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RESEARCH ARTICLE

ASSESSMENT OF INTRODUCED GENOTYPES OF MAIZE IN GEORGIA CONDITIONS

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ABSTRACT

Maize is viewed as a productive crop in Georgia. Assessment of genotypes of maize showed that introduced hybrids maize were significantly more productive than the local varieties commonly grown in Georgia. Improvements in yield over local varieties were generally between 15-25%. However, all hybrids were susceptible to *Exserohilum. turcicum*, and yield gains were greatest when fungicide was applied.

INTRODUCTION

Maize is viewed as a productive crop in Georgia and cultivated on 200 – 220 thousand ha. Most of the maize cultivation in Georgia occurs in the West of the country, where it is the main cereal crop and is widely used for human and livestock consumption. But its yield does not exceed more than 2.0-2.1 t per hectare (Jinjikhadze, 2000). One of the main reasons for this low yield is that only 2 % of the crop is hybrid maize. Mainly, local breeding varieties and variety populations are sown. The most significant disease of maize is considered to be Northern Corn Leaf Blight (caused by the fungus Exserohilum turcicum) worldwide (Mepharishvili, 2006).

Our Institute carries out evaluation of the imported maize germplasm to identify varieties that perform well under local conditions. Based on these traits, some improved genotypes have been identified. Before release, these genotypes require further evaluation for yield and adaptation in the diverse agroecological conditions of Georgia, and assessment of their grain quality traits. The goal of this study is to determine levels of resistance in introduced maize cultivars to major diseases occurring in Georgia; assess appropriateness for cultivation in Georgian agricultural systems and test the effect of fungicide application.

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MATERIALS AND METHODS

Maize germplasm

The six maize genotypes: *Ajametis Tetri*, *Qartuli krugi*, *Lomtagora 1* (a local cultivar selected from ICARDA/CIMMYT international nurseries), *Eleonora* (FAO 700, hybrid of company "Pioner"), *Cecilia* (FAO 500, hybrid of company "Pioner") and *Clariti KS* (FAO 330, hybrid of company "Caussade-Semences") were used in the yield trials study. Four genotypes: Kartuli krugi (local check), Lomtagora 1, Eleonora, Cecilia were planted in Marneuli and Tetritskharo (Eastern Georgia), and five genotypes: Ajametis tetri (local check), Lomtagora 1, Eleonora, Cecilia, and Clariti were sown in Kobuleti and Khobi (Western Georgia).

Field plots

Field trials were established at four sites representing different agroecological zones: Kobuleti Khobi (Western Georgia), Tetritskharo, Marneuli (Eastern Georgia). The plots were planted in land under sunflower – wheat –maize rotation. In each of the two season's plots were ploughed, disked and harrowed before sowing. Plots were sown in May. The experimental design was a randomized complete block with four replicates. Seed of six genotypes were planted in single subplots with size $100m^2$. All plots were sown by hand with 70cm between rows. The maize genotypes were tested under natural infection. Super phosphate and urea was broadcast before planting, which was done by hand. An additional Nitrogen fertilizer was applied 4 weeks after planting. Plants

were hand weeded three times during the growing season. The fungicide of Syngenta company Alto Super (propiconazole 250 g + cyproconazole 80 g) was applied with a hand-sprayer at the rate of 05.kg/ha once (Bowen, 1988). Average yield in ton per hectare was estimated (*http://maizedoctor.cimmyt.org*). The statistical analysis of the obtained results was done using ANOVA software.

RESULTS AND DISCUSSION

Very high air temperature (max. 45^0C) and low humidity during intensive plant vegetation and yield establishment in 2012 reduced the growth of all varieties, especially in Tetritskharo. This was particularly evident in the height of hybrids - Cecilia and Eleonora did not exceed 1.2m, although thei height in accordance with the certificate is 2.3m; the cobs had not been produced or weakly developed because of a very hot summer and lack of precipitation. In western Georgia at Kobuleti and Khobi maize trials growth of plants was better compared to Marneuli and Tetritskharo trials.

In 2013 trials growth was normal. High air temperature and very little precipitation limit the disease development. Particularly, single spots of North corn blight were recorded on the lower leaves in both regions. Severity was very low at 0.5-1%. Low incidence of North corn leaf spot was observed in Kobuleti in 2013 on hybrids Cecilia, Eleonora, Clariti. In Khobi, Physoderma was also found on these varieties. In Marneuli and Tetritskharo serious disease symptoms were not present but episodic incidence of Maize Chlorotic Dwarf virus was recorded on all genotypes: Kartuli krugi, Lomtagora 1, Eleonora, Cecilia. During July 2012-2013 maize plants were treated by fungicide in Marneuli, Tetritskharo, Kobuleti and Khobi than slight spots were recorded. Development of North corn blight was prevented on protected plots. All tested genotypes showed resistance to North corn blight under natural conditions. In Khobi and Kobuleti maize cobs yield was harvested in the end of September and October in 2012 and 2013, respectively, in Marneuli and Tetritskharo – in October and November.

