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GENETIC STUDIES IN TOMATOES (*LYCOPERSICON ESCULENTUM* MILL.) I. SOME QUALITATIVE CHARACTERS

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Abstract

A tomato mutant 'Anobik' and the variety 'Oxheart', their F_1, F_2 and backcrosses were used for studying the inheritance of some qualitative characters. Plant stature, growth habit, leaf shape and fruit length were found to be governed by single factor pairs. Wilty-foliage was governed by duplicate gene action. Complementary gene action was noticed for the breadth of fruit and locule number. The dwarf gene (*d*) made the plant short only in the presence of a self-pruning (*sp*) gene when both were in the recessive state. Classification of tomato fruits on the basis of length and breadth appeared to be more accurate and in line with the gene expression, instead of on the basis of fruit shape used by earlier workers. Several recombinants with improved plant types and better quality fruits have been selected for further improvement.

Introduction

The tomato mutant 'Anobik' is characterized by a dwarf plant with short internodes, broad leaves and small fruits. It was obtained from a local cultivar through gamma-irradiation (Rahman *et al.* 1975). 'Oxheart' is a commercial tomato variety having high acceptance for the quality of its fruits. It needs more care than the former, including staking. The mutant and the cultivar differ morphologically and also for various other traits (Fig. 1a, 1b and Table 1).

A hybridization programme was undertaken between these two strains of tomato to obtain desirable recombinants and to study the inheritance of various qualitative as well as quantitative characters. This paper deals only with the inheritance studies of some of the qualitative characters. Similar works have been reported by MacArthur (1931, 1934), Yeager (1937), Chaudhary and Khanna (1972), Rick and Butler (1956), and others using other varieties of tomatoes.

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Materials and Methods

Oxheart (P_1), Anobik (P_2), reciprocal F_1 ($P_1 \times P_2$ and $P_2 \times P_1$), their F_2 and backcrosses (B_1 and B_2) were planted in a randomized block design with 5 replications at a planting distance of 75 cm ×75 cm. The population included 1050 plants of F_2 generation, 95 plants each of P_1, P_2, B_1 and B_2. Three weeks old seedlings were transplanted in November, 1978. Fertilizer at the rate of 20 kg N, 40 kg P and 8 kg K per acre was applied in 3 instalments. Suckers below the first flower truss or main branching point were deshooted. The segregating populations were counted and categorized into normal and dwarf, determinate and indeterminate, wilty and broad and narrow-leaved.

Classifications on the basis of length and breadth of fruit and locule number was also done. Pseudo-fruits were avoided in classifying them for length, breadth and locule number of fruits. The average of the first three fruits were considered as indices for these traits. The following range found in the parents for length, breadth and locule numbers were used to classify the fruits of other generations.

Fruit dimension (cm) : 'Anobik' short length=3.1-5.0, narrow breadth=3.1-5.5.
'Oxheart' long length=5.1-7.0, wide breadth =5.6-7.5.

Locule number : 'Anobik' 3 locular=2—4 nos.
'Oxheart' multilocular=5–8 nos.

Table 1. Various characters of the mutant 'Anobik' and the variety Oxheart.

Characters	Anobik/gene symbol	Oxheart/gene symbol
Height (cm)	33, Dwarf *d*	105, tall d^+
Plant type	Determinate, *sp*	Indeterminate, sp^+
Internode length in main axis (cm)	2.1	5.3
Leaf type	Broad leaves without serration, *c*	Narrow leaves with serration, c^+
Leaf length (cm)	19.3	30.9
Leaf breadth (cm)	18.1	23.1
Fruit length (cm)	4.1, short length-sl^+	6.1, long length-*sl*
Fruit breadth (cm)	4.2, narrow breadth - nb^+	6.5, wide breadth-*nb*
Top shoot type	Non-wilty, wt^+	Wilty, *wt*
Locule number/fruit	3	6

Results and Discussion

The segregation ratios obtained for various characters in the F_2 population are given in Table 2.

