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Maturity Groups and Phenology of Maize in a Rainforest Location

Oluwaranti A.*, M. A. B. Fakorede and F. A. Adeboye
Department of Crop Production and Protection,
Obafemi Awolowo University, Ile-Ife, Nigeria.
*Corresponding Author's Email: boluwaranti@yahoo.com

Abstract – **Maturity period is one of the essential characters looked out for by farmers before a maize variety is selected for cultivation. There is need to understand the cause of varietal differences for traits associated with maturity at the seedling and vegetative stages of growth in the early and late seasons of the rainforest agro-ecology. Therefore the objectives of this study were to determine the relationship between maturity groups and their vegetative and reproductive traits, and identify the best trait that determines maturity in maize.**

Eight maize varieties consisting of 2 varieties per maturity group were planted during 2011 early and late cropping seasons. Data were collected on emergence counts 5, 7, and 9 days after planting (DAP) and dry matter accumulation from 9 DAP to 39 DAP. Data were also collected on flowering, vegetative, reproductive and yield component traits. Emergence percent, emergence index, emergence rate index, growth rate, relative growth rate and yield were calculated from the data collected.

Maturity effect was highly significant (P = 0.01) for seedling, vegetative and growth rate traits except emergence rate index, relative growth rate. Significant maturity effect (P = 0.05) was also observed for grain yield. There were no significant replications and variety within maturity effects. Speed of emergence (EI) of the intermediate to late maturing varieties is the fastest when compare to the early and extra-early maturity groups. Emergence %, Emergence Index, growth rate and relative growth rate had positive correlation with yield. The study indicated that intermediate to late maturity groups emerged faster than the extra-early and early maize maturity groups. Late and intermediate maturity groups had higher dry matter accumulation in comparison to extra-early and early maturity groups. It was concluded in the study that emergence %, emergence index and days to anthesis and/or silking contributed significantly to maturity classification in maize unlike growth rate (GR), relative growth rate (RGR).

Keywords – **Maize, Maturitygroup, Phenology, Rainforest.**

I. Introduction

Maize (*Zea mays* L.) is one of the most important cereal crops in the world which is recognized as a leading commercial crop of great agro-economic value (Muhammad *et al.*, 2003).It is the world's best adapted crop and the third most important crop after wheat (T*riticumaestivum* L.) and rice (*Oryzasativa* L.). Maize is one of the most widely accepted and cultivated crops under rain-fed condition throughout West and Central Africa (CIMMYT, 1988). Maturity period is one of the essential characters looked out for by farmers before a maize variety is selected for cultivation (Mtambanengwe *et al.*, 2007). Extra-early maturing variety (80-85 days to maturity) eaten as fresh or green maize at about 60 days after planting (DAP) can be planted at the most early period of the planting season and harvested almost twice within the season. Early maturing variety (90-95 days to maturity) eaten fresh at about 65 DAP can be planted early and be harvested before the end of the season. Intermediate maturing variety (105 -110 days to maturity) does not require a full season to mature, and tends to produce higher yield than early maturing varieties. Late maturing variety (115 – 120 days) needs to be planted very early in the season, often with the first rains and gives the highest yield under favourable conditions.

Maize phenology is generally divided into vegetative (from emergence to tasseling according to the number of fully expanded leaves, n, designated byVn) and reproductive (from silking to physiological maturity according to the degree of kernel development, designated by Rn) stages (Hanway, 1971; Ritchie *et. al.*, 1992)

Maize phenology is the quantitative and qualitative description of a plants life cycle from seed to the start of another life cycle of maize. Qualitative aspects of phenology include morphological development and the partitioning of the life cycle into distinct stages of development, such as seedling emergence, flowering, and physiological maturity. Quantitative aspects of development include rate of development and the duration of the life cycle. Phenology differs among plant species and varies among cultivars within a species (Tollenaar 1990; Vegas and Sadras 2003)

The relationship of the seedling and vegetative periods with maturity groups in maize is yet to be determined which has been hypothesized to cause the crop's maturity difference. The integrated influence of seasons and nitrogen fertilization on maize growth rates in terms of phenology based growth analysis is not well understood (Naresh and Singh, 2001). Considering the thousands of maize variety available for farmers depending on suitability and choice, the farmer's main concern is to be able to plant as many times as possible within a season. Furthermore, different maturity groups of maize have different quality that makes them acceptable as a variety of maize.

