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COMPARATIVE STUDY ON THE SOMATIC CHROMOSOME NUMBER, GROWTH, YIELD AND DISEASE INCIDENCE OF CULTIVATED TOMATOES AND THEIR WILD RELATIVE

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ABSTRACT

Two Lycopersicon species consisting of one local and two exotic varieties of L. esculentum Mill and one wild variety of L. pimpinellifolium Jusl, were evaluated for chromosome number, growth, flowering and fruiting pattern, yield and susceptibility to tomato disease complex in the rainy seasons (May - September) of 1998 and 1999. The somatic chromosome studies showed that both species have chromosome number of 24. The wild variety showed high tolerance to the disease complex associated with high humidity; had the least incidence of flower and premature fruit drop and highest fruit set as measurable indices of adaptation to high humidity conditions. The two exotic varieties and the local variety on the other hand were severely diseased and correspondingly had poorer fruit set. The high fruiting of the wild variety did not however, translate to higher fruit yield on weight basis because of its small-sized fruits.

The indicators of adaptation of the wild tomato to high humidity conditions afford a potential resource for desirable characteristics especially disease resistance. Therefore its hybridization with the cultivated tomato varieties that are susceptible to stresses associated with high humidity and selection from among the segregating generations may provide opportunities for generating adapted tomato lines for the humid tropics.

Key words: Chromosome number, wild tomato, disease, *Lycopersicon esculentum*.

INTRODUCTION

Precipitation limits tomato yield in two ways. When rainfall is scanty and inadequate, the accompanying drought limits tomato growth and yield. Excessive precipitation on the other hand is deleterious to the tomato plant in that the heavy and prolonged rains result in poor soil of low fertility owing to leaching. The high humidity associated with it provides enabling environment for proliferation of insect pests and diseases of tomato (Yang, 1978; Geiseberg and Stewart, 1986; Williams, *et al.*, 1991; Hubell, *et al.*, 1998). As a result, tomato production has, over the years, been restricted mainly to the north of latitude 10°N of Nigeria where the weather is drier and less humid and the night temperatures are considerably lower.

Omidiji (1981) observed that among other things, the relationships of species are usually assessed on such criteria as morphological characteristics, eco-geographical distribution, karyotypic distinction, meiotic chromosomal association, and chemotaxonomic principles and crossability. In many studies with crop species (Seithe, 1971; Anaso and Uzo, 1990), the evaluations of morphological characters and crossability have both been widely used in the establishment of relationships.

The local tomato variety has some good adaptive features to the high humidity conditions but its quality is poor and preference for it is low. The few exotic varieties are susceptible to diseases associated with high humidity and their yield pattern under humid conditions is poor and unstable. For these reasons there has been considerable interest in the development of tomato lines that tolerate high humidity conditions. On the contrary, however, there is paucity of information on this important aspect of tomato production under field conditions. Perhaps suitable genotypes for rather humid environments have not been identified and as such, investigations on such genotypes are rare. Yield stability of tomatoes in the humid tropics requires the genetic improvement of cultivars adapted to stresses associated with high temperature and high humidity. The search for such genotypes would form an important step in such an improvement programme. The present study is aimed at evaluating some cultivated tomato varieties and a wild tomato relative for the attributes which can be exploited in developing high yielding varieties with better adaptation to high rainfall conditions in the tropics.

MATERIALS AND METHOD

Three varieties of *L. esculentum* namely: Roma VF, Tropica and Nsukka local, and a wild species, *L. pimpinellifolium*, that is closely related to the cultivated tomatoes were used. The attributes of these varieties are given below:

Roma VF	-	determinate medium to large plant; average height; and bright red oblong shaped fruits.
Tropica	-	determinate small compact plant with medium dense foliage and deep red round-shaped fruits.
Nsuuka local	-	determinate large plant with dense foliage and bright red multi-ridged round fruits.
Wild variety	-	determinate large plant with small leaflets and bright red tiny round fruits.