Table 2. Segregation patterns of some qualitative characters in tomato

Characters	Ratios in F_2*		χ_2	P value	Test cross ratio		Inheritance pattern
	Dominant	Recessive			Dominant	Recessive	
1. Plant stature	3:1 (2130:672)		1.546	0.10-0.25	1:1		Monogenic
2. Growth habit	3:1 (714:236)		0.0127	0.90-0.95	1:1		Monogenic
3. Foliage	16:1 (868:62)		0.2755	0.60-0.75	1:3		Duplicate gene action
4. Seaf shape	3:1 (698:252)		1.1804	0.25-0.50	1:1		Monogenie
5. Fruit length	3:1 (733:217)		2.3493	0.10-0.25	1:1		Monogenic
6. Fruit breadth	9:7 (546:404)		0.5781	0.25-0.50	1:3		Complementary action
7. Locule number	9:7 (543:407)		0.3182	0.50-0.75	1:3		Complementary gene action

* Figures in paranthesis refer to the actual number of plants.

Normal vs dwarf height : Dwarf and normal type seedlings were easily recognizable in the F_2 population. It is clearly evident from Table 2 that this character is controlled by a single gene, normal allele being dominant over dwarf. A test cross ratio of 1:1 was obtained which confirmed the monogenic inheritance. The dwarf character was found to be associated with the hard stem and shortened internodes. The dwarf gene (*d*) may be operating through limiting the growth of sclerenchymatous tissues, i. e. the length of sclerenchymatous tissues are reduced in the plant. Possibly this gene does not disturb the rate of synthesis of parenchymatous tissues, which is evident by the presence of thick stem and leaves in these plants.

Determinate vs indeterminate growth : The 3:1 ratio of indeterminate: determinate obtained in the F_2 plants indicate the monogenic behaviour for this trait. This is confirmed by the test cross ratio of 1:1. Although the determinate growth character (self-pruning, *sp*) was present in the dwarf parent ('Anobik'), it was not linked with the *d* gene since these two characters assorted independently. Normal indeterminate, dwarf indeterminate, normal determinate and dwarf determinate types obtained in the F_2 populations fell in the ratio of 9:3:3:1. Hence the dominance of indeterminate over determinate is further confirmed. The dwarf gene (*d*) was found to be incapable of reducing the plant height in the presence of indeterminate growth habit (sp^+). Salib *et*

Eig. 1. Morphological variations in the two parents of tomato.

al. (1970) have also reported determinate-indeterminate growth habit to be a monogenic trait. This was reported to be an important character in that, Khanna and Chaudhary (1974) found a high degree of heterosis among the crosses involving determinate and indeterminate groups.

Wilty vs non-wilty plants : The 'Oxheart' variety has a characteristic wilty appearance of top shoot (*wt*) while the mutant, 'Anobik', is 'non-wilty' (*wt*+). In the F_2 population, the progeny segregated into 15 non-wilty and 1 wilty types indicating that this character is under the duplicate gene action, non-wilty being dominant over the wilty behaviour. A test cross ratio of 3:1 also confirmed this behaviour.

Broad vs narrow leaves : Narrow leaf (c+) was found to be dominant over the broad leaf (*c*). The leaf characters followed a monogenic ratio. The leaf morphology was also influenced by the presence or absence of the *d* or the *sp* gene (Fig. 2) as was the case with growth habit. The leaves having shape and size of the 'Anobik' type but with prominent veins and pointed leaflets

