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Comparison of growth and yield components of five maize varieties in Ibadan, South west Nigeria

F.B Anjorin and D. J. Ogunniyan

Institute of Agricultural Research and Training, Awolowo University, P.M.B. 5029, Moor Plantation, Ibadan, Nigeria.

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ABSTRACT

Trials were carried out using five maize varieties in Ibadan, Oyo state Nigeria in 2010 and 2011 maize cropping seasons. The varieties were planted in a randomized complete block design of three replicates. The objective was to evaluate the relationship existing among various growth and yield components as they contribute to grain yield. The result showed that varieties differed significantly in days to 50% flowering, field weight and number of kernel per cob (P<0.05), leaf area, ear length and 1000 grain weight (P<0.01), plant height and grain yield/ha (P<0.001). ART98-SW5OB and Obatanpa were superior in almost all the agronomic traits evaluated while ART98-SW6 OB was least in plant height and produce flowers earlier than the other varieties. Years, variety and years of evaluation interaction were however not significantly different. Ear length correlated positively and strongly with plant height and number of kernels per cob (P<0.001). Plant height and other agronomical traits were positively associated with grain yield except days to 50% flowering and numbers of kernel per cob. Growth and yield components are related in one way or the other; hence selection for secondary yield traits that correlate positively with primary yield components is fundamental to the overall grain yield development in maize.

Introduction

Maize (Zea mays L.) is an important crop in many parts of the developing world. It occupies the third place after wheat and rice (FAOSTAT, 2010). Maize is the most extensively distributed cereal crop been adapted to a wide range of environments (Remison, 2005). It is an important crop in many parts of the developing world where livelihoods of millions of resource poor farmers depend on maize cultivation (Upadhyay *et al*., 2008).

Various plant traits contribute directly or indirectly to grain yield in maize, such agronomic traits include: days to flowering, days to silking, tassel branches, plant height, ear height, leaf length, leaf width, leaf area, ear weight, grain moisture, kernel number per row and 1000 kernel weight (Malik *et al*., 2005).

The contributions of various parts of maize plant to grain yield had been observed by several authors. Leaf growth was observed as an important component influencing light interception, crop growth and yield in cereal (Gallagher and Biscoe, 1978) as final yield of dry matter has been shown to be proportional to the total amount of radiation intercepted by crop during the growth period (Scott and Jaggard, 1978). Plant height, cob length, ear height, number of rows per cob, number of kernel per cob, weight of 1000 kernels were observed to be positively correlated with grain yield (Kurmar and Kurmar, 1997; Selvaraj. and Nagarajan, 2011). Grain yield is largely determined by many factors which are genetic and fluctuating environmental conditions which usually made direct selection for yield to be unreliable (Talebi *et al*., 2007). Deductions from correlation coefficient analysis are important useful tool that could be used successfully in selecting traits influencing yield (Menkir, 2008). Genetic correlations between agronomic traits and secondary traits can be used to improve primary ones that are poorly inherited or cannot be measured easily (Malosetti *et al*., 2008). The objective of this study was to evaluate the relationship existing among various growth and yield components of five maize varieties as they contribute to grain yield.

Materials And Methods

Five open pollinated maize varieties (ART98-Sw5OB, ART98-Sw6 OB, Tzpb, Ile1 ob and Obatanpa) were planted in 2010 and 2011 maize cropping seasons at the Institute of Agricultural Research and Training, Ibadan, Nigeria. Land preparation was done mechanically by ploughing, harrowing, ridging. Soil physico-chemical soil analysis indicated that the Soil pH was 6.09%, Organic matter 1.33%, Organic N 0.096 and P (ppm) 7.36, Sand 75.9 % Silt 15.5% and Clay 7.8%. Seeds were sown at two seeds per hill in six rows of 4.5 x 4m at spacing of 75 x 50 cm to obtained plant population of 53,333 stands per hectare.

