Genetic Variability for Grain Yield, Flowering and Ear Traits in Early and Late Sown Full – Sib Families of Sweet Corn in Makurdi (Southern Guinea Savanna), Nigeria

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Field experiments were carried out to estimate genetic variation in full – sib families of a sweet corn population during the early and late sowing dates of 2012 at the Federal University of Agriculture, Makurdi, Nigeria. Experiments were laid out as lattice but analysed using Randomised Complete Block Design (RCBD) with three replications. Families differed significantly (P < 0.01) for all the traits (days to anthesis, days to silking, anthesis – silking interval (ASI), ear traits of ears/plant, cob length, kernel rows/cob and kernels/row on cob and grain yield), indicating genetic variability for these traits. The Genotypic Coefficient of Variation (GCV), Phenotypic Coefficient of Variation (PCV) and Genetic Advance (GA) were higher for ASI compared to days to anthesis and silking, but with similar range for the ear traits. Heritability was however moderate for ASI and high for days to anthesis and silking. The higher heritability and GA observed for most of the traits in the late sowing date is an indication that progress in selection will be faster during this date. Full-sib recurrent selection for grain yield via ear traits should therefore be used to improve the local sh2 sweet corn population in the Southern Guinea Savanna of Nigeria.

Keywords: GA, GCV, heritability, PCV, sh2 sweet corn

INTRODUCTION

Maize is a very important and dynamic crop (Entringer et al., 2016) in the world and the most important staple cereal in Africa (Ajiboye et al., 2018) that is produced, marketed and consumed in both the forest and savanna ecologies of Nigeria. It is the most widely grown cereal in the country, and has replaced sorghum and millet in the savanna due to its optimum performance in the ecology and availability of improved high yielding varieties (Fajemisin, 1984). Between 1980 and 1990, Nigeria was responsible for producing over 50% of the total grain output in West and Central Africa (Badu – Apaku et al., 2012). However, per capita consumption within the same period was only 16kg/year which was almost the lowest for the region, even with a net import of 3,000 metric tonnes between 1990 and 1992. Therefore, there is the need for Nigeria to increase its output and become a net exporter.

Out of the total land area cultivated to maize (corn) in Nigeria, more than 90% is devoted to the production of field corn (dent, flint and flour maize) alone. Hence, field corn is used to not only produce dry grain for flour and other products, but also to substitute two other types of corn (pop and sweet corn) as green maize (Ojo and Odoa, 2016; Abe et al., 2019), in view of their low yield, poor adaptation and narrow genetic base (Tracy, 2001; Agele et al., 2008; Olaoye et al., 2009; Teixeira et al., 2013; Mahato et al., 2018). Therefore, there is the need to obviate this trend, by intensifying the production of pop and sweet corn towards releasing the field corn for other uses. Concerted research effort towards the development of improved high yielding pop and sweet corn varieties precedes the release of such varieties to farmers for

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production. Much research effort had been intensified in the development of improved varieties of popcorn with a dearth of information on sweet corn research in Nigeria. Previous effort at introducing and breeding of sweet corn had led to the development of tropically adapted sh2 corn populations by four cycles of mass selection from broad-based temperate super-sweet sh2 corn population (Adetimirin, 2008). These tropically adapted sh2 corn populations have served as base populations for sweet corn improvement in Nigeria and have been further improved by crossing to field corn to generate sh2 super-sweet corn populations (Abe and Adelegan, 2019; Abe et al., 2019). Unfortunately, these research efforts are concentrated in the rain forest ecology where the environmental conditions are completely different from the savanna ecology of the country. Hence, there is the need for the improvement of these populations for the savanna ecology of Nigeria.

Elsewhere, the current research effort in sweet corn is concentrated on quality traits. However, the neglect in sweet corn research in Nigeria necessitates that research effort should first be focused on quantitative traits towards the selection of high yielding genotypes prior to addressing research in qualitative traits.

Full-sib recurrent selection has been extensively used in preference to other Population improvement in maize in previous studies (Bänziger et al., 2000; Ajala et al., 2010).

Rainfall amount and distribution during the rainy season affect the expression of the quantitative traits of grain yield and yield components, and research results on maize sown at different dates in both the forest and savanna ecologies of Nigeria (Kim and Ajala, 1996; Ojo et al., 2007, Oluwaranti et al., 2008; Ojo and Odoba, 2016) attest to this.

The current research was therefore initiated to determine genetic variability for grain yield, flowering and ear traits in early and late sown full – sib families of sweet corn in Makurdi (Southern Guinea Savanna), Nigeria.

