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Variability among Twenty Tomato Cultivars for Yield Traits and Storability, Southern Guinea Savannah Ecological zone of Nigeria

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ABSTRACT
A screen house experiment was conducted at Kabba college of Agriculture in kogi state of Nigeria from March – August 2021 and repeated at the same time in the year 2022, to study the variable characteristics associated with twenty tomato cultivars. The aim of the study is to sort out the most promising among the tested cultivars based on the yield and fruit quality for adoption as cultivar of choice for large scale production in the study area. Ten local and ten exotic cultivars were studied. The local cultivars were; Dan acre, Dan Hausa, Dan Karufi, Ishase, Ake –Ago pitis Testicles, Liye, Aho-Avegh, gou, local wrinkle, and Igede collected from Zaria, Kaduna, Zaria, Benue, Kabba and Ibadan. The exotic cultivars were; Tima, Rio Grande, Tropimech, Tomato peto 85, Roma VF, Roma savanna, Tomato-82-B, cobra F1, Boomerang and plum roma. Seedlings were raised from the selected 20 cultivars and transplanted to the screen house four week after planting. The experimental design was complete randomization, each treatment was replicated 3 times. Date was obtained for growth, yield and quality parameters. The growth and yield parameters were subjected to analysis of variance using FLSD at 5% probability level. The result from the experiment showed significant differences in all the growth and yield parameters. The fruit quality (storability, nutrient content), also varied across the cultivars. Based on the yield and quality parameters, five (5) most promising among the tested cultivars (Cobra, Boomerang, Rio grande, Ishaze and Dan karufi) were selected for further studies.

INTRODUCTION
Nigeria is the fourteenth largest producer of tomatoes in the world and rank second in the Africa continent after Egypt, with average annual production of about 1.8 metric tons. Ironically, the country is also the largest importer of tomato paste in the world, importing 150 metric tons valued at $170 million. The current demand for fresh tomato in Nigeria is at about 2.45million metric tons per annum Sunday et.al, 2018. The country has a population of over 170 million people with an estimated national population growth rate of 5.7% per annum, and an average economic growth rate of 3.5% per annum in the past five years (Ugonna

*et al.,*2015). Unfortunately, the country still experiences shortage in critical inputs, lack of improved technology, low yield and productivity, high post- harvest losses and lack of processing and marketing infrastructure. Hence the high demand for tomato and its by-products far outweighs the supply. At present, a significant percentage of processed tomato products used in Nigeria are imported, resulting in unnecessary pressure on foreign reserve hence it is necessary to increase the production of tomato. In order to actualize this, there is a need to explore more areas with potential for large scale production thereby expanding the scope of production. Large scale production of tomato should therefore be encouraged in the south west savannah ecological zone.

The selection of cultivars depends on the quality of fruit, adaptability to the environment, reliability and resistance to diseases and pests, plant growth habit, and the planting time. FAO (1990) reported variation in fruit set among varieties under high temperature. Similarly, development of cultivars tolerant to heat, salinity stress and resistant to flood, change in the sowing date, use of efficient technologies like drip irrigation, soil and moisture conservations measures, fertilizers management through fertigation, use of grafting techniques, use of plant regulators, protected cultivation, improving pest management are the effective adaptations strategies for reducing the impact of climate change (Pushparani *et al.*, 2017).
Curme (1992) also observed variation amongst certain varieties with temperature as low 7.2°C and with temperature as high 26.6°C. Schaible (1990) had created more flexible situation in respect of variety and temperature interactions. There are literally hundreds of different tomato cultivars. Some cultivars are suitable for hot season and some for rainy seasons (Nguyen 2004, Tuan 2015). Favorite varieties need to be identified based on some combination of flavor, texture, appearance and resistance to diseases. For optimum growth, there is the need to select appropriate cultivars for different ecological zone for efficient performance. The main objective of this work was to identify the most appropriate cultivar(s) of tomato that can be adopted for large scale production in southern Guinea Savannah Ecological zone of Nigeria.

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MATERIALS AND METHODS

Experimental site

The experiment was carried out at the Research Site of Horticultural Section, College of Agriculture, Kabba. The site is located at latitude of 07° 35' N and longitude of 06° 08' E and is 1000 m above sea level, in Southern Guinea Savanna Agro Ecological Zone of Nigeria, where the dry seasons are dry and hot while, wet seasons are cool. The rainfall spans between months of April to November with peak in June. The dry season extends from December to March. The mean annual rainfall is 1570mm per annum with an annual temperature range of 18°C - 32°C. The mean relative humidity (RH) is 60% (Babalola, 2010). The major soil order within the experimental site is Gleysol (Higgins, 1957; Babalola, 2010).

