Vegetable Science (2012) 39 (2) : 189-191

Genetic studies of quality traits in tomato (*Solanum lycopersicum* L.) under low temperature

Dechin Droka, Raj Kumar, Subodh Joshi and RK Yadav

Received : February, 2012 / Accepted : August, 2012

Tomato (*Solanum lycopersicum* L.) is an important vegetable crop due to its high nutritional and antioxidant properties. The pulp and juice are digestible, promote gastric secretion and help in blood purification. Though a lot of work has been reported regarding inheritance of quantitative characters in tomato (Megha *et al.* 2005; Singh 2005), but much attention has not been paid to know the inheritance of qualitative traits that to under low temperature. Heterosis breeding will be useful in the development of varieties/hybrids having high fruit quality traits. The generation mean analysis has a general application for genetic evaluation of any population irrespective of gene frequency and mating design. This provides not only valid estimate of gene effects but also an ambiguous test for presence or absence of epistasis. The knowledge of gene effects controlling the inheritance of characters under low temperature helps in choosing the appropriate breeding method for crop improvement.

The experiment was conducted for two seasons at Research Farm, Division of Vegetable Science, IARI, New Delhi by involving 4 tomato varieties i.e. two cold set (Pusa Sheetal, Pusa Sadabahar) and two normal set (Pusa Rohini and Booster) during November, 2006 and 2007. Three F_1s and F_2s were produced by crossing the aforesaid parents followed by selfing of F_1's. Simultaneously 3 F_1s were back-crossed to both of their parents to develop back-cross generations B_1 and B_2. Three sets of F_1s, F_2s along with their parents and B_1 and B_2 generations were raised during November in RBD at a spacing of 45 cm x 45 cm with 3 replications. All the cultural practices recommended for successful cultivation of tomato were followed to raise the crop. Data were recorded on randomly selected 10 plants in parents and F_1s, B_1 and B_2 and 20 plants in F_2s population from each replication. The pooled data of seven quality characters namely, lycopene content, total soluble solids (TSS), acidity, vitamin C, pericarp thickness, shelf life and yield/plant of 3 replications was subjected to statistical analysis for heterosis, gene effects for both interacting and non-interacting crosses as per the method suggested by Hayman (1958).

The value of heterosis for 7 qualitative characters for 3 crosses *viz*., Pusa Sheetal x Booster, Pusa Sheetal x Pusa Sadabahar and Pusa Sadabahar x Pusa Rohini is shown in Table 1. Highly significant positive heterosis was recorded for yield/plant, vitamin C, lycopene content and TSS over better parent and over mid parental value (except vitamin C) in cross Pusa Sheetal x Booster. Similarly, second cross, Pusa Sheetal x Pusa Sadabahar exhibited significant heterosis for yield/plant, pericarp thickness and lycopene content over better parent for yield/plant and pericarp thickness over mid-parental value. In case of Pusa Sadabahar x Pusa Rohini, highly significant heterosis over better parent and over mid-parental value was recorded for yield/plant, vitamin C, lycopene content, acidity and pericarp thickness. Maximum heterosis for yield/plant (30.92%) was recorded in cross Pusa Sadabahar x Pusa Rohini for TSS (0.52%) in Pusa Sheetal x Booster. Heterosis for yield/plant and TSS was also reported by Wang *et al.* (1998).

Gene effects

The gene effects for 7 quality traits are presented in Tables 2, 3 and 4 which will be helpful in determining the quality breeding programme in tomato.

Yield/plant

In cross Pusa Sheetal x Pusa Sadabahar, the main gene effects, additive component was found significant in desirable direction indicating the importance of pedigree or recurrent selection for improvement of this trait. Among the epistatic components, additive x dominance component was found significant in desirable direction.

Dechin Droka, Raj Kumar, Subodh Joshi and RK Yadav
Division of Vegetable Science, Indian Agricultural Research Institute, New Delhi-110 012

Table 1. Per cent heterosis for different quality traits over better parent (BP) and mid-parent (MP) in 3 crosses

Characters	P.Sh x BS		P.Sh x PS		PS x P.ROH	
	BP	MP	BP	MP	BP	MP
Yield/plant (kg)	17.97**	26.23**	16.01**	16.58**	29.04**	30.92**
Vitamin C (mg/100 g)	2.07**	1.15	-1.27	-1.38	3.40**	1.87**
Lycopene content (mg/100g)	0.93**	0.67**	0.63*	-0.07	3.10**	1.37**
TSS (^{O}Brix)	0.97**	0.52**	-0.27	-0.33	0.10	0.08
Acidity (%)	-0.02	-0.03	0.01	-0.03	-0.05**	-0.09**
Pericarp thickness (cm)	0.08**	0.06	0.19**	0.12**	0.13**	0.07*
Shelf life (days)	0.00	-0.33	0.67	0.33	1.17*	0.75

