Biotechnological studies on rootkont nematode resistance in tomato

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Six tomato cultivars i.e. Edkawi, Super Marmand, Renita,PI 376072, Nemared, and Anahu were used in making non reciprocaldiallel pattern of crosses to obtain F1 seeds in order to study thegenetics of resistance to the root knot nematode. Cultivar Edkawi hasnot been evaluated for resistance to root knot nematode before. Thetomato cultivar Super Marmand is known for susceptibility to rootknot nematode. However, the other cultivars line Ronita, PI 376072,Nemared and Anahu are considered resistant.Seeds of cultivars Edkawi and Super Marmand were obtainedfrom Germplasm Preservation Laboratory, Faculty of .Agric.Moshtohor, Zagazig University, Department of Horticulture, Egypt.The seeds of the resistant cultivars were obtained from the NationalGermplasm Resources Laboratory, Beltsville, U.S.A. The seeds of thedifferent par-ental germplasm and their F1 seeds were used in thegreenhouse, field, and bioassayexperiments.Meloidogyne incognita Race 1 was used in testing the differenttomato genotypes for resistance to root knot nematode, since it wasfound to be the most common race in most of the tomato growingareas in EgyptI. Greenhouse Experiment:Seeds of the different tomato parental germplasm in addition totheir F I seeds were planted in clay pots, 25 ern in diameter (oneplant/pot) containing sterilized sandy clay soil (1: 1, v/v). When theseedlings reached the (4 true leaves stage), each plant was iBoculatedwith 5000 fresh nematode eggs (initial population, Pi)' Then pots werearranged in a randomized complete block design, with five replicates.The recorded temperature in the greenhouse ranged from 26 to 32Coduring the period of conducting this experiment. Sixty days afterinoculation, the plants were cut off at the soil surface and the soil wasgently washed off from the roots. The roots of the individual plantswere examined and the following measurments were recorded:a) Number of galls (Eggmasses)b)Number of eggsc) Repraduction (R) factorThe results can be summarized as follows.1. The parental cultivars Ronita, Nemared,and Anahu were themost resistant genotypes, while Edkawi, Super Marmand, andPI 316072 showed. high susceptibility, using number of galls,number of eggs, and reproduction factor as criteria to evaluate theresistance of the different tomato genotypes to the root-knotnematode.2. The additive type of gene interction was more important thannon-additive type of gene interaction, in the inheritance of tomatoresistance to the root-knot nematode.3- The resistance to the root-knot nematode was found to becomplete dominant over susceptibility in the different F1 hybrids .4- The parental cultivars R-oB~ Nemared and Anahu pr-oved to begood combiners to from FI hybrids with high leves of resistance tothe root-knot nematode.5- An intermediate broad sense and low narrow sense heritabilitiyestimates were calculated, indicating the importance of selectingfor resistance to the root-knot nematode an family mean basisinstead of selecting. on individual plant basis.II. Reid Experiment:Seeds of the different parental gennplasm and-related F1's were- planted ·in 10 em-pots filled withsterilized sand and clay (1:I,v:v) onMarch 9,1997. Ten pots were assigned to each genotype. The emergedseedlings were thined to one plant /pot, Five pots from each genotypewere used for the purpose of artificial inoculation using 5000 freshnematode eggs (initial population, Pi) per pot. The other five potsfrom each genotype were Ieftintact. The inoculated and uninoculatedseedlings of each genotype were transplanted in the field on May 1,1997. Before transplanting, holes with the size of60 X 50 X 50 emwere digged in the field and filed with soil contains sterilized sand andclay (1: 1, v: v). Each hole was 1 meter apart from the next hole.