There is need to understand the cause of varietal differences for traits associated with maturity at the seedling and vegetative stages of growth in the early and late seasons of the rainforest agro-ecology. Therefore the objectives of this study were to determine the relationship between maturity groups and their vegetative and reproductive traits, and identify the best trait that determines maturity in maize.

II. Materials and Methods

The study was carried out during the2011 early and late cropping seasons at the ObafemiAwolowo University Teaching and Research Farm (OAU T & RFarm). Eight maize varieties of different maturity groups were planted. Plantings were done on the 28th of June and 2nd of September, 2011. Each variety was sown in 5m row length by six rows plot, and the plots were laid out in a randomized complete block design with 4 replications. The rows were 75cm apart and 50cm within row. Primextra which is a pre-emergence herbicide was sprayed on the field one day after planting. NPK fertilizer was added 3 weeks after planting at the rate of 120kg /ha of N, 60kg/ha of P and 60kg/ha of K.

Data Collection and Statistical Analysis

Emergence counts were taken 5, 7 and 9 days after planting (DAP). Samplings for dry matter accumulation or dry weight began 9 DAP when 5 seedlings were removed from the border rows of each plot. This was done at 5-day interval from 9 to 39 DAP. The samples were dried in the oven to constant moisture content at 80°C and the dried samples were weighed and the values were recorded for each variety on plot basis. Grain filling analysis was only carried out, starting from 5 to 40 days after silking by taking 5 ears per plot. The fresh weight of the 5 ears was taken before the samples were oven dried to constant moisture content at 80°C and the dried samples were weighed for each plot. Data were also collected on days to 50% tasseling, anthesis, and silking, plant and ear heights, ear number and weight per plot, ear length, ear diameter, kernel row number, shelling percentage, kernel moisture and plant aspect.

From the data collected, the seedling vigor of each variety was determined by taking the following data: Emergence percentage (E%), emergence index (EI), and emergence rate index (ERI) which were calculated as follows:

$$E\% = \frac{(\text{Emerged seedling at 9 DAP})}{\text{Seed planted}} \times 100$$

$$EI = \frac{\sum(\text{Emerged plants in a day})(\text{DAP})}{\text{Emerged plants 9 DAP}}$$

$$\text{ERI} = \frac{\text{EI}}{\text{E\%}} \text{ (expressed on a 0 to 1 scale)}$$

Growth rate (GR) and relative growth rate (RGR) were obtained using dry matter per plant (W1 to W7) from the following linear regression models:

$W = a + bt$

$W_1 = a_1 + b_1 t$

Where W = dry weight per plant

$W_1 =$ log dry weight

t = time in days after planting (DAP)

a and $a_1$are intercepts of the regression models

b and b_1 = regression coefficients = GR and RGR, respectively

Data collected were subjected to Analysis of variance (ANOVA) and Pearson correlation analysis using Statistical Analysis Software package (SAS, 2003). Test of statistical significance included Least Significant Difference (LSD) at 0.05 level of probability.

III. Results and Discussion

Analyses of variance revealed highly significant (P = 0.01) maturity effects for all seedling, vegetative and growth rate traits except emergence rate index and relative growth rate in the early season trial (Table 1). Maturity effect was also significant (P = 0.05) for grain yield (Table 1). Maturity means squares were the largest source of variation for these traits. Maturity groups highly affected the number of seedlings that emerged and the speed with which they emerged, growth rate, flowering traits, vegetative traits and grain yield.