Experimental design

The experiment was laid out in complete randomized design CRD comprising twenty treatments namely; dan acre, Dan Hausa, Dan Karufi, Ishaze, Ake- Ago, Local wrinkle, igede, tima, Rio grande, Tropimech, Tomato peto 85, Roma VF,Roma savanna, Tomato-82-B,Cobra,Boomerang and plum roma and each treatment was replicated three times. A total of sixty (60) plastic buckets of 20-liter capacity were perforated for easy drain of water and filled with garden soil amended with poultry manure two weeks before transplanting and arranged in a screen house measuring 9m by 3.5m.
Data was collected on the following;

Stem height, Stem girth, Number of leaves, Number of branches, Days to flower initiation, Days to 100% flowering, Days to fruit set, Days to 100% fruiting, Fruit length, Fruit girth, Number of fruit per plant, Fruit weight. The data collected from the two years were pooled together and means were subjected to analysis of variance (ANOVA). Treatment means were compared using the Fisher least significant difference (F-LSD) at 5% probability level as stipulated by (Obi, 2002). Statistical analysis was done using (GENSTAT, 2007) Discovery Edition 3.

RESULTS

Table 1 Showed the analysis of variance on the height of various cultivars of tomato subjected to experimentation. From the analysis, it was observed that significant differences occurred across the cultivars. Dan Hausa had the highest height of 98.00cm while Plum Roma had the lowest height of 69.00cm

Table 2 showed the cultivar effect on the leaves of tomatoes at 6, 8, 10 and 12 weeks after planting. There were significant differences amongst the cultivars. The highest number of leaves at 12 weeks after planting was recorded on cultivar Tima (37.69) and was followed by cultivar Igede (33.67). The lowest number of leaves was recoded in cultivar Plum roma (19.00)

Table 3 showed the cultivars effects on the stem girth of tomatoes from 6- 12WAP. There were significant differences across the tomato cultivars. The widest stem girth was recorded in Dan Karufi and cobra (3.93cm). The lowest was recorded in plum roma. (2.80cm)

Table 4 is effect of cultivars on the means days to flowering and fruiting. There were no significant differences on days to flower initiation and 100% flowering across the cultivars. However, Igede cultivar recorded shortest days to flower initiation and 100% flowering (42 and 47) days respectively. The shortest days to fruiting was recorded in cobra (56 days). Plum Roma did not produce a single fruit throughout the experimental period even though flowers were produced.

Table 5 is analysis of variance on yield component (average fruit length, fruit circumference, number of fruits per plant, average single fruit weight and average fruit yield per plant). There were significant differences in the mentioned parameters across the tested cultivars of tomato. The longest average fruit length was recorded in Ako Avegh (10.33cm). The widest average fruit circumference was observed in Roma Savannah (14.33cm). The highest average single fruit weight was observed in Dan Karufi and Tomato 82B as they were statically similar

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(33.53g/plant). The highest average fruit weight per plant was recorded in Boomerang (383.33g). Other varieties with higher yield are cobra (296.33g/plant), Rio grande (232.67g/plant), Ishaze (232.67g/plant), Tomato 82B (228.67g/plant) and dan karufi (222.67g/plant) respectively. The five most promising among the tested cultivars will be taken to the field for further studies.

Table 6 showed the effects of cultivars on the shelf life of different tomato. At day 10 of storage, cultivars Aho Averge, Gou, and Igede had the highest percentage fruit rot of 80% while cultivar, Dan Karufi, Isheze, Boomerang, Cobra, Rio grande, and Tomato 82B did not record any rot at day 10 of the experiment.

Table 1: Effects of cultivars on the height of tomato

Cultivars	PH6 (cm)	PH8(cm)	PH10(cm)	PH12 (cm)
C1	21.67	63.00	77.67	88.33
C2	23.67	66.67	84.67	94.33
C3	16.00	58.67	80.33	89.00
C4	10.33	60.33	90.33	98.00
C5	24.00	64.67	85.67	89.00
C6	18.67	62.00	87.00	96.00
C7	12.67	52.67	84.00	86.00
C8	23.00	57.33	81.00	84.33
C9	23.67	60.67	83.67	88.33
C10	25.33	70.00	91.00	97.33
C11	33.33	79.67	86.00	96.67
C12	26.33	71.00	89.33	92.67
C13	14.33	57.67	83.33	91.33
C14	13.33	48.33	68.00	82.00
C15	15.67	44.67	78.33	81.67
C16	14.33	44.67	65.67	70.67
C17	9.67	40.00	65.00	84.00
C18	18.00	65.67	78.00	82.00
C19	19.67	67.33	75.33	82.33
C20	30.07	54.67	67.00	69.00
FLSD(0.05)	6.12	15.36	17.79	17.95

