Population Performance of F_3 Progenies Obtained from Interspecific Crosses between the Wild and Cultivated Tomatoes

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Abstract

Large populations of four F_3 families namely; Wild x Roma, Wild x Local, Wild x Tropica and Local x Tropica were evaluated for growth, yield and yield components under rainfed conditions of the derived savanna ecology of Nigeria. The results showed that the progenies did not differ with respect to number of days to anthesis. The F_3 hybrid between two cultivated tomatoes, Local x Tropica was taller than the progenies with the wild parentage. The reverse was however, the case with respect to the number of branches, trusses and fruits per plant as the offspring with the Wild parentage performed better than the hybrids obtained from the two cultivated tomatoes. The existence of transgressive segregants in all the families is a positive indication that selection would be effective in the improvement of the metric traits.

Introduction

Tomato improvement has predominantly been accomplished through conventional plant breeding methodologies and this approach shall continue to be the most effective procedure in the near future. Novel approaches involving biotechnological tools have emerged and are attracting patronage and would continue to complement the conventional breeding methods. Field crosses and cytological studies (Uguru and Atugwu, 2001) have shown that it is possible to produce hybrids between cultivated tomatoes *(Lycopersicon esculentum)* and the Wild relative (*L. pimpinellifolium)* by conventional breeding methods. The interspecific hybrids arising from these crosses have shown high level of pollen viability and fertility, a phenomenon that has permitted the furtherance of the new hybrids to higher generations. Such interspecific hybridizations stand at a priority with emphasis assigned to the wild species because of its genetic proximity to the cultivated tomato (Chen and Foolad, 1999). This species has also been associated with a wide range of tolerance to biotic and abiotic factors (Foolad and Lin 1999; Tanksley *et al.*, 1996; Grandillo and Tanksley, 1996a, 1996b; Miller and Tanksley, 1990) that would be utilized in the improvement of the commercially cultivated tomatoes that are largely vulnerable to such stresses.

Elite tomato varieties are grown under rainfed conditions with irregular fresh fruit yields depending on the prevailing weather conditions. Modern agricultural technology demands cultivars with satisfactory stable mean yields. To achieve this would require selection for adaptation to specific locations endowed with peculiar environmental conditions. A wide tomato germplasm base would be necessary for such a crop improvement programme. Thus, this study was set up with the aim of evaluating the growth and yield performance at the F_3 generation of inter - specific hybrids obtained from crosses between cultivated tomatoes and their wild relative.

Materials And Method

The materials used in this research comprise three cultivated tomatoes viz; Roma, Tropica and Local and one wild tomato relative, *Lycoperscion pimpinellifolium.* These were evaluated with four F_3 derived from Wild x Roma, Wild x Local, Wild x Tropica and Local x Tropica. These were obtained from the

Department of Crop Science, University of Nigeria, Nsukka tomato breeding stock.

The seeds of the experimental materials were sown in nursery boxes filled with a soil mixture of top soils, well-cured poultry droppings and river sand mixed at a ratio 3: 2:1 by volume. The nursery was shaded with palm fronds to reduce the direct impact of sunshine. Seedlings were transplanted in single row plots at an intra-row spacing of 45 cm on ridges spaced 1 metre apart. Weeding was done manually with the weeding hoe and NPK complete fertilizer (15-15-15) was applied at the rate of 12.74g at two weeks after transplanting.

Data were collected on days to anthesis, plant height at flowering, branches/plant, trusses/plant, fruits/plant and fruit yield/plant. Characters such as number of braches, trusses, and fruits per plant were counted on a plant basis. Days to anthesis were determined as the days from planting to when the flowers opened. Plant height was measured using a metre rule. Fruit yield per plant was measured using a mettler balance and recorded in grammes.

The data collected were fitted into frequency distributions using the SPSS software package version 10.0.

Results

Days to anthesis: Figure 1 shows the frequency distribution of the hybrids in days to anthesis. The four families had frequencies that approximated normal distribution and were endowed with similar mean values. The distributions showed strong tendencies towards early anthesis as the family means were lower than those of the parents in all the crosses.

