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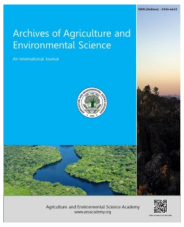

ORIGINAL RESEARCH ARTICLE

CrossMark

Effects of crossbreeding on fruits characteristics of two species of tomatoes (*Solanum esculentum* L. and *Solanum pimpinellifolium* L.)

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ABSTRACT

Solanum esculentum L. and *Solanum pimpinellifolium* L. (species of tomato) were crossbred to raise F1 so as to assess the effect of crossbreeding as a tool for tomato improvement as shown in yield. This was done by emasculating *S. esculentum* using it as female parent and transferring ripe pollen grains from *S. pimpinellifolium* the male parent using artificial means. Analysis of Variance (ANOVA) was employed in data analysis. Result showed that the parental plants and F1 hybrid differed significantly in fresh fruit weight, number of seeds per fruit, fruit colour, fruit width and fresh fruit length. F1 hybrid had the highest number of seeds per fruit when compared to the parental plants. *S. esculentum* recorded the highest fresh fruit weight, fruit width and fresh fruit length when compared to *S. pimpinellifolium* and F1 hybrid, though the F1 hybrid was statistically at par with *S. esculentum* in fresh fruit length. *S. pimpinellifolium* had the least fresh fruit weight, fruit width, number of seeds per fruit and fresh fruit length (1.80± 0.01, 8.03 ±1.0, 110.56 ± 0.01 and 4.00 ± 0.03, respectively). *S. pimpinellifolium* had a very dark red coloured fruits, followed by the F1 hybrid with dark red coloured fruits. *S. esculentum* had a light red coloured fruits based on the colour guide and the scale point used. The obtained data indicated that when two tomato plants of different but closely related varieties are crossbred, a new variety that combines the characters of the parental plants and enhanced genetic attributes is produced. F1 hybrid had the highest number of seeds per fruit and though had fruits smaller in size than *S. esculentum* but performed better than *S. pimpinellifolium* indicating that crossbreeding could be a tool for tomato improvement.

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INTRODUCTION

Most of the crop plants existing in the world today have been in existence as far back as the early times (Emedo *et al*., 1995 and Ilodibia *et al*., 2010). Some of these crop plants as we know them today have changed tremendously both in their physical appearance and in structure (Emedo *et al*., 1995 and Ilodibia *et al*., 2010). Long ago, most of these plants were growing wild unattended and uncared for (Emedo et *al*., 1995). At first, man accepted what nature had provided for his survival. Crossbreeding, inbreeding and selection of plants occurred naturally without man's interference (Emedo et *al*., 1995 and Ilodibia *et al*., 2010). Only the plants that could withstand adverse weather and environmental conditions survived. Eventually man found out that certain plants were more useful to him. He learnt that if he could select best seeds for planting and if he could use certain cultural practices he could obtain large quantities and better quality of food for his family and the world at large. By purposeful manipulation of plants, (crop breeding otherwise) the desired characteristics of plants are produced for the benefit of man.

Crop breeding contributes substantially to greater agricultural sustainability which will be accomplished not only by the breeding of basically higher yielding varieties but also by development of varieties that help to stabilize production through resistance to disease , drought, heat, cold and wind (Allard, 1960). Increased yield has been the ultimate aim of most breeders. Sometimes this has been accomplished by providing varieties basically more productive, not because of specific improvements such as in disease resistance but as a result of generally greater physiological efficiency (Allard, 1960).

Tomato belongs to the genus *Solanum* of the family Solanaceae. It is one of the most important fruit crops in the world. It ranks second in importance to potato in many countries (Parray *et al*., 2007). *Solanum* species are native of Ecuador, Peru, and the Galapagos Island, though most evidence suggests that the site of domestication was Mexico (Taylor, 1986). Tomato is highly versatile and is used in thousands of recipes right across Europe, from ketchup to chowder, pizzas to bloody marys (Smith, 1994). In Nigeria, tomato is a special ingredient in the food of both the poor and the rich. The tomato stew is eaten with relish, especially on Sundays and during festivals. Tomatoes have both nutritional and medicinal values. It is important for neutralizing the acids produced during the digestion of meat and other fatty acids (Ilodibia *et al*., 2010). It is valuable roughage which promotes digestion and helps to alleviate constipation (Parray *et al*., 2007). Tomato is a source of carbohydrates, fats, proteins, vitamins and minerals which when eaten makes the eye brighter than using cosmetics on it (Gojale, 2002; Chopra *et al.,* 2017). It can be grinded and canned for industrial and economical purposes. It can also be used for horticultural purpose (Ilodibia *et al.,* 2010).

