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BREEDING TOMATOES FOR THE CARIBBEAN

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ABSTRACT

For over 15 years the INRA Antilles Guyane Plant Breeding Station in Guadeloupe and IRAT Antilles in Martinique have been working in cooperation on breeding tomato varieties adapted to the Caribbean.

The main problems encountered were heat tolerance and disease resistance, especially to Bacterial Wilt caused by *Pseudomonas solanacearum* which prohibits growing of susceptible tomato lines in infested areas.

The first step of this work was the introduction and screening of an extensive world collection. This resulted in the identification of some tropical and subtropical varieties suited for cultivation in certain situations in the French Antilles.

The second step was to breed varieties better adapted to our conditions. This resulted in the release of lines resistant to *P. solanacearum* and/or heat tolerant. The last variety released, "Caraibe," which is both heat tolerant and resistant to *P. solanacearum,* also carries resistance to *Stemphylium solanae* (Gray Leaf Spot) and *Fusarium oxysporum* (Races 0 and 1).

Further breeding is needed to add root knot nematode resistance, *Cladosporium fulvum* (Leaf Mould) resistance, to improve fruit quality and to diversify varietal types.

RESUMEN

Por mas de quince años la Estación Guyana del Mejoramiento Genético, INRA Antilles, en Martiníca, ha estado trabajando cooperativamente, con miras hacia un mejoramiento genético de variedades de tomate adaptadas para el Caribe. Los principales problemas encontrados fueron: tolerancia al calor y resistencia a enfermedades, especialmente al Añublo Bacterial, causadas por *Pseudomonas solanacearum,* lo cual no permite el creciminento de tomate de lineas susceptibles, en areas infestadas. La primera etapa del mencionado trabajo fué, la introducción de y la selección de una colleccion mundial muy extensa. Esto dío como resultado, la identificación de algunas variedases tropicales y sub-tropicales aptas para el cultivo, en ciertas situaciones, en las Antillas Francesas.

La segunda etapa fué, de mejorar genéticamente, variedades las cuales son mejor adaptadas a nuestro medio. Esto dío como resultado el relevo de lineas resistentes a *P. solanacearum,* y con o sin tolerancia al calor. La ultima variedad relevada, 'Caraibe', la cual es tolerante al calor y resistente a *P. solanacearum,* tambien es resistente a *Stemphylium solanae* (Mancha gris) y *Fusarium oxysporum* (Raza 0 y I). Se necesita llevar a cabo un mejoramiento genético adicional para, poder obtener resistencia al Nodulador, al *Cladosporium fulvum* (Moho), mejorar la calidad del fruto y diversificar los tipos varietales.

Keywords: Tomato, *Lycopersicon esculentum,* heat tolerance, disease resistance, breeding, French Antilles, hot humid tropics.

Tomatoes are the most popular vegetable worldwide. Over 45 million tonnes are produced on more than 2 million hectares. Out of this total, only about 15% are produced in the tropics. This limitation is due to many different causes, prime among which are lack of appropriate varieties adapted to the tropical climate, thus leading to very low yields, extreme susceptibility to diseases and parasites, poor organization of marketing and severe post harvest losses. The situation in the Caribbean is that of the hot, humid tropics with added difficulties due to land limitation and steepness. For more than twenty years two French research institutes IRAT (Institut de Recherches Agronomiques Tropicales et de Cultures Vivrieres) and INRA (Institut National de la Reacherche Agronomique) have been conducting research in Guadeloupe and Martinique to solve problems of tomato production in the Caribbean. These studies concern cultural practices, plant protection and plant breeding. This paper is the summary of work done on breeding tomatoes for adaptation to the climate of the West Indies and for resistance which are now grown on a commercial scale in our area as well as in many other tropical countries.

Climate and its Effects on Growth, Flowering and Fruiting

Climate

The climate of Guadeloupe and Martinique is that of the hot, humid tropics. Average yearly temperature is 25°C at sea level (–0.5°C at 100m altitude). Daily variations are small (4 to 7°C) and there is little year to year difference (about 1°C). There are two main seasons, the dry season (December to May) and the rainy season (June to September). During the latter, day temperatures are high though not excessive; maximum seldom reaches 32°C, but night temperatures often average 25°C. Atmospheric numidity is always high 80 – 90% (Table 1).

