SEASONAL EFFECT OF CONTROLLED HAND – POLLINATED MAIZE ACCESSIONS ON THE GROWTH AND GRAIN YIELD IN RAIN FOREST AGRO-ECOLOGY OF NIGERIA

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ABSTRACT
A field experiment was carried out during the early and late 2015 planting seasons to investigate the effect of season and accession on the performance of controlled hand- pollinated maize in Owerri, rain forest Agro-ecology of Nigeria. The Experiment was conducted at the research farm of Federal University of Technology, Owerri (Lat. 05^0, 27" and 50,23" N, and Long. 07^0 O2" and 40, 33" E). The treatments consist of Early and Late planting seasons and three Maize accessions. The 2 x 3 factorial experiment with six treatment combinations was laid out in randomized complete block design (RCBD) and replicated four (4) times. Data collected were subjected to Analysis of Variance (ANOVA); and means were separated using lease significant difference (LSD) at 5% level of probability. Results indicates significant variation in the seasons. Plants hand-pollinated in early planting season showed superiority over late season plants in the yield traits. Significant differences were observed amongst the accessions in most of the parameters measured in the two planting seasons. Correlation studies show significant positive correlation between grain yield and cob weight, cob length, grain weight, number of grains per cob. This suggests the characters as an important selection index for maize yield improvement, which implies that selection to improve these traits could lead to simultaneous increase in grain yield.
Keywords: Maize season, accession, hand pollination, rain forest.

INTRODUCTION
A number of researchers have identified optimum time of planting for early and late season maize in the various ecological zones of Nigeria. Fajemisin (1985) reported mid-march to first week of April for forest zone and first to third week of April for derived-savanna; whereas Obi (1987) recommended August-September for the forest zone and mid July to end week of August for derived Savanna zone, for second season maize. Maize is influenced by temperature. Length of growing season; length of day; amount, distribution and efficiency of rainfall. Prolonged heat and drought during pollination period often result in desiccation of leaf tissue, pollen grains and poor seed setting (Obi, 1991).

Pollination success in Maize is critical to final yield. The number of Kernels set is largely determined near the time of pollination, and yield losses due to reduced kernel set at pollination cannot be regained. Controlled pollination is a key factor for successful crop improvement. It is performed to prevent unwanted cross pollination and resultant hybrids, and is essential in carrying out the required type of mating. In maize, controlled pollination could be achieved through hand pollination by the transfer of pollen from the tassel to the silk

The extent of success for controlled hand-pollination in maize could be determinate by weather situation of the environment. Carcova and Otegui (2001) observed poor seed set in maize at temperature above 38^0C, which they attributed to direct effect of high temperature and pollen desiccation. Westgate and Boyer (1986) findings suggest that heat stress which depends on the season decreases fresh grain yield and accelerates grain filling rate with increase in starch content and starch granule size. The study was conducted to determine the effect of season and accession on the performance of controlled hand-pollinated maize in Owerri, rain forest Agro-ecology of Nigeria.

MATERIALS AND METHODS
The research was conducted during the early and late planting seasons of 2015 at the Center for Agricultural Research and Extension (CARE) farm of Federal University of Technology, Owerri situate between Lat. 05^0, 27" and 50,23" N, and Long. 07^0 O2" and 40, 33" E at an attitude of 9/m above sea level in South-eastern Nigeria. The experimental site has a mean annual rainfall of 2300-2700mm and average minimum temperature of 33^0C with the month of March as the warmest month.

The treatments constitute of early and late planting seasons, and three maize accessions – Isiochi Maize, Ugboko Maize, Nwaba white obtained from Ebonyi State University germplasm bank. The 2 x 3 factorial experiment with Six treatment combinations was laid out in randomized complete block design (RCBD) and replicated four (4) times.

The experimental field was manually prepared and early planting down on 1st April 2015 while late planting was done in August, 2015. Plant spacing of 0.25m within row and 0.75m between rows was used. The seeds were planted three (3) per hole of about two (2) cm depth and later thinned down to one plant per hill, giving a theoretical plant population of 53,333 plants /ha.

Manual wedding was carried out as need be to keep weed pressure low. Split fertilizer application of NPK 15:15:15 was done at the rate of 400kg ha^{-1} at 2 and 8 WAP.