Theinoculated and uninoculated seedlings of the differentgenotypes i.eparents and F1 populations were transplanted into these holesaccording to the randomized complete block design. The individualplants of the different genotypes were evaluated for the followingcharacters .1.Number of days from teransplanting to first flower anthesis2. Fruit set perecentage3.Number fruits/plant4. Average fruit weight (gm)5. Plant Yield (gm)6. Detached Leaves fresh weight (gm)7. Plant height (em)8.Number ofbranchs9. Roots fresh weight/plant (gm)10. Root Phenols ContentII.Leaf Chlorophylls ContentThe results ean be summarized as follows:1- Under the condition of the artificial inoculation with root-knotnematode, number of days from trasplanting to first floweranthesis was less than that recorded for the uninoculated plants forthe cultivars Edkawi, Super Marmand, and PI 376072.2- The eultivar Ronita showed the highest percentages of fruit setwhether the plants were inoculated (78.8%) or not (83.0%).3- Relatively high percentage of fruit set was associated with theinoculated plants of the FI hybrids Edkawi x Nemared (83.8%),and Edkawi x Ronita (82.2%),. which indicated that such F 1hybrids could be recommended in the areas which may havepossible soil infestation with root-knot nematode.4- The values of the fruit weight of the inoculated anduninoculated plants of the parental genotypes Ronita, PI 376072,Nemared, and Anahu were not significantly different from eachother, which could be due to the high level of resistance to theroot-knot nematode showed by these tomato germplasm.5- The cultivar Nemared showed the highest plant yield under thecondition of artificial infestation with root-knot nematode. On theother hand, the parental genotype PI 376072 had the lowest plantyield under such conditions.6- The fresh weight of the leaves detached from the inoculatedplants of the parental cultivars Edkawi, Super Marmand, andPI 376072 were significantly less than the fresh weights of theleaves detached {rom the uninoculated plants of the samegenotypes which can be attributed to the effect of inoculation withroot-knot nematode.7- Under the condition of the artificial infestation with root-knotnematode, the plants of the parental cultivar Nemared had thehighest number ofbranchs/plant (15.0) followed by Ronita (14.0),PI 376072 (13.0), and Anahu (11.0).8- With all parental genotypes, the healthy plants were higher thanthe inoculated ones within the same genotype.9- The highest root fresh weightof the parental genotypes was thatassociated with the cultivar Nemared which had an average of 565gm for the inoculated and uninoculated plants. The parentalgenotypes Edkawi, Nemared, Ronita, and Anahu showed nosignificant difference between the fresh weight of the inoculatedplants and that of the uninoculated plants. On the other hand, thesusceptible cultivar Super Marmand showed significant differencebetween the root fresh weight of the inoculated plants (172.6 gm)and that of the uninoculated plants (225 gm).10- Both the healthy and infected plants of the parental cultivarswhich previously reported as resistant to the root-knot nematode,i.e., Ronita, PI 376072, Nemared and Anahu, had highest rootphenols content than that of the other cultivars, i.e. SuperMarmand, which was previously reported as susceptible cultivar,and cultivar Edkawi. However, the root phenols content of healthyand inoculated plants of the cultivar Edkawi were higher than thatof the cultivar Super Marmand. The obtained results in the presentstudy indicated that root phenols content can be used as a criterionin selection for resistance to the root-knot nematode in tomatobreeding programs.11- The leaf chlorophyll content of the uninoculated plants of thedifferent parental genotypes and F I hybrids were, eithersignificantly or not significantly, higher than the leaf chlorophyllcontent of the inoculated plants.12- The mean square v-alues for gener.al (gca) and specific (sca)combining ability were significant for the different studiedcharacters under the conditions of inoculation with root-knotnematode, indicating the involvement of both the additive andnon-additive types of gene interaction in the inheritance of thesecharacters.13- The gca/sca ratios exceeded unity for the characters which wereevaluated for the plants of the different parents and F1 hybridsunder the condition of artificial with root-knot nematode. Thesecharacter were: number of days from-transplanting to first flower. -anthesis,.percentage of fruit set, average fruit weight, plant yield,plant height, number of branchs, root fresh weigh, and rootphenols content. These results indicated that the additive type ofgene interaction was ’more important than the dominance type, inthe inheritance of the previously mentioned characters.14- The gca/sca ratios were less than 1, for leaf chlorophyll contentand number of fruits/plant, under the condition of infection withroot-knot nematode, which indicated that the dominance type ofgene interaction was more important than the additive type of geneinteraction