Table 1: Climatic data, Saint François, 1965–1984

Month	Temperature Minimum °C	Temperature Maximum °C	Day/Night Variation °C	Rain mm	Radiation mj/m²	Insolation 1/10 hour
January	21.73	27.74	6.01	61.88	16.99	73.67
February	21.51	27.77	6.26	38.56	19.08	77.78
March	21.78	28.11	6.33	43.09	21.27	77.16
April	22.52	28.74	6.22	83.21	21.76	77.74
May	23.59	29.32	5.73	109.17	20.69	71.95
June	24.38	29.95	5.57	78.08	20.83	73.01
July	24.51	30.12	5.61	114.08	21.05	74.84
August	24.41	30.24	5.83	112.36	21.31	77.37
September	23.91	29.98	6.07	146.41	19.96	70.16
October	23.64	29.82	6.18	157.35	18.33	69.79
November	22.99	29.87	6.08	153.07	16.52	72.05
December	22.11	28.14	6.03	117.05	15.27	67.58

Average winds, which are the trade winds, blow regularly from the East (NE, E, SE). Rains are very irregular in quantity and distribution and day length varies from 11 to 13 hours. Tomato production is mostly a problem during the rainy season, due to high night temperatures, relative humidity, rainfall and poor light conditions resulting from overcast skies.

Effects on growth, flowering and fruiting

Temperature affects growth, flowering, fruitset and fruit growth (1, 4, 11, 12). Bad light conditions affect pollination and fruitset (9). High relative humidity is unfavorable for pollen liberation and germination (9, 13)

In our case, during the cool dry season tomato production is almost normal, whereas during the warm rainy season we observe serious disorders etiolation, poor flowering, small clusters, small fruits, fruit cracking, blossom end rot - all of which lead to low yields and poor fruit quality.

Over a five year period, with Florida commercial varieties, yields averaged 16 to 20 tonnes/ha in August/September and 35 to 40 tonnes/ha in January/February (Fig. 1) with European varieties yields were under 5 tonnes/ha.

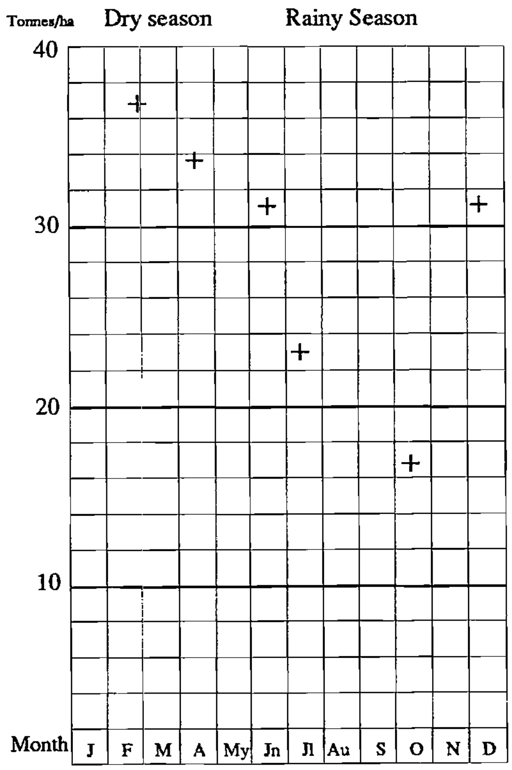

Fig.1. Average yield of four tomato varieties in 14 trials over 5 years at IRAT, 1963–1968

Breeding for Heat Tolerance

Screening for heat tolerant material

We screened local and introduced material. The first introductions that we made in 1969 were very extensive and included genotypes described for setting fruit under adverse conditions (4) and commercial varieties from various countries of temperate and subtropical and tropical climates. Observations on fruitset and yield enabled us to confirm the good level of tropical genotypes and of those released for resistance to cold sterility. In this group the most outstanding was Summertime, which surpassed cultivars such as Swift, Coldset, Porter, Nagcarlang and Fireball. The temperate varieties had poor fruitset, the worse being the European greenhouse varieties.

Further introductions were based solely on heat tolerant material from plant breeders working on that subject – Cueto (Cuba), T.P. Hernandez (Louisiana), P.W. Leeper (Texas), M.A. Stevens (California) and R. L. Villarfal (Philippines, then AVRDC, Taiwan). Some included parthenocarpic gene pat 2, from the Russian variety, Severianin.

Breeding

In the first part of our breeding programme we used the pedigree method from crosses between small-fruited, heat-tolerant material and Florida commercial varieties chosen for fruit quality and disease resistance.

After a few years we adopted a recurrent selection method followed by a modified single seed descent, from multiple crosses, between improved heat tolerant material. Resulting lines were assessed in the Antilles (Guadeloupe, Martinique), then in Louisiana in the summer of 1982 and 1983 at Louisiana State University (LSU, Baton Rouge).

Results and discussion

In Guadeloupe, best results were obtained from crosses including Summertime, Saladette and BL 6807. According to studies made by M.A. Stevens and co-workers, this is due to greater dehiscible pollen production (Saladette) and better translocation (BL 6807). We never got outstanding results with Malinkta 101 and/or Nacarlang, compared to, or in combination with, other varieties. This seems to indicate that we do not have problems with gamete viability. We also have no obvious advantage with parthenocarpy.

