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EFFECT OF LOW TEMPERATURE ON INHERITANCE OF YIELD AND YIELD ATTRIBUTING TRAITS IN TOMATO

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ABSTRACT: To understand the mode of inheritance of the yield and yield attributing traits it is imperative to determine an efficient breeding method, which is crucial to pace up the genetic improvement of any crop. To estimate the inheritance of different yield attributing traits under low temperature regimefour contrasting tomato lineswere utilized to develop different populations. Data recorded from two locations (Katrain, Himachal Pradesh and IARI, New Delhi) comprising of six generation means (P_1,P_2, F_1, F_2, B_1 and $B_{2)}$ were subjected to Bartlett test for test of homogeneity of variances and estimated by generation mean analysis. Results revealed that the estimates obtained from each cross varied under low temperature regime in tomato. Duplicate epistasis was found to be prevalent, but the presence of complementary type of epistasis was observed forplant height (Pusa Sadabahar × Pusa Sheetal and Pusa Uphar × Pusa Sadabahar)and complementary epistasis was also observed for days to 50% flowering in the (Pusa Sadabahar × Pusa Sheetal).Both the additive and non-additive gene effects were found to play a major role in the expression of yield and yield related traits, which indicated the use of reciprocal recurrent selection or bi-parental mating for its improvement. For traits, like number of branches per plant in Pusa Sadabahar × Pusa Sheetal and yield per plant in the cross Pusa Rohini × Pusa Uphar, where the interallelic interactions were more important than the main gene effects, a breeding plan based on restricted selection by way of intermitting was found the most desirable to get segregates followed by selection and/or a diallel selective mating system may be opted to recover desirable transgressive segregants.

Key words: Gene effects, generation mean analysis, tomato, yield, low temperature

Tomato (*Solanum lycopersicum* L.Syn. *Lycopersicon esculentum* Mill..) is one of the most popular vegetable, which is grown all over the world commercially. Tomato has acquired thestatus of world's most popular vegetable crop due to its wider adaptability to various agro-climatic conditions. At present tomato ranks, second next to potato in terms of global vegetable production In India, tomato has wider coverage in comparison to other vegetables and contributes around 11.5 % of total world's tomato production from an area of 0.797 Million hectares with a production of 20.708 Million tonnes and productivity of 25.9 tonnes per hectare (National Horticulture Board, 2016-17).

Tomato production is highly influenced by environmental factors such as temperature, light, relative humidity and carbon dioxide level in the atmosphere. Being a warm season crop and reasonably resistant to heat and drought, it can be grown under a wide range of soil and temperature but the most optimum range of temperature for its record yield is 20 to 24ºC. However, there should be 5-8ºC difference between day and night temperatures to get higher yield from this crop. The mean temperature below 16 and above 27ºC is not desirable for its cultivation. In tropical and subtropical regions, heat stress is a major limiting factor for the growth, reproduction and yield of crop. Lack of tolerance to high temperature in most tomato cultivars is one of the major limitations for growing an economic crop in regions where the temperature during the growing season, even for a short duration, reaches 38ºC or higher (Stevens and Rudich, 1978). These problems can be minimized by the improvement of cultural practices and breeding approaches. Breeding for tolerance to temperature stress is proposed as the best and easiest strategy for tropical tomato breeding (Warner and Erwin, 2005). Estimation of genetic variability and correlations of various yield attributing traits *viz.*, per cent fruit set, yield per plant, and fruit weight in tomato under high-temperature conditions will be helpful in formulating selection strategies for these traits in future tomato breeding programme. Hence the present study focuses on assessment of available genetic variability, heritability and character association for yield and yield component traits in selected thermos- tolerant tomato genotypes under high temperature conditions.

Though the yield in tomato is significantly contributed by the fruit weight, number of fruits per truss and number of fruits per plant; there are several other genetic and environmental factors (Singh and Singh, 1985; Dhaliwal and Nnandpuri, 1988)that play vital role too. There is a need to postulate and develop an effective plant breeding programme depending on the assessment of polygenic variation, selection of elite genotypes, choice of parents andbreeding procedures. Therefore, an understanding of the mode of inheritance of the yield and its components is crucial to aid in the choice of efficient breeding methods and pace up the genetic improvement.Generation mean analysis has a general application for genetic evaluation of any population irrespective of gene frequency and mating design. This will provide not only valid estimate of gene effects but also an unambiguous test for presence or absence of epistasis.