Table 1: Mean squares from the analysis of variance of seedling, vegetative traits and yield of 8 maize varieties evaluated at the ObafemiAwolowo University Teaching and Research Farm during the early cropping season of 2011

Traits	Rep (d.f. = 3)	Maturity (d.f. = 3)	Variety/maturity (d.f. = 28)	CV%
E%	262.12	2410.37**	65.34	17.94
EI	2.12	19.41**	0.52	17.68
ERI	4.00×10^{-4}	3.5×10^{-3}	5.4×10^{-3}	0.61
GR	1.78	10.45**	5.82	28.12
RGR	5.00×10^{-5}	1.00×10^{-2}	4.00×10^{-5}	31.87
TS	7.62	133.87**	5.41	6.15
PS	10.95	105.87**	6.23	6.10
SK	10.91	96.58**	5.31	6.10
PHT	469.87	780.27**	38.62	9.09
EHT	124.17	419.96**	123.99	15.41
G/YLD	0.11	2.21*	0.47	50.52

*, ** significant at 0.05 and 0.01 levels of probability, respectively.

Where: E% - Emergence percent, EI - Emergence Index, ERI - Emergence Rate Index, GR - Growth Rate, RGR - Relative Growth Rate, TS - Days to 50% tasseling, PS - Days to 50 % Pollenshed, SK - Days to 50% Silking, PHT - Plant Height, EHT - Ear height, G/YLD - Grain Yield.

The implication of significant maturity group effect on flowering, vegetative traits and yield is that the time for the expression of these traits by the genotypes vary with maturity groups. As reported by Vinaet. al. (2004), maize plant will produce maximum yield on a per stage

basisby optimum supply of nutrients and the maize plant needto be maintained under favorable environmental conditions (i.e., temperature, solar radiation, soil moisture).photosynthetic biomass (i.e., size of the factory) as corroborated by Vina*et. al.,* 2004

There were no significant replications and variety within maturity effects. This implies that different varieties within each maturity group were not different with respect to emergence, seedling, vegetative flowering and yield of the 8 maize varieties of different maturity groups.

Similar trend was observed from the late season trial (Table 2). Maturity group was highly significant for growth rate and relative growth rate. Therefore the rate of growth of different maturity group differs with respect to each other. There was no significant mean squares for varieties within maturity groups for growth rate or relative growth rate. Replication was not found to be significant with respect to all the emergence and growth rate traits. This further confirmed that number and rate of seedling emergence were greatly affected by maturity group which explains the phenological differences and similarities of maize with respect to maturity.

Emergence index which expresses the speed of emergence of seedlings is 6.9 for extra-early, 6.8 for early, 3.7 for intermediate, and 5.0 for late maturing varieties (Table 3).

Table 2: Mean squares derived from the analysis of variance of vegetative traits of four maturity groups from evaluated at the OAU T & R Farm, Ife during the late planting season 2011

Traits	Rep (d.f. = 3)	Maturity (d.f. = 3)	Variety/maturity (d.f. = 28)	CV%
E%	143.12	278.03**	53.53	17.25
EI	27.40	13.17**	2.00	23.83
ERI	49.24	1.01	1.09	15.25
GR	0.08×10^{-1}	$0.65 \times 10^{-1**}$	$0.37 \times 10^{-1**}$	12.6
RGR	0.08×10^{-4}	$1.08 \times 10^{-4*}$	1.9×10^{-5}	8.05

*, ** significant at 0.05 and 0.01 levels of probability, respectively.

Table 3: Means of seedling, vegetative traits and yield of 4 maturity groups of maize evaluated at the Obafemi Awolowo University Teaching and Research Farm during the early cropping season of 2011

	Maturity groups				
Traits	**Extra-Early**	**Early**	**Inter**	**Late**	**$LSD_{0.05}$**
E%	77.1	75.1	40.5	55.6	10.0
EI	6.94	6.80	3.70	5.00	1.03
ERI	9.00	9.00	8.83	9.00	0.01
GR	3.81	5.68	4.76	6.45	1.51
RGR	0.16×10^{-1}	0.24×10^{-1}	0.016×10^{-1}	0.19×10^{-1}	0.62×10^{-2}
TS	54.6	55.3	61.8	62.3	3.2
PS	56.5	57.6	62.6	63.9	3.5
SK	57.9	58.8	63.4	65.0	3.1
PHT	133.5	141.3	142.2	157.1	13.6
EHT	53.5	55.5	58.3	70.1	10.5
YLD	1.0	1.3	1.8	2.2	0.8

This indicated that the speed of emergence of the intermediate to late maturing varieties is the fastest when compare to the early and extra-early maturity groups. Unfavorable conditions occurring between crop emergence and leaf development can also be identified to limit the size of the leaves and thus the amount of Maturity group was significant with respectto grain filling rate and grain yield while it wasn't significant for the relative grain filling rate. Therefore the amount of nutrient material available does not determine the rate at which various maturity group fill their grains when compared to each other. This study demonstrated that Emergence % correlated positively with Emergence Index (Table 4). Emergence % and emergence index are positively and negatively correlated with relative growth rate respectively, while emergence rate index was negatively correlated with growth rate.

