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Short Communication

Root anatomical and morphological basis for drought resistance in tomato (*Solanum lycopersicon*)

Manoj Kulkarni[1] and Uday Deshpande[2]

[1]School of Biotechnology, Vidya Pratishthan, Baramati 413 133
[2]School of Life Sciences, SRTMU, Nanded 431 606

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Present investigation was aimed at understanding the role of root anatomical features imparting drought resistance. It was interesting to note that roots of mutant derivative had more number of xylem poles along with increased diameter imparting drought resistance. Cultivated species with lower number of xylem poles and smaller diameter were found to be drought susceptible. Henceforth, in drought resistance breeding, due weightage need to be given on root anatomical and morphological parameters to develop true and stable drought resistant tomato genotypes.

Tomato (*Solanum lycopersicon* formerly *Lycopersicon esculentum*) is one of the most important vegetable crops grown in India. Building genetic resistance against abiotic stresses like drought in tomato genotypes has been long felt need in tomato breeding. Many morphological, physiological and biochemical differences in plant varieties have been reported to be associated with drought resistance. However studies related to the anatomical features imparting drought resistance is a new and novel concept, which needs to be better focused. Anatomical features are stable features over seasons and years. These parameters are genetically governed and can be introgressed.

Deshpande and Kulkarni [1] reported anatomical polymorphism in tomato roots and emphasized on higher number of xylem poles, wider diameter and deeper roots for drought resistance.

Total 16 genotypes including mutant derivatives and 5 hybrids were evaluated under field conditions in year 2003-2004. All the genotypes were transplanted in RBD design with two replications having the spacing 60 × 60 cm. Root anatomy of all the genotypes was studied in detail (90 days after transplanting) using light microscopy by adopting standard methods of investigation. The root samples were allowed to remain in fixative for 48 hours. Afterwards the samples were transferred to 70 per cent alcohol to store them for further studies. Observations on anatomical parameters of root cross sections were recorded using standardized ocular micrometer. Morphological observations were taken 90 days after transplanting.

Protoxylem and metaxylem: Highest number of protoxylem was observed in Hy-3 having total 39 protoxylem. Amongst germplasm lines mutant derivative MTG 1-4 has highest protoxylem counting 37 and lowest in TG-42 (i.e. 16 only) is susceptible to water stressed condition. Susceptible cultivars number ranged between 16-23 whereas resistant cultivars were with 28-39 protoxylem vessels. More number of protoxylem closely spaced with increased diameter imparted drought resistance to mutant derivatives and its hybrid. (Table 1). Higher number of poles was first thought to be involved with improved capabilities for water transport associated with increased xylem elements [2, 3], but it is now understood to be more directly involved with a greater potential for improved lateral root growth. A direct correlation was observed between the number of xylem poles in the taproots of cotton seedlings and the number of lateral roots produced. Metaxylem radius ranged between 20-32 μm was reported in rice [4].

Root length: Longer the roots, resistant the genotype to water stress. Water stress susceptible genotype (i.e. TG-13) was noted with 27 cm long roots whereas resistant genotype Hy-3 possessed deeper roots i.e. 71 cm. Drought resistant cultivars has 35-40 feeder roots/5cm length, considerably low in drought susceptible cultivars ranging from 20-32/5 cm length. The main center of absorption is the young roots. The feeder roots are structures substantially increasing the absorbing surface of roots [5]. Root: Shoot fresh biomass was also compared (Table 1). Mutant, its hybrids and mutant derivatives exhibited yield loss in range of 22.3 to 37.5 precent as compared to cultivated genotypes ranging in between 35.3 to 65 percent. Total dry matter of plants in both conditions was also compared. Dry

Table 1. Root anatomical and morphological comparison for drought resistance

Genotype	Number of xylem vessels per microscopic field	Diameter of xylem vessels (μm)	Distance between xylem vessels (μm)	Root length (cm)	Root:shoot ratio	Fresh biomass weight of roots (g)	Fresh biomass weight (root: shoot) (g)	Number of feeder roots/ 5 cm
MTG 1-1	38.00*	202.80	103.32	67.00*	1.29	49.00	0.08	49.00*
MTG 1-2	31.00	192.70	112.14	39.00	0.67	43.00	0.06	43.00
MTG 1-3	33.00	186.48	117.18	43.00	0.76	39.00	0.055	39.00
MTG 1-5	13.00	113.40	154.98	17.00	0.53	11.00	0.071	11.00
TG 42	16.00	214.20	280.98	32.00	0.53	31.00	0.041	31.00
TG 2-3	21.00	186.48	249.48	30.00	0.22	23.00	0.048	23.00
Hy-1	39.00	228.60	100.80	49.00	0.39	47.00	0.056	47.00
Hy-2	28.00	180.10	194.98	47.00	0.65	33.00	0.071	33.00
Hy-3	39.00*	205.30	114.66	71.00*	0.88	39.00	0.054	39.00*
MTG 1-4	37.00*	190.00	94.50	62.00*	1.31	44.00	0.048	44.00*
Hy-4	18.00	192.70	364.14	37.00	0.54	27.00	0.048	27.00
Hy-5	20.00	167.50	212.94	40.00	0.30	24.00	0.050	24.00
TG-5	23.00	205.38	274.68	32.00	0.24	19.00	0.040	19.00
TG-13	19.00	173.88	337.68	27.00	0.43	23.00	0.044	23.00
TG-80	16.00	151.20	318.78	38.00	0.46	32.00	0.042	32.00
TG-64	18.00	176.40	343.98	35.00	0.53	29.00	0.040	29.00
SE ±	2.33		7.18	1.60		1.03		1.77
CD (5%)	6.51		22.05	4.70		3.10		5.30
Population mean	28.33	190.01	158.72	45.40		35.00		35.00

*Significant at 5% level.

matter content in water stressed situation was correlated with different morphological and anatomical features to find genotypic correlation.

Dry matter production under stress clearly indicated close association of anatomical parameters imparting drought resistance. Root morphological parameters like root length (r = 0.795), feeder root/5 cm (r = 0.583), tertiary root (r = 0.791) and root fresh weight (r = 0.687) are of prime importance. These characters are strongly and positively associated with drought resistance. Two root anatomical parameters i.e. distance between xylem vessels (r = –0.354) and number of metaxylem (r = –0.386) indicated negative association with drought resistance are worth mentioning. These findings advocate emphasis on root anatomical traits for improved drought resistance in tomato breeding.

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