MATERIALS AND METHODS: The experimental materials consisted of four parental lines, comprising of two low temperature tolerant cultivars (Pusa Sadahahar and Pusa Sheetal) and two normal cultivars (Pusa Rohini and Pusa Uphar), which were crossed to produce six generations (P_1,P_2, F_1, F_2, B_1 and B_2) from the cross of Pusa Sadabahar × Pusa Sheetal, Pusa Rohini × Pusa Uphar and Pusa Uphar × Pusa Sadabahar. Hybridization among parental lines was carried out by hand emasculation and pollination to produce three F_1 hybrids. The F_1 progeny was self- pollinated and backcrossed to obtain F_2 and respective backcrosses in the Vegetable Research Farm, IARI, New Delhi.

Three set of F_1's along with their parents, F_2, B_1 and B_2 generations were evaluated during the winter season of 2014-15 at IARI regional station (Katrain, Himachal Pradesh). The plants were grown on to raised beds in experimental field with a spacing of 60 cm x 45 cm. The experiment was laid out in RBD with 3 replications. The same set of population was also grown at IARI Research Farm, New Delhi during 2014-2015. Data was recorded on 10 plants in parents and F_1, 20 plants in B_1 and B_2 and 40 plants in F_2per replication for various yield traits. The traits*viz.* days to first flowering, days to 50% flowering, number of flowers per truss, number of fruits per truss, number of fruits per plant, number of branches per plant, plant height (cm), average fruit weight (g) and yield per plant (kg) were assessed from both the locations and pooled after Bartlett test for test of homogeneity of variances (Bartlett, 1937) and estimated by generation mean analysis. The first 5 flowertruss were tagged and allowed to develop until fruits were formed during the cold stress period to record the number of flowers and fruits per truss and then the average was calculated. SASQuant partitions additive, dominance and epistatic effects were analyzedbased on the Hayman's mean separation analysis procedure (Hayman 1958; Gamble 1962).The A, B, C and D scaling tests were carried out for the aforementioned traits indicating the presence of non-allelic interactions in almost all cases.The 'A' and 'B' scaling tests provided the evidence for the presence of additive × additive (i), additive × dominance (j) and dominance × dominance (l) types of gene interactions. The 'C' scaling test provided a test for 'l' type of epistasis and the 'D' scaling test indicated the presence of 'i' type of gene interaction. The entire statistical analysis was carried out using SAS 9.4 software package available at ICAR-IASRI, New Delhi.

RESULTS AND DISCUSSION: The mean data for yield and its related traits pertaining tothree cross combinations are presented in the Table1. The A, B, C and D scaling test was non-significant for number of fruits per truss and number of fruits per plant in the cross Pusa Sadabahar × Pusa Sheetal; days to 50% flowering and average fruit weight in Pusa Rohini × Pusa Uphar; and yield per plant in Pusa Uphar × Pusa Sadabahar (Table 2). The estimates of almost all the scales were significant, which revealed non-allelic interaction for the genetic control of the attributes under investigation. Component 'm' was significant for all the traits in the three cross combinations indicating that they are inherited quantitatively.

The perusal of the data showed an interacting cross indicating inadequacy of simple additive dominance model and presence of epistasis (duplicate type) in all the three cross combinations for days to first flowering. In the cross, Pusa Sadabahar × Pusa Sheetal, both additive and dominance gene effects were highly significant and the additive × additive and dominance × dominance interactions were also found to be highly significant. However, the magnitude of the non-allelic interactions was found to be greater than the other estimates of gene effects. In the cross, Pusa Rohini × Pusa Uphar, the dominance gene effect was highly significant in undesirable positive direction. In this cross, additive × additive and dominance × dominance non-allelic interaction was highly significant, however, the dominance × dominance component showed a desirable negative direction as well as a greater magnitude, which infers the predominant role of non-additive genes for the improvement of this trait for earliness through heterosis breeding. All the main gene effects as well as the non-allelic interactions were highly significant in the cross Pusa Uphar × Pusa Sadabahar, with the preponderance of non-additive gene effects.Duplicate epistasis and additive × additive gene effects were also reported significantly higher for this trait by Chahal *et al*. (2004).

