

TRIALS TO OVERCOME THE INCOMPATIBILITY OF CROSSES BETWEEN *LYCOPERSICUM ESCULENTUM* AND *LYCOPERSICUM GLANDULOSUM* BY REPEATED GRAFTING

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ABSTRACT

In breeding tomatoes for resistance to "Corky root" *Lycopersicum glandulosum* is used as a resistant parent. Crosses of tomato with *L. glandulosum* are difficult to effect because of the incompatibility of the partners. To overcome this incompatibility the "approach method" was applied beside the conventional crosses.

Repeated reciprocal grafting of tomato onto *L. glandulosum* and also *L. glandulosum* on tomato did not increase the number of effected matings. The statement that by repeated grafting the characters of the scion change under the influence of the stock could not be confirmed.

INTRODUCTION

In breeding tomatoes for "Corky root" resistance we use *L. glandulosum* as a resistant parent. Some strains of this wild relative of the tomato are resistant not only to "Corky root" (29) but also to *Cladosporium fulvum* and the nematode *Meloidogyne incognita* (2). The strain selected at our Institute possesses a high degree of resistance to all three mentioned diseases. However the crosses of tomato (subgenus *Eulycopersicon*) with *L. glandulosum* (subgenus *Eriopersicon*) are difficult to effect because of high incompatibility of the partners. Furthermore, successful matings can be only expected using tomato as a female parent and *L. glandulosum* as a male parent (16, 21, 25). Our own experiments confirmed both statements. Of about 500 flowers of *L. glandulosum* pollinated with tomato pollen a few set rudimentary fruits; most of the flowers dropped 6-14 days after pollination. Tomato flowers pollinated with *L. glandulosum* pollen abundantly set normal looking but seedless fruits.

In 1955 we pollinated about 300 tomato flowers with *L. glandulosum* pollen but we found no viable seeds. Therefore we decided to work not only with conventional methods, but also with Russian methods of hybridisation, notwithstanding negative results obtained with those methods by many investigators (4, 6, 7, 12 and others).

The "approach method" (8, 17, 18 and others) is understood to be repeated reciprocal grafting of two incompatible partners. One graft generation represents a young plant grown from seed, grafted upon the incompatible partner, and then producing seed again, which will be sown to give the next graft generation. According to the authors each following graft increases the influence of the stock on the scion, brings the partners nearer to each other and thus makes them more compatible.

According to investigators (1, 3, 13 and others) grafting results in changing the characters of the scion by influence of the stock.

In our trials we did not consider possibilities of provoking mutants, chimeras and other deviations of the parent types, which can be brought about by grafting. The object of the experiment was to obtain answers to the following questions:

First, are we able to overcome the incompatibility of the above mentioned partners by repeated reciprocal graftings and second, do the characters of the scion change under influence of the stock?

MATERIALS AND METHODS

We started our experiment with true breeding lines of the tomato variety Money-maker (symbol "M") and *L. glandulosum* (symbol "G") in September 1955, and after completing the observations on the fifth graft generation, the experiment was finished in October 1958.

The first and third generation have been grown in a hothouse in the winter, without controls; the second, fourth and fifth in a cold glasshouse in spring and summer, with controls.

Plants grown in the winter received additional illumination from Mercury lamps (Quick 125) from November 1st till January 15th. The intensity of the illumination was 60 w/m², the duration from 7 a.m. till 3 p.m.

In order to obtain the greatest possible influence of the stock on the scion, we strictly applied methods recommended in the literature. Seedlings at the first leaf stage have been used as scions, while the stocks were already at the first truss stage. Stocks were decapitated below the first truss and scions grafted by the cleft-graft method (fig. 1). Scions were successively defoliated; only the growing point and the youngest leaflet were left on the scion. In the first, second and third generations the M scions were decapitated as soon as the fruit had set (fig. 2 and 4). M scions of the fourth and fifth generations were not decapitated after the pollination of the flowers of the first truss, they were only defoliated till the fruits were half grown, and then left to grow on. In this way in a long growing-season of the spring and summer the M/G plants were able to develop two further trusses (fig. 3). All flowers of those trusses were pollinated with G/M pollen. Thus the chances of successful mating were increased threefold.