Design: Design was a randomized complete block design (RCBD) with three replicates. N.P.K fertilizer was applied 2 weeks after planting and urea was applied 2 weeks to tasselling at the rate of 100 kg ha^{-1}. Weed control was achieved using pre emergence herbicides and rouging. The dry maize cobs were harvested and shelled after sun drying and grain yield taken after adjustment to 13 % moisture levels.

Data taken: Growth and yield data were taken on five selected tagged plants of the two middle rows. These include days to 50% flowering, plant height (taken with meter rule from the base of the plant to the tip of the tassel), ear height, leaf area (obtained by the formula, Leaf Area = L x B x 0.25 (Olaoye *et al*., 2009), where L = length of leaf and B=broadest width of the leaf), field weight per plot, kernel number per cob, cob length, 1000 kernel weight and total grain yield per hectare.

Data Analysis: Data collected were analyzed using SAS version 8 to compute analysis of variance (ANOVA) and significant differences were determined at probability levels of 5, 1 and 0.1%. Significant interactive means were separated

Tele:
E-mail addresses: folakeawoeyo@yahoo.com

using standard error at P<0.05, while differences in character means were determined at P<0.05 using the Least significant difference. Average correlation among the agronomic traits was obtained using Pearson Correlation Coefficients.

Result and Discussion

Days to 50% flowering

Years of planting, variety and years of planting interactive means were not significantly different. The varieties however differ significantly in the number of days to flowering at P< 0.05. TZPB and Obatanpa had the highest days (54.50 and 55.16) to flowering and were not significantly different from each other while ART98-Sw6OB flowered earlier with 52.33 days (Tables1&2). Table 3 presented the associations existing among the agronomic traits of this study. Flowerings date was significantly positively correlated with plant height, this agreed with the findings of Troyer and Larkins (1985) who earlier observed that internode extension terminates at floral initiation and that early flowering maize genotypes are usually characterized with short plant heights. Flowering date was also significantly positively associated with ear length and number of kernel per cob, but it was positively and non significantly associated with ear height but non significantly negatively associated with leaf area, number of leaves, 1000 grain weight and grain yield as presented. In this study flowering date was observed to be negatively correlated with grain yield (Table 3).This findings agreed with earlier work of Lee *et al*., (1986) and Tyagi *et al*., 1988). This however contradicts the reports of Kurmar and Kurmar, (1997) and Nawar *et al*., (1998).

Plant height

Years of planting, variety and years of planting interactive means were not significantly different. The varieties however differed significantly at (P<0.01) in plant height (Table 1).Variation in plant height observed among the varieties could be attributed to differences existing in the genetic composition of the maize varieties (Ali *et al*., 2006).

ART98- Sw5 OB and Obatanpa had the highest height of 185.16 cm and 177.50cm respectively and were not significantly different from each other while ART98-Sw6 OB had the lowest height of 144.66cm (Table 2). Plant height correlated positively though non significantly with harvest field weight, number of kernel per cob, ear length, leaf area and number of leaves per plant (Bello *et al*., 2010; Khayatnezhad *et al*., 2010; Reddy *et al*., 1990) (Table 3). However plant height was strongly positively correlated with flowering date and grain yield. The length of vegetative phase and dry matter yield in maize has been reported to be positively associated with the size of the plant (weight, height, e.t.c) while taller hybrids produce higher dry matter (Begna *et al*., 2000). Increased plant height provides more green area for increased photosynthetic activities and more assimilate for grain filling (Haseeb-ur-Rehman *et al*., 2010). Nevertheless, the rate of translocation of assimilates to the kernels of shorter hybrids were found to be greater than those of taller ones.

Ear height

Ear height is an important yield determinant feature, the higher the ear of the main height the more the number of ears that can develop from the nodes beneath. In this study ear height was significantly different at P<0.05 (Table 1). ART98-Sw5OB had the highest ear height of 69.6cm; ART98-Sw6OB and Obatanpa were least and were not significantly different from each other (Table 2). Ear height correlated positively though non significantly with plant height (Hasen, 1976), harvest field weight, leaf area and grain yield (Table 3). Ear height correlated significantly positively with number of leaves per plant and correlated non significantly negatively with 1000 grain weight (Salama *et al*., 1994, but significantly negatively correlated with number of kernel per cob according to (Sadek *et al*., 2006). In this study ear height correlated non significantly positively with grain yield, similar association with grain yield had been earlier reported by Khakim *et al*., (1998).