For days to 50% flowering,the additive component was highly significant in positive direction in Pusa Sadabahar × Pusa Sheetal. Additive x dominance component was found to be highly significant and the type of epistasis was complementary, which is in close conformity with the findings of Negi *et al*. (2013). On the other hand, the dominance component of main gene effect was found significant in negative direction desirable for earliness in Pusa Uphar × Pusa Sadabahar. In this cross, the additive × dominance and dominance × dominance epistatic components were also found significant with a predominance effect of the latter, indicating the role of non-additive gene effects in improvement of this trait. Barooah and Talukdar (2001) reported the importance of duplicate epistasis for this trait. Saidi *et al*. (2008) reported of both additive and non-additive gene actions controlling the expression of this trait.

Duplicate type of epistasis was observed in all the three cross combinations for number of flowers per truss. In Pusa Sadabahar × Pusa Sheetal, both the main gene effects were significant with comparatively higher magnitude of dominance variance. Among the epistatic components, additive × additive variance was found highly significant in negative direction. The dominance component was significant among the main gene effects alongwith additive × additive interaction in Pusa Rohini × Pusa Uphar which was found to be important in the inheritance of this trait.Additive component was significant in negative direction among all the estimates of gene effects in Pusa Uphar × Pusa Sadabahar.

In Pusa Rohini × Pusa Uphar, only the additive gene effect was found to be highly significant for number of fruits per truss, but in negative direction. Whereas, in Pusa Uphar × Pusa Sadabahar, both the main gene effects, the additive as well as the dominance component was significant but in negative direction. The additive × additive interaction, among the epistatic components was also found to be significant in negative direction. Opposing signs of (h) and (l) indicated the presence of duplicate type of epistasis in both the cross combinations. Fixable and non-fixable gene actions were found responsible for the inheritance of this trait by Chahal *et al*. (2004).

The additive and dominance component was highly significant in negative direction among the main gene effects in Pusa Rohini × Pusa Uphar and Pusa Uphar × Pusa Sadabahar for number of fruits per plant. In these crosses, the additive × additive component and dominance × dominance component were highly significant in negative and positive direction respectively. Katoch and Vidyasagar (2004), Saidi *et al*. (2008) and Kumar *et al*. (2013) reported of both additive and dominance geneeffects controlling this trait.It was observed that the non-additive gene actions were prevalent for this trait to intensify the breeding programme, which is similar to the findings of Dutta *et al*. (2013).The type of epistasis was duplicate type.

The non-allelic interactions were found to have higher magnitude for number of branches per plant in Pusa Sadabahar × Pusa Sheetal and Pusa Uphar × Pusa Sadabahar. However, in Pusa Rohini × Pusa Uphar,the character was controlled by both additive and non-additive gene effects. The dominance (h) and dominance × dominance (l) showing opposing signs indicated the presence of duplicate type of epistasis. Duplicate epistasis was also reported by Negi *et al*. (2013) for this trait.

Complementary epistasis were observed in two of the cross combinations for plant height, which was also reported by Negi *et al*. (2013). The importance of additive as well as the non-additive gene actions were exhibited in Pusa Rohini × Pusa Uphar. Among the main gene effects, the additive gene effect was highly significant tending to negative direction in Pusa Sadabahar × Pusa Sheetal and positive in Pusa Uphar × Pusa Sadabahar. Among the epistatic components, only the additive × dominance interaction was found highly significant in Pusa Sadabahar × Pusa Sheetal, whereas, the additive × additive and additive × dominance components were found highly significant Pusa Uphar × Pusa Sadabahar. The non-allellic interactions were found to have higher magnitude for this trait.

Foraverage fruit weight, the dominance gene effect was found to be significant in negative direction in two of the cross combinations, whereas in the other cross, additive component was found significant tending to negative direction. However, it was found that the epistatic interactions were found to be more important in controlling the trait in Pusa Sadabahar × Pusa Sheetal**.** Opposing signs of (h) and (l) indicated the presence of duplicate type of epistasis in these two crosses. Preponderance of non-additive gene action was reported by Saidi *et al.* (2008) and Dutta *et al*. (2013).