in the inheritance of these charcters.15- The additive and dominance type of gene interaction wereequally important in the inheritance of detached leaves freshweight under the condition of artificial infestation with root-knotnematode.16- The narrow sense heritability for the different studied charactersranged from very low to intermediate which indicated theimportance of selecting for these characters in the segregatinggenerations under the condition of artificial inoculation with rootknotnematode, based on family mean basis in replicatedexperiments to reduce the non-additive effects on the expression ofthese characters.III. penetration bioassay experiment:Root tips.ofthe·differentparentalcnhivars and related F 1's wereused in conducting a. bioassay to determine the penetration rate ofnematode larvae. Seeds of each genotype were soaked for three min.in 95% ethanol followed by 10 min. soaking in 0.5% sodiumhypochloride. Then seeds were washed-with sterilized distilled waterand then transfered to sterile O.8-9A water.agar plates where they weremaintained for feur days at 28Co• Then a .Smm-long. root tip wasexcised from each new devloping seedling and transferred to a sterilepetri plate containing Gamborg's B-5 medium. Three days later eachroot tip was inoculated with one eggmass taken from the susceptiblecultivar (Marmand) inoculated with M incognita race 1. Fivereplications were used for each genotype and another five root tipswere left uninoculated as control. All petri plates were incubated at28Co for ten days after inocuJati<m. All root tips were then washed andstained, using the acid-fuchsin lactophenol technique. Thepenetrations of the tested genotypes by the nematode was judged by1he .mrmber of pentrated larvae. The results can-be summarized-asfollows:-1- Number of larvae penetrated the root tips within 10 days afterinoculation were 90.00,81.67 and 53.33 for the parental genotypesEdkawi, Super Marmand, and PI 376072, respectively. On theother hand, larvae of the root-knot nematode did not penetrate theroot tips of the parental cultivars Ronita, Nemared, and Anahu.2- The root tips of the F1 hybrids Edkawi x Super Marmand, SuperMarmand x PI 376072, and Edkawi x PI 376072, were penteratedby 77.0-0, 41.67, and 1.67 larvae, respectively within lO'days.afterinoculation, while the root tips of the other F 1 hybrids had not beenpenetrated.3- The penetration bioassay was efficient and dependable indetecting the resistance and the degree ofthesusceptibifity of thedifferent tomato germplasm to the root-knot nematode.4- Both the additive and dominance type of the gene interactionwere found to be involved in the inheritance of resistance to thepenetration of root-knot nematode larvae. However, the role of theadditive type of gene interaction was more important than the roleof the dominance type.5- An intermediate value of broad sense heritability (63.72%) wascalculated for resistance to penetration of root-knot nematodelarvae, while the narrow sense heritability estimate was belowintermediate (35.6SOIo).B3sed- on these results, selection forresistance to larvae penetration in the segregating generationsshould be done on family mean basis.V. Resistance bioassay experiment.Seeds of the different parental gentoypes and related Fi 'S wereplanted in sterilized sandy clay soil (1 :1,v:v). One seed was. sown ineach pot, and five pots were used for each gentoype. Twenty five daysafter emergence of seedlings each seedling recieved 5000 -Mincognita eggs. Then the pots were arranged in a randomizedcomplete block design at the greenhouse. The recorded greenhousetemperature ranged from 28C" to 31C". After 15 days frominoculation, the seedlings were removed and its roots were washedwith running water. The number of galls formed at that time wascounted under a dissecting microscope. The reactions of the testedgenotypes to nenmIode were gudged by the number of galls producedon the roots of the tested seedlings. The gall rating was made as in thegreenhouse experiment. The results can be summarized as follows1-The bioassay was efficient and accurate in detecting the differencesamong the parental genotypes and F I hybrids concerning resistanceto the root-knot nematode.2- The additive type of gene interactions was more important in theinheritance of resistance to the root-knot nematode, comparing tothe dominance type of gene interaction.3- The broad and narrow sense heritability estimates calculated forresistance to root-knot nematode, evaluated by resistance bioassaywere (69.33%), and (30.67%), respectively.