**MATERIALS AND METHODS**

**Location**

The experiment was conducted during the early and late rain fed cropping seasons of 2012 at the Teaching and Research Farm of the Federal University of Agriculture Makurdi, Nigeria. Makurdi is located on latitude 07° 41’N and longitude 08° 37’E, in the southern Guinea Savanna agro – ecological zone of Nigeria. Meteorological information for Makurdi is presented in Table 1 while the soil physical and chemical characteristics for the experimental sites are summarized in Table 2. There was no rain in the months of January, February, March and December. Soil samples were taken for analysis prior to planting for each sowing date.

**Table 1: Meteorological data of Makurdi in 2012**

<table>
<thead>
<tr>
<th>Month</th>
<th>Number of rainy days</th>
<th>Total rainfall (mm)</th>
<th>Average Temperature (°C)</th>
<th>Average Humidity (%)</th>
<th>Relative Humidity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
<td>Minimum</td>
</tr>
<tr>
<td>January</td>
<td>-</td>
<td>-</td>
<td>18.3</td>
<td>34.6</td>
<td>26</td>
</tr>
<tr>
<td>February</td>
<td>-</td>
<td>-</td>
<td>22.7</td>
<td>35.9</td>
<td>38</td>
</tr>
<tr>
<td>March</td>
<td>-</td>
<td>-</td>
<td>23.5</td>
<td>38.2</td>
<td>38</td>
</tr>
<tr>
<td>April</td>
<td>6</td>
<td>143.2</td>
<td>22.8</td>
<td>35.2</td>
<td>53</td>
</tr>
<tr>
<td>May</td>
<td>11</td>
<td>145.2</td>
<td>21.4</td>
<td>31.9</td>
<td>64</td>
</tr>
<tr>
<td>June</td>
<td>8</td>
<td>160.6</td>
<td>21.1</td>
<td>30.6</td>
<td>70</td>
</tr>
<tr>
<td>July</td>
<td>13</td>
<td>351.9</td>
<td>20.6</td>
<td>29.8</td>
<td>73</td>
</tr>
<tr>
<td>August</td>
<td>13</td>
<td>174.3</td>
<td>20.6</td>
<td>29.4</td>
<td>74</td>
</tr>
<tr>
<td>September</td>
<td>13</td>
<td>190.7</td>
<td>20.5</td>
<td>30.2</td>
<td>73</td>
</tr>
<tr>
<td>October</td>
<td>16</td>
<td>199.1</td>
<td>20.4</td>
<td>31.1</td>
<td>68</td>
</tr>
<tr>
<td>November</td>
<td>1</td>
<td>27.3</td>
<td>20.7</td>
<td>33.4</td>
<td>55</td>
</tr>
<tr>
<td>December</td>
<td>-</td>
<td>15.5</td>
<td>15.5</td>
<td>34.5</td>
<td>30</td>
</tr>
</tbody>
</table>

**Planting Materials**

A local shrunken-2 (sh2) sweet corn population was obtained from the International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria to generate full-sib families in 2011. Paired plants were identified and crossed (including reciprocal crosses) to generate full-sib (FS) families in 2011. At harvest, seeds from cobs of each pair were shelled and bulked to form a particular full-sib family giving a total of one hundred and eight (108) full – sib families. The 108 FS families were evaluated during the early and late planting dates of the 2012 cropping season.

**Experimental Layout and Cultural Practices**

The experiments were laid out in a lattice with three replications during the early (16th June) and late (1st August) plantings of 2012 cropping season, but analysed using Randomised Complete Design (RCBD) for each planting date. Three seeds of each of the 108 full – sib families were sown to designated plots on June 16th (early planting) and August 1st (late planting), 2012, at an intra - row spacing of 0.50m on ridges spaced 75cm apart. Emerged seedlings were later thinned down to two stands per hill two weeks later.
Compound fertilizer (NPK 20:10:10) was applied 2 weeks after planting, and top dressed with urea (46% N) at 5½ weeks after planting to supply 120kg N/ha, 45kg P₂O₅/ha and 45kg K₂O/ha. Hoe weeding was carried out at 2½ weeks after planting and just before top dressing.

**Data Collection and analysis**

Data collected in the course of the experiments include days to anthesis, days to silking, anthesis – silking interval (ASI), ears/plant, cob length, kernel rows/cob and kernels/row on cob) and grain yield, during the early and late planting dates (Table 3). Families were consistent in flowering across the early and late seasons, with similar range in days to anthesis and silking. Mean anthesis-silking interval (ASI) was almost 3 days with a very wide range of 0 to 6 days in both seasons (Table 4). Genetic variance was higher than error variance for all the traits in both seasons except for ASI and kernels/row on cob in the early season. Genotypic and Phenotypic Coefficients of Variation (GCV and PCV) and Genetic advance as a percentage of the mean (%) (GA) were low (< 10%) for days to anthesis and silking, but high for ASI in both seasons. The GCV and PCV were higher than 30% for ears/plant and grain yield in the late season and very high (> 100%) for grain yield in the early season.