The main gene effects were found to be non-significant in two cross combinations for yield per plant. On the contrary, the dominance component was found highly significant in negative direction in Pusa Sadabahar × Pusa Sheetal. Among the non-allelic interactions, additive × additive and dominance × dominance component were found significant in Pusa Sadabahar × Pusa Sheetal and Pusa Rohini × Pusa Uphar. Hence, the non-additive gene effects were higher for the genetic control of this trait. Duplicate type of epistasis was indicated by the presence of opposing signs of (h) and (l). The varied effects of additive and non-additive gene actions finds ample support of such studies on tomato from earlier reports of Bhatt *et al.* (2004), Katoch and Vidyasagar (2004), Patel *et al.* (2010), Zdravkovic *et al*.(2011) and Droka *et al*. (2012).

The estimates obtained from each cross varied and the study on the genetics of yield and yield related traits under low temperature regime in tomato revealed thatthe traits were under the control of both fixable and non-fixable gene effects. When both the additive and non-additive gene effects were found to be involved in the expression of these traits,suggested the use of reciprocal recurrent selection or bi-parental mating for itsimprovement.In cases, where there ispositive additive x additive type gene action and duplicate epistasis seen in some traits like days to first flowering in Pusa Sadabahar × Pusa Sheetal and Pusa Rohini × Pusa Uphar and number of flowers per truss in the latter cross, suggests the possibility of obtaining transgressive segregants in later generations. However, additive x additive type non-allelic interaction was found significant for most of the characters in negative direction which inferred to little scope of improvement through simple selection methods. The significance of dominance and dominance x dominance effects and duplicate type of epistasis (average fruit weight in Pusa Sadabahar × Pusa Sheetal; days to first flowering in Pusa Rohini × Pusa Uphar; and days to 50% flowering, number of fruits per plant and number of branches per plant in Pusa Uphar × Pusa Sadabahar), indicates that theprogress of improving the trait through selection will be impeded because of predominantly dispersed alleles at the interacting loci which may decrease the variation in the F_2 and subsequent generations. Hence, heterosis breeding followed by effective selection procedure may be rewarding. The phenomenon of duplicate epistasis was considered unfavourable from a breeder's point of view because of its decreasing effect on the analyzed trait (Zdravkovic *et al*. 2000). The presence of complementary type of epistasis for plant height in two of the crosses and days to 50% flowering in Pusa Sadabahar × Pusa Sheetal infers for the improvement of the traits through heterosis breeding.

It was concluded from the present study that the traits like number of branches per plant in Pusa Sadabahar × Pusa Sheetal and yield per plant in the cross Pusa Rohini × Pusa Uphar, where the interallelic interactions were more important than the main gene effects, a breeding plan based on restricted selection by way of intermating the most desirable segregates followed by selection and/or a diallel selective mating system may be opted to recover desirable transgressive segregants.

Table -1: Pooled mean data over two locations for yield and related traits in genetic populations of three tomato cross combinations.

Cross/ Generations		Days to first flowering	Days to 50% flowering	Number of flowers per truss	Number of fruits per truss
PS × PSh	P_1	51.5	62.5	5.4	3.4
	P_2	56.3	66.0	5.1	2.7
	F_1	51.0	62.2	5.1	4.0
	F_2	51.2	64.9	6.7	3.7
	B_1	54.6	65.4	6.0	3.6
	B_2	57.1	63.1	5.6	3.3
PR × PU	P_1	60.8	74.2	4.8	1.6
	P_2	62.6	70.7	5.2	1.9
	F_1	59.0	73.0	4.9	2.0
	F_2	60.2	73.9	4.5	1.9
	B_1	62.9	74.5	4.8	1.4
	B_2	62.9	73.7	5.0	2.0
PU × PS	P_1	62.6	70.7	5.2	1.9
	P_2	51.5	62.5	5.4	3.4
	F_1	56.6	63.5	5.6	2.4
	F_2	57.7	64.1	5.3	3.1
	B_1	57.9	62.1	4.9	2.2
	B_2	55.0	63.7	5.4	3.1