For the chromosomal studies, the root tips of the wild and cultivated tomato species were used. The samples were prepared by enzymatic maceration of the root tips using the enzyme solution of cellulase-R10 (5%) and pectolyase (1%) in a micro-centrifuge tube. Slide spacemen was made using a single root tip to which two drops of a freshly prepared solution of 3 ethanol: 1 acetic acid was added. The root sample on the slide was macerated with the fine tip of forceps and stained by immersing it in Leishman's stain with 0.01M phosphate buffer for 30 minutes. The slide was examined under the microscope and photographed on ILford PAN F50 film using a 100x/1.35 oil immersion objective.

In the field study, the varieties were evaluated under field conditions in the rainy seasons (May-September) of 1998 and 1999 at the Faculty of Agriculture research farm, University of Nigeria, Nsukka (latitude, 06° 52 N, longitude 07° 24 E; 447.26cm altitude). The experimental design was a randomised complete block (RCBD) with three replications. Each block was divided into plots and each plot received 4.8kg of well-cured poultry dropping. The seedings were transplanted 30 days after planting. Entries were in four rows. There were six plants to the row, spaced 0.45m within row and 0.6m between rows. Each plot had 24 plants and data were collected from the plants in the middle rows and the results were analyzed as means of single plants. Data were collected on days to flowering and fruiting; number of branches, trusses, flowers and fruits as well as fresh fruit yield per plant from two plants in the middle rows. All the plants in each plot were considered for the data on disease incidence, which was obtained as the ratio of infected plants to all the plants in each plot and expressed in percentage. The vertical and horizontal circumferences of the fruits were determined in the laboratory using a micro-meter screw guage.

Analysis of variance was done to test the treatments for significance using the F-test as described by Little and Hills (1978). Significant treatment means were compared using the least significant difference (LSD).

RESULTS AND DISCUSSION

Figures 1a and b show the somatic chromosomes of the wild and cultivated tomato lines, respectively. Both have chromosome number of 2n=24. This is in line with the report by Rick and Butler (1956) that no Lycopersicon species has been found to deviate from the chromosome number of 24.

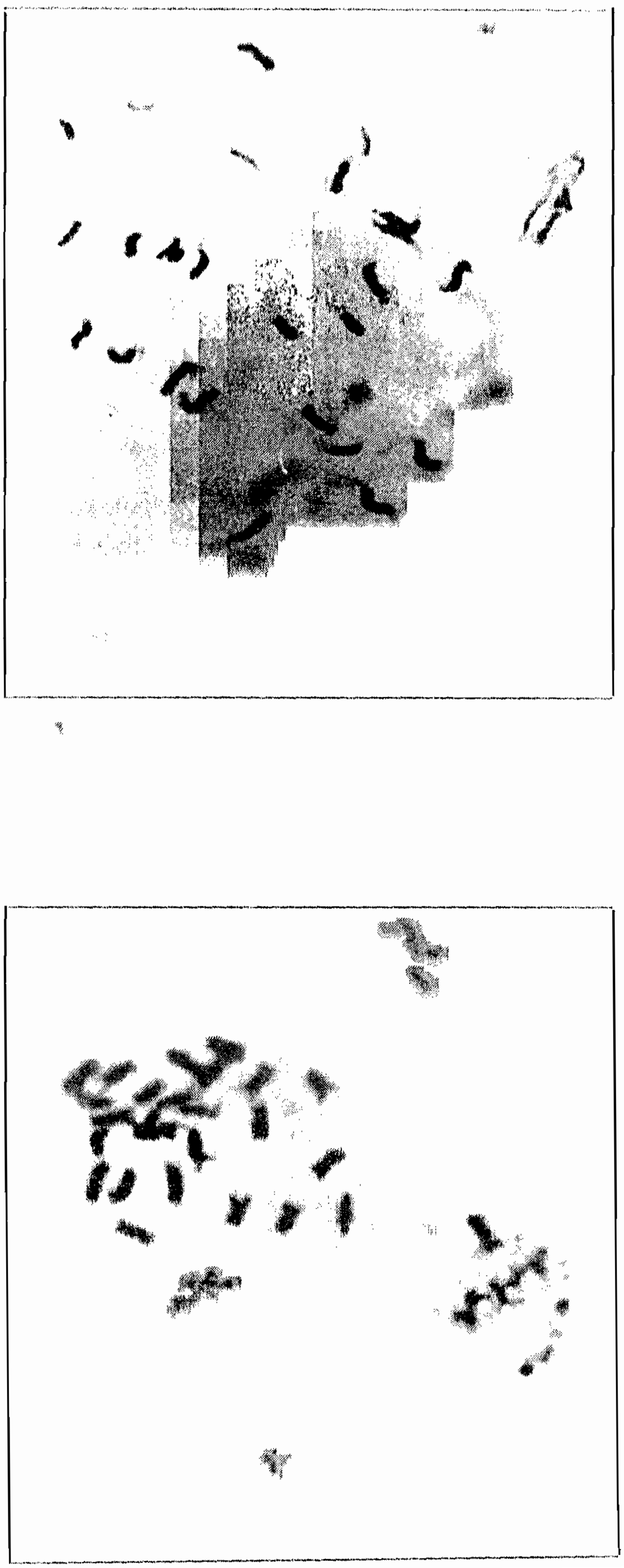
Table 1 shows the mean monthly minimum and maximum temperatures, rainfall and relative humidity in Nsukka during the experimental periods in 1998 and 1999. The period from April to September had the highest rainfall and relative humidity in the two years. The recorded temperature range of 20.4 - 33.1° (is unsatisfactory for optimal growth and yield of tomato (Bashir *et al.*, 1979). For optimum fruit set, tomato requires temperatures of 15-20° C (Villareal and Lai, 1978). The minimum temperature of 20.35°C reported during the experimental period exceeded this range thereby implicating temperature as a limiting factor for optimal fruit yield except perhaps for heat-tolerant lines.