Controlled hand pollination of five desirable plants of each accession was carried out using tassel-bag procedure (Obi, 1991). Bagging of tassels designated as pollen donors was between 3pm – 4pm at 50% tassel shedding, and the ears were covered with shoot bags upon emergence and before the appearance of silk to minimize contamination. Selected plants were pollinated by 9.30am the next day and pollen bags used to cover the pollinated ears until harvest to avoid contamination. The cobs were harvested when the plant has completely senesced and has reached physiological maturity using black layer formation as an index of maturity (Baker, 1973).

Data of the mean value of the five measurements made on five plants per treatment plot per replicate were collected for the following traits, numbers of days to 50% emergence, days to 50% tasselling, days to 50% silking, days to physiological maturity, plant height, stem girth, leaf area index, cob length, cob weight, number of grains per cob, cob rows, 1000 seed weight, grain weight per cob, grain yield, and pollen weight. The data were subjected to analysis of variance using the, GenStat Release 10.3 De (PC windows) of 10 April, 2006. The fishers least significant difference (F – LSD) as described by Obi (2002) was used to detect significant difference between treatment means.

RESULTS AND DISCUSSION

The effect of season and accession on the growth traits of maize is presented in Tables 1 and 2. The result shows no significant difference among the accessions in both early and late planting seasons for the growth traits except in the tasseling and silking time where significant variation was observed. The accessions that tasseled first also silked first indicate the possibility of using it to estimate maturity. All the accessions were classified as made maturing based on tasselling and silking time. There was no significant accession x season interaction for the vegetative growth traits except in the percentage emergence.

Table 1: Effect of season and accession on plant emergence, tasseling, silking and number of days to physiological maturity of hand-pollinated maize.

Maize accession	Days to 50% emergence		Days to 50% tasseling		Days to 50% silking		Days to maturity	
	Early season	Late season	Early season	Late season	Early season	Late season	Early season	Late season
Isiochi	4	6	53.5	58.3	62.5	66.8	101.8	91.0
Ugboko	4	5	49.8	53.5	61.0	63.5	96.8	89.8
Nwaba white	5	5	55.3	60.3	64.0	68.3	102.5	89.8

LSD (0.05)				
Accession (A)	NS	1.4	1.9	NS
Season (S)	1	1.2	1.5	1.7
A x S	NS	NS	NS	NS

NS = Non significant F_test

Table 2: Effect of season and accession on plant height, stem girth, and leaf area index of hand-pollinated maize.

Maize Accession	Plant height (Cm)		Stem girth		Leaf Area index	
	Early season	Late season	Early season	Late season	Early season	Late season
Isiochi	195.8	136.4	7.6	5.5	3.3	2.7
Ugboko	195.5	134.8	6.6	5.4	2.3	2.2
Nwaba white	195.8	133.5	7.1	5.8	3.3	2.2

LSD (0.05)			
Accession (A)	NS	NS	NS
Season (S)	25.9	0.8	NS
A x S	NS	NS	NS

NS = Non significant F-test

Significant variation was observed in the yield characteristics (Tables 3 and 4) for the season and accession. However, no significant difference was recovered for accession x season interaction in cob weight, cob rows, number of seeds per cob, grain weight, and grain yield per hectare. The growth and yield characteristics performed significantly better in early planting season. The higher yield and yield components observed in the early planting season could be attributed to more favourable weather condition compared to the late planting season when there was sudden cessation of the rain during the reproductive phase (Table 5). The mean rainfall in early planting season was 15mm and was evenly distributed from May to June and this period corresponds with flowering and grain filling stages. However, in late planting season, there was early reduction in rainfall from 20mm to 15mm at the end of September and was not evenly Distributed. Water logging observed during this period could have resulted in the leaching of the soil nutrients and consequently yield reduction.

Table 3: Effect of season and accession on cob length, cob weight, number of grains per cob and cob rows of hand-pollinated maize

Maize accession	Cob length (cm)		Cob weight (cm)		No. of seeds/ cob		Cob rows	
	Early Season	Late season	Early season	Late season	Early season	Late season	Early season	Late season
Isiochi	11.8	11.9	93.2	67.5	275	262	12	10
Ugboko	12.6	6.3	75.1	20.8	250	119	10	14
Nwaba white	14.1	10.0	138.4	62.4	380	247	13	13

LSD (0.05)	Cob length	Cob weight	No. of seeds/ cob	Cob rows
Accession (A)	1.1	15.2	39.9	NS
Season (S)	0.9	12.4	32.3	NS
A x S	1.6	NS	NS	NS

NS = Non significant F_test

Table 4: Effect of season and accession on 1000 seed weight, grain weight/cob, pollen weight and yield (t) of hand – pollinated maize.

