COMPARISON OF TRADITIONAL AND IMPROVED TROPICAL MAIZE POPULATIONS IN BENIN

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ABSTRACT

Two types of tropical maize populations, PTMB3 (HOLLIKOUI), a traditional population widely cultivated in Benin and DMRESRW, an elite improved population, were compared for important agronomic traits during two consecutive years in southern Benin in two locations corresponding to two different types of growing conditions: Abomey-Calavi (favourable conditions) and Abomey (unfavourable conditions). A randomized complete block design with four replications was used. PTMB3 was significantly later than DMRESRW and had plant and ear heights significantly greater. The two populations were very mildly infected by diseases. Husk cover was excellent in PTMB3 and intermediate in DMRESRW. PTMB3 had a grain yield significantly lower than that of DMRESRW in favourable growing conditions and not significantly different from it in unfavourable growing conditions. The harvest index of DMRESRW was significantly higher than that of PTMB3. The type of grain of PTMB3 is highly appreciated by consumers in Benin at the opposite of that of DMRESRW. PTMB3 appears then better than DMRESRW for husk cover and grain quality whereas DMRESRW is better than PTMB3 for earliness, reduced plant and ear heights, grain yield in favourable growing conditions, and harvest index. The two populations need to be improved: PTMB3 for earliness, reduced plant and ear heights, grain yield and harvest index; DMRESRW for husk cover and grain quality.

Keywords: benin, improved populations, maize, traditional populations, varieties.

INTRODUCTION

Maize (*Zea mays* L.) is a cereal crop cultivated worldwide. It is a staple food for an estimated 50% of the people in Sub-Saharan Africa (IITA, 2009). In Benin Republic, maize is the most important cereal crop on the basis of area cultivated and production (FAO, 2013). It is grown from north to south; but, the highest producing zone is the south (ONASA, 2013).

Two types of cultivars are grown in Benin: traditional populations and improved varieties. The improved varieties were introduced mainly from the International Institute of Tropical Agriculture (IITA) and the International Maize and Wheat Improvement Center (CIMMYT). They have high potential grain yields. The traditional populations may be obtained from natural mating between maize populations introduced from Americas via Europe (Westengen *et al*., 2012; Mir *et al*., 2013). Their potential grain yields are relatively low (Abadassi, 2014); but, they are the most cultivated varieties in Benin despite consistent efforts made to popularize improved varieties. It is, therefore, important to compare the two types of varieties in other to identify their relative strengths and weaknesses.

This work was initiated to compare a traditional maize population widely grown in Benin to an elite improved tropical maize population introduced in Benin and cultivated in many other countries of tropical Africa. The traits studied were: earliness (days to pollen-shed, silking and maturity, number of leaves), plant and ear heights, reaction to diseases (rust due to *Puccinia polysora*, tropical blight caused by *Exserohilum maydis* and maize streak due to maize streak virus), husk cover, grain yield and its components, and harvest index.

MATERIALS AND METHODS

Populations and evaluation

Two populations were compared:

- PTMB3 (HOLLIKOUI), a traditional population widely cultivated in Benin
- DMRESRW, an elite tropical population bred by IITA and cultivated in several countries of tropical Africa. It is the most widely popularized maize improved variety in Benin.

The populations were evaluated during two consecutive years in two locations in South- Benin, forest zone: Abomey-Calavi (latitude: 6°27'N; longitude: 2°22'E; altitude: 10 m) and Abomey (latitude: 7°11'N; longitude: 1°59'E; altitude: 260 m). The experimental design was a randomized complete block design with four replications. Soils were fertile at Abomey-Calavi and poor at Abomey. Each entry was grown in six 4.5 m rows separated by 0.80 m. Hills along the row were 0.50 m apart. Plots were overplanted and thinned to 2 plants per hill (50000 plants.ha^{-1}). Fertilization consisted of 200 kg/ha of NPKSB (14-23-14-5-1) before planting and 25 kg/ha of urea (46% N) two and six weeks after planting. Weeding was appropriate. Rainfall was sufficient and well distributed except in the second year at Abomey where a long drought period did not permit the evaluation.