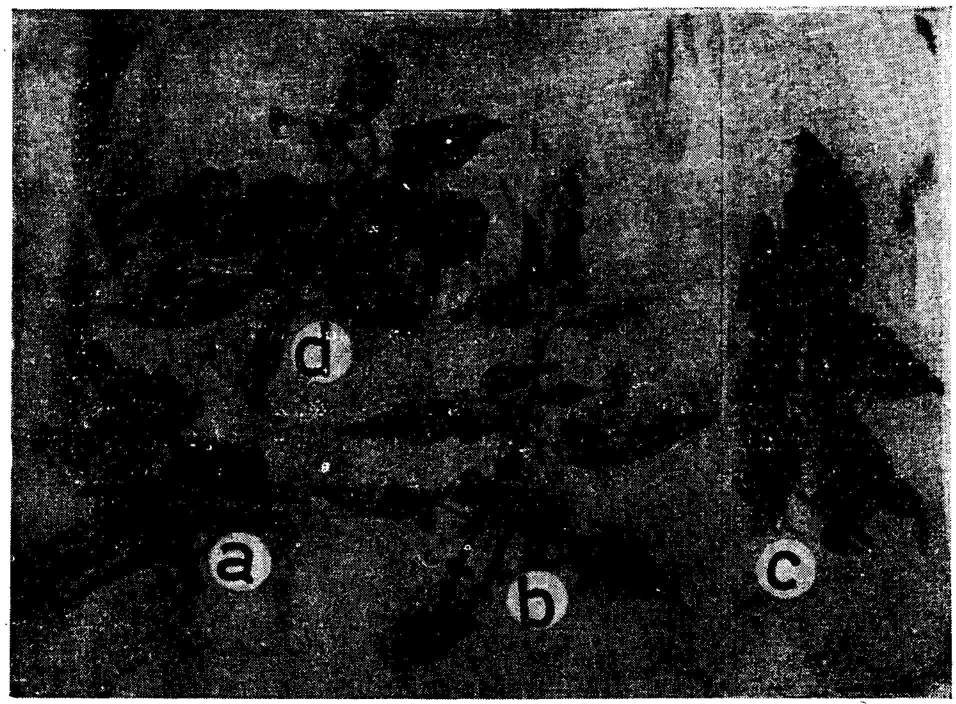

Fig. 2. Parental leaves (a, b) and their recombinants in F_2 (c, d) ; (a) 'Anobik' (*dd sp sp*), (b) Oxheart (*d+d+ sp+ sp+*), (c) recombinant (*dd sp+/-*), (d) recombinant (*d+/- sp sp*).

were *d sp*+ carriers. On the other hand, leaves with broad leaflets, long pinnae, entire margin and blunt tips carried *d*+*sp* genes. In the F_2 some leaves, longer than the normal 'Oxheart' type, were noticed indicating some modifiers to be operating.

Length and breadth of fruits : The segregating progenies were classified on the basis of the length and breadth of fruits rather than the shape and size used by other workers (Dennet and Larson 1953, Mac Arthur 1931 and 1934). It was found necessary to classify them separately because some recombinants for length and breadth characteristics appeared in the progeny. For example, some long fruits appeared where the long length, characteristic of 'Oxheart' and the narrow breadth from 'Anobik' were combined. In this study the short length was found to be dominant over the long length and the character was under a monogenic control. Again, the narrow breadth was found to be dominant over the wide breadth and showed complementary gene action (Table 2).

Yeager (1937) had reported that the inheritance of the size and shape of tomato fruit was under a complex phenomenon and had a large influence of environmental conditions. The dominant and recessive behaviour of the length and breadth of tomato fruits as explicit in this study, clearly show that these two characters need separate treatment. Classification on the basis of length and breadth of fruit was more acceptable because it was in line with the gene expression. This may explain why Yeager (1937) reported the size and shape of tomato fruit to be under a complex gene mechanism.

Locule number in fruits : 'Anobik' fruits had 3 locules whereas 'Oxheart' was multilocular (6 locules). In the F_1, 3 locules were found to be dominant over the multilocules. Moreover this character was found to be under the complementary gene action. According to Rick and Butler (1956), locule number was a complex character which was determined by 2 major genes and numerous polygenes or modifiers, and was greatly influenced by environment. Locule number was reported to be controlled by 2 pairs of genes (Choudhary and Khanna 1972), 5 pairs (Ahuja 1968) and 1 pair (Dennet and Larson 1953). These differences could be ascribed perhaps due to the different varieties used by these workers.

Some promising segregants have been selected for further breeding and selection. These include a number of short plants with good quality fruits (long, trilocular and fleshy) and some tall plants with a greater number of fruits. These have shown promise of higher yield and better quality fruits.

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