In each graft-generation three seedlings of the tomato were grafted on to *L. glandulosum* (symbol M/G) and two seedlings of *L. glandulosum* on tomato (symbol G/M). The latter were used for selfing and as pollinators for M/G, but not as pistillate parents for the crosses. By grafting M on G and also G on M we hoped to accelerate the "approaching" of the partners.

One flower of each grafted plant was pollinated by hand with its own pollen, to secure seeds for the next generation; the remaining flowers of the M/G plants were pollinated with the pollen of G/M plants of the same graft-generation to test the possibilities of the approach method. The seeds as well as the seedlings for grafting and planting were taken at random.

Throughout the growing season the grafted and ungrafted plants were observed very accurately for any deviations from the controls. Special attention was paid to the following distinct characters typical of the partners:

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Character	<i>Moneymaker</i>	<i>L.glandulosum</i>
Roots – susceptibility to: “Corky root”	very susceptible	resistant
<i>Meloidogyne incognita</i>	very susceptible	resistant
Stem –	thick, sturdy	thin, weak
Leaves – susceptibility to: <i>Cladosporium fulvum</i>	very susceptible	resistant
Flowers – pistil	shorter than staminal column	longer than staminal column
Fruit – unripe	evenly light green	greyish-green, striped
Fruit – ripe	red	whitish-grey, striped, 1–1.5 cm Ø
Seeds –	5–8 cm Ø greyish, silvery pilose	brown, naked save the apex 1,000–1,300 in a gram

The experimental data are presented in tables 1 and 2.

TABLE 1. RESULTS OF CROSSES WITHIN SPECIES OF SUCCESSIVE GRAFT-GENERATIONS

Period	Crosses		Number of		of which:			Ap- pear- ance of seed	Number of seeds		Symbol
	♀	♂	pollinated flowers	fruits set	Nubbins +)	Seed- less	Normal with seeds		Total	In one fruit	
September '55 till	M/G	M/G	3	2	1	0	1	M	47	47.0	M ₁
January '56	G/M	G/M	4	3	0	0	3	G	107	35.7	G ¹
January '56 till	M ₁ /G	M ₁ /G	3	3	1	0	2	M	191	85.5	M ₂
September '56	G ₁ /M	G ₁ /M	3	2	0	0	2	G	104	52.0	G ₂
September '56 till	M ₂ /G	M ₂ /G	3	2	1	0	1	M	37	37.0	M ₃
January '57	G ₂ /M	G ₂ /M	3	2	0	0	2	G	78	39.0	G ₃
January '57 till	M ₃ /G	M ₃ /G	3	2	0	0	2	M	153	76.5	M ₄
September '57	G ₃ /M	G ₃ /M	3	2	0	0	2	G	87	43.5	G ₄
February '58 till	M ₄ /G	M ₄ /G	3	2	0	0	2	M	163	81.5	M ₅
October '58	G ₄ /M	G ₄ /M	4	2	0	0	2	G	107	53.5	G ₅

* Small, badly developed, unmarketable parthenocarpic fruits below 20 gr.

TABLE 2. RESULTS OF CROSSES BETWEEN SPECIES, WITH AND WITHOUT REPEATED GRAFTING

Period	Crosses		Number of		of which:			Appearance of seeds	Number of seeds	
	♀	♂	pollinated flowers	fruits set	Nubbins	Seed-less	Normal with seeds		Total	In one fruit
Jan.-Sept. '56	M	G	180	161	15	146	0	-	0	0
Jan.-Sept. '57	M	G	250	217	20	196	1	Hybrid	1	1
Febr.-Oct. '58	M	G	196	161	13	147	1	Hybrid	1	1
	Total		626	539	48	489	2	Hybrid	2	-
September '55 till Jan. '56	M ₁ /G	G ₁ /M	14	10	3	7	0	-	0	0
January '56 till September '56	M ₁ /G	G ₁ /M	16	11	2	9	0	-	0	0
September '56	M ₁	G ₁ /M	120	103	11	92	0	-	0	0
September '56 till Jan. '57	M ₂ /G	G ₂ /M	7	5	2	3	0	-	0	0
January '57 till September '57	M ₃ /G	G ₃ /M	53	42	5	37	0	-	0	0
September '57	M ₃	G ₃ /M	250	211	19	192	1	Hybrid	1	1
February '58 till September '58	M ₄ /G	G ₄ /M	54	45	5	40	0	-	0	0
September '58	M ₄	G ₄ /M	200	156	11	144	1	Hybrid	1	1
	Total		714	583	58	524	2	Hybrid	2	-

DISCUSSION AND RESULTS

Our experiment was based on the assumption that if the plants used are homozygous, if they are treated quite similar and if the growth conditions are alike, we need not work with many individuals, because similar stocks will influence similar scions in a similar manner.

