Reaction of Tomato (*Solanum Lycopersicum*) Genotypes to Tomato Leaf Curl Virus (Tlcv) and Their Combining Ability For Resistance against The Virus

مهدی صیدی (۱)، سودهاکار واراده (۲)

Mehdi Saidi (1) Sudhakar Demudhar Warade (2)

1. Assistant Professor of Horticulture (Ph.D.), Department of Horticulture, College of Agriculture, Ilam University, 2. Professor of Horticulture (Ph.D.), Department of Horticulture, Mahatma Phule Agricultural University

Eleven diverse parents and their 24 hybrids derived through a line × tester mating fashion evaluated for reaction to tomato leaf curl virus (TLCV) and their combining ability for resistance to the virus during *Rainy Season* 2005 under field epiphytotic conditions at Rahuri, India. The results showed that among the parents, COMLCR-7 and H-24 were immune, COMLCR-4, 18-1-1, H-86, H-36, H-88 and COMLCR-9 were resistant and M-3-1, 87-2 and Floradade were susceptible to TLCV. While among the hybrids, M-3-1 × COMLCR-7, M-3-1 × H-24, M-3-1 × H-36, M-3-1 × 18-1-1 and Floradade × COMLCR-7 were resistant. Combining ability studies revealed that among the lines only M-3-1 and among the testers 18-1-1, H-36, COMLCR-7 and H-24 exhibited significant negative GCA effect for this trait. The crosses 87-2 × H-88, Floradade × COMLCR-4 and M-3-1 × H-24 were superior specific combiners for resistance to the virus. GCA and SCA variances showed the predominance of dominance gene action for reaction to TLCV.

INTRODUCTION

Tomato is susceptible to more than 200 diseases. Loses in yield due to diseases may be as high as 70 to 100 percent (Sherf and MacNab, 1986). Leaf curl disease (Figure 1) caused by Tomato Leaf Curl Virus (TLCV) is the most serious disease throughout India, particularly during summer season and is responsible for the failure of the crop. Infected plants bear few or no fruits (Green and Kalloo, 1994) and yield losses may be as high as 100 percent (Kalloo, 1988). Use of chemicals for the control of the disease not only is ineffective, but also has several disadvantages, particularly the cost of chemicals and their residual effects, which ultimately affects adversely the consumer's health. Therefore, it is imperative to concentrate on the development of hybrids/cultivars resistant to the disease. Identification of resistance sources is the first step in disease breeding programs. During the past few years, several sources of resistance to leaf curl virus (Banerjee and Kalloo, 1989; Zamir *et al.*, 1994; Hassan and Abdel-Ati, 1999; Mala and Vadivel, 1999 and Nainar and Pappiah, 2002) among the wild and cultivated tomatoes identified in India and elsewhere. On the other hand, combining ability has a prime importance in plant breeding since it provides information for the selection of parents and the nature and magnitude of involved gene action (Saidi *et al.*, 2008). The knowledge of genetic structure and mode of inheritance of different characters helps breeders to employ suitable breeding methodology for their improvement (Kiani *et al.*, 2007). Therefore, the present study conducted to identify resistant breeding lines/ varieties resistant to TLCV and having good negative combining ability combined with acceptable yield.

MATERIALS AND METHODS

The present investigation was carried out at Tomato Improvement Scheme, Department of Horticulture, Mahatma Phule Agricultural University, Rahuri, India during *kharif*, 2005. The parent material consisted of three lines (susceptible), eight testers (resistant) and a susceptible check (Punjab Chhuhara) selected based on resistance to Tomato Leaf Curl Virus (TLCV), diverse morphological and quantitative characteristics. The genotypes and their hybrids screened for reaction to TLCV under natural field conditions. A highly susceptible variety, Punjab Chhuhara; was grown in the alternative rows parallel to the experimental plants to provide uniform inoculums. Against insect pests, no control measure applied.