Plant height: With respect to plant height (Fig, 2), the families showed continuous distribution with a mean of 25.8 cm for Wild x Local; 27.6 for Wild x Roma; 24.4 for Wild x Tropica and 34.3 for Local x Tropica. Transgressive segregants were observed in both directions in all the progenies but with a bias towards tallness.

Branches/plant: The number of branches per plant ranged from 1 to 17 with a mean of 6.8 in Wild x Local; 1 to 16 with a mean of 8.0 in Wild x Roma; 1 to 12 with mean values of 6.0 and 6.8 for Local x Tropica and Wild x Tropica, respectively (Fig. 3). The progeny, Wild x Roma was the most prolific in branching. Extreme segregates exceeded the parental means in favour of profused branching habit.

Trusses/plant: The mean number of trusses of the F_3 families exceeded those of the better parent in all the crosses (Fig. 4). Transgressive segregation was discernable in the positive direction. In all the crosses, differences among the F_3 means were appreciably large with the cross, Local x Tropica having the smallest range with a mean of 6.4. The hybrids with the wild parentage, Wild x Local, Wild x Tropica, and Wild x Roma produced higher number of trusses than the offspring of the two cultivated tomatoes.

Fruits/plant: With respect to fruits per plant (Fig. 5), the families maintained a trend similar to that of number of trusses per plant. The interspecific hybrids produced more fruits than the offspring of the two cultivated tomatoes. The interspecific hybrids took after their wild parent in the inheritance of fruit number. Fruit number ranged from 3 to 340 with a mean of 81.6 in Wild x Local; 5 to 429 with a mean of 79.8 in Wild x Roma; 5 to 215 with a mean of 69.4 in Wild x Tropica and from 1 to 47 with a mean of 12.9 in Local x Tropica. The mean number of fruits obtained from the interspecific hybrids was five times or more than that of the hybrid arising from the two cultivated tomatoes.

Fruit yield/plant: The fruit yield in the different families averaged higher than the means of their respective parents (Fig.6). Although, skewed, the spread is indicative of continuous variation. Extreme segregants exceeded the means of the parents in all the crosses. The F_3 from Wild x Tropica had the largest fruit yield range of 1 to 1,100g with a mean of 33.97 g/plant. Using the mean values alone, the hybrid, Local x Tropica had the highest fruit yield/plant.

Discussion

All the individual families showed continuous distribution with no evidence of segregation due to major gene effects. There were no discernable inter family differences in the days to anthesis. Their distributions centred around their respective mid-parental values. But within family variations were observed as many individual plants in each family had the tendency to flower over an extended period of time. Synchronous anthesis is a desirable attribute as it promotes uniform maturity and allows for organized harvest and sale of produce. The similarity in days to anthesis among the F_3s suggests the existence of potentials for increased synchronization of flowering among the offspring arising from the interspecific hybrids. There was a wide range in plant height in all the different F_3s. The spread around the mean suggests the existence of short internode, normal internode and long internode genotypes in the various families. This provides a good opportunity for selection either for dwarf erect genotypes or relatively massive bushy types. The progenies varied greatly with respect to branching habit. The F_3 from Wild x Roma branched more profusely with a mean of eight branches/plant in comparison to the hybrids, Wild x Local, Local x Tropica and Wild x Tropica with means of 6.8, 6.0 and 6.8, respectively. Extreme segregants would appear to be more beneficial from the Wild x Local and Wild x Roma crosses as plants with up to 18 branches could be isolated. The number of branches per plant is an important yield component as the fruit bearing trusses are borne on the branches. Literally therefore, this agronomic feature would describe profuse branching habit as a desirable agronomic trait and selection based on prolific branching habit would