The four varieties did not differ in days to flowering and fruiting in 1998, although the wild variety showed a trend towards a greater earliness to flowering (Table 2). This trend was consistent in the 1999 planting. The wild tomato variety produced significantly greater number of branches, trusses, flowers and fruits per plant in the two years than the other cultivated varieties. The magnitude of the differences in the agronomic attributes among the cultivated tomatoes was of the same order. Although not statistically significant, the range of overall variation among the varieties in disease incidence appeared noticeable. Tolerance to high humidity diseases appears to be a varietal characteristic. Roma and Nsukka Local were the most susceptible to the disease complex because their disease ratings were statistically similar in both years (Table 2). Disease incidence of 47 and 35 per cent, and 68 and 61.3 per cent were recorded for the Nsukka local and Tropica in 1998 and 1999, respectively. The wild variety had the least disease incidence of 10.4 and 11.7 per cent in 1998 and 1999 thus reinforcing previous reports (Foolad and Lin, 1997; Chen and Foolad 1999) that *L. Pimpinellifolium* is a major gene source for disease resistance in tomatoes. Contrary to expec-

Table 1: Mean monthly minimum and maximum temperatures, rainfall and relative humidity of Nsukka, January - September 1998 and 1999.

	Minimum Temperature (°C)		Maximum Temperature(°C)		Relative Humidity (%)		Rainfall (mm)	
Month	1998	1999	1998	1999	1998	1999	1998	1999
January	20.35	21.0	30.70	29.9	57.75	74.20	0.0	23.11
February	21.32	23.1	29.53	32.3	57.74	83.07	0.0	36.32
March	21.51	23.3	29.35	33.1	63.29	80.03	18.6	28.20
April	21.51	22.3	29.58	31.2	73.68	80.33	160.6	260.61
May	20.58	21.6	29.32	29.7	76.19	80.48	91.3	151.89
June	21.76	22.2	29.73	29.5	77.41	80.50	278.2	177.30
July	20.93	20.7	29.87	26.6	77.35	80.33	133.3	182.60
August	21.12	20.5	29.90	26.6	77.35	72.58	81.8	232.20
September	20.60	20.6	30.70	27.6	77.19	72.03	317.2	333.00