Cross/ Generations		Number of fruits per plant	Number of branches per plant	Plant height (cm)	Average fruit weight (g)	Yield per plant (kg)
PS × PSh	P_1	46.3	6.9	57.6	48.3	2.4
	P_2	45.7	8.3	80.6	46.7	2.0
	F_1	51.6	7.8	57.6	53.3	2.5
	F_2	50.8	7.3	62.2	55.3	2.4
	B_1	49.1	7.0	61.7	50.9	2.1
	B_2	50.7	7.1	67.5	49.0	1.8
PR × PU	P_1	42.1	7.2	87.4	46.2	2.0
	P_2	47.3	8.7	97.5	44.2	1.9
	F_1	47.5	7.6	99.9	41.7	2.0
	F_2	51.2	10.8	110	43.8	2.0
	B_1	43.9	7.1	101	43.2	1.7
	B_2	49.3	8.6	95.9	41.5	1.7
PU × PS	P_1	47.3	8.7	97.5	44.2	1.9
	P_2	46.3	6.9	57.6	48.3	2.4
	F_1	55.1	8.5	104	50.6	2.0
	F_2	57.7	8.6	108	44.8	2.2
	B_1	48.2	7.2	104	40.9	2.2
	B_2	46.6	7.3	97.9	45.9	1.8

PS= Pusa Sadabahar, PSh= Pusa Sheetal, PR= Pusa Rohini, PU= Pusa Uphar

Table- 2: Scaling tests for yield and related traits in three tomato cross combinations (pooled over two locations).

S.No	Character	Pusa Sadabahar x Pusa Sheetal				Pusa Rohini x Pusa Uphar				Pusa Uphar x Pusa Sadabahar			
		A	B	C	D	A	B	C	D	A	B	C	D
1	Days to first flowering	6.7** (0.90)	6.9** (0.78)	-5** (1.40)	-9.3** (0.75)	6.0** (1.20)	4.2** (1.53)	-0.6 (2.22)	-5.4** (1.10)	-3.4** (0.64)	1.7* (0.82)	3.3** (1.17)	2.5** (0.75)
2	Days to 50% flowering	6.1** (1.49)	-2.0 (1.48)	6.7** (2.40)	1.3 (1.28)	1.8 (2.61)	3.7 (2.90)	4.7 (4.02)	-0.4 (2.04)	-10** (2.22)	1.4 (1.70)	-3.8 (3.42)	2.4 (1.82)
3	Number of flowers per truss	1.5** (0.32)	1.0** (0.29)	6.1** (0.52)	1.8** (0.26)	-0.1 (0.32)	-0.1 (0.33)	-1.8** (0.56)	-0.8** (0.25)	-1.0* (0.46)	-0.4 (0.35)	-0.8 (0.74)	0.3 (0.33)
4	Number of fruits per truss	-0.2 (0.48)	-0.1 (0.43)	0.7 (0.74)	0.5 (0.36)	-0.8** (0.28)	0.1 (0.44)	0.1 (0.53)	0.4 (0.35)	0.1 (0.46)	0.5 (0.46)	2.4** (0.73)	0.9* (0.38)
5	Number of fruits per plant	0.3 (2.72)	4.1 (3.16)	8.0 (4.81)	1.8 (2.77)	-1.8 (2.86)	3.8 (3.44)	20.4** (4.70)	9.2** (2.75)	-5.1 (3.24)	-8.2* (3.61)	27.9** (5.56)	20.6** (3.15)
6	Number of branches per plant	-0.8** (0.30)	-1.9** (0.42)	-1.7** (0.59)	0.5 (0.29)	-0.6 (0.47)	0.9 (0.49)	12.1** (0.8)	5.9** (0.40)	-2.8** (0.36)	-0.8* (0.33)	1.8** (0.58)	2.7** (0.27)
7	Plant height	8.2** (2.48)	-3.2 (2.98)	-4.6 (4.84)	-4.8* (2.30)	14.7** (2.71)	-5.6* (2.50)	55.3** (4.19)	23.1** (2.51)	6.7 (3.82)	34.2** (3.01)	69.1** (5.86)	14.1** (2.90)
8	Average fruit weight	0.2 (2.17)	-2.0 (2.49)	19.6** (4.18)	10.7** (2.22)	-1.5 (2.05)	-2.9 (2.29)	1.4 (3.65)	2.9 (1.92)	-13** (2.85)	-7.1* (3.43)	-14.5** (4.86)	2.8 (2.42)
9	Yield per plant	-0.7* (0.31)	-0.9** (0.33)	0.2 (0.52)	0.9** (0.28)	-0.6 (0.46)	-0.5* (0.25)	0.1 (0.59)	0.6 (0.36)	0.4 (0.59)	-0.7 (0.43)	0.5 (0.84)	0.4 (0.43)