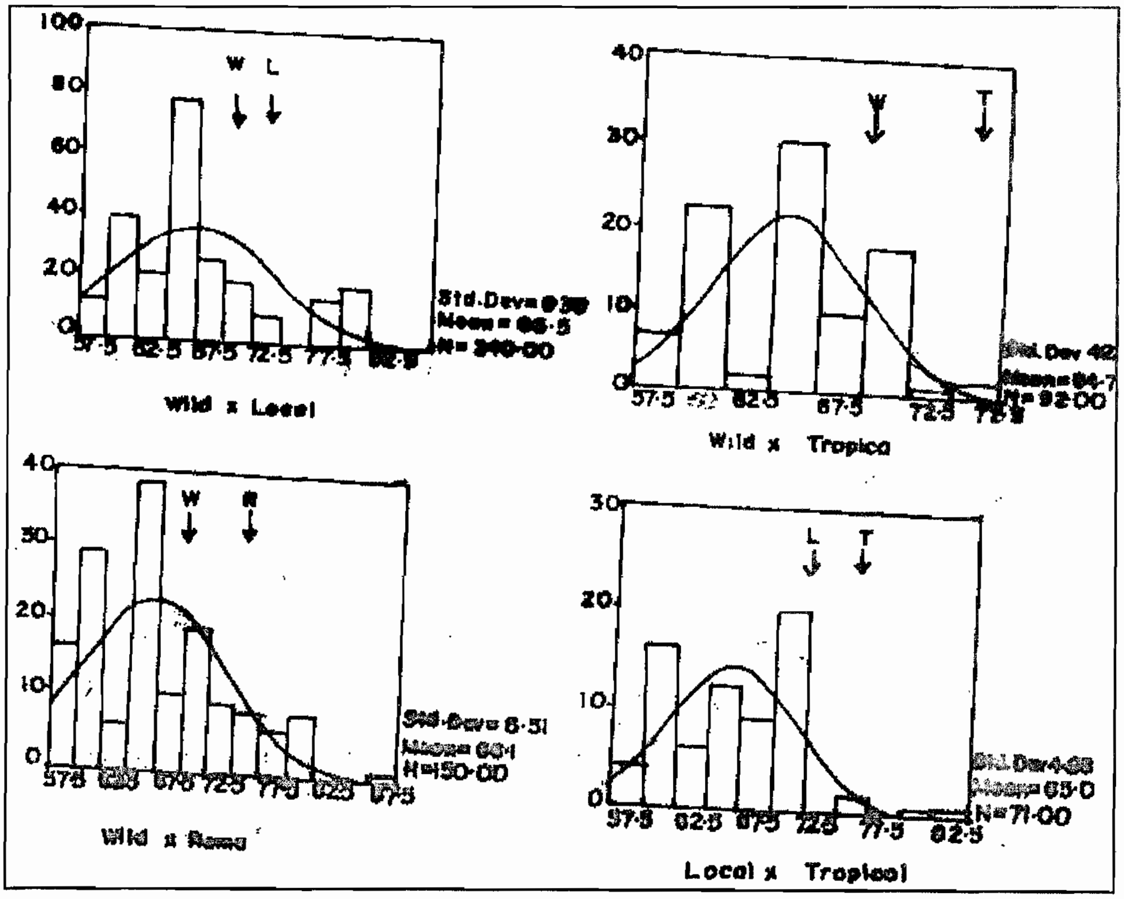

Fig. 1: Frequency distribution for days to anthesis of four tomato F_3 generations (L = local, W = wild, T = Tropica and R = Roma)

Table 1: Records on the quantitative characters of the F_3 tomato hybrids (Range, mean, and standard deviation values)

CHARACTER	CROSS	RANGE	MEAN ± SE	SD
Days to anthesis	*I	57 – 84	66.53	6.39
	II	57 – 87	66.29	6.51
	III	57 – 74	64.73	4.22
	IV	57 – 82	65.8	4.98
Plant height	I	10 – 85	25.80	10.25
	II	6 – 51	27.60	6.11
	III	10 – 38	24.40	5.35
	IV	21 – 58	34.30	8.56
Branches/ plant	I	1 – 17	6.80	3.44
	II	2 – 16	8.00	2.88
	III	1 – 11	6.80	2.03
	IV	2 – 12	6.00	2.14
Trusses/Plant	I	2 – 83	21.5	14.10
	II	2 – 75	20.5	14.15
	III	1 – 39	17.6	10.00
	IV	1 – 13	6.4	3.38
Number of fruits/plant	I	3 – 340	81.60	62.52
	II	5 – 429	79.80	69.92
	III	5 – 215	69.40	49.30
	IV	1 – 47	12.9	8.41
Fruit yield/plant	I	4 – 917	246.90	206.70
	II	6 – 1035	264.10	208.17
	III	18 – 1112	339.70	243.73
	IV	17 – 927	347.00	220.17