However, all the other agronomical practices carried out as per recommendations. All genotypes evaluated in a randomized block design with three replications. There were 10 plants of lines, testers and F_1s per replication spaced at 90 × 30 cm. The susceptible check spaced with similar distance parallel to parents and F_1 hybrids on the alternate rows.

Percentage of disease incidence of TLCV calculated by the following formula:

$$PDI = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \times 100$$

Then, disease reaction recorded by following rating given below:

Symptoms	PDI	Disease rating
Symptoms absent	0	Immune
Very mild curling	< 10	Resistant
Curling, puckering	10 to 15	Moderately resistant
Curling, puckering	15 to 20	Moderately susceptible
Curling, puckering	20 to 30	Susceptible
Sever curling, puckering	> 30	Highly susceptible

Symptom severity grades designated with numerical values of 0 to 4 based on visual observation of disease on the individual plants. To quantify the disease severity, a response value was given to each grade as follows:

Symptoms	Symptom severity grade	Response value
Symptoms absent	0	0
Very mild curling up to 25%	1	0.25
Curling, puckering of 26-50%	2	0.50
Curling, puckering of 51 – 75%	3	0.75
Sever curling, puckering of >75%	4	1.00

Then, percentage of symptoms intensity (PSI) calculated by the following formula:

$$PSI = \frac{\text{Sum of response values for all infected plants}}{\text{Total number of plants} \times \text{maximum response value}} \times 100$$

Combining ability analysis carried out following Kempthorne (1957). In case of TLCV incidence and intensity, the lines/ hybrids having negative GCA/SCA effects considered as superior.

RESULTS AND DISCUSSION

Disease incidence and intensity recorded with 15 days intervals. However, after two heavy rains at 80 to 100 days after transplanting (Appendix 1), almost all genotypes infected with tomato spotted wilt virus (TSWV) and late blight, which were severe enough to mask the visual symptoms of TLCV. The TLCV infected plants, which re-infected by TSWV, died within 15 days. Therefore, data on reaction to TLCV was available only by 75 days after transplanting.

I. Reaction of genotypes to TLCV

Analysis of variance for design of experiment (Table 1) revealed that the magnitude of mean sum of squares due to parents vs. crosses, lines, testers and lines vs. testers were highly significant for all studied traits except the last one for yield per ha. Mean performance of parents and their crosses for reaction to TLCV (Table 2) revealed that the mean TLCV PDI at 75 DAT for the lines, was maximum in M-3-1 (34.29 %) and minimum in Floradade (20.99 %) which was at par with 87-2 (23.02 %). While among the testers, COMLCR-9 recorded the maximum (4.98 percent) and COMLCR-7 and H-24 recorded the minimum PDI (0.01 %) at 75 days after transplanting. Mean performance of the hybrids for this trait ranged from 3.17 % in the cross 87-2 × COMLCR-7 which was on a par with the crosses M-3-1 × H-24, M-3-1 × H-36, M-3-1 × 18-1-1, 87-2 × 18-1-1 and Floradade × COMLCR-7 to 29.15 % in the cross 87-2 × COMLCR-9. The Maximum PDI at 75 DAT recorded for hybrids, was significantly lower than the maximum PDI recorded for the lines (M-3-1). Except the susceptible check, the percentage of disease infection (PDI) at 45, 60 and 75 days after transplanting was same for almost all genotypes, indicating that

