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OPTIMAL TIME OF THE DAY FOR CONTROLLED MAIZE POLLINATION IN RAIN FOREST AGRO-ECOLOGY OF SOUTH-EASTERN NIGERIA

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ABSTRACT
Prevailing weather condition dictates the extent of success for controlled pollination in any given location for any crop and therefore is critical to final yield in Maize. A field experiment was conducted at the Centre for Agricultural Research and Extension (CARE) Farm of Federal University of Technology, Owerri (Latitude 050, 30" N, Longitude 070 O2" E) during the 2015 and 2016 planting seasons., to determine the optimal time of the day for controlled hand-pollination on maize performance. The treatments constitute three maize accessions and hand pollination done between 7.30 am to 9.30am; 10.00am to 12.00noon; and 12.30pm to 2.30pm. The 3 x 3 factional experiment was laid out in Randomized complete block design (RCBD) with four (4) replications. Data collected in the two years were pooled as there was no significant difference and thereafter subjected to analysis of variance (ANOVA), and means separated using-least significant difference (LSD) at 5% level of probability. No significant difference was observed in the growth and yield attributes with respect to time of day for hand pollination when averaged across the accessions. However, based on cob weight and number of grains, Nwoba white accession performed better than the other accessions between the pollination time of 7.30am to 9.30am. Therefore controlled hand pollination in maize could be carried out between 7.30am and 2.30pm, but between 7.30am and 9.30am could give a better performance.
Keywords: Maize, optimal-time, hand-pollination, rain-forest and accession

Introduction

Maize (*Zea mays L.*) is a versatile crop grown over a range of agro-climatic zones. The rainforest agro-ecological zone of Nigeria is the major supplier of eating green maize in Nigeria. The recent achievement by breeders in the development and release of superior maize varieties with higher yield potentials and better resistance to pests and diseases has played a central role in maize production increase in Nigeria. Nelson (2007) reported that pollination success in maize is critical to its performance and final yield. The number of kernel set is largely determined near the time of pollination, and yield losses due to reduced kernel set at pollination cannot be regained. Aldrich, *et al.* (1986), observed that poor seed set is more often associated with poor timing of pollen shed with silk emergence. Controlled pollination is a prerequisite for successful crop improvement. It is performed to prevent cross pollination and resultant unwanted hybrids and it is essential to making the particular types of mating required in crop breeding. In maize, controlled pollination is achieved through hand-pollination by the transfer of pollen from the tassel to the silk. The performance of hand pollinated crop is often influenced by the fluctuating environmental factors that prevail around the crop pollination such as temperature, light intensity, humidity, rainfall. These fluctuations could dictate the extent of success for controlled pollination in any given location for any crop. Pleasant (2000) reported that the best time for supply of fresh high-quality pollen is from mid to late morning after the morning dew has dried; and Jeff (2013) findings indicated that pollination is most effective when weather is perfect with June 21 as the ideal date to pollinate. Carcova and Otegui (2001) reported poor seed set in maize at temperature above 38^0C which he attributed to both direct effect of high temperature and pollen desiccation. Westgate and Boyer (1986) findings suggest that heat stress decreases fresh grain yield and accelerates grain filling rate, and increases starch content and starch granule size. The findings of Salami (2016) indicated differential responses for cob and seed traits when pollination was done between 10.00 and 12.00 hours in Ado – Ekiti, Nigeria. A situation in Nigeria where breeders and growers use a generalized time of the day more suitable to certain areas to hybridize, irrespective of the agro-ecology, could seriously affect the success and effectiveness of pollination and subsequent maize performance. Knowledge of the best time of the day for successful controlled maize pollination during hybridization by maize breeders will increase efficiency and higher productivity of the maize, and will also serve as a prelude for further research and improvement of the crop. Therefore, this experiment was conducted to determine the effect of time of hand-pollination on maize grain yield and ascertain the effect of accession on time of pollination and maize performance.

Materials and Methods

The experiments were conducted at the centre for Agricultural Research and Extension (CARE) farm of Federal University of Technology, Owerri – Latitude 05^0, 30" N and Longitude 07^0 02" E at an altitude of 91m above sea level in south – eastern Nigeria during the 2015 and 2016 planting seasons. 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 three maize accessions, Isiochi Maize, Ugboko Maize Nwaba white obtained from Ebonyi State University Germplam bank, and hand pollinations done between 7.30am to 9.30am; 10.00am to 12.00 noon; and 12.30pm to 2.30pm. The experimental design was 3 x 3 factorial in randomized complete block with four (4) replications. The planting was done on 1st of April in the two years at a spacing of 0.75m between the rows and 0.25m within the row to give a standard planting density of 53,333 plants ha^{-1}. The seeds were planted three per hole of about 2cm depth and later thinned down to one per hill. Manual weeding was done 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 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 a day before pollination. The ears were covered with shoot bags upon emergence and before the appearance of silk to minimize contamination. The pollen was used to pollinate the selected plants within each of the designated time of day. The cobs were harvested piece meal 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 at harvest for the following traits, cob length, cob weight, cob rows, number of grains per cob, 1000 seed weight, grain weight per cob, grain yield, and pollen weight. Data collected in the two years were pooled as there was no significant difference and thereafter subjected to analysis of variance using the GenStat Release 10.3 De (pc/window 7) of 10 April, 2006. The Fisher's least significant difference (F-LSD) as described by Obi (2002) was used to detect significant difference between treatment means.