** I = Wild x Local II = Wild x Roma III = Wild x Tropica IV = Local x Tropica*

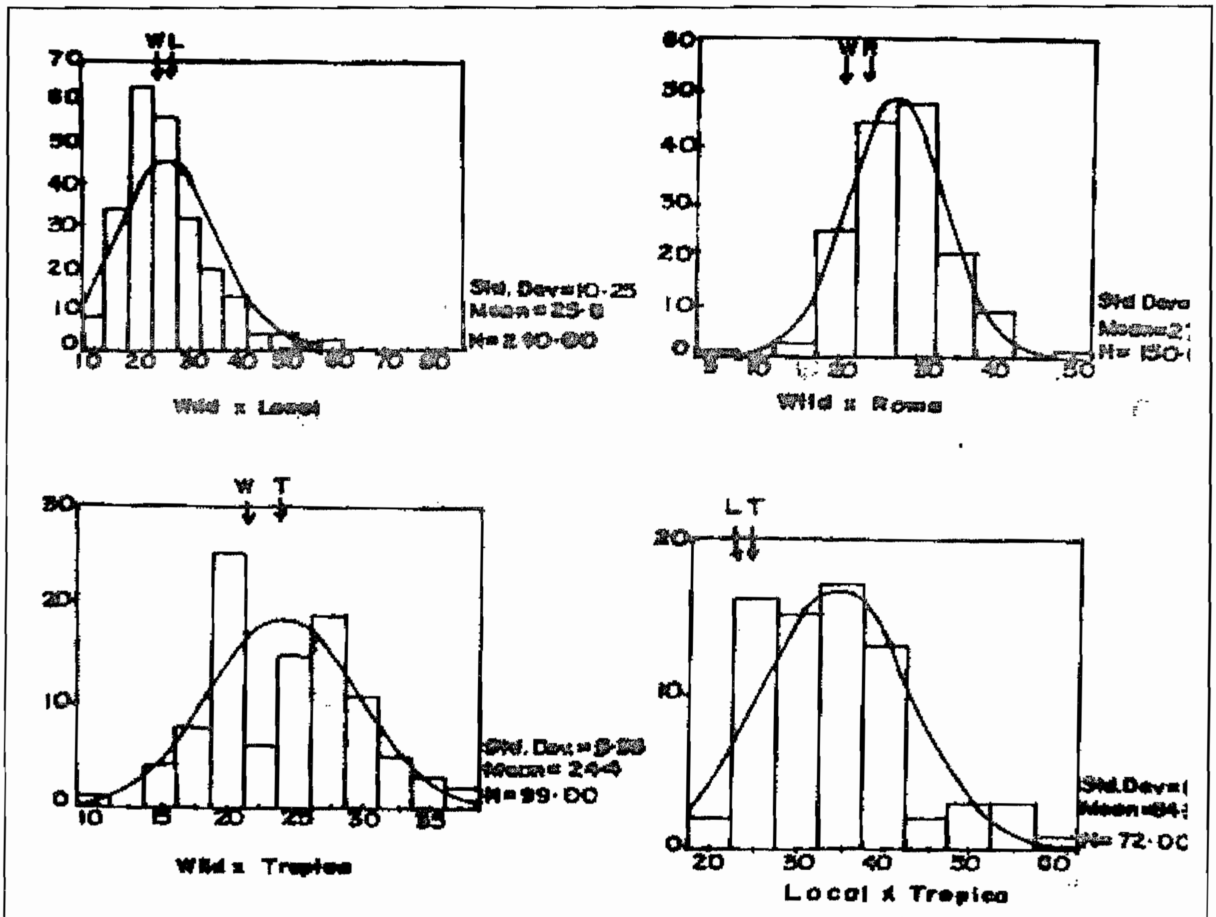

Fig. 2: Frequency distribution for plant height at flowering of four tomato F_3 generations (L = local, W = wild, T = Tropica and R = Roma)