Broad sense heritability was high for days to anthesis and silking and moderate for ASI in both seasons. The trend in heritability for the ear traits and grain yield differed between seasons. Heritability was very high for the ear traits of cob length (99.31%), kernel rows/cob (99.26%), kernels/row on cob (98.58%) in the late season compared to the moderate to high heritability (46.27 – 81.05%) observed for the same traits in the early season. Similarly, grain yield recorded a higher heritability of 98.32% in the late season compared to a lower value of 88.38% observed for the early season.

**RESULTS**

Highly significant difference in full sib families was observed for the flowering traits (days to anthesis, days to silking and anthesis-silking interval), ear traits (ears/plant, cob length, kernel rows/cob and kernels/row on cob) and grain yield, during the early and late planting dates (Table 3). Families were consistent in flowering across the early and late seasons, with similar range in days to anthesis and silking. Mean anthesis-silking interval (ASI) was almost 3 days with a very wide range of 0 to 6 days in both seasons (Table 4). Genetic variance was higher than error variance for all the traits in both seasons except for ASI and kernels/row on cob in the early season. Genotypic and Phenotypic Coefficients of Variation (GCV and PCV) and Genetic advance as a percentage of the mean (%) (GA) were low (< 10%) for days to anthesis and silking, but high for ASI in both seasons. The GCV and PCV were higher than 30% for ears/plant and grain yield in the late season and very high (> 100%) for grain yield in the early season.

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DISCUSSION

Genotypes were generally earlier in the late season compared the early season. This observation is in agreement with the previous findings of Oluwaranti et al. (2015) who observed that genotypes were earlier in the late season compared to the early season for the rain forest ecology of Nigeria. The minimal variation of only one day observed for days to anthesis and silking between the early and late season in the current work could be attributed to consistent diurnal and nocturnal temperatures during the growing stage of the crop. The inconsistency in the days to flowering (tasseling, anthesis and silking) between seasons observed in the previous studies (Oluwaranti et al., 2015) was attributed to a positive correlation between these traits and temperature. The consistent values of the components of genetic variation and the high heritability observed for the flowering traits of days to anthesis and silking in the current work, is an indication that these flowering traits are least affected by the environment and could be selected for, at any time of the year. Mean values for flowering (days to anthesis, silking and ASI) and ear (cob length and number kernel/row) traits in the current study are very close to previously observed values in the evaluation of a sweet corn derived populations (Abe et al., 2019). However, the very wide range in the values of these flowering and ear traits observed in the current study compared to the previous (Abe et al., 2019), is a favourable development and makes the current full-sib families amenable to selection for these traits.
The high GCV estimate that resulted in high PCV and GA observed for the anthesis – silking interval and grain yield in the current study had been previously observed (Urrea – Gomez et al., 1996) in maize evaluated on acid soils and attributed to spatial variability. The very high coefficients of variation observed in the early season could be attributed to the wide range in the grain yield. For example, the highest grain yield of 4021 kg/ha recorded for the best family, is 27 times the value of 147.00 kg/ha recorded for the poorest family during the early season. The grain yield of 589.00 kg observed for the best family in the late season was only 3.89 times the value of 151.30 kg/ha recorded for the poorest family in the same season.

The higher grain yield of 1413.00 kg/ha observed for the early season compared to the very poor yield of 245.80 kg/ha recorded for the late season, despite similar range in the flowering and ear traits in both seasons, could be attributed to the uneven distribution of rainfall during the late season. Rainfall distribution in the month of October was uneven, while it rained only once in November. This led to the dearth of moisture required for dry matter accumulation for the grains and drastically reduced grain yield in the late season. The implication of this result is that only extra early maturing genotypes of sweet corn that would be physiologically mature before the middle of October should be planted late (late July – first week of August). Also, medium to late maturing genotypes should be planted between late June and early July to allow for the harvest of properly filled dried seeds/grains.

The implication of the higher heritability observed for ear traits and grain yield in the late compared to the early season, is that a faster progress in selection for the improvement of ear traits and grain yield would be better achieved when sweet corn is planted late compared to early planting.

CONCLUSION

The current study has established that there is sufficient and reliable variability for flowering (days to anthesis and silking) and ear traits given the values of GCV, heritability and GA for these traits in the full-sib families. Full-sib recurrent selection for different maturity groups and grain yield via the yield components of cob length, kernel rows/cob and kernels/row on cob should therefore be used to improve the local sh2 sweet corn population in the Southern Guinea Savanna of Nigeria.

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**Accepted 20 May 2020**

**Citation:** Ojo GOS, Vange T, Adeyemo MO (2020).
Genetic Variability for Grain Yield, Flowering and Ear
Traits in Early and Late Sown Full – Sib Families of Sweet
Corn in Makurdi (Southern Guinea Savanna), Nigeria.
International Journal of Plant Breeding and Crop Science,
7(1): 661-666.

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