Days to 50% pollen-shed, 50% silking and 50% maturity (dried husks) (days after planting) and number of leaves were recorded on a plot basis. Plant or ear height was measured on a plot basis as the distance between soil surface and panicle base (plant height) or the superior ear insertion point (ear height). Diseases were scored after silking under natural infection using a 1 - 5 scale (1 = very mild infection; 5 = very high infection). Husk cover was scored at maturity with a 1 - 5 scale [1 = excellent (tight husk going beyond the ear tip); 5 = very poor (naked ear tip)]. Grain yield and 1000 grain weight were recorded per plot at 15% moisture. Number of ears per plant (nep) and number of grains per ear (nge) were computed as follows:

nep = ne/nph

with ne = number of ears harvested on the plot; nph = number of plants harvested on the plot
nge = (gwe/tgw) ×1000
gwe = grain weight per ear
tgw = 1000 grain weight.

Harvest index (hi) was estimated using the formula:
hi = ew/epw
ew = weight of all the ears harvested on the plot; epw = weight of all the plants harvested on the plot.

Statistical analysis

Analyses of variance were realized for each trait. Pooling analyses were performed when residual variances were homogeneous at the 5% level. When significant ($P<0.05$) differences among entries appeared, the means of the populations were compared using Newman-Keuls test.

RESULTS AND DISCUSSIONS

Significant differences among populations were noted for all traits in all trials except plant and ear heights, number of grains per ear, 1000 grain weight at Abomey, number of ears per plant at Abomey in the first year and Abomey-Calavi in the second year and grain yield at Abomey in the first year and Abomey-Calavi in the second year. A significant population effect was noted in pooled analyses for all traits listed in tables 1 and 2. Population means are shown in Tables 1 to 4.

Earliness

PTMB3 appeared significantly later than DMRESRW. Differences ranged from 5 to 12 days and 3 to 6 leaves depending on variable, location and year. Variations with location and year are probably due to genotype × environment interaction. Tables 5 and 6 show that that interaction was significant in several cases. Growth duration was longer in the highest location, Abomey. That result agrees with those reported by Ayuk-Takem (1978) and Abadassi (2001). Those authors obtained also growth duration increase with altitude.

Table-1. Population means per trait (pooling analysis for locations in the first year).

Trait	Population		cv (%)
	PTMB3	DMRESRW	
Days to 50% pollen-shed	62.3a	52.7b	1.9
Days to 50% silking	65.8a	55.3b	1.8
Plant height (cm)	237a	182b	7.7
Ear height (cm)	135a	80b	12.2
Husk cover	1.1b	3.1a	16

For each trait, means followed by the same letter are not significantly different at the 5% level.
cv = coefficient of variation.

Table-2. Population means per trait (pooling analysis for years at Abomey-Calavi).

Trait	Population		cv (%)
	PTMB3	DMRESRW	
Days to 50% pollen-shed	59.2a	49.9b	2.2
Days to 50% silking	62.1a	51.8b	1.4
Number of leaves	24.2a	20.9b	4.5
Ear height (cm)	151a	97b	10.5
Grain yield (kg/ha)	3974b	5709a	15.8

For each trait, means followed by the same letter are not significantly different at the 5% level.
cv = coefficient of variation.

Plant and ear heights

PTMB3 had plant and ear heights significantly greater than those of DMRESRW. Differences were 55 or 60 cm for plant height and 54 or 55 cm for ear height. That result may be explained by positive correlation between plant height and growth duration (Jacquot, 1970) and plant and ear heights (Kim and Hallauer, 1989; Abadassi, 2015) in maize. Genotype × environment interaction is probably responsible for variations with location and year. However, that interaction was not significant in the pooled analyses permitted (Tables 5 and 6).

Table-3. Population means per trait at Abomey.

Trait	Population		cv (%)
	PTMB3	DMRESRW	
Days to 50% maturity	99.7a	87.7b	2.9
Number of leaves	22.7a	16.7b	3.3
Number of ears per plant (1)	1.06	1.04	15.7
Number of grains per ear (1)	250	235	10.5
1000 grain weight (g) (1)	213	242	5.5
Grain yield (kg/ha) (1)	2848	3001	28.7
Rust	1	1	
Tropical blight	1	1	
Maize streak	1	1	
Harvest index	0.32b	0.57a	9.7

For each trait, means followed by the same letter are not significantly different at the 5% level.

(1) Population effect was not significant.
cv = coefficient of variation.

Table-4. Population means per trait at Abomey-Calavi.