Several species of tomato (*Solanum)* exist including *Solanum esculentum* and *Solanum Pimpinellifolium.* Studies have shown that yield in tomato is mainly formed by fruit size QTLs, whereas the remaining factors like soluble solids, locule may play a complementary role in the expression of tomato yield (Aurelio, 2015). *S. esculentum* is a medium-large fruited size modern cultivated species that bear 2-4 locules, but has small-moderate lycopene content, low disease resistance, light red and low fruit soluble solid (Chen *et al*., 1999 and Khalf-Allah *et al*., 1972). On the other hand *S. pimpinellifolium* is a small-fruited wild species that bear 2-locules but is known for high disease resistance, high fruit soluble solids, high lycopene content and deep red in colour (Chen *et al*., 1999 and Khalf-Allah *et al*., 1972), both of which are extremely important traits to tomato industry. Lycopene, the primary determinant of red color of the tomato fruit, is an important indicator of fruit quality and a vital factor for making high-quality products in processing industries. Soluble solids and lycopene have been extensively studied by tomato geneticists and breeders and considerable efforts have been made to improve these traits in new cultivars (Chen *et al*., 1999 and Khalf-Allah *et al*., 1972). Furthermore, the modern scientific method of crop improvement was necessitated by the present demands of modern man for good quality crops; having good taste, early maturity, increased yield, more nutrients and that can meet the immediate needs of man in terms of food and raw materials (Ilodibia *et al*., 2014 and 2015). Hence, this research aimed at hybridizing two species of tomato *Solanum esculentum* and *Solanum Pimpinellifolium* to produce a hybrid that might combine the qualities of the two varieties with substitution of their undesirable traits to meet the popular demands of the society. Such a hybrid of the two varieties is likely to be of better quality and demand than either of the two varieties. Accordingly, the problem and focus of the researchers is to crossbreed the two species S. *esculentum* and *S. Pimpinellifolium* and compare their yield with that of the hybrid. It will cover the first filial generation in related qualities.

MATERIALS AND METHODS

Source of materials: The species of tomatoes used for the study were collected between the months of April- May 2016 from the Botanical garden Amawabia, Anambra State. These species were authenticated by a plant taxonomist in the Department of Botany Nnamdi Azikiwe University, Awka where the specimen vouchers were deposited.

Area of study and research design: The experiment was carried out at the teaching and research farm of Department of Botany, Nnamdi Azikiwe University Awka, Anambra State, Nigeria. Design of the study was Randomized Complete Block Design replicated three times.

Materials and experimental procedure: Seeds of two species of tomato (*Solanum esculentum* and *pimpinellifolium)*, twenty (20) black polythene bags, weighing balance, twine, and metre rule, a pair of forceps, aluminium foil, animal manure and loam soil were used for the experiment. After the seeds were obtained, a viability test was carried out on them. This was done by soaking a handful of each variety in a beaker containing distilled water for approximately 3 minutes. The seeds that floated on the surface of the soil were discarded while those that sank to the bottom of the beaker were sown in a transparent glass jar containing loamy soil. After six days, germination occurred proving the seeds to be viable. A total of twenty black polythene bags were obtained, perforated and filled with 5kg of loamy soil each. Ten of the polythene bags were labelled *S. esculentum* while the other ten were labelled *S. pimpinellifolium* which are the two species to be studied. The seeds of each species were broadcast accordingly on the soil surface (six seeds per bag). The seedlings were later pruned to three seedlings per bag when they were 10 cm high. Flowering of the *S. esculentum* started at 50 days and continued when at 55 days *S. pimpinellifolium* started flowering. It was at this stage that the crossing or hybridization was done. Artificial crossing was adopted because tomato is a self-pollinating crop. This involved the removal of anthers with a pair of forceps from the *S. esculentum*, thus using it as a female parent before it dehisces and covering it with a study bag (foil) to avoid natural crossing by insects. This was followed by the collection and transference of ripe pollen grains from the *S. pimpinellifolium* (male parent) to the stigma of the emasculated plant (*S. esculentum)*. Although several crosses were made but only few were successful. This pollination process was followed by fertilization and subsequent production of fruits (the F_1 hybrid). This procedure is as outlined by (Ilodibia *et al*., 2014).