Results and Discussion

Results in Tables 1 and 2 show significant variation in the maize accessions for cob length, cob weight, number of grains per cob, 1000 seed – weight, grain weight per cob, grain yield, and pollen weight. Nwaba white produced the longest cob 14.1cm, highest cob weight of 138.4gm, number of grins per cob (380), grain weight (117.2gm), grain yield (2.770 t/ha), pollen weight (2.5gm) whereas Ugboko maize produced the shortest cob (6.3cm), least cob weight (20.8gm), least number of grains per cob (229), least grain weight (52.9gm) least grain yield (1.500t/ha) and least pollen weight (2.0gm). The significant variation observed among the maize accessions for the traits measured could be attributed to genetic makeup and higher adaptation to the prevailing environmental conditions. The results are in line with that of Grzesiak (2001), who also observed considerable genotypic variability among various maize genotypes. Similarly, Sokolove and Guzhva (1997) reported pronounced variation for different morphological traits among inbred lines. Shah *et al.* (2000) and Igubal *et al*. (2011) also reported significant amount of variability for different morphological traits. Similar result was reported by Miti *et al.*

(2010), which indicated that selection for better performance of maize varieties could be based on its inherent ability to tolerate the prevailing biotic factors within the period of growth and development. No significant difference however, was observed at the different times of pollination as well as the accession x time interaction in all the parameters measured when averaged across the accessions. However, based on cob weight and number of grains, Nwaba white accession performed better than the other accessions between the pollination times of 7.30am to 9.30am. Favorable temperatures in the early house of pollination (7.30am to 9.30am) may have enhanced higher yield even though not significantly. High temperature after pollination could change the dynamics of grain filling of maize resulting in lower grain filling. The study by (Wilhelm, 1999) showed a 7% reduction in kernel growth rate per heat unit when exposed to heat stress after pollination of maize inbred lines. The relative lower performance at 12:30pm to 2.30pm compared to that done in the early honors of pollination could have been accounted for by the level of desiccation of the pollens which may have minimized its viability.

Conclusion

The result of this study implies that controlled hand pollination in maize breeding can be done between 7.30am and 2.30pm in Owerri area of rain forest ecology of Nigeria, but between 7.30am and 9.30am, better performance could be achieved. However, for maize breeding programme involving large numbers of plants for which hand-pollination is necessary, if daily batches cannot be completely handled between 7.30am to 9.30am, hand-pollination could continue up to 12noon when the temperature would not have increased optimally.

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Table 1: Effect of time of hand-pollination and accession on cob length, cob weight, cob rows and number of grains per cob

Maize accession	Cob Length (cm)			Cob weight (gm)			Cob rows			No of grain per cob		
	12.30-2.30pm	10.00-12.noon	7.30-9.30am	12.30-2.30pm	10.00-12.noon	7.30-9.30am	12.30-2.30pm	10.00-12.noon	7.30-9.30am	12.30-2.30pm	10.00-12.noon	7.30-9.30am
Isiochi	11.4	12.0	11.8	98.2	94.4	93.2	11	11	12	260	279	275
Ugboko	11.5	11.0	12.6	87.6	83.0	75.1	12	11	10	301	229	250
Nwaba white	12.6	13.7	14.1	89.3	105.9	138.4	12	12	13	314	348	380
LSD $_{(0.05)}$												
Accession (A)			1.1			15.2			NS			39.5
Time (T)			NS			NS			NS			NS
AxT			NS			NS			NS			NS

Table 2: Effect of time of hand-pollination and accession on 1000 – seed weight, grain weight per cob, pollen weight and grain yield

Maize accession	1000 seed wt (gm)			Grain weight/cob (gm)			Pollen wt (g)			Grain yield (t/ha)			No. of days to maturity		
	12.30-2.30 pm	10.00-12. noon	7.30-9.30 am	12.30-2.30pm	10.00-12. noon	7.30-9.30 am	12.30-2.30 pm	10.00-12. noon	7.30-9.30am	12.30-2.30 pm	10.00-12. noon	7.30-9.30 am	12.30-2.30 pm	10.00-12 noon	7.30-9.30 am
Isiochi	485.0	445.0	418.0	75.6	73.01	71.4	2.1	2.2	2.2	1.965	1.962	1.865	101.3	101.5	101.8
Ugboko	418.0	456.0	489.0	66.1	62.1	52.9	2.0	2.0	2.1	1.503	1.662	1.500	100.8	113.5	96.8
Nwaba white	458.0	480.0	403.0	66.3	85.6	117.2	2.5	2.5	2.5	1.788	2.118	2.770	101.0	99.3	102.5
LSD (0.05)															
Accession (A)	52.3			14.1				0.2		0.31		NS			
Time (T)	NS			NS				NS		NS		NS			
A x T	NS			NS				NS		NS		NS			

NS = Non Significant F – test