the plants might be infected at nursery only. The percentage of disease infection in all of the entries except M-3-1 was statistically less than the susceptible check (Table 2). The resistance observed in COMLCR-7 might be due to its potato leaf type combined with highly dense trichomes (Snyder and Carter, 1985) or tacky exudation of the glandular leaf trichomes. The resistance of H-24 and H-36 is introgressed from *L. hirsutum* f. *glabratum* (Banerjee and Kalloo, 1990). The mean TLCV PSI at 75 DAT for the lines ranged from 18.92 % in Floradade to 33.36 % in M-3-1. While for testers, H-88 recorded the maximum (3.92 %) and H-24 and COMLCR-7 recorded the minimum PSI (0.01 %) at 75 DAT. Mean performance of the hybrids for this trait ranged from 0.83 % in the cross M-3-1 × 18-1-1 at par with M-3-1 × H-24 (0.88 %) to 27.58 % in the cross Floradade × H-88. The mean PSI recorded for the crosses M-3-1 × 18-1-1, M-3-1 × H-24, M-3-1 × H-36, 87-2 × COMLCR-7 and 87-2 × 18-1-1 was statistically on a par with the mean PSI exhibited by the testers COMLCR-7 and H-24, which showed no symptoms and the testers 18-1-1, COMLCR-4 and H-36 which exhibited 2.12, 3.03 and 3.24 % PSI, respectively. Being PSI almost equal to PDI for all genotypes; assumed that as soon as the plants infected, the virus distributed in whole of the plant's body within a few weeks. Therefore, recording only the percentage of disease incidence can be reliable to determine the reaction of tomato genotypes to TLCV.

II. Combining ability and gene action for resistance against TLCV

Analysis of variance for combining ability (Table 3) carried out for the studied traits and showed significant differences among genotypes, and thereby observed data subjected to further analysis for estimation of combining ability. Variances due to line and tester effects were non-significant, while variances due to line × tester effect were highly significant for all the studied traits. On the other hand, the SCA variances were greater than GCA variances for TLCV percentage of disease infection (PDI) and percentage of symptoms intensity (PSI). Similarly, dominance variance was greater than additive variance for both of the characters (Table 6), indicating the predominance of dominance gene action for reaction to TLCV. Hence, resistant to tomato leaf curl virus can be achieved through hybridization and heterosis breeding programs. Estimates of general combining ability effects of parents are presented in Table 4. Among the lines 87-2 (-1.338) and M-3-1 (-0.829) and among the testers 18-1-1 (-5.458), COMLCR-7 (-4.223), COMLCR-4 (-2.481) and H-36 (-1.806) recorded significant negative GCA effects on TLCV PDI at 45 DAT. While at 60 and 75 DAT, among the lines only M-3-1 and among the testers 18-1-1, COMLCR-7, H-36 and H-24 exhibited significant and negative GCA effects on the character (Table 4). Several workers have observed negative general combining ability effects on TLCV infection and non-additive gene action for resistance to the virus in tomato (Dharmatti *et al.*, 1999; Sajjan, 2001 and Tashildar, 2003). Similarly, the line M-3-1 and the testers 18-1-1, H-36, COMLCR-7 and H-24 were the best general combiners having significant negative GCA effects on percentage of symptoms intensity (PSI) at 75 DAT. Estimates of specific combining ability effects of the crosses on reaction to TLCV are presented in Table 5. The results revealed that among the 24 crosses, 7, 10 and 11 crosses exhibited significant SCA effects on TLCV PDI in desirable negative direction at 45, 60 and 75 DAT, respectively. As regards to estimates of SCA effects, the hybrids 87-2 × H-88, Floradade × COMLCR-4 and M-3-1 × H-24 were found to be superior specific combiners for this trait. For TLCV PSI, however negative and significant SCA effects were observed in 11 crosses, the maximum desirable SCA effects were recorded by the cross 87-2 × H-88 (-12.162), followed by 87-2 × COMLCR-7 (-7.235) and Floradade × COMLCR-4 (-6.076).

For conclusion, the study revealed that the breeding lines/cultivars viz., COMLCR-7, COMLCR-9, COMLCR-4, H-24, H-36, H-86, H-88 and 18-1-1 were resistant to TLCV, but the M-3-1, 18-1-1, COMLCR-7, H-36 and H-24 as the best general combiners for resistance against the virus can be utilized in resistance breeding programs. Furthermore, the resistant hybrids viz., 87-2 × COMLCR-7, M-3-1 × H-24, M-3-1 × H-36, M-3-1 × 18-1-1, 87-2 × 18-1-1, Floradade × COMLCR-7, 87-2 × H-88, Floradade × 18-1-1, Floradade × H-36 and Floradade × COMLCR-4 can be exploited in the areas where tomato leaf curl virus is prevalent.