In Louisiana, where night temperatures (23 to 26°C) are comparable to those of Guadeloupe, but day temperatures are higher, we had some differences. During periods with days under 32°C almost all of the heat tolerant lines did well. But as soon as the day temperatures exceeded 32°C, the advantage of parthenocarpy became obvious.

Breeding for Disease Resistance

The major disease that threatens tomatoes in our region is Southern Bacterial Wilt caused by *Pseudomonas solanacearum* E.P. Smith that prevents cultivation of any susceptible variety in infested volcanic soil. Until recently coral soils or black vertisols, such as those encountered in the outer Caribbean Islands of Barbados, Grande-terre (Guadeloupe) and Antigua, were thought to be immune, but a case of *Pseudomonas* has been reported in Grande-terre, Guadeloupe.

Other diseases of less importance, but also of serious incidence, are caused by root knot nematodes, *Stemphylium solani, Alternaria solani, Xanthomonas vesicatoria, Fusarium oxysporum, Cladosporium fulvum* and *Phytophthora infestans* (Late Blight). Also of importance are spider mites and non parasitic diseases, such a blossom end rot, fruit cracking, blotchy ripening, catface and sunscald.

Breeding for Pseudomonas resistance

Materials and methods

Several sources of resistance were available, viz., CRA 66 (Guadeloupe), UPR 199 (Puerto-Rico), PI 126 (Panama) and H 7996 (Hawai). A breeding program combining Back-Crossing, Pedigree then recurrent selection was under taken.

The most extensively used was CRA 66 in which resistance is multigenic (4, 5 genes) and semi dominant. It holds well in many tropical countries and also in Taiwan and Florida.

Results

Breeding results in the release of several lines – IRAT L3, Carette (Indeterminate types) and Caraibe (Determinate type) Caraibe, which also is heat tolerant, is now the most extensively grown on a commercial scale (Fig. 2).

Breeding for other diseases

In collaboration with INRA-Avignon (France) Vegetable Breeding Station, we also introduced resistance to *Fusarium oxysporum* (Races 0 and 1), *Stemphylium solanae* and root knot nematodes. We are now aiming to introduce combined resistance to root knot nematodes and *Cladosporium fulvum* from the linkage, MiCf2, Origin ONTARIO 7620 (KERR).

