integrity Research Journals

Journal of Bioscience and Biotechnology Discovery
Volume 6(2), pages 13-18, April 2021
Article Number: DB8E85971
ISSN: 2536-7064
https://doi.org/10.31248/JBBD2021.150
https://integrityresjournals.org/journal/JBBD

Full Length Research

Exploitation of rank summation index for the selection of 21 maize hybrids for green maize production in South-eastern Nigeria

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Received 16th February, 2021; Accepted 10th March, 2021

ABSTRACT: Green (fresh) maize (*Zea mays L.)* provides food security and income to farmers especially when other crops are still in the field. However, research on green maize varieties is scarcely reported in the literature or information on suitable genetic material (germplasm) for green maize production. Two local maize landraces collected from south-eastern Nigeria and five improved varieties sourced from the International Institute of Tropical Agriculture (IITA) were used for this experiment. These seven genotypes were crossed in a half diallel mating system in a randomized complete block design (RCBD) with four replications. Data collected were subjected to analysis of variance and those found significant (p = 0.05) were further subjected to diallel analysis using Griffing's method II and model I for fixed effects. Rank summation index was used for all the traits studied to identify and select the best performer amongst the genotypes. The rank summation index identified and selected the crosses between DTMA-4 X OKA BENDE-WHITE, OKA MBAISE X OKA BENDE-WHITE, PVA SYM 8 F2 X OKA BENDE-WHITE, POOL 66/ACR-91 X OKA BENDE-WHITE and DMR-ESRY X OKA BENDE-WHITE for the production of green maize in south-eastern Nigeria.

Keywords: Green maize, maize hybrid, rank summation index, south-eastern Nigeria.

INTRODUCTION

Maize (*Zea mays L*) is one of the most important sources of carbohydrates and minerals for humans and animals and also a good source of raw materials for industries. The nutritional quality of maize is very important and is mainly determined by the genotype and the growing conditions as well as the post-harvest technology.

According to IITA (2001) report, maize contains 80 per cent carbohydrates, 10 percent protein, 3.5 percent fibre and 2 percent mineral, vitamin B are also present in maize. Green maize (fresh on the cob) is eaten parched, baked, roasted or boiled and plays important roles in filling the hunger gap while other crops are yet to mature.

Okoli and Okoronkwo (2020) reported that the development of highly nutritious crops will improve the nutritional status of the region and generally the standard of living of farmers in South-eastern Nigeria.

Wheat, rice and maize are the most important cereal crops in the world but maize is the most popular because it is high yielding, easy to process, readily digested and lowers cost than other cereals (Jaliya et al., 2008). Maize has a variety of uses as it can be used in the livestock industry to make livestock feeds, for export purposes and also used as human food and for industrial products. Palatability tests allow consumers and breeders to select genotypes with the best quality (Okoli, 2020).

Maize breeders are interested in simultaneously improving various targeted traits without affecting the performance of other non-target traits. One way of selecting for more than one trait at a time is through index selection. Mulamba and Mock (1978) developed the rank summation index, calculated by ranking genotypes for the traits of interest and then summing the ranks of each trait.

Table 1. Evaluated genotypes.