PH: plant height, C1: Aho avegh, C2: Ako ago, C3:Dan acre, C4:Dan hausa, C5:Dan karufi, C6:Gou, C7:Liye, C8:Ishaze, C9:localwrinkle, C10:Igede, C11:Boomerang, C12:Cobra, C13:Roma savannah, C14;RomaVF, C15:Rio grande, C16:Tima, C17:Tropemech, C18:peto 86, C19:Tomato 82B, C20:Plum roma

WAP – Weeks after planting

Table 2: Effect of cultivars on the number of tomato leaves

Cultivars	NL6	NL8	NL10	NL12
C1	9.00	26.00	30.00	35.00
C2	7.00	12.67	24.00	33.67
C3	5.33	13.67	21.00	29.33
C4	4.33	11.33	20.33	27.33
C5	8.33	19.00	22.67	34.00
C6	6.33	15.67	23.00	29.00
C7	7.00	19.33	26.00	30.33
C8	8.33	19.67	24.00	30.67
C9	9.33	20.33	25.67	32.33
C10	10.33	24.33	33.67	33.66
C11	8.67	20.67	24.33	29.67
C12	9.33	17.00	21.67	31.33
C13	5.67	20.33	22.33	27.67
C14	6.33	15.00	18.33	31.00
C15	5.67	14.33	17.00	27.00
C16	8.67	26.33	28.33	37.67
C17	5.33	9.67	15.67	26.00
C18	5.67	12.67	17.33	27.67
C19	6.00	13.00	18.33	27.00
C20	6.33	11.67	17.67	19.00
FLSD(0.05)	2.54	6.81	9.42	9.12

NL: Number of leaves, C1: Aho avegh, C2: Ako ago, C3: Dan acre, C4: Dan hausa, C5: Dan karufi, C6: Gou, C7:Liye, C8:Ishaze, C9:localwrinkle, C10:Igede, C11:Boomerang, C12:Cobra, C13:Roma savannah, C14;RomaVF, C15:Rio grande, C16:Tima, C17:Tropemech, C18:peto 86, C19:Tomato 82B, C20:Plum roma

WAP – Weeks after planting

Table 3: Effects of cultivars on the Stem girth of tomato

Cultivars	SG 6(cm)	SG 8(cm)	SG 10(cm)	SG 12(cm)
C1	2.33	3.47	3.63	3.73
C2	2.87	3.53	3.70	3.73
C3	2.10	3.43	3.56	3.87
C4	1.83	3.20	3.37	3.77
C5	3.07	3.60	3.70	3.93
C6	2.90	3.63	3.77	3.87
C7	3.00	3.53	3.70	3.77
C8	2.60	3.53	3.67	4.03

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C9	3.07	3.40	3.87	3.93
C10	2.97	3.37	3.57	3.83
C11	3.00	3.30	3.53	3.70
C12	2.97	3.33	3.53	3.93
C13	2.13	3.20	3.53	3.73
C14	2.00	3.27	3.53	3.87
C15	1.67	3.30	3.50	3,73
C16	2.00	3.00	3.20	3.47
C17	1.13	3.23	3.47	3.53
C18	1.33	3.27	3.43	3.60
C19	2.83	3.20	3.83	3.83
C20	2.13	2.40	2.70	2.80
FLSD(0.05)	0.71	0.60	0.65	0.12

SG: stem girth, C1:Aho avegh, C2:Ako ago, C3:Dan acre, C4:Dan hausa, C5:Dan karufi, C6:Gou, C7:Liye, C8:Ishaze, C9:localwrinkle, C10:Igede, C11:Boomerang, C12:Cobra, C13:Roma savannah, C14;RomaVF, C15:Rio grande, C16:Tima, C17:Tropemech, C18:peto 86, C19:Tomato 82B, C20:Plum roma
WAP – Weeks after planting