P.Sh.: Pusa Sheetal; BS = Booster; PS = Pusa Sadabahar; P.ROH = Pusa Rohini

Dominance x dominance gene effects with duplicate epistasis were found significant in cross Pusa Sadabahar x Pusa Rohini suggesting that progress can be achieved through heterosis breeding. Similar findings were also reported by Katoch and Vidyasagar (2004). Non-additive gene action for yield/plant was reported by Thakur and Joshi (2000). However, Bhatt *et al.* (2004) reported the importance of both additive and non-additive gene action.

Vitamin C (mg/100 g)

Additive gene effects were found significant in cross Pusa Sheetal x Pusa Sadabahar indicating the simple selection for increasing vitamin C content. Duplicate and complementary type of epistasis were predominant in cross Pusa Sheetal x Pusa Sadabahar and Pusa Sadabahar x Pusa Rohini. Roopa *et al.* (2001) and Kumar *et al.* (1999) reported the importance of non-additive gene action for vitamin C content.

Lycopene content (mg/100 g)

In all the three crosses, additive gene effects and duplicate type of epistasis was found significant indicating the importance of simple selection method for improvement in lycopene content. In contrast to our findings, Roopa *et al.* (2001) and Kumar *et al.* (1997) reported the importance of non-additive gene action for lycopene content in tomato.

Table 2. Gene effect and standard error for different parameters in cross Pusa Sheetal x Booster

Characters	m	d	h	i	j	l	Epistasis
Yield/plant (kg)	1.76 (1.40)	0.37 (7.40)	0.37 (0.30)	0.36 (0.22)	0.23 (0.13)	0.94 (0.53)	C
Vitamin C (mg/100 g)	20.00** (0.57)	-0.33 (0.79)	-3.33 (2.85)	0.59 (2.79)	0.88 (0.85)	5.83 (4.07)	D
Lycopene content (mg/100g)	4.66** (0.27)	-2.56** (0.19)	-2.56 (1.16)	-2.59 (1.15)	-2.30** (0.21)	7.46** (1.37)	D
TSS (^{O}Brix)	5.10** (0.25)	0.56** (0.13)	0.56 (1.05)	0.86 (1.04)	1.01** (0.15)	-1.03 (1.20)	D
Acidity (%)	0.17 (1.45)	-5.66** (1.97)	-5.56 (7.12)	0.12 (6.99)	-6.50** (2.04)	33.33** (0.10)	D
Pericarp thickness (cm)	0.52 (1.66)	-4.33 (2.28)	-4.33 (8.92)	0.15 (8.08)	-6.67 (2.90)	-0.22 (0.13)	C
Shelf life (days)	2.33** (0.33)	0.67 (0.33)	0.67 (1.54)	4.00* (1.49)	0.33 (0.40)	-6.00** (2.05)	D

Table 3. Gene effect and standard error for different parameters in cross Pusa Sheetal x Pusa Sadabahar

Characters	m	d	h	i	j	l	Epistasis
Yield/plant (kg)	1.72** (0.12)	0.45* (0.16)	0.66 (0.58)	0.33 (0.58)	0.44* (0.16)	1.32 (0.81)	C
Vitamin C (mg/100 g)	19.10** (0.49)	3.43** (0.70)	0.42 (0.25)	1.79 (2.42)	3.54** (0.74)	-1.23 (3.52)	D
Lycopene content (mg/100g)	4.47 (8.82)	1.90** (0.16)	-3.60** (0.52)	-3.53** (0.49)	1.20** (0.21)	6.13*8 (0.83)	D
TSS (^{O}Brix)	4.53*8 (0.20)	-9.99** (0.24)	2.54* (0.96)	2.86** (0.94)	-3.33** (0.28)	-6.40** (1.31)	D
Acidity (%)	0.25 (33.33)	6.67** (1.88)	0.44 (4.16)	0.46 (3.99)	0.11 (1.98)	-0.89 (8.01)	D
Pericarp thickness (cm)	0.57 (1.45)	8.66** (1.33)	-3.00 (6.71)	-0.15 (6.36)	1.67 (2.16)	8.67 (8.89)	D
Shelf -life (days)	2.33** (0.33)	-0.33 (0.46)	5.00** (1.68)	4.67* (1.63)	-0.67 (0.53)	-6.00** (2.45)	D

Table 4. Gene effect and standard error for different parameters in cross Pusa Sadabahar x Pusa Rohini