S/N	Entries	Experimental code	Status
1	DTMA-4	V1	Parent
2	DMR-ESRY (POOL 18-SR)	V2	Parent
3	PVA SYM 8 F2 (PRO VIT A)	V3	Parent
4	POOL 66/ACR-91 SUWAN – 1- SR (QPM)	V4	Parent
5	DTMA – W	V5	Parent
6	Oka Mbaise	V6	Parent
7	Oka Bende-white	V7	Parent
8	DTMA-4 X DMR-ESRY (POOL 18-SR)	v1v2	Hybrid
9	DTMA-4 X PVA SYM 8 F2 (PRO VIT A)	v1v3	Hybrid
10	DTMA-4 X POOL 66/ACR-91 SUWAN – 1- SR (QPM)	v1v4	Hybrid
11	DTMA-4 X DTMA – W	v1v5	Hybrid
12	DTMA-4 X Oka Mbaise	v1v6	Hybrid
13	DTMA-4 Oka Bende-white	v1v7	Hybrid
14	DMR-ESRY (POOL 18-SR) X PVA SYM 8 F2 (PRO VIT A)	v2v3	Hybrid
15	DMR-ESRY (POOL 18-SR) X POOL 66/ACR-91 SUWAN – 1- SR (QPM)	v2v4	Hybrid
16	DMR-ESRY (POOL 18-SR) X DTMA – W	v2v5	Hybrid
17	DMR-ESRY (POOL 18-SR) X Oka Mbaise	v2v6	Hybrid
18	DMR-ESRY (POOL 18-SR) X Oka Bende-white	v2v7	Hybrid
19	PVA SYM 8 F2 (PRO VIT A) XPOOL 66/ACR-91 SUWAN – 1- SR (QPM)	v3v4	Hybrid
20	PVA SYM 8 F2 (PRO VIT A) X DTMA – W	v3v5	Hybrid
21	PVA SYM 8 F2 (PRO VIT A) X Oka Mbaise	v3v6	Hybrid
22	PVA SYM 8 F2 (PRO VIT A) X Oka Bende-white	v3v7	Hybrid
23	POOL 66/ACR-91 SUWAN – 1- SR (QPM) X DTMA – W	v4v5	Hybrid
24	POOL 66/ACR-91 SUWAN – 1- SR (QPM) X Oka Mbaise	v4v6	Hybrid
25	POOL 66/ACR-91 SUWAN – 1- SR (QPM) X Oka Bende-white	v4v7	Hybrid
26	DTMA – W X Oka Mbaise	v5v6	Hybrid
27	DTMA – W X Oka Bende-white	v5v7	Hybrid
28	Oka Mbaise X Oka Bende-white	v6v7	Hybrid

The advantage of the rank summation index is that phenotypic and genotypic variance and covariance are not needed in their calculation. The rank summation index has not been fully exploited in the selection of maize genotypes in South-eastern Nigeria and that forms the major aim of the present study.

MATERIALS AND METHODS

The research was carried out at the Centre for Agricultural Research, School of Agriculture and Agricultural Technology of the Federal University of Technology Owerri, Imo State, Nigeria between July and November 2016. The centre is located at latitude 5°27'N and longitude 7°02'E with mean temperature of 29°C, relative humidity of 89%, and an altitude of 50 to 70 cm above sea level.

Description of genotypes used for the study

The material consisted of 28 genotypes, 7 of which were parents and the remaining 21 were crosses as shown in the Table 1. The parent genotypes used in this study were two local open-pollinated (Oka mbaise designated as V6 and Oka bende-white designated as V7) and five improved genotypes from International Institute of Tropical Agriculture (IITA), Ibadan Nigeria (DTMA-y, DMR-ESRY (POOL 18-SR), PVA SYM 8 F2 (PRO VIT A), POOL 66/ACR-91 SUWAN – 1- SR (QPM), and DTMA – W designated as V1, V2, V3, V4, and V5, respectively.

Experimental design and field layout

The genotypes used in this study were two (2) local open-pollinated (OKA MBAISE designated as V6 and OKA BENDE WHITE designated as V7) and five (5) advanced genotypes from International Institute of Tropical Agriculture (IITA), Ibadan Nigeria (DTMA-y, DMR-ESRY (POOL 18-SR), PVA SYM 8 F2 (PRO VIT A), POOL 66/ACR-91 SUWAN – 1- SR (QPM), and DTMA – W designated as V1, V2, V3, V4, and V5, respectively. NPK 15:15:15 was applied at equivalent rate of 300 kg/ha two

Table 2. Rank summation index (RSI) of all the studied traits.