Number of leaves

The number of leaves produced per plant was significantly different among the varieties at P<0.05(Table1).Varietal differences observed in the number of leaves produced among different maize genotypes had been earlier reported by Victor *et al*., (2011). ART98-Sw5OB and TZPB had the highest number of leaves of 13.61 and 13.00 per plant respectively and were not significantly different from each other while Ile1ob had the least value of 12.16 leaves (Table 2). The number of leaves produced per plant correlated positively and significantly with ear height, positive and non significantly with plant height, field weight. It however correlated significantly negatively with number of kernel per cob and ear length (Table 3).

Leaf area

Leaf area per plant differed significantly among the varieties at P<0.05 (Table 1). Ile1ob, ART98-Sw5OB and Obatanpa had the highest values of 606.04cm^2, 612.07 cm^2 and 571.81 cm^2 respectively and were not significantly different while Tzpb had the least value of 511.42 cm^2 (Table 2). Leaf area was significantly positively correlated with field weight and positively not significantly correlated with ear height, plant height, number of kernel per cob and cob length but negatively correlated with flowering date and significantly negatively correlated with number of leaves per plant (Table 3).

Ear length

Ear length differed significantly among the varieties. Ile1ob and Obatanpa had the maximum ear length of 14.60cm and 14.80cm and were not significantly different from each other. Sw6 had the shortest ear length of 12.88cm. In this study ear length was strongly and positively associated with plant height and number of kernels per cob (Selvaraj and Nagarajan, 2011). Ear length also correlated positively though non significantly with leaf area (Haqqani and Pundey, 1994), 1000 kernel weight and grain yield (Sadek *et al*., 2006). Higher leaf intercepts more light and efficient photosynthetic system played an important role for the development of lengthy cobs (Gardner *et al*., 1985). Ear length was non significantly negatively correlated with ear height and number of leaves per plant.

Field weight

Field weight of the harvested weight differed significantly among the varieties (Table1). Ile 1ob had the highest field weight of 3.5 kg while Obatanpa had the least value (2.63kg) (Table 2)

Fresh weight was significantly positively correlated with leaf area and non significantly positively correlated with 1000 kernel weight, grain yield, number of leaves per plant, ear length, ear height and plant height (Golam *et al*., 2011).

Number of kernel per cob

Number of kernel per cob varied significantly among the varieties at P<0.05 (Table 1). Obatanpa was superior in number of kernels per cob (418.67) while ART98-Sw6OB was least 351.33(Table 2). Number of kernel per cob correlated positively with ear length, and non significantly with leaf area and 1000 grain weight. However negative correlation was observed between number of kernel per cob and number of leaves per plant and grain yield in this study, this contradicted the finding of Saha and Mukherjee, 1985).

Table 1: Pooled ANOVA of Growth and Yield components of five maize varieties grown in 2010 and 2011 in Ibadan

Traits	Variety	Year	Variety × Year	Error	Mean	Coefficient of variation
Days to tasselling	7.91*	1.63	0.21	18.93	53.83	1.90
Plant height	1588.21***	8.53	3.95	173.03	167.93	7.83
Ear height	134.0	27.07	10.15	73.47	62.15	13.79
No. of leaves	0.96	0.00	0.00	0.41	12.73	5.08
Leaf area	9927.8**	0.00	0.00	2156.42	571.98	8.11
Kernels/cob	4571.07*	791.56	367.68	1005.98	384.14	8.25
Ear length	3.73**	0.00	0.00	0.59	13.97	5.49
Field weight	0.88*	0.00	0.00	0.21	15.19	0.46
1000-grain weight	1029.70**	197.23	30.86	168.34	312.03	4.15
Grain yield	4.27***	0.58	0.28	0.45	7.81	8.65

* ** *** denote effects significant at 5, 1 and 0.1 percent probability level respectively.