Table 4: Effect of cultivars on days to flowering and fruiting

Cultivars	1ST FL	100%	1ST FL	100% FL
C1	47.00	55.00	61.00	80.00
C2	49.00	59.00	72.00	81.00
C3	56.00	60.00	71.00	83.00
C4	62.00	71.00	75.00	83.00
C5	47.00	56.00	72.00	90.00
C6	59.00	62.00	65.00	76.00
C7	57.00	64.00	71.00	84.00
C8	48.00	52.00	64.00	75.00
C9	48.00	54.00	71.00	74.00
C10	42.00	47.00	69.00	71.00
C11	51.00	52.00	58.00	71.00
C12	45.00	48.00	56.00	64.00
C13	49.00	55.00	62.00	67.00
C14	53.00	54.00	70.00	79.00
C15	53.00	57.00	72.00	79.00
C16	47.00	54.00	75.00	81.00
C17	45.00	52.00	73.00	82.00
C18	49.00	54.00	71.00	78.00

C19	54.00	61.00	71.00	92.00
C20	48.00	47.33	0.00	0.00
FLSD(0.05)	14.70	15.13	Ns	Ns

FL; flower, FR: fruiting, C1:Aho avegh, C2:Ako ago, C3:Dan acre, C4:Dan hausa, C5:Dan karufi, C6:Gou, C7:Liye, C8:Ishaze, C9:localwrinkle, C10:Igede, C11:Boomerang, C12:Cobra, C13:Roma savannah, C14;RomaVF, C15:Rio grande, C16:Tima, C17:Tropemech, C18:peto 86, C19:Tomato 82B, C20:Plum roma.

Table 5: Tomato cultivars and yield component.

Cultivars	AFL(cm)	AFC (cm)	AFN	ASFW(g)	AFWP (g)
C1	10.33	8.67	7.33	16.83	121.00
C2	8.33	13.63	4.67	24.43	132.33
C3	8.00	11.33	2.33	24.93	58.67
C4	8.27	11.50	4.00	23.10	92.33
C5	7.00	14.00	9.00	33.53	222.67
C6	8.67	12.33	5.67	30.03	153.00
C7	9.00	12.33	3.00	22.50	66.67
C8	8.00	12.33	8.67	28.77	232.67
C9	7.60	10.67	4.33	25.53	128.33
C10	9.00	8.33	12.67	16.00	196.67
C11	8.33	12.67	10.67	30.03	383.33
C12	8.07	12.50	9.67	32.43	296.33
C13	9.00	13.00	3.67	30.43	103.00
C14	9.00	14.33	3.33	28.23	143.00
C15	8.00	10.50	5.00	32.43	232.67
C16	9.00	10.17	6.00	26.27	164.33
C17	5.50	8.67	5.00	16.07	78.00
C18	7.83	10.00	5.00	23.53	116.67
C19	7.83	10.00	7.67	13.53	288.68
C20	0.00	0.00	0.00	0.00	0.00
	FLSD(0.05)	2.36	2.47	5.01	33.02

FL; Average fruit length, FC: Average fruit circumference, FN: Average fruit number, ASFW: average single fruit weight, AFWP: Average fruit weight per plant, C1:Aho avegh, C2:Ako ago, C3:Dan acre, C4:Dan hausa, C5:Dan karufi, C6:Gou, C7:Liye, C8:Ishaze, C9:localwrinkle, C10:Igede, C11:Boomerang, C12:Cobra, C13:Roma savannah, C14;RomaVF, C15:Rio grande, C16:Tima, C17:Tropemech, C18:peto 86, C19:Tomato 82B, C20:Plum roma

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Table 6: Tomato cultivars and percentage fruit rot (Cumulative total).

Cultivar	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day10
C1	_	_	10	10	30	40	50	60	70	80
C2	_	_	_	10	10	30	30	40	40	50
C3	_	_	_	_	10	20	40	40	50	50
C4	_	_	10	20	20	30	30	40	40	50
C5	_	_	_	_	_	_	_	_	_	0
C6	_	_	20	30	30	40	50	60	70	80
C7	_	_	_	_	10	10	10	20	30	40
C8	_	_	_	_	_	_	_	_	_	0
C9	_	_	_	20	20	30	30	40	40	50
C10	_	_	20	20	30	40	50	60	70	80
C11	_	_	_	_	_	_	_	_	_	0
C12	_	_	_	_	_	_	_	_	_	0
C13	_	_	_	_	_	_	_	10	20	20
C14	_	_	_	_	_	_	_	_	10	20
C15	_	_	_	_	_	_	_	_	_	0
C16	_	_	_	_	10	10	20	20	40	50
C17	_	_	_	_	10	10	10	20	30	40
C18	_	_	_	_	_	_	20	30	40	50
C19	_	_	_	_	_	_	_	_	_	0
C20	No fruit									