ACKNOWLEDGEMENTS

The senior author is grateful to Head, Department of Horticulture, MPKV, Rahuri; Officer In-charge, Tomato Improvement Scheme, MPKV, Rahuri, India, for providing all the necessary facilities needed for the experiment.

LITERATURE CITED

BANERJEE M. K., KALLOO G. (1989): Effect of tomato leaf curl virus on biochemical attributes in resistant/susceptible plants of tomato (*Lycopersicon esculentum* Mill.). *Vegetable Science,* **16(1):** 21-31.

BANERJEE M. K., KALLOO G. (1990): Nature of resistance to tomato leaf curl virus (TLCV) in two species of *Lycopersicon*. *Haryana Agricultural University Journal of Research*, **20(3):** 225-228.

DHARMATTI P. R., MADALAGERI B. B., MANNIKERI I. M., PATIL R. V. (1999): Combining ability for tomato leaf curl virus resistance in summer tomatoes (*Lycopersicon esculentum*). *Advances in Agricultural Researches in India*, **11:** 67-72.

Green S. K., Kalloo G. (1994): Leaf curl and yellowing viruses of pepper and tomato: an overview. Asian Vegetable Research and Development Center, *Technical Bulltein,* No. 21.

HASSAN A. A., ABDEL-ATI K. E. A. (1999): Genetics of tomato yellow leaf curl virus tolerance derived from *Lycopersicon pimpinellifolium* and *Lycopersicon pennellii*. *Egyptian Journal of Horticulture*, **26(3):** 323-338.

KALLOO G. (1988): Vegetable breeding. Volume II. CRC Press, Boca Raton, Florida, USA.

KEMPTHORNE O. (1957): An introduction to genetic statistics. *John Wiley and Sons,* New York, 458-471.

KIANI G., NEMATZADEH G. A., KAZEMITABAR S. K., ALISHAH O. (2007): Combining ability in cotton cultivars for agronomic traits. *International Journal of Agriculture and Biology,* **9 (3):** 521-522.

Mala M., Vadivel E. (1999): Mean performance of tomato genotypes for leaf curl incidence. *South Indian Horticulture,* **47(1-6):** 31-37.

NAINAR P., PAPPIAH C. M. (2002): Studies on sources of resistance for tomato leaf curl virus (TLCV) disease in wild species of tomato (*Lycopersicon esculentum* Mill.). *South Indian Horticulture,* **50 (1-3):** 266-269.

SAIDI M., WARADE S. D., PRABU T. (2008): Combining ability in tomato (*L. esculentum* Mill.) for yield and its contributing traits. *International Journal of Agriculture and Biology,* **10(2):** 238-240.

SAJJAN M. N. (2001): Heterosis, combining ability, RAPD analysis and resistance breeding for leaf curl virus and bacterial wilt in tomato (*Lycopersicon esculentum* Mill.). M. Sc. Thesis. *University of Agricultural Science,* Dharwad, India.

SHERF A. F., MACNAB A. A. (1986): Tomato. In: Vegetable diseases and their control (2nd ed.). *John Wiley & Sons,* 599-696.

SNYDER J. C., CARTER C. D. (1985): Trichomes on leaves of *Lycopersicon hirsutum*, *Lycopersicon esculentum* and their hybrids. *Euphytica*, **34:** 53-64.

TASHILDAR M. B. (2003): Evaluation of tomato F_1 hybrids for disease resistance and yield. M. Sc. Thesis. *Mahatma Phule Agricultural University,* Rahuri, India.

ZAMIR D., EKSTEIN-MICHELSON I., ZAKAY Y., NAVOT N., ZEIDAN M., SARFATTI M., ESHED-HAREL E., PLEBAN T., OSS H., KEDAR N., RABINOWITCH H., CZOSNEK H. V. (1994): Mapping and itrogression of a tomato yellow leaf curl virus tolerance gene, Ty-1. *Theoretical and Applied Genetics*, **88:** 141-146.