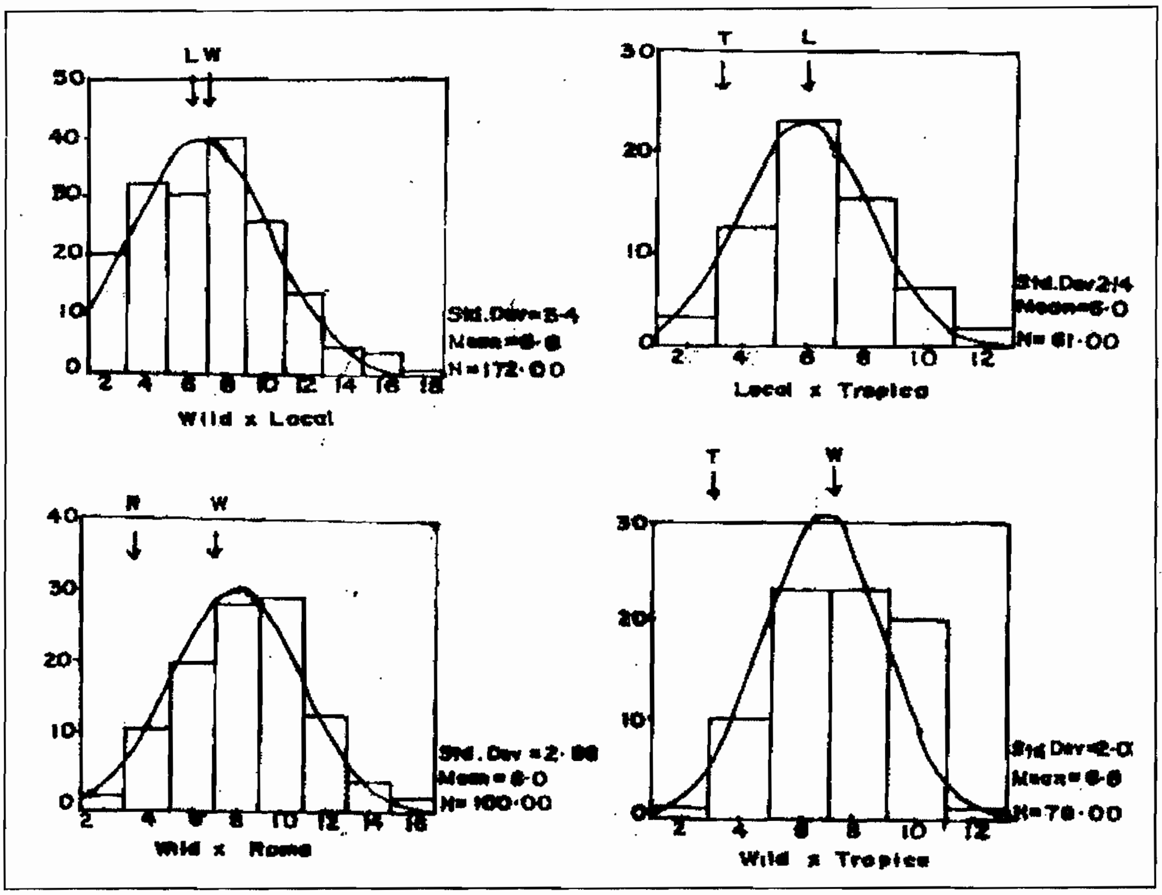

Fig. 3: Frequency distribution for number of branches of flowering of four tomato F_3 generations (L = local, W = wild, T = Tropica and R = Roma)