Genotype	Days to 50% Emergence	R1	Percentage Emergence	R2	Plant stand	R3	Days to 50% tasselling	R4	Days to 50% silking	R5	Leaf area (Cm^3)	R6	Plant height (cm)	R7	Stem girth (cm)	R8	Days to maturity	R9
v1v2	3.8	1	91.2	7	23.3	7	58.8	10	67.3	19	44.2	16	110.5	18	0.7	15	114.5	15
v1v3	3.8	1	92.5	5	24.5	3	43.0	3	47.8	1	91	3	134.5	9	0.75	12	136	21
v1v4	4.0	3	86.9	10	25	1	42.3	2	53.5	3	86.2	7	178.5	3	0.975	5	129.3	17
v1v5	4.0	3	93.6	4	17.5	21	55.5	9	65.5	16	48.8	14	115.2	17	0.575	19	100.8	7
v1v6	4.0	3	85.3	12	24.3	5	48.3	5	56.8	4	78.5	10	135.5	8	0.75	12	103	9
v1v7	4.3	6	94.8	2	24	6	51.8	7	63.8	10	45.2	15	116.8	15	0.95	6	103.5	10
v2v3	4.3	6	96.6	1	18.8	18	47.5	4	58.8	5	42.2	18	120	14	0.775	10	129	16
v2v4	4.3	6	91.1	8	21	13	50.8	7	62.3	7	48.9	13	124	12	0.775	10	132	19
v2v5	4.3	6	94.0	3	21.8	12	41.0	1	49.5	2	86.5	6	165.5	4	1.025	4	98.25	4
v2v6	4.5	10	63.5	21	19.3	17	50.0	6	62.5	8	42.3	17	122.5	13	0.7	15	98.25	4
v2v7	4.8	11	77.7	18	24.8	2	61.8	20	66.8	17	79.3	9	149.2	6	0.8	7	113.3	14
v3v4	5.0	12	76.5	19	23.3	7	61.3	19	67.5	20	71.3	11	182.2	2	1.125	3	98.5	6
v3v5	5.0	12	82.5	14	18	19	61.3	19	67.8	21	32.7	21	105.2	19	0.55	20	105.5	12
v3v6	5.0	12	79.9	17	23.3	7	59.5	12	62.5	8	92	2	134.2	10	0.8	7	104.8	11
v3v7	5.0	12	82.0	15	19.5	16	60.5	17	65	13	52.7	12	115.8	16	0.8	7	96	2
v4v5	5.0	12	85.9	11	20.8	14	60.3	15	60.5	6	84.4	8	160.8	5	1.175	2	132.3	20
v4v6	5.0	12	88.7	9	23.3	7	59.8	13	65.3	15	89.1	4	139.8	7	0.725	14	111.8	13
v4v7	5.0	12	92.3	6	24.5	3	58.8	10	64.8	12	101	1	247.2	1	1.325	1	102.5	8
v5v6	5.3	19	83.5	13	20.3	15	60.3	15	67	18	41.5	19	101.8	20	0.5	21	130.5	18
v5v7	5.3	19	80.1	16	23	11	60.8	18	64.5	11	87.8	5	126.8	11	0.7	15	96.75	3
v6v7	5.5	20	76.1	20	18	19	59.8	13	65	13	40.3	20	97.2	21	0.675	18	89.5	1

weeks after planting and also at tasselling. The field was also treated with furadan 3% granular formulation of carbofuran to minimize stem borer and termite attack. The experimental design was randomised complete blocks with four replications. The genotypes were grown in three row plots. A diallel was generated during the second maize planting season of August, 2015 at the Centre for Agricultural Research, School of Agriculture and Agricultural Technology Teaching and Research Farm of Federal University of Technology Owerri. Half-diallel mating method involving the parents and excluding the reciprocals (that is, 21 crosses). The first filial generation was used for this study.

Data collection

Data were collected for plant stand, days to 50% emergence, days to 50% tasselling, leaf area (cm²), days to maturity, plant at harvest, days to 50% silking, plant height (cm), stem girth (cm), ear height (cm), cob length (cm), number of rows/cob, grain weight/cob, field weight (FWT), number of grains/cob, grain weight/cob, and grain yield (t/ha).

Data analysis

Rank summation index was used as described by

Table 2. Contd.