Table 1. Effects of fungicide treatment (factor A) and varieties (factor B) in maize grain yield

Tetritskharo, 2013					
A (Fungicide treatment)	**B (genotype)**				Mean for "A" (LSD_{05}=0.45)
	Kartuli krugi (Standard)	Lomtagora 1	Eleonora	Cecilia	
I (Untreated)	9.8	10.1	12.2	11.2	10.9
II (Treated)	10.3	10.9	14	12	11.8
Mean for **"B"** (LSD_{05}=0.65)	10.1	10.5	13.1	11.6	11.3
Marneuli, 2013					
A (Fungicide treatment)	**B (genotype)**				Mean for "A" (LSD_{05}=0.45)
	Kartuli krugi (Standard)	Lomtagora 1	Eleonora	Cecilia	
I (Untreated)	6.7	6.0	7.8	7.8	7.1
II (treated)	7.3	7.3	8.5	8.1	7.8
Mean for **"B"** (LSD_{05}=0.65)	7.0	6.7	8.2	8	7.5
Marneuli, 2012					
A (Fungicide treatment)	**B (genotype)**				Mean for "A" (LSD_{05}=0.12)
	Kartuli krugi (Standard)	Lomtagora 1	Eleonora	Cecilia	
I (Untreated)	5.6	6.2	4.6	4.8	5.3
II (treated)	5.7	6.5	4.7	5.2	5.5
Mean for **"B"** (LSD_{05}=0.09)	5.7	6.4	4.7	5	5.4
Khobi, 2013						
A (Fungicide treatment)	**B (genotype)**					Mean for "A"
	Ajametis Tetri (Standard)	Lomtagora 1	Eleonora	Cecilia	Clariti	
I (Untreated))	5.7	5.1	6.6	4.6	3.1	5.02
II (treated))	5.9	5.2	7.0	5.0	2.9	5.2
Mean for **"B"** (LSD_{05}=0.41)	5.8	5.2	6.8	4.8	3	5.1
Khobi, 2012						
A (Fungicide treatment)	**B (genotype)**					Mean for "**A**" (LSD_{05}=0.04)
	Ajametis Tetri (Standard)	Lomtagora 1	Eleonora	Cecilia	Clariti	
I (Unprotected)	6.2	9.8	7.7	8.1	6.4	7.6
II (Protected)	6.5	10.1	9.4	8.3	6.6	8.2
Mean for **"B"** (LSD_{05}=0.06)	6.4	9.9	8.6	8.2	6.5	7.9
Kobuleti, 2013						
A (Fungicide treatment)	**B (genotype)**					Mean for "**A**" (LSD_{05}=1.0)
	Ajametis Tetri (Standard)	Lomtagora 1	Eleonora	Cecilia	Clariti	
I (Unprotected)	7.9	7.7	8.3	9.1	6.2	7.8
II (Protected)	8.8	8.9	9.8	10.0	7.1	8.9
Mean for **"B"** (LSD_{05}=1,4)	8.4	8.3	9.0	9.5	6.7	8.6
Kobuleti, 2012						
A (Fungicide treatment)	**B (genotype)**					Mean for "A" (LSD_{05}=0.8)
	Ajametis Tetri (Standard)	Lomtagora 1	Eleonora	Cecilia	Clariti	
I (Unprotected)	8.8	8.2	9.1	8.0	6.2	8.1
II (Protected)	10.2	10.4	11.1	10.4	6.9	9.8
Mean for "B" (LSD_{05}=1.0)	9.5	10.3	10.1	9.2	6.7	6.6

Plant height, corn ear length, number of kernels per ear, weight of kernels per ear, average yield and weight of thousand kernels (WTK) were measured. We conducted two-level factorial dispersion analysis of maize yield data. As the table 1 shows average yield from unprotected/ protected plots was nearly same in 2012-2013 years in Kobuleti and varied between 6.2/9.1-6.9/11.1t/ha. Compared to standard Ajametis tetri (8.8/10.2), all varieties except hybrid Clariti showed the highest yield. According to our tests average yield of Clariti – 6.2 t/ha (unprotected plot) and 7.1 t/ha (protected plot) was lower than potential grain yield -14t/ha (*www.caussade.ru*). The highest yield was obtained from hybrids Eleonora (9.1/11.1t/ha) and Cecilia (9.0/10.4t/ha). Nearly the same yield was given by the rest varieties. Value of weight of thousand kernels for all tested varieties (286-433gr) was high, but it was behind standard variety Ajametis tetri (565-600gr).