Table 4: Pearson correlations among emergence traits, growth rate, relative growth rate and grain yield of 8 maize varieties of different maturitygroups evaluated at the Obafemi Awolowo University Teaching and Research Farm during the early cropping season of 2011.

	E%	EI	ERI	GR	RGR
E%					
EI	1.00**				
ERI	0.06	0.03			
GR	-0.23	-0.22	-0.72**		
RGR	0.47	-0.46	-0.12	-0.87**	
G/YLD	0.55*	0.55*	-0.42	0.67**	0.93**

This result corroborate the findings of Fakorede and Agbana (1983) which observed that maize varieties with high Emergence % and low values for emergence index, and varieties with high emergence rate index accumulated dry matter at a higher rate than varieties with slow emergence. This also indicated that varieties that emerged rapidly showed high rate of dry matter accumulation. Emergence %, Emergence Index, growth rate and relative growth rate had positive correlation with yield, indicating that vigorous growth at seedling and vegetative stages of development have direct effect on grain yield of maize varieties evaluated in this study.

The study observed that E%, EI and RGR were effective indicators for seedling vigor in maize, ERI and GR were not effective because they were influenced more by the environment than the genetic constitution of the seedling

IV. Conclusion

In conclusion, intermediate to late maturity maize maturity groups were observed to emerge faster than the extra-early and early groups. Intermediate and late maturity groups have higher dry matter accumulation in comparison to extra-early and early maturity groups. Dry matter accumulation could be a useful parameter in the determination of days to an thesis and silking. Emergence %, emergence index and days to an thesis and/or silking contributed significantly to maturity classification in maize unlike growth rate (GR), relative growth rate (RGR).

References

[1] CIMMYT, 1988. Maize production regions in developing countries. *CIMMYT Maize program report.* CIMMYT ElBatan, Mexico, 138.

[2] Fakorede M. A. B. and Agbana S.B. (1983). Heterotic effects and association of seedling with mature plant characteristics and grain yield in some maize cultivars *maydica*XXVIII 327 – 338.

[3] Hanway, J. 1971. How a corn plant develops. *Spec. Rep.* 48. Iowa State Univ., Ames.

[4] Muhammad R., Abid H. andMahmood T., 2003. Growth analysis of hybrid maize as influenced by planting techniques and nutrient management. *International Journalof Agriculture & Biology* 5(2): 1560–8530.

[5] Mtambanengwe F., Jones J. and Kosina P. (2007) Choosing the right maize variety.*International Rice Research Institute*(IRRI)

[6] Naresh K. S. and Singh C. P., 2001. Growth analysis of maize during long and short duration crop seasons: influence of nitrogen source and dose. *Indian* J. *Agric. Res.,* 35(1): 13-18.

[7] Ritchie, S.W., J.J. Hanway, and Benson G.O., 1992. How a corn plant develops. Spec. Rep. 48 (rev.). Iowa State Univ. Coop. Ext. Serv., Ames.

[8] SAS Institute, 2003. SAS user guide; Statistics SAS Inc., Cary, N.C, USA SAS 9.3

[9] Tollenaar M., 1990. The influence of developmental patterns on grain yield of maize. *Crop Science*30: 181-193.

[10] Vega C. R. C. and Sadras V. O., 2003. Size-dependent growth and the development of inequality in maize, sunflower and soybean. *Annals of Botany* 91(7): 795-8

[11] Vina A., Giitelson A. A., Rundquist D.C., Keydan G., Leavitt B. and Schepers J., 2004. Monitoring maize (Zea mays L.) phenology with remote sensing. Agron. J. 96:1139-1147