Data collection and statistical analysis: Data were collected on fresh fruit weight, fruit width, fruit colour, number of seeds per fruit and fresh fruit length (cm) of parental plants and F1 hybrids. Fresh fruit weight was determined by weighing after harvesting using the weighing balance. Number of seeds per fruits was determined by visual counting after harvesting and drying. Fruit length was obtained by cutting the fruits longitudinally and measuring, in (cm), from stem to blossom end. Fruit width was measured using measuring tape. Fruit colour was obtained using colour guide and compared on a scale of 1- 4, 4 - very dark red, 3- dark red, 2- light red, 1- very light red. Data collected were subjected to the analysis of variance (ANOVA) and treatment means were separated using Duncan multiple range test at 5% level of probability. Differences in mean value were considered significant at $P<0.05$.

RESULTS AND DISCUSSION

Results of the study are presented in Table 1. Results indicated that when two tomato plants of different but closely related varieties are crossbred, a new variety which possesses improved characters of the two parent plants and additional genetic attributes are produced. This is a strong expression of hybrid vigour. Secondly, when two plants with a pair of contracting characters are crossbreed, one of the characters would often appear in the offspring while the other remained masked. The results showed significant differences ($P< 0.05$) between the parental species and the F1 hybrid in fresh fruit weight, number of seeds per fruit, fruit colour, fruit width and fresh fruit length supporting hybrid vigour. Accordingly, F1 hybrid recorded highest number of seeds per fruit when compared to the parental plants indicating hybrid vigour. This result is in line with what Anthony (1992) said that crossbreeding can lead to increase in genetic variation in the population. It encourages the expression of hybrid vigour. *S. esculentum* recorded the highest fresh fruit weight, fruit width and fresh fruit length when compared to *S. pimpinellifolium* and F1 hybrid. The F1 hybrid is statistically at par with *S. esculentum* in fresh fruit length. *S. pimpinellifolium* had the least fresh fruit weight, fruit width, number of seeds per fruit and fresh fruit length. This finding conforms to what Mendel (1866) pointed out that when two plants with a pair of contracting characters are crossbreed, one of the characters would often appear in the offspring while the other remained masked. The characteristics that appeared in the offspring he called dominant characteristic while the one that did not appear he called recessive characteristic. Hence, Mendelian first law of segregation states that, the characteristics of an organism are controlled by genes which occur in pairs, of such a pair of genes only one can be carried in a single gamete. Similarly, the difference in fresh fruit weight, fruit width, and fresh fruit length of S. *esculentum* and *S. pimpinellifolium* in relation to the F1 hybrid showed that *S. esculentum* has a number of dominant characters (Table 1). Furthermore, the F1 of the cross although showed expression of hybrid vigour, had fruits smaller in size (fruit weight, fruit width, fruit length) than *S. esculentum* but higher than *S. pimpinellifolium* (Table 1). This agrees with the findings of Ilodibia *et al*. (2014) and Anaso (1982) where they crossed S. *aethiopicum* and *S. anomalum* and *C. annuum* and *C. frutescens* respectively. This finding also tally with the Allard (1960) opinion that the progeny of crossbreeding will combine many of the qualities of both parents, thus producing a crop which is superior in some extent to either of the parents. Finally, S. *pimpinellifolium* had a very dark red coloured fruit, followed by the F1 hybrid with dark red coloured fruit. *S. esculentum* had a light red coloured fruits based on the colour guide and the scale point used. Red color of the tomato fruit is an important indicator of fruit quality and a vital factor for making high-quality products in processing industries.

Table 1. Average fresh fruit weights, No. of seeds per fruit, fruit colour, fruit width and fresh fruit length of *S. esculentum, S. pimpinellifolium* and F1 generation.

Tomato species	Fresh fruit weight (g)	No. of seeds per fruit	Fruit colour	Fresh fruit width (cm)	Fresh fruit length (cm)
S. *esculentum*	2.28± 0.02 [a]	128.06 ± 0.02 [b]	Light red- 2.00	15.23 ±1.0 [a]	5.00 ± 0.05 [a]
S. pimpinefolium	1.80± 0.01 [b]	110.56 ± 0.01 [c]	Very dark red-4.00	8.03 ±1.0 [c]	4.00 ± 0.03 [b]
F1 generation	2.25± 0.02 [a]	135.05 ± 0.01 [a]	Dark red- 3.00	13.10 ±1.1 [b]	4.08 ± 0.02 [a]

Results are in mean± standard deviation. Columns followed by the same letter are not; significantly different at $P<0.05$ level of significance.

Conclusions

The obtained data indicated that when two tomato plants of different but closely related varieties are crossbred, a new variety that combines the characters of the parental plants and enhanced genetic attributes is produced. F1 hybrid had the highest number of seeds per fruit and though had fruits smaller in size than *S. esculentum* in fresh fruit length but performed better than *S. pimpinellifolium* indicating that crossbreeding could be a tool for tomato improvement.

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