Maize accession	1000 seed wt(gm)		Grain weight/cob		Pollen weight (gm)		Grain yield /h (t)	
	Early season	Late season	Early season	Late season	Early season	Late season	Early season	Late season
Isiochi	418.0	464.0	71.4	42.6	2.2	1.7	1.865	1.497
Ugboko	489.0	326.0	52.9	6.1	2.1	0.9	1.500	0.685
Nwaba white	403.0	316.0	117.2	40.2	2.5	1.6	2.770	1.247

LSD (0.05)	1000 seed wt	Grain weight/cob	Pollen weight	Grain yield
Accession (A)	52.3	14.1	0.2	0.31
Season (S)	42.4	11.5	0.2	0.26
A x S	74.0	NS	0.3	NS

NS = Non significant F_test

Table 5: Weather observation in the study area in 2015 planting season

2015 MONTHS	TEMPERATURE WARMEST	COOLEST	PRECIPITATION RAINFALL (MM)
APRIL	32.1	23.3	11
MAY	31.3	23.0	14
JUNE	30.3	22.6	16
JULY	28.7	22.3	19
TOTAL	122.4	91.2	60
MEAN	30.6	22.8	15
AUG	28.7	22.4	19
SEPT	29.3	22.3	20
OCT	30.2	22.3	15
NOV	31.2	22.3	6
TOTAL	119.4	89.3	60
MEAN	29.85	22.325	15

Source: RSS weather statistics for Owerri, Imo State (Nigeria)

Even through the Crop yield was generally higher in the early planting season despite the slight higher minimum and maximum temperature, it demonstrations that though temperature is an important factor, it can only by inclusive of other factors and complex interaction of weather variables. This finding corroborates Salami (2016) work where he recorded longer Cob length in 2008 than in 2007 despite the fact that temperature during pollination was higher in 2008.

The Significant differences recorded in the yield characteristic among the maize accessions in the two seasons could be attributed to genetic and environmental effect. The results are in line with that of Grzesiak (2001) who also observed considerable genotypic variability among various maize genotypes. Simililarily, Igubal *et al*. (2011) and Shah *et al.* (2000) reported significant amount of variability for morphological traits among some maize accessions.

The correlation studies (table 6) indicate significant positive correlations between grain yield and cob weight (r = 0.995**) cob length (r = 0.841**), grain weight (r = 0.935**), number of grains per con (0.968**). This implies that selection to improve these traits could therefore lead to simultaneous increase in grain yield, though the effectiveness of this would depend on their heritability and genetic response of the particular trait to the environment. Pollen weight was positively correlated with days to tasseling, days to silking, stem girth, cob weights, cob length, grain weight, number of grain, and grain yield.

Table 6: Correlation of traits studied

	Days to Tasselling	Days to Silking	Plant Height	Stem Girth	Lead Area	1000 dry seed weight	Cob Weight	No of Rows	Cob Length	Grain Weight	No of Grains	Grain Yield	Pollen Weight
Days to Tasselling	1												
Days to Silking	.575	1											
Plant Height	-.550	-.191	1										
Stem Girth	-.321	-.015	.891**	1									
Lead Area	-.500	-.227	.901**	.843**	1								
1000 dry seed weight	-.338	-.266	.140	-.076	.286	1							
Cob Weight	.530	.211	.174	.242	.291	.054	1						
No of Rows	-.113	.058	.234	.357	.032	-.340	-.330	1					
Cob Length	.301	.186	.178	.105	.254	.449	.836**	-.460	1				
Grain weight	.544	.277	.146	.198	.289	.162	.962**	-.232	.820**	1			
No of Grains	.450	.229	.173	.200	.307	.140	.967**	-.441	.870**	.918**	1		
Grain Yield	.532	.225	.183	.255	.295	.031	.993**	-.371	.841**	.935**	.968**	1	
Pollen Weight	.410	.412	.330	.446	.396	.123	.521	-.014	.383	.572	.526	.513	1

CONCLUSION

The result of the study shows significant seasonal effect on the parameters studied. Plants hand-pollinated in the early planting season performed better in the yield characteristics than the late season plants. Significant differences were also observed amongst the accessions in most of the traits examined in the two planting seasons with Nwaba white accession performing best in cob weight and number of grains.

Correlation studies show significant positive correlation between grain yield and cob weight, cob length, grain weight, and number of grains per cob. Pollen weight was positively correlated with number of days to tasseling, number of days to silking, stem girth, cob weight, grain weight number of grain and grain yield. This suggests the characters as an important selection index for maize yield improvement.

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