C1:Aho avegh, C2:Ako ago, C3:Dan acre, C4:Dan hausa, C5:Dan karufi, C6:Gou, C7:Liye, C8:Ishaze, C9:localwrinkle, C10:Igede, C11:Boomerang, C12:Cobra, C13:Roma savannah, C14;RomaVF, C15:Rio grande, C16:Tima, C17:Tropemech, C18:peto 86, C19:Tomato 82B, C20:Plum roma

DISCUSSIONS

Different cultivars exhibited variation in their growth and yield parameters. Characteristics such as plant height, stem girth, number of leaves, number of days to flower initiation and 100% percent flowering and yield parameters such as average fruit size, average fruit weight per cultivar, fruit length, fruit circumference varied from cultivar to cultivar and in most cases were significantly different from each other when subjected to analysis of variance. This variation can be attributed to their various genetic properties. cultivars differ in their growth and yield potential depending mainly on the physiological process which is controlled by interplay of both genetic make-up and

the environment. Differential performance of crop variety could be attributed to genetic variability, adaptability, morphological features, and physiological factors during the crop growth period. This observation agreed with that of the earlier researches in this area of study. Isah *et al* (2014) recorded significant differences in plant height by tomato cultivars (47.60-110.50 cm). The tallness, shortness and other morphological differences recorded are varietal characteristics, which are controlled and expressed by certain genes. These results coincide with the findings of Haque *et al* (1988) who reported difference in the growth parameters of tomato lines. Kallo *et al* (1998) and Manoj and Ragav (1998) also reported differences in growth parameters among cultivars/hybrids of tomato put under evaluation and screening trials. There were significant differences in the yield attributes (fruit weight, fruit number, fruit circumference, fruit length) of the various cultivars tested in this experiment. These significant differences were observed across the cultivars. Boomerang, Cobra, Igede , Ishaze and Rio grande were significantly better than other cultivars as higher yield output were realized in those cultivars. Tropimech, Dan hausa, Dan acre recorded the lowest yield attributes. Plum roma did not produce a single fruit even though flowers were produced. This observation was consistent for the two years of experimentation. This observation agreed with Kallo et al (1998) who reported variation in the yield attributes of various cultivars tested in their experiment. The yield of the various cultivars in their experiment varied between2.85 – 7.40 kg per plant. The result shows that variation in yield among the cultivars was statistically significant.

There was variation in the rotting of fruit across the cultivars when selected fruit were placed in shelf and observed for ten days (table6). Tomato 82B, Rio grande, Boomerang, Cobra and Ishaze cultivars recorded zero percent rot at the end of the observation period implying that there was no fruit rot among the listed cultivars after ten days in the shelf. However, other cultivars like; Aho aveg, Igede, Gou, Dan acre recorded a fruit rot range of 50 – 80% within the period of ten days when observation was carried out. This fruit rotting is a major challenge in tomato production enterprises as most fruit hardly get to

the market before damage due to rotting. It is therefore essential to plant tomato cultivars that can maintain a long period of wholesomeness either in store or in transit to the market. Global postharvest losses of tomato are as high as 30-40%. It is much higher in developing countries like Nigeria due to improper handling procedures and lack of methods to prevent decay (Prigojin *et al.,* 2005). As a way of increasing the profit margin of stake holder in the tomato value chain, there is a need to reduce damaged tomato at the point of marketing and this can be achieved through planting of tomato that have a long period of shelf life as it will also reduce s the damage threshold of tomato when it is been transported from one place to another. Idah *et al.,* 2007 reported that damaged fruits mainly consisted of bruised, rotten, compressed and water-soaked fruits. In particular, an average of 13.89% of fresh tomato fruits was reportedly damaged during transportation. This means, in every consignment of 7,500 kg (lorry load) of tomato fruits about 1041.67 kg (representing 13.89%) of the fresh tomato fruits would be bad. In terms of money, for an average price of N200.00 per kg, the losses due to this damage is about N200, 000.00 per lorry load if such damaged fruits are completely discarded.

CONCLUSION

Tomato still remains a vegetable of choice for man consumption though highly perishable and the large-scale production of this crop is limited to the northern part of Nigeria where there is clement weather condition for commercial production while there is limited production in the middle belt and southern part of the country. Because of the gap in tomato supply in the middle belt and southern part of the country especially in the southern guinea savannah ecological zone, there is a need for importation of can tomato from other countries especially when the supply gap cannot be bridged based on the supply from the northern Nigeria. Part of the strategy that can foster sustainable production in the areas, where there are gaps is by getting the right cultivars with the good shelf life. In this experiment, the listed cultivars; Rio grande, Boomerang, Cobra, Ishaze and are known to exhibit the desirable traits, they are therefore selected for further investigation.

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