Genotype	Plant at harvest	R10	Ear height (cm)	R11	Cob length (cm)	R12	Number of rows per cob	R13	Number of grains per cob	R14	Grain weight per cob(kg)	R15	Field weight (kg)	R16	1000weight (kg) seed	R17	Grain yield (t ha^{-1})	R18	Rank summation index
v1v2	15.3	7	134.25	2	11.8	16	13	8	278.2	4	1.243	10	138.2	10	448.6	18	2.67	16	199
v1v3	16.5	3	125.75	7	13.75	9	14.3	3	205.2	16	1.473	6	181.4	1	508	7	3.09	9	119
v1v4	17	1	133.75	3	16.12	1	13	8	210	15	1.462	7	158	3	546.3	2	3.63	1	92
v1v5	9.5	21	114.75	16	11.78	17	10.8	18	165.2	19	1.223	11	119.8	17	487.9	10	2.65	17	256
v1v6	16.3	5	125.75	7	13.38	11	14	5	320	3	1.178	13	177.8	2	526.5	4	3.01	11	129
v1v7	16	6	121.25	11	11.25	19	10.8	18	230.8	11	1.41	8	137.2	12	467.1	14	2.53	19	195
v2v3	10.8	18	110.75	20	12.25	15	12.3	13	226.8	12	0.735	18	127.2	15	473.1	13	2.76	15	231
v2v4	13	13	120.75	12	14.38	5	10.8	18	176.8	18	0.655	19	115.8	19	504.5	9	3.23	5	213
v2v5	13.8	12	127	6	12.88	13	12.8	10	345	2	1.58	2	133.8	13	541.4	3	2.90	13	116
v2v6	11.3	17	108	21	10.5	21	12.5	12	246.5	8	0.335	21	139.5	9	449.1	17	2.36	21	258
v2v7	16.8	2	120.75	12	14.25	6	14.5	2	270.2	5	1.53	4	145.5	7	509.4	6	3.21	6	154
v3v4	15.3	7	124.75	9	15.13	3	14.3	3	257	6	1.555	3	138.2	10	484.1	11	3.40	3	154
v3v5	10	19	114	18	13.13	12	12.3	13	151.2	20	0.647	20	125.8	16	461	16	2.95	12	303
v3v6	15.3	7	113	19	14	7	13.3	7	214.5	14	1.09	16	150.5	5	506.9	8	3.15	7	176
v3v7	11.5	16	114.75	16	14.5	4	12.3	13	236.5	10	1.175	14	112.5	20	439.4	19	3.26	4	226
v4v5	12.8	14	127.25	5	15.25	2	12.8	10	250.5	7	1.27	9	142	8	519.3	5	3.43	2	155
v4v6	15.3	7	128.25	4	11.38	18	13.5	6	243	9	1.522	5	147.5	6	467.1	14	2.56	18	181
v4v7	16.5	3	135	1	14	7	15.3	1	346.8	1	1.615	1	156.5	4	606.9	1	3.15	7	80
v5v6	12.3	15	120.25	14	13.75	9	11.8	17	150.2	21	1.093	15	116.2	18	430.4	21	3.09	9	297
v5v7	15	11	121.5	10	11.25	19	12.3	13	216.2	13	1.208	12	130	14	482.6	12	2.53	19	232
v6v7	10	19	118.5	15	12.75	14	10	21	180.2	17	0.913	17	111.8	21	431.1	20	2.87	14	303

Mulamba and Mock (1978) for all the traits studied to identify and select the best performer amongst the genotypes. Following ranking, a selection index is obtained by summing the ranks of the genetic materials associated with each trait studied.

RESULTS AND DISCUSSION

Table 2 shows the overall performance of the 21 progenies of the seven maize genotypes using their rank summation index (RSI). In selecting the best genotypes for fresh maize production, DTMA-4 X OKA BENDE-WHITE, OKA MBAISE X OKA BENDE-WHITE, PVA SYM 8 F2 X OKA BENDE-WHITE, POOL 66/ACR-91 X OKA BENDE-WHITE and DMR-ESRY X OKA BENDE-WHITE had the lowest RSI 80, 88, 100, 116, 127 respectively for all the studied traits and therefore should be selected.

Table 3 presents RSI of the six qualities evaluated for sensory evaluation of the F1 genotypes of the seven evaluated maize genotypes. The ranking of the 21 F1 maize genotypes for consumption desirability and acceptability parameters; colour, grain size, hardness, appeal, taste and preference grouped the genotypes into four categories. The Table showed that OKA MBAISE X OKA BENDE-WHITE, DTMA – W X OKA BENDE-WHITE, DTMA – W X OKA MBAISE, POOL 66/ACR-91 X OKA

Table 3. Rank Summation Index (RSI) of consumption acceptability of F1 genotypes.