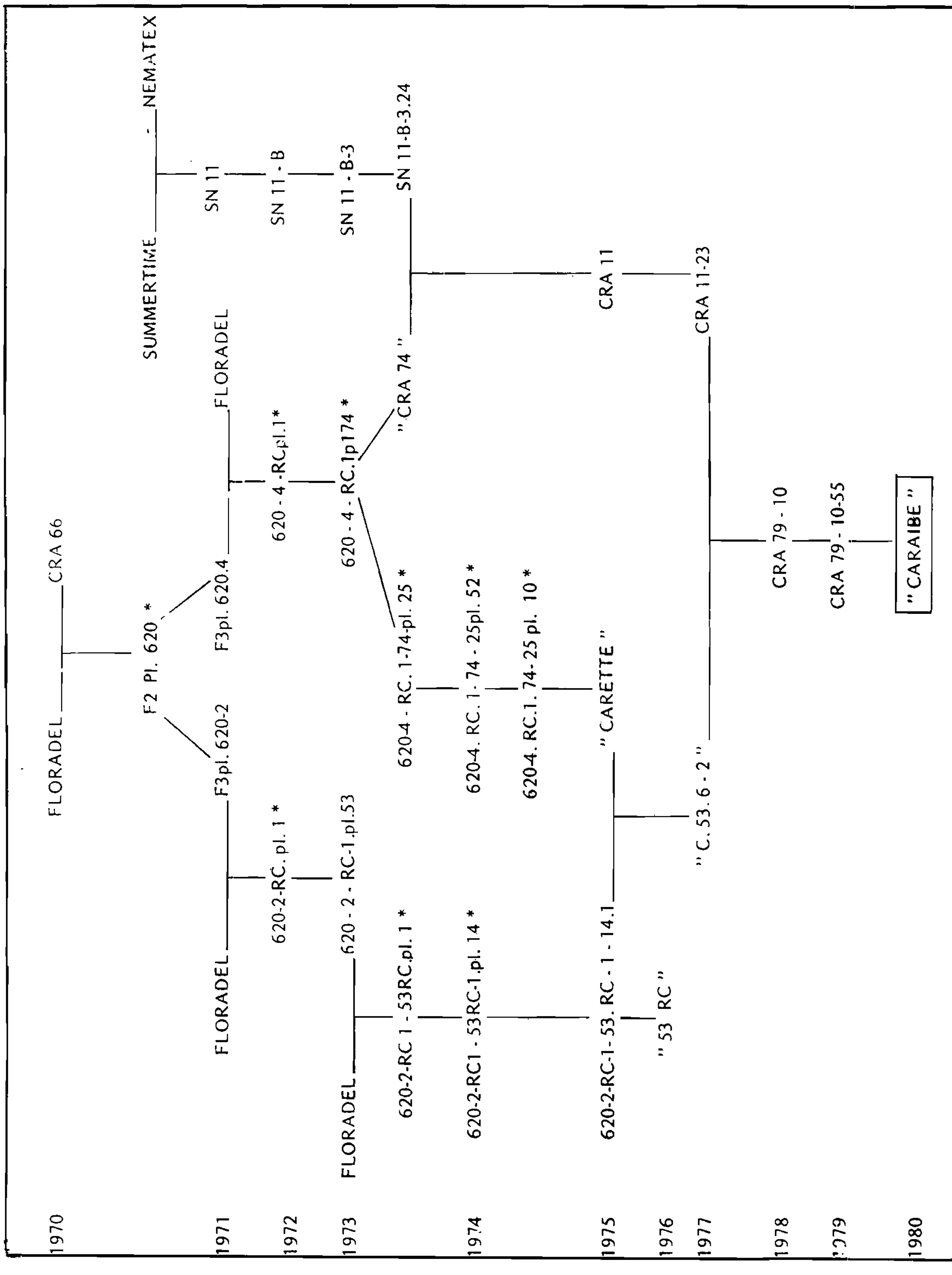

Fig. 2 Pedigree of CARAIBE

Conclusion

Breeding for heat tolerance enabled us to substantially increase tomato yields in the French Antilles, with the release in 1980 of the variety, "Caraibe," also resistant to Southern bacterial wilt *(Pseudomonas solanacearum)*. The observation of breeding material carrying different characters of heat tolerance lead us to the conclusion that heat stress in our region may be due mainly to carbohydrate starvation injury (10) resulting from high night temperatures, relative length of the nights and reduced daylight, all conditions that favour respiration to the detriment of photosynthesis. It might be interesting in these conditions to breed for reduced respiration rate and greater photosynthetic efficiency, leading to a higher level of net photosynthesis together with good translocation ability.

For *P. solanacearum* resistance we are aiming to combine different sources of resistance with the aim of obtaining high levels and stability in resistance. On a practical point of view we have to diversify the varieties to suit different types of cultivation.

References

1. Abdalla, A.A. and K. Verkerk. 1968 Growth, flowering and fruitset of the tomato at high temperature *Neth J. Agric. Sci.* 16 : 7176.

2. Anais G. 1978. Tomate amelioration pour l'adaptation au milieu. *Journées scientifiques* INRA Antillies Guyane 17.18.19 Octobre 1978.

3. Anais, G. 1984. Breeding tomatoes for heat tolerance in the French Antilles *9th Meeting of the Tomato Working Group of Eucarpia* - Wageningen 22 – 24 May 1984.

4. Beshir, A., E.L. Ahmadi, M. A. Stevens 1979. Reproductive responses of heat tolerant tomatoes to high temperatures. *J. Amer. Soc. Hort. Sci.* 104 (5) : 686 – 691.

5. Graham, T.O. 1966. Cold and heat sterility; New tomato types which help combat adverse floral set. TGC no. 16. p. 56 – 58.

6. Hernandez, T.P., G. Anais, S.M. Barineau and H.Y. Hanna 1983. Further studies on heat tolerance in tomatoes. Abstract of the Southern Region 43rd Ann. Meet. Amer. Soc. Hort. Sci. *Hort Science* 1, 18 (2) : 169.

7. Kaan, F. H. Laterrot and G. Anais 1975. A study of 100 tomato varieties in relation with climatic adaptation and resistance to 7 prevalent diseases in the West Indies. *Proc. XIIth Ann. meet. Carib. Food Crop Soc.* pp. 102 – 110.

8. Koot, Y. and W. Van Ravestijn 1962. The germination of tomato pollen on the stigma (as an aid to the study of fruit setting problems) *XVIth International. Hort. Cong.* 452 – 461.

9. Levitt, J. 1972. High temperature or heat stress., In *Response of plants of environmental stresses.* Academic Press N.Y. pp. 272 – 321.

10. Schaible, L.W. 1962. Fruit setting responses of tomato to high night temperature. *Proceedings plant science symposium.* Campbell Soup Co. pp. 89 – 98.

11. Stevens, M.A. 1981. Resistance to heat stress in crops. Campbell Institute for Agricul. Research pp. 458 – 487.

12. Villareal, R.L. Mercado F.C. Sen Hsiving Lai and Tai – Li Hu. Fruit setting ability of heat tolerant moisture tolerant and traditional tomato cultivars grown under field and greenhouse conditions. The *Philippine Journal of Crop Science* Vol. II (2) : 55 – 61.