*, ** Significant at 5 & 1% levels

Table -3:Gene effect and standard error foryield and related traits in cross Pusa Sadabahar x Pusa Sheetal (pooled data over two locations).

S.No.	Characters	m	d	h	i	j	l	Epistasis
1	Days to first flowering	51.2** (0.30)	-2.5** (0.52)	15.7** (1.63)	18.6** (1.58)	-0.1 (0.56)	-32.2** (2.50)	D
2	Days to 50% flowering	64.9** (0.49)	2.3** (0.88)	-4.65 (2.71)	-2.6 (2.62)	4.05** (0.97)	-1.5 (4.25)	C
3	Number of flowers per truss	6.7** (0.10)	0.4* (0.18)	-3.75** (0.57)	-3.6** (0.55)	0.25 (0.20)	1.1 (0.89)	D
4	Number of fruits per truss	3.7** (0.15)	0.3 (0.27)	-0.05 (0.84)	-1.0 (0.81)	-0.05 (0.29)	1.3 (1.32)	

5	Number of fruits per plant	50.8** (0.91)	-1.6 (1.61)	2.0 (5.11)	-3.6 (4.87)	-1.9 (1.91)	-0.8 (8.03)	
6	Number of branches per plant	7.3** (0.13)	-0.1 (0.24)	-0.85 (0.73)	-1.0 (0.71)	0.55* (0.24)	3.7** (1.12)	D
7	Plant height (cm)	62.2** (0.98)	-5.8** (1.60)	-1.9 (5.26)	9.6 (5.06)	5.7** (1.71)	-14.6 (8.03)	C
8	Average fruit weight (g)	55.3** (0.88)	1.9 (1.36)	-15.6** (4.58)	-21.4** (4.44)	1.1 (1.52)	23.2** (6.86)	D
9	Yield per plant (kg)	2.4** (0.10)	0.3 (0.18)	-1.5** (0.57)	-1.8** (0.54)	0.1 (0.21)	3.4** (0.90)	D

*, ** Significant at 5 & 1% levels

Table- 4: Gene effect and standard error for yield and related traits in cross Pusa Rohini x Pusa Uphar (pooled data over two locations).

S.No.	Characters	m	d	h	i	j	l	Epistasis
1	Days to first flowering	60.2** (0.49)	-0.97 (0.87)	8.1** (2.67)	10.8** (2.62)	0.9 (0.91)	-21** (4.14)	D
2	Days to 50% flowering	73.9** (0.67)	0.8 (1.54)	1.35 (4.34)	0.8 (4.07)	-0.95 (1.72)	-6.3 (7.35)	
3	Number of flowers per truss	4.5** (0.11)	-0.2 (0.19)	1.5* (0.61)	1.6** (0.59)	-0.02 (0.20)	-1.4 (0.95)	D
4	Number of fruits per truss	1.9** (0.10)	-0.6** (0.21)	-0.55 (0.60)	-0.8 (0.57)	-0.45 (0.25)	1.5 (0.98)	D
5	Number of fruits per plant	51.2** (0.78)	-5.4** (1.68)	-15.6** (4.91)	-18.4** (4.59)	-2.8 (2.03)	16.4* (8.20)	D
6	Number of branches per plant	10.8** (0.19)	-1.5** (0.33)	-12.15** (1.01)	-11.8** (1.00)	-0.75* (0.33)	11.5** (1.53)	D
7	Plant height (cm)	110** (0.87)	5.1** (1.52)	-38.75** (4.77)	-46.2** (4.63)	10.15** (1.77)	37.1** (7.39)	D
8	Average fruit weight (g