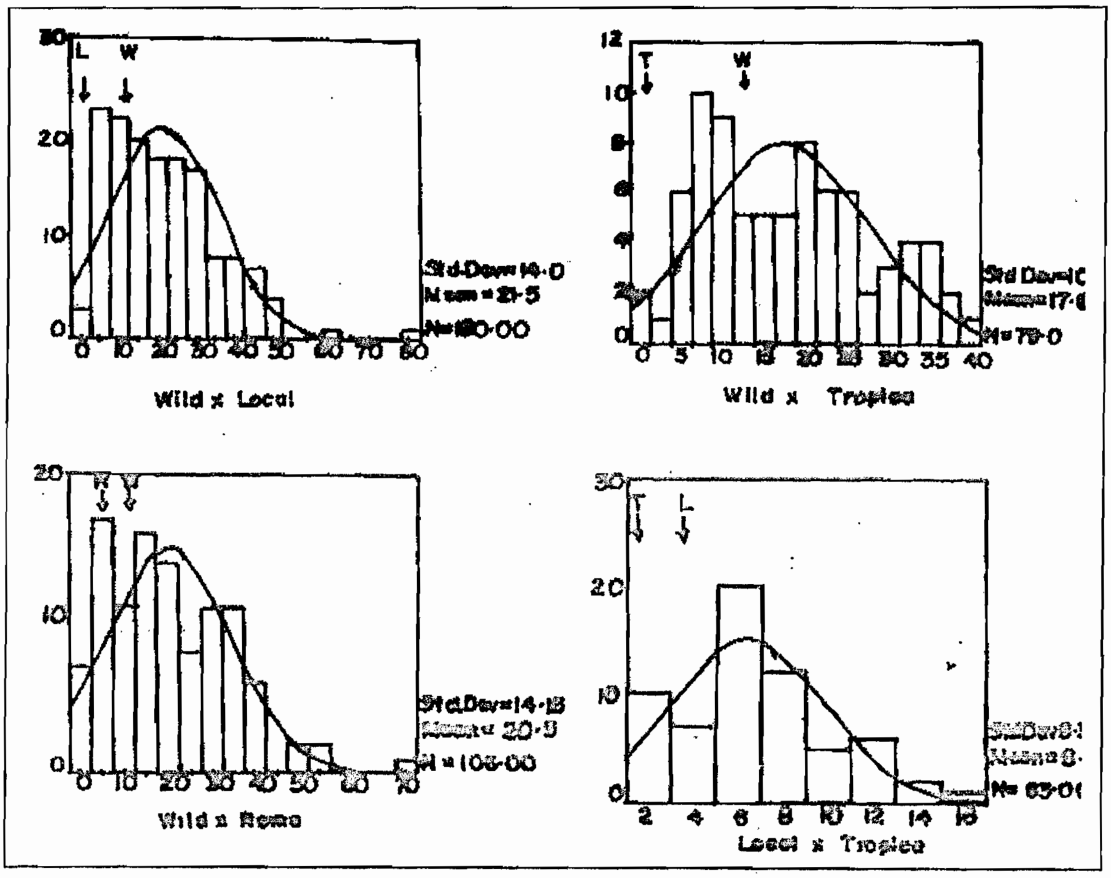

Fig. 4: Frequency distribution for number of trusses per plant of four tomato F_3 generations (L = local, W = wild, T = Tropica and R = Roma)