Characters	m	d	h	i	j	l	Epistasis
Yield/plant (kg)	2.29 (6.74)	-0.27 (0.13)	-1.39** (0.39)	-2.03** (0.38)	-0.25 (0.13)	4.43** (0.62)	D
Vitamin C (mg/100 g)	18.33*8 (0.44)	-0.50 (0.64)	1.53 (2.32)	-0.33 (2.18)	-2.03* (0.69)	5.60 (3.51)	C
Lycopene content (mg/100g)	6.40** (0.22)	-2.50** (0.26)	-1.10 (1.10)	-2.47* (0.99)	-0.77* (0.31)	3.27* (1.42)	D
TSS (^{O}Brix)	4.60** (0.10)	-0.69 (0.43)	-4.99** (0.95)	-0.13 (0.94)	-0.41 (0.44)	0.37 (1.78)	D
Acidity (%)	0.47 (8.18)	0.20 (1.91)	-0.87 (5.74)	-0.79 (5.20)	0.16 (2.01)	0.59 (9.72)	D
Pericarp thickness (cm)	0.45 (2.89)	3.67 (3.18)	3.39** (0.13)	0.33* (0.13)	9.50* (3.68)	-0.22 (0.17)	D
Shelf life (days)	2.67** (0.33)	0.33 (0.33)	1.42 (1.52)	0.67 (1.49)	0.75 (0.39)	1.83 (1.93)	C

Total soluble solids (TSS%)

For TSS also, additive gene effect was of greatest importance in cross Pusa Sheetal x Booster. While, in cross Pusa Sheetal x Pusa Sadabahar, dominant gene effects and duplicate epistasis were predominantly important suggesting that heterosis breeding may be useful for TSS improvement. Importance of additive gene action was also reported by Singh *et al.* (1998). However, Dhaliwal *et al.* (1999) and Roopa *et al.* (2001) highlighted non-additive gene action for total soluble solids.

Acidity (%)

Additive gene effects were of greatest importance in cross Pusa Sheetal x Booster and Pusa Sheetal x Pusa Sadabahar indicating the predominant role of selection method in acidity improvement. However, Kumar (1999) reported the importance of non-additive gene action for acidity.

Pericarp thickness

Additive gene effect was significant in cross Pusa Sheetal x Booster, while dominant gene effect and duplicate epistasis was important in cross Pusa Sheetal x Pusa Sadabahar indicating the importance of selection and heterosis breeding respectively in both the crosses. Dhaliwal *et al.* (1999) also reported importance of non-additive gene action for this trait.

Shelf-life

Dominant gene action was found important in cross Pusa Sheetal x Pusa Sadabahar indicating the importance of heterosis breeding method for improvement of shelf life in tomato. Roopa *et al.* (2001) also reported the importance of non-additive gene action for shelf- life.

References

Bhatt RP, Adhikari RS, Biswas VR and Kumar Narendra (2004) Genetic analysis for quantitative and qualitative traits in tomato under open and protected environment. Indian J Genet and Plant Breed 64(2): 125-29.

Dhaliwal MS, Singh S, Badhan BS and Cheema DS (1999) Diallel analysis for total soluble solid contents, pericarp thickness and locule number in tomato. Vegetable Science 26(2): 120-22.

Hayman BI (1958) The separation of epistatic effects from additive and dominance variance in generation means. Hered 12: 336-55.

Katoch V and Vidyasagar (2004) Genetic studies on yield and its components in tomato. J Appl Hort 6: 45-7.

Kumar T, Pradeep, Tewari RN and Pauchauri DC (1999) Line x tester analysis for processing character in tomato. Vegetable Science 24(1): 34-8.

Megha U, Singh JP, Singh A and Joshi A (2005) Studies on genetic variability in tomato. Prog Hort 37(2): 463-65.

Roopa L, Sadashiva AT, Reddy KM, Rao KPG and Prasad BCN (2001) Combining ability studies for long shelf life in tomato. Vegetable Science 28: 24-6.

Singh AK (2005) Genetic variability, correlation and path coefficient studies in tomato under cold arid region of Ladakh. Prog Hort 37(2): 437-43.

Singh S, Dhaliwal MS, Cheema DS and Brar GS (1998) Diallel analysis of some processing attributes in tomato. J Genet Plant Breed 52: 265-69.

Thakur MC and Joshi A (2000) Combining ability analysis of yield and other horticultural traits in tomato. J Hort Sci 29: 214-16.

Wang L, Ward M, Ying S, Shoping T and Yu QH (1998) Genetic and correlation studies on quantitative characters in processing tomato. Adv Hort 2: 378-83.