Source: UNN/KUL Linkage Programme (Experimental site, Faculty of Agriculture, University of Nigeria, Nsukka).



a b

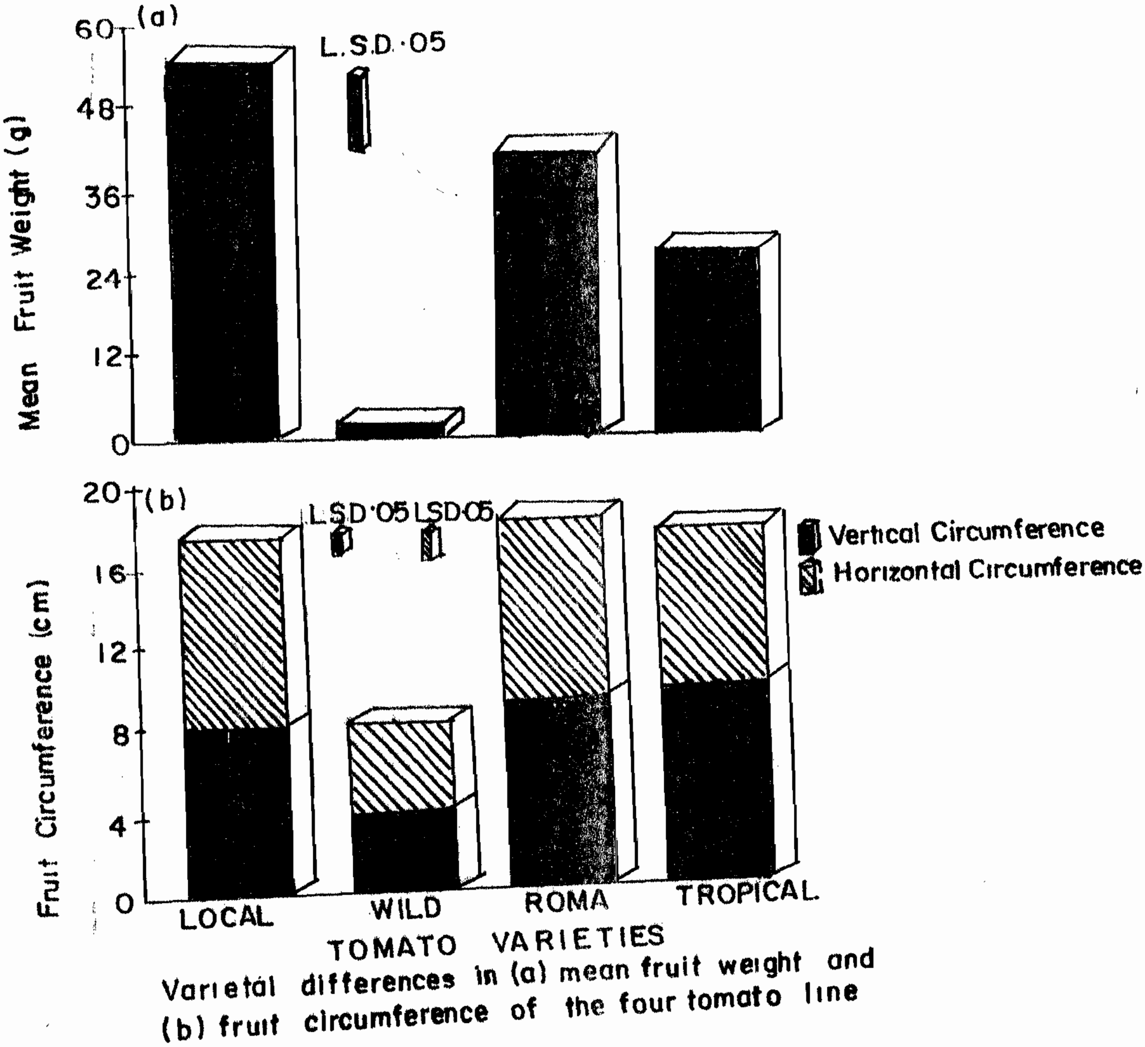
Fig. 1 Mitiotic Chromosomes of (a) wild tomato (*Lycopersicon Pimpinellifolium*) 2n =2 4 and (b) cultivated tomato (*L. esculentum*) 2n =2 4..