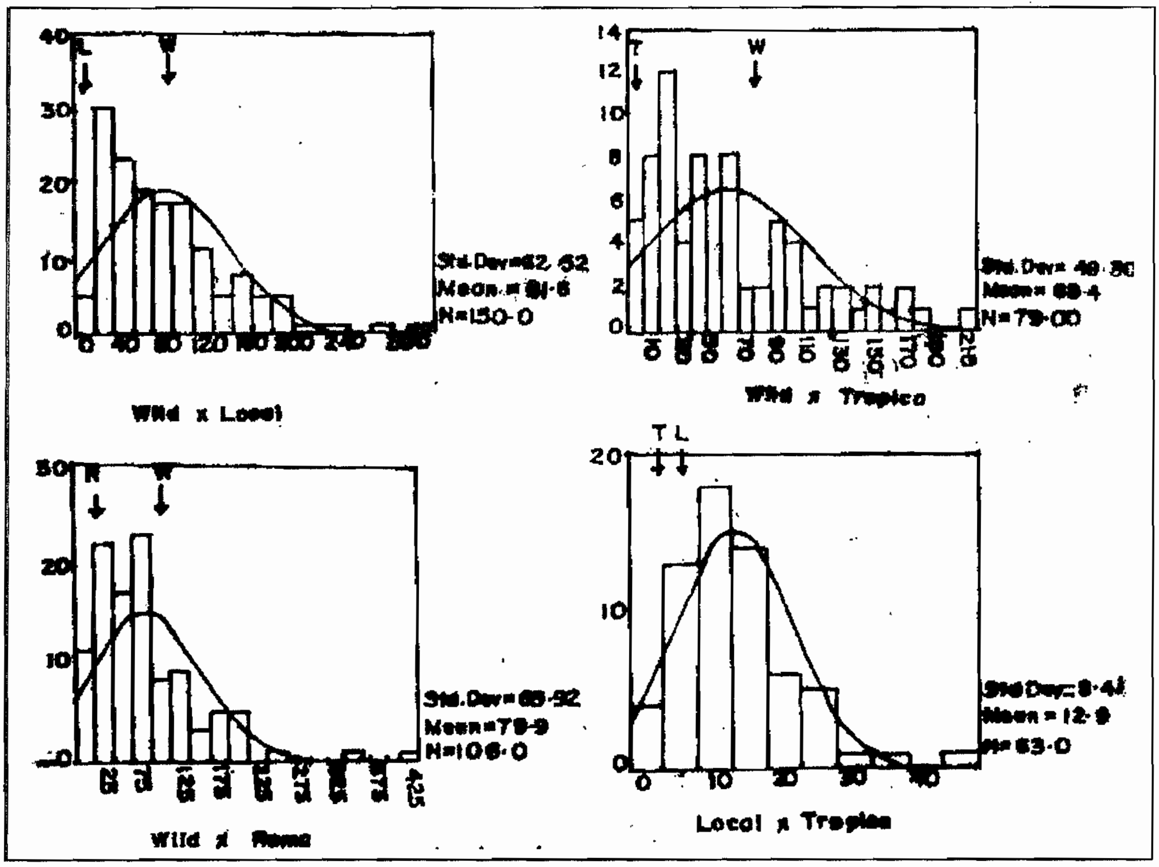

Fig. 5: Frequency distribution for number of fruits per plant of four tomato F_3 generations (L = local, W = wild, T = Tropica and R = Roma)