F_1 hybrids	Colour	Rank	Grain size	Rank	Hardness	Rank	Appeal	Rank	Taste	Rank	Preference	Rank	RSI
v1v2	2.00	6	2.17	16	2.67	11	1.83	6	2.00	11	1.83	11	61
v1v3	2.00	6	2.17	16	2.67	11	1.83	6	2.00	11	1.83	11	61
v1v4	2.00	6	2.17	16	2.67	11	1.83	6	2.00	11	1.83	11	61
v1v5	2.00	6	2.17	16	2.67	11	1.83	6	2.00	11	1.83	11	61
v1v6	2.00	6	2.17	16	2.67	11	1.83	6	2.00	11	1.83	11	61
v1v7	2.00	6	2.17	16	2.67	11	1.83	6	2.00	11	1.83	11	61
v2v3	2.00	6	1.83	6	2.33	6	1.83	6	2.00	11	1.67	1	36
v2v4	2.00	6	1.83	6	2.33	6	1.83	6	2.00	11	1.67	1	36
v2v5	2.00	6	1.83	6	2.33	6	1.83	6	2.00	11	1.67	1	36
v2v6	2.00	6	1.83	6	2.33	6	1.83	6	2.00	11	1.67	1	36
v2v7	2.00	6	1.83	6	2.33	6	1.83	6	2.00	11	1.67	1	36
v3v4	2.00	6	1.83	6	2.17	1	1.83	6	1.00	1	2.00	17	37
v3v5	2.00	6	1.83	6	2.17	1	1.83	6	1.00	1	2.00	17	37
v3v6	2.00	6	1.83	6	2.17	1	1.83	6	1.00	1	2.00	17	37
v3v7	2.00	6	1.83	6	2.17	1	1.83	6	1.00	1	2.00	17	37
v4v5	2.00	6	1.83	6	2.17	1	1.83	6	1.00	1	2.00	17	37
v4v6	1.67	1	1.00	1	3.00	17	1.33	1	1.33	6	1.67	1	27
v4v7	1.67	1	1.00	1	3.00	17	1.33	1	1.33	6	1.67	1	27
v5v6	1.67	1	1.00	1	3.00	17	1.33	1	1.33	6	1.67	1	27
v5v7	1.67	1	1.00	1	3.00	17	1.33	1	1.33	6	1.67	1	27
v6v7	1.67	1	1.00	1	3.00	17	1.33	1	1.33	6	1.67	1	27

BENDE-WHITE and POOL 66/ACR-91 X OKA MBAISE had the best and highest consumption acceptability with an RSI of 27. This was followed by DMR-ESRY X OKA BENDE-WHITE, DMR-ESRY X OKA MBAISE, DMR-ESRY X DTMA – W, DMR-ESRY X POOL 66/ACR-91, and DMR-ESRY X PVA SYM 8 F2 with an RSI of 36. This was followed by POOL 66/ACR-91 X DTMA – W, PVA SYM 8 F2 X OKA BENDE-WHITE, PVA SYM 8 F2 X OKA MBAISE, PVA SYM 8 F2 X DTMA – W and PVA SYM 8 F2 X POOL 66/ACR-91 with an RSI of 37. This was followed by DTMA-4 X OKA BENDE-WHITE, DTMA-4 X OKA MBAISE, DTMA-4 X DTMA – W, DTMA-4 X POOL 66/ACR-91, and DTMA-4 X PVA SYM 8 F2 with an RSI of 61.

The identification of the best groups supports the usefulness of a selection index; in this case, RSI was used for selection purpose for the developed maize genotypes (Ngwuta et al. 2001). Green maize is mainly used for fresh maize consumption, and several physical characteristics and chemical composition traits determine acceptability or rejection (Okoli, 2020).

A fresh maize genotype must be superior in quality and must have special characteristics (soft, attractive, nutritious, sweet etc.) before it would be acceptable to consumers. The emphasis on obtaining highly palatable fresh maize genotypes has increased in recent years as a result of greater concern for the nutritional needs of people who obtain the major portion of their diet from this product.

Okoli (2020) reported that the quality characteristics of a variety of fresh maize are complex and that selection requires a long series of testing procedures to evaluate many different quality components of each genotype.

Conclusion

The rank summation index was very effective in the selection of the best genotypes for green maize production in the South-eastern Nigeria. Genotypes DTMA-4 X OKA BENDE-WHITE, OKA MBAISE X OKA BENDE-WHITE, PVA SYM 8 F2 X OKA BENDE-WHITE, POOL 66/ACR-91 X OKA BENDE-WHITE and DMR-ESRY X OKA BENDE-WHITE are recommended from this study for fresh maize production and consumption. Further study is recommended with the rank summation index for the production of other cereal crops.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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