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Induction of Alloplasmic Cytosterility in Tomato by Somatic Hybridization

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Induction of alloplasmic cytotesterility in tomato by somatic
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Abstract

Although many important traits originated in wild relatives have been introgressed into commercial tomato cultivars, the potential germplasm resources are severely limited in many instances by unilateral incompatibility and hybrid sterility among these crosses. Therefore, somatic hybridization is emerging as a complementary technique in the breeding of tomato. Moreover, somatic hybridization can generate novel combinations of nuclear and cytoplasmic determinants not previously available by conventional breeding.

This proposal was centered around the generation of somatic hybrids and cybrids between tomato (Lycopersicon esculentum) and related Lycopersicon or Solanum species, in order to expand the available gene pool in this crop, and specifically to search for nuclear-cytoplasmic interactions conducting to cytoplasmic male sterility. In the following, we summarize the main achievements of this project:

1. Establishment of protocols for isolation, fusion, culture and regeneration of protoplasts from tomato and related Lycopersicon and Solanum species
2. Isolation and extensive characterization of somatic hybrids between L. esculentum and S. lycopersicoides
3. Establishment of experimental protocols for cybridization in tomato, based on the use of a cytoplasmic albino recipient cultivar, and on irradiation of the cytoplasmic donor genotype.
4. Regeneration and characterization of L. esculentum/L. peruvianum cybrids.
5. Valuable information was gathered on the fate of nuclear and cytoplasmic genophores in Lycopersicon/Solanum cybrids and somatic hybrids.
6. Expansion of the cytoplasmic and nuclear gene pool available for future tomato breeding.

The genetic and biochemical characterization of the genotypes obtained through this joint project is still in progress in both participating laboratories.

Objectives of the original research proposal

In the following, the objectives stated in the original proposal are included.

The overall, long term goal of the proposed research is to determine whether genetic exchange and plasmon transfer between tomato and its related wild Lycopersicon and Solanum species will lead to the synthesis of nuclear-cytoplasmic male sterility.

The specific objects are:

1. To improve the protoplast systems in species to be used as donors or recipients of alien plasmon.
2. To improve protocols for enucleation of protoplasts in the pertinent Lycopersicon and Solanum species.
3. To attempt the introduction of cms-inducing plasmons from alien species into tomato cultivars or lines of L. esculentum
4. To search for alloplasmic nuclear-plasmon combinations of Lycopersicon and related Solanum species which exhibit cms.

It is also expected that basic information will be gained about the role of homoplasmic-versus-heteroplasmic condition in hybrid plants for overcoming cases of incompatibility among Solanaceous species.

Finally we expect to create a wider germplasm base in tomato for future breeding purposes by providing combinations of cytoplasmic and nuclear genomes previously unattainable.

Description of cooperation

The two laboratories involved in this project have a long tradition of cooperative work. This was manifested in the way the present project was designed and executed.

Both Israeli scientists visited MSU in different occasions. In those meetings results of previous work were elaborated and discussed, technical achievements were extensively discussed and exchanged, and future working plans and collaborations were designed. The American scientist will visit the Volcani Center in the near future, in order to plan joint BARD projects for the next year.

Plant material relevant to this project was freely exchanged between both laboratories, and expertise obtained on methodologies pertinent to the project were made available immediately to the counterpart laboratory. A major invited joint publication was prepared within the conceptual framework of this project.

Evaluation of the research achievements

Although this project is formally terminated, the molecular and genetic analyses from genotypes obtained within its framework is still in progress. A full appreciation of the achievements will be only possible when this characterization will be completed. However, the already published and summarized information enables to indicate the following achievements:

1. Establishment of protocols for isolation, fusion, culture and regeneration of protoplasts from tomato and related Lycopersicon and Solanum species
2. Isolation and extensive characterization of somatic hybrids between L. esculentum and S. lycopersicoides
3. Establishment of experimental protocols for cybridization in tomato, based on the use of a cytoplasmic albino recipient cultivar, and on irradiation of the cytoplasmic donor genotype.
4. Regeneration and characterization of L. esculentum/L. peruvianum cybrids.
5. Valuable information was gathered on the fate of nuclear and cytoplasmic genophores in Lycopersicon/Solanum cybrids and somatic hybrids.
6. Expansion of the cytoplasmic and nuclear gene pool available for future tomato breeding

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1. Derks FHM, Zelcer A, Colijn-Hooymans CM (1989) Plant regeneration of mesophyll protoplasts from a cytoplasmic albino mutant of Lycopersicon esculentum cv Large Red Cherry (submitted for publication)
2. Handley LW, Nickels RL, Cameron MW, Moore PP, Sink KC (1986) Somatic hybrid plants between Lycopersicon esculentum and Solanum lycopersicoides. Theor Appl Genet 71:691-697
3. Izhar S, Zelcer A, Sink KC (1986) Somatic hybridization as a tool for genetic improvement of crops (in revision)

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4. Levi A, Ridley BL, Sink KC (1988) Biased organelle transmission in somatic hybrids of Lycopersicon esculentum and Solanum lycopersicoides Curr Genet 14:177-182
5. Moore PP, Sink KC (1988) Molecular analysis of single copy and repetitive genes on chromosome 2 in intergeneric tomato somatic hybrid plants Pl Mol Biol 11:139-145
6. Moore PP, Sink KC (1988) Characterization of a Lycopersicon esculentum x Solanum lycopersicoides somatic hybrid lacking a glutamate oxaloacetate transaminase isozyme. Plant Cell Tissue Organ Cult 13:39-47
7. Niedz RP, Sink KC (1988) Multifactor analysis of environmental preconditioning of tomato seedlings on protoplast culture and development. J Plant Physiol (in press)
8. Zelcer A, Izhar S, Wolf D, Levy B, Soferman O (1988) Somatic hybridization between tomato and other Lycopersicon or Solanum species. In: Puite KJ, Dons JJM, Huizing HJ, Kool, Koornneef M, Krens FA (eds) Progress in Plant Protoplast Research, Kluwer Acad Publ, pp. 225-226
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13. Zelcer, A (1989) Cell engineering in tomato: relevance to plant breeding. Abs Otto Warburg Symp "Plant Cell Interact & Model Systems", Rehovot, p. 6
14. Zelcer A, Izhar S, Wolf D, Levy B, Soferman O (1987) Somatic hybridization in tomato and related species. Abs Ann Meet Isr Soc Bot, Isr J Bot 36: 48