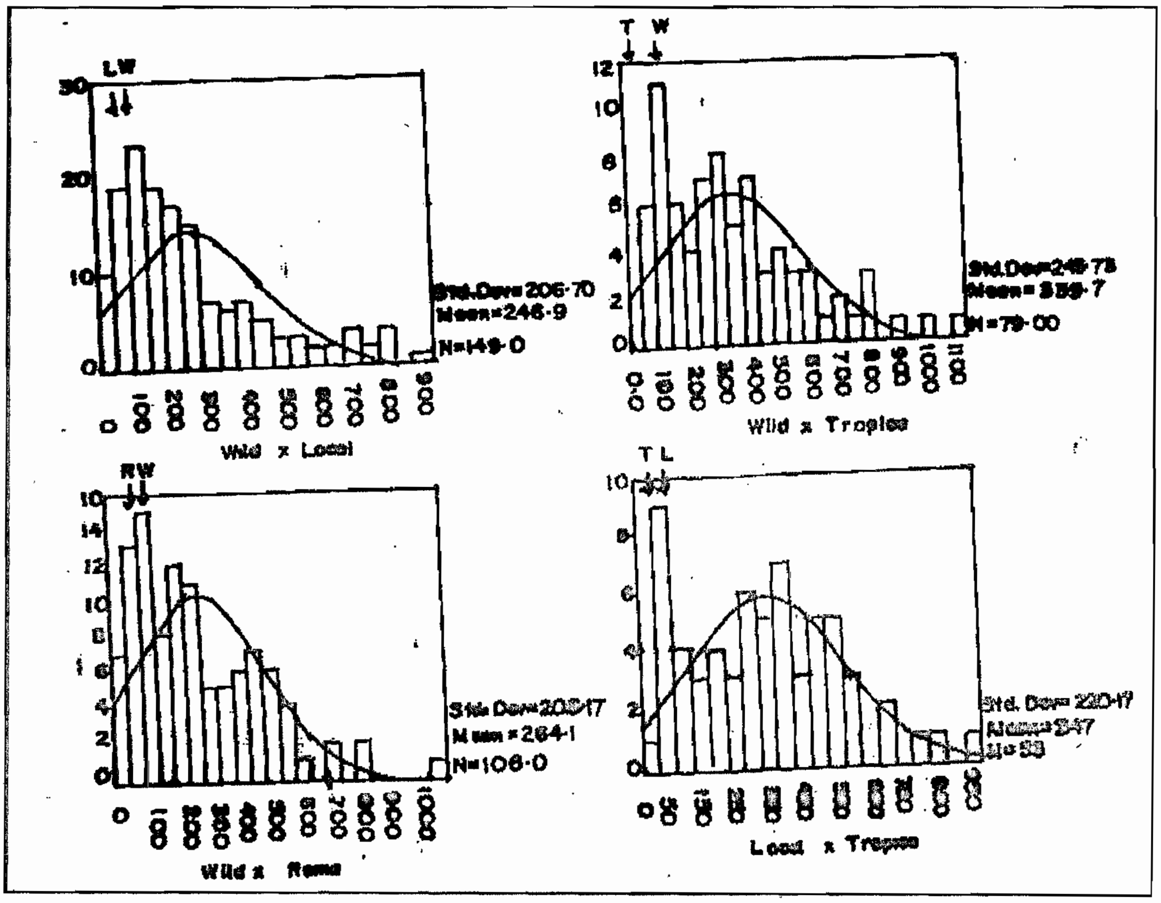

Fig. 6: Frequency distribution for fruit yield per plant of four tomato F_3 generations (L = local, W = wild, T = Tropica and R = Roma)

be reliable in yield improvement. The differences between the family means in number of trusses per plant are of great agronomic value. Because of its cardinal role as the fruit bearing structure, higher number of trusses should be given substantial weight in any selection aimed at increasing fruit yield in tomatoes. Variation in terms of number of trusses per plant was highest in the cross, Wild x Local and plants with as many as 80 trusses were recorded. This was closely followed by the hybrids Wild x Roma and Wild x Tropica in that order. The occurrence of some transgressive segregants with respect to fruits/plant in the F_3 distribution that is skewed towards reduced fruit number indicate the influence of complementary factors in the inheritance of fruiting ability in tomatoes.

The higher fruit yield per plant of Local x Tropica in comparison to the other crosses is contrary to expectation as it ranked least in number of fruits per plant. This could be linked to the differences in the size of fruits produced by Local x Tropica and the interspecific hybrids. That the 12.9 fruits produced by Local x Tropica weighed more than the 81.6 fruits, 79.8 fruits and 69.4 fruits produced by Wild x Local , Wild x Roma and Wild x Tropica is an indication that the hybrids of the two cultivated tomatoes had larger fruit size. The hybrid, Local x Tropica, like the two parents produced large fruits (Uguru and Atugwu, 2001) in contrast to the progenies with the Wild parentage with reduced fruit size arising from the effects of the wild parent (Uguru and Onwubiko, 2002). This observation is in line with earlier reports that small fruit size had dominating effects over large fruit size in blackberry (Caldwell and Moore, 1982) and in raspberry (Moore *et al.*, 1974).

It is evident from these results that substantial improvements through selection are possible even at F_3 generation. Selection from the extreme segregants would change the gene frequency thereby generating new populations with higher mean values than the original parents. Such selections would increase the gene frequencies of the desirable traits (Uguru and Umukoro, 2004) with consequent multiplier effects that would eventually translate to higher mean values.

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