Table 2: Mean values of nine agronomic characters of the tomato varieties during the 1998 and 1999 growing seasons

	Agronomic Character																			
	1998										1999									
Variety	DTLF	DTFr	B/p	T/p	Fl/T	Fl/p	Fr/p	RE(%)	FY/p(g)	DI(%)	DTFL	DTFr	B/p	T/p	Fl/T	Fl/p	Fr/p	RE(%)	FY/p(g)	DI(%)
Local	63	67	8	11	4	47	26	53.3	471	47.0	68	73	9	11	6	60	18	32	750	68
Tropica	64	68	4	6	4	27	13	46.7	176	35.0	68	79	5	7	7	48	10	21	210	61.3
Roma	66	70	4	8	5	50	28	55.6	248	53.0	68	78	9	11	6	73	26	43	421	80.3
Wild	61	69	20	70	10	729	445	62.2	312	14.0	58	69	22	40	10	498	449	88	627	11.7
LSD (0.05)	ns	ns	4.4	15.4	1.9	227.6	128.0	ns	ns	ns	2.6	2.4	2.5	6.0	0.5	45.0	210	41.5	120	13.2

DTFL = Days to flowering, DTFR = Days to fruiting, B/p = Branches/plant,
T/p = Trusses/plant, FL/T = Flowers/Truss, FL/p = Flowers/plant,
Fr/p = Fruits/plant, RE = Reproductive Efficiency,
FY/p = Fruit yield/plant, DI = Disease incidence.

tation, Tropica with a comparatively lower disease incidence than Roma and Nsukka local consistently had the least number of branches, trusses, flowers and fruits per plant thus suggesting the influence of other factors in the determination of the yield attributes. Perhaps the high temperature and high rainfall with the associated high humidity may have had direct effects on the varieties. It is likely that the varieties reacted differently to the prevailing weather conditions with some physiological implications. The poor fruits set in Tropica as implicated by the low reproductive efficiency may have arisen from either poor pollination or fertilization which are strongly influenced by temperature (Ravestijn, 1970). The profuse branching habit of the wild variety appears to have gone well with the potential for the production of the other yield components as it had the highest number of trusses, flowers and fruits per plant in the two seasons.



The higher fruit yield of the local over the wild variety in the two years is due to the larger fruits size of the former. Whereas the Nsukka local produced fewer but larger fruits, the fruits of the wild variety were many but characteristically small (Fig. 2a). The mean fruit weight of the wild variety was 2.1g compared to the 54.3g of the local. The smallness of the fruits of the wild variety evidently had a reduction effect on the large number of fruits that were produced thus limiting its fruit yield to values that were comparable to the yield of the other varieties. The fruits of the three cultivated varieties, Tropica, Roma and local, had similar vertical and horizontal circumference and each was significantly greater than the value for the wild variety in these respects (Fig.2b). These explain why the wild tomato with 445 and 449 fruits per plant in 1998 and 1999 had fresh fruit yields that were comparable to the fruit yield of Tropica, Roma and local varieties that produced only 13, 28 and 26 fruits/plant in 1998 and 10, 26, and 18 fruits/plant, respectively in 1999. The poor fruiting potentials of the local, Roma and Tropica varieties evaluated in this study underscores the need to develop cultivars that can tolerate high rainfall and the associated humidity and disease conditions. The wild tomato appears to be a promising variety with sufficient inherent adaptive features for the development of such cultivars. The equal chromosome number would permit chromosome association between the two species and perhaps favour crossability (Seithe, 1971; Anaso and Uzo, 1990) between them. While exploiting these features, the plant breeder may not loose sight of the small-sized fruits of the wild variety. Breeding efforts should also concentrate on increasing the fruit size while still retaining the qualities of good adaptation to high humidity.

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