Before discussing the results of our experiment it should be noted, that after our unsuccessful trials to effect the cross between *L. esculentum* and *L. glandulosum*, we started to pollinate the flowers twice: directly after emasculation and four days later. This method produced better results. We got viable hybrid plants not only from embryo culture, but also from fully developed seeds found in the ripe fruits. The average was one viable hybrid seed per ± 200 pollinations, while there was never more than one viable hybrid seed in a fruit. If there were more, they were found to be due to accidental cross-pollination.

Assuming that the "Approach method" works, and that approaching progresses with each graft-generation, we must expect an increase in successful matings in each following generation.

In table 1 are presented the results of the crosses *within* the species of the successive

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FIG. 1. LYCOPERSICUM ESCULENTUM SCION SIX DAYS AFTER GRAFTING ONTO LYCOPERSICUM GLANDULOSUM STOCK.



FIG. 2. DEFOLIATED AND DECAPITATED L.ESCULENTUM SCION.

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FIG. 3. TWO ADDITIONAL TRUSSES ON LYCOPERSICON
ESCULENTUM SCION.

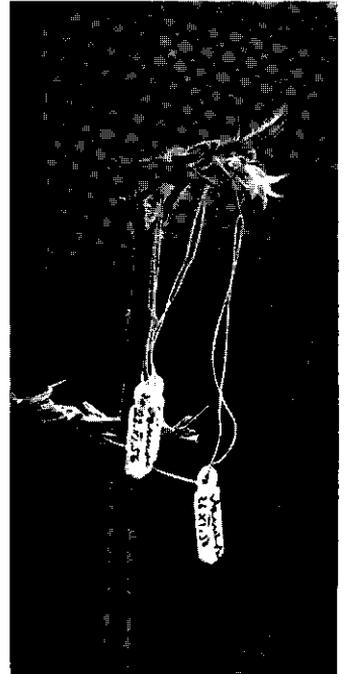


FIG. 4. DETAIL OF FIG. 2.

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graft generations. It will be seen that the numbers of seed of *L. glandulosum* per one fruit vary from 35 to 53 (average 44), those of *L. esculentum* from 37 to 85 (average 70). They do not show any tendency to increase or decrease in the successive graft generations.

Table 2 gives the results of the crosses *between* the species. In the upper part of the table the results of the crosses without any grafting are found, amounting to 2 seeds in 626 pollinated flowers (539 fruits set). In the lower part of the table one finds the results of the crosses of the successive graft generations. The total result of the different generations is now 2 seeds in 714 pollinated flowers (583 fruits set). The frequency of seed setting in both cases is of the same order. There is no evidence of an increase in successful matings in the successive generations. It seems that nothing has changed by application of the "approach method". The conventional crosses of the two highly incompatible partners proved to be as effective as the crosses of the same partners after having been "prepared".

Our observations on experimental plants for possible deviations from the parent types, as a result of the repeated graftings, gave negative results. Except for retarding of the growth of the grafted plants caused by defoliation, we did not observe any changes neither in habit nor in other characters of the plants. Therefore, considering the results of our experiments, we can not confirm the opinion that repeated grafting as a rule will change the characters of the scion by influence of the stock.

SAMENVATTING

Pogingen om de incompatibiliteit in kruisingen tussen L. esculentum en L. glandulosum met behulp van herhaald enten te overwinnen

Bij het kweken van tomaten op resistentie tegen "kurkwortel" wordt *L. glandulosum* gebruikt als een resistente geniteur. Kruisingen van *L. glandulosum* met de tomaat zijn zeer moeilijk te realiseren als gevolg van de incompatibiliteit van de partners. Om deze incompatibiliteit te overwinnen werd naast de gebruikelijke kruisingsmethode ook de „methode van toenadering” toegepast.

Herhaald reciproom enten van de tomaat op *L. glandulosum* en omgekeerd had niet tot gevolg dat het aantal gelukte combinaties toenam.

De vermelding in de literatuur, dat door herhaald enten de eigenschappen van de ent veranderen onder invloed van de onderstam, kon niet worden bevestigd.

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