Table 2: Mean values for growth and yield components traits of five maize varieties grown in Ibadan

Variety	DYF	PLH (cm)	EHT (cm)	No LVS	LA(cm^2)	K/C	ELT (cm)	FW(kg)	1000GW (g)	GY (t/ha)
Ile-1OB	54.16^{ab}	174.00^{ab}	59.33^{ab}	12.16^{b}	606.04^{a}	405.37^{ab}	14.60^{a}	3.53^{a}	302.88^{bc}	7.14^{c}
ART98 SW 5OB	53.00^{bc}	185.16^{a}	69.60^{a}	13.16^{a}	612.07^{a}	366.95^{bc}	14.06^{ab}	3.38^{ab}	314.63^{b}	9.19^{a}
ART98 SW6 OB	52.33^{c}	144.66^{c}	59.00^{b}	12.83^{ab}	558.40^{ab}	351.33^{c}	12.88^{c}	2.84^{bc}	312.53^{bc}	7.22^{bc}
TZPB	54.50^{a}	158.33^{bc}	64.00^{ab}	13.00^{a}	511.42^{b}	378.40^{bc}	13.51^{bc}	2.88^{bc}	298.06^{c}	7.48^{bc}
Obatanpa	55.16^{a}	177.500^{a}	58.70^{b}	12.50^{ab}	571.81^{a}	418.67^{a}	14.80^{a}	2.63^{c}	332.05^{a}	8.00^{b}
LSD	1.24	15.95	10.39	0.78	56.32	38.47	0.93	0.56	15.73	0.81

Values with same alphabets in down the columns are not significantly different at $P \leq 0.05$.

DYF= days to 50% Flowering, PLH=plant height, EHT= Ear height, No LVS=number of leaves, LA= Leaf area, K/C=Kernel per Cob, ELT= Ear length, FWT= Harvest fresh weight, 1000 GW=1000 Grain weight and GY= Grain yield. LSD=Least significant difference.

Table 3: Correlation among various growth and yield traits of five maize varieties

Trait	DYF	EHT	PHT	FWT	K/Cob	ELT	No LVS	LA	1000GW
EHT	0.03								
PHT	0.46*	0.23							
FWT	-0.18	0.13	0.35						
K/Cob	0.57**	-0.40*	0.34	-0.15					
ELT	0.46*	-0.23	0.60***	0.00	0.70***				
NoL	-0.09	0.50**	0.23	0.01	-0.43*	-0.38*			
LA	-0.20	0.18	0.08	0.53**	0.06	0.18	-0.44*		
1000GW	-0.05	-0.18	-0.05	0.06	0.23	0.00	0.28	0.53*	
GY	-0.03	0.25	0.54**	0.12	-0.05	0.15	0.04	0.33	0.14

* ** *** denote effects significant at 5, 1 and 0.1 percent probability levels respectively.

DYF=50% days to Tasselling, PHT=plant height, EHT= Ear height, NOLVS=number of leaves and LA= Leaf area, K/C=Kernel per Cob, ELT= Ear length, FWT= Harvest fresh weight, 1000 GW=1000 grain weight and GY= Grain yield.

Weight of 1000 grains

Weight of 1000 grains differed significantly among the varieties (Table 1). Obatanpa had the highest 1000 grain weight of 332.05g while Tzpb had the least weight of 298.06 (Table 2). Weight of 1000 grains weight was significantly positively correlated with leaf area but non significantly positively correlated with field weight, number of kernel per cob, ear length, number of leaves per plant and grain yield.

Conclusion

Plant height is a very important growth trait in determining grain yield because of its strong positive association with grain yield. It is also of importance to note that the short maize varieties flower earlier than the tall varieties and were also characterized with short length ears. ART98-SW5OB and Obatanpa were superior in grain yield and most of the traits evaluated while Ile 1ob had lowest grain yield. Indirect selection for and improvement of secondary yield traits like plant height, ear length, late flowering genotypes amidst other would enhance increased grain yield.

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