Trait	Year	Population		cv (%)
		PTMB3	DMRESRW	
Days to 50% maturity	1	89.5a	82b	1
	2	90.7a	86b	1.7
Number of ears per plant	1	1.34a	1.09b	5.1
	2 (1)	1.08	1.00	5
Number of grains per ear	1 (1)	323	365	12.7
	2 (1)	322	339	18
1000 grain weight (g)	1	209b	326a	10.6
	2	203b	296a	4.8
Rust	1	1	1	
	2	1	1	
Tropical blight	1	1	1	
	2	1	1	
Maize streak	1	1	1	
	2	1	1	
Plant height (cm)	2	239a	179b	10.1

For each trait, means followed by the same letter are not significantly different at the 5% level.

(1) Population effect was not significant.
cv = coefficient of variation.

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Table-5. Pooling analysis for locations in the first year.

Trait	Pooled error MS	Population × location interaction	
		MS	F
Days to 50% pollen-shed	1.30	2.10	1.60 ns
Days to 50% silking	1.25	4.86	3.89*
Number of leaves	0.54	3.01	5.57*
Plant height	283.98	246.87	0.87 ns
Ear height	218.52	424.35	1.94 ns
Husk cover	0.063	0.201	3.19*
Grain yield	531478	2357567	4.44*

* significant (P<0.05); ns non significant (P>0.05).

Reaction to diseases, husk cover

The two populations showed very mild infection (score 1). Husk cover was excellent in PTMB3 and intermediate in DMRESRW. A good husk cover confers resistance to the maize weevil *Sitophilus zeamais* (Meikle *et al*., 1998, Demissie *et al*., 2008).

Grain yield components

PTMB3 had a number of ears per plant significantly higher than or not significantly different from that of DMRESRW. For number of grains per ear, the two populations were not significantly different. One thousand grain weight of DMRESRW was significantly higher than that of PTMB3 or not different from it. Variations with location and year are probably due to genotype × environment interaction.

Grain yield

DMRESRW gave a grain yield significantly higher than that of PTMB3 at Abomey-Calavi. No significant difference was noted at Abomey. Variations with location and year may be caused by genotype × environment interaction. That interaction was significant in the first year as shows Table-5. Growing conditions (especially soil fertility) were favourable at Abomey-Calavi and unfavourable at Abomey. That may explain higher yields obtained at Abomey-Calavi. The results suggest:

- the potential grain yield of DMRESRW is probably higher than that of PTMB3
- the two populations may not be significantly different for grain yield in unfavourable growing conditions.

Harvest index

PTMB3 harvest index was significantly inferior to that of DMRESRW. It is, however, similar to the harvest index reported by authors such as Yamaguchi (1974), Goldsworthy *et al*. (1974), Bjarnason *et al*. (1985) and Abadassi (2001) for several tropical maize varieties.

Table-6. Pooling analysis for years at Abomey-Calavi.

Trait	Pooled error MS	Population × year interaction	
		MS	F
Days to 50% pollen-shed	1.49	7.55	5.07*
Days to 50% silking	0.70	8.81	12.59**
Days to 50% maturity	1.49	7.93	5.32**
Number of leaves	1.12	2.22	1.98 ns
Ear height	203.56	629.01	3.09 ns
Number of ears per plant	0.0031	0.0182	5.87**
Grain yield	510795	121167	0.24 ns

* significant (P<0.05); ** highly significant (P<0.01); ns non significant (P>0.05).

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CONCLUSIONS

The traditional population PTMB3 appeared significantly later than the improved population DMRESRW in southern Benin. It had greater plant and ear heights. The two populations were very mildly infected by diseases. Husk cover was excellent in PTMB3 and intermediate in DMRESRW. PTMB3 had a grain yield significantly lower than that of DMRESRW in favourable growing conditions and not significantly different from it in unfavourable growing conditions. DMRESRW had a harvest index significantly higher than that of PTMB3. The type of grain of PTMB3 (small white grain easy to grind) is highly appreciated by consumers in Benin at the opposite of the big white difficult to grind grain of DMRESRW.

PTMB3 appears, then, better than DMRESRW for husk cover and grain quality whereas DMRESRW is better than PTMB3 for earliness, reduced plant and ear heights, grain yield in favourable growing conditions, and harvest index. The two populations need to be improved: PTMB3 for earliness, reduced plant and ear heights, grain yield and harvest index; DMRESRW for husk cover and grain quality.

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