The yield values ranged between 6.2 -9.8t/ha on unprotected plots and 6.5 -10.1t/ha on protected plots in Khobi in 2012. The highest yield - 9.8-10.1t/ha was shown by the Georgian variety Lomtagora 1. In 2013 the average yield (5.0-7.0t/ha) and yield components were very low. Compared to Kobuleti trials data average yield of all tested varieties was low in Khobi trials (especially, low yield was on widely grown in West Georgia variety Ajametis tetri). However, weight of thousand kernels on variety Ajametis tetri (392/419gr.) was higher than for the rest tested entries. The lowest TKW (277/152) showed hybrid Clariti in both 2012/2013 years.

The lowest grain yield was recorded on all varieties on unprotected plots (4.6-6.2t/ha) and also on protected plots (4.8-6.6t/ha) in Marneuli in 2012. However, a high value of TKW (279-361gr) was recorded for all varieties. A comparatively high average yield was recorded on cv. Lomtagora 1 (6.2/6.6t/ha). Lomtagora 1 is also characterized by high number and weight of kernels per ear. The low yield in 2012 at Marneuli the trial can be explained by very high air temperature (max.38 C) and very low precipitation. Trials were irrigated once, but this was not sufficient for a high yield. Average yields of all tested varieties (6.0-8.5t/ha- 6.7/8.8t/ha) increased in 2013; however, it was lower than at Kobuleti and Tetritskharo trials in 2013. Because the 2012 growing season was unfavorable (very high air temperature, lack of precipitation) for growth of maize in Tetritskharo, cobs had not been produced and it was impossible to obtain a yield from Tetritskharo trials. Here it should be noted that this region is unirrigated. But in 2013 the highest yield was harvested from Tetritskharo trials as in 2013 environmental conditions were more conducive for plants growth as precipitation was more frequent. Average temperature during vegetation period was 17^0C and rainfall – 300mm. The yield value ranged between 9.8 -12.2t/ha on unprotected plots and 10.3 -14.0 t/ha on protected plots. The highest yield was shown by Eleonora (12.2/14.0 t/ha and Cecilia (11.2/12.0t/ha).

Notwithstanding the high air temperature at all sites in 2012, high yields were recorded at Marneuli, Kobuleti and Khobi maize trials. This can be explained by the fact that Marneuli trials were irrigated, Kobuleti and Khobi regions are characterized with heavy rainfall and in addition the ground waters are located near soil surface, which provides maize plants with humidity during vegetative growth. But in Khobi and Kobuleti trails yield were lower in 2013 than in 2012 as rainfall was recorded while kernels were maturing and in this case yield was harvested very late; cobs of the majority entries were damaged by insects European corn borer (Ostrinia nubilalis) and corn earworm (Heliothis armigera). Fisher's coefficient and Least Significant Difference (LSD) were calculated. Accordance with these values the effects by each of the two factors (fungicide treatment and variety) on yield was significant and interaction effect of fungicide and variety was not significant for Marneuli 2012/2013, Tetritskharo 2013, Kobuleti 2012 trials. However, for Khobi 2012 trials the effects of Fungicide (factor A), genotype (Factor B) and interaction effect A x B were significant, and in Khobi 2013 trial only one factor (variety) was significant. Thus, nearly all the tested maize genotypes differed from each other on yielding and other agronomic traits as by years so by locations. Yielding in 2012/2013 from Kobuleti trails did not differ significantly. Hybrids Eleonora and Cecilia showed the highest yield in nearly all location and they can be submitted for release in all sites.

Our experiments showed that hybrid maize varieties were significantly more productive than the local varieties commonly grown in Georgia. Improvements in yield over local varieties were generally between 15-25%, although in one trial a 40% yield improvement was observed (on the hybrid Eleonora in fungicide-protected plots in Eastern Georgia. However, the hybrid varieties we tested were susceptible to *E. turcicum*. And yield gains were greatest when fungicide was applied. We now have sufficient data to recommend the hybrid Eleonora as a high-yielding alternative for Georgian farmers, although maximum benefit will only be realised if farmers have access to high quality seed, fungicide and appropriate advice on its use.

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