	9.13
	4	28	SINA 21	12.95
	5	6	GUAT 1030	13.39
	6	35	BRAZ 1832	13.51
	7	29	BRAZ 2017	13.73
	8	49	BRAZ 1442	13.75
	9	16	OAXA 553	13.95
	10	13	GUAT 1093	14.16
	Mean			12.18
Susceptible landraces	1	42	VENE 897	28.33
	2	63	CAQU 321	28.92
	3	26	BRAZ 4	29.25
	4	65	BRAZ 1495	29.26
	5	17	BRAZ 2454	29.96
	6	58	CHIS 94	30.15
	7	46	VALL 385	30.18
	8	2	GUAT 1008	32.37
	9	51	BRAZ 1346	32.93
	10	57	VALL 380	38.55
	Mean			30.99
Resistant Hybrid Checks	1	75	CKIR07013	9.53
	2	72	CKIR06009	10.74
	3	73	CKIR07008	18.15
	4	74	CKIR07001	23.17
	Mean			15.4
Susceptible hybrid checks	1	70	CKPH08032	19.52
	2	69	CKPH09001	21.65
	3	71	CKPH09002	22.54
	Mean			21.24
Trial mean				21.29
CV (%)				38.61
LSD				13.26

against that of resistant hybrid checks of 15.4 cm. Resistant landraces were also better than the susceptible hybrid checks which had an overall mean of 21.24cm. Resistant landraces had a lower overall mean tunnel length (12.18cm) than the susceptible landraces (30.99cm) (Table 2).

Recommendation

The landraces identified with high levels of resistance should be used for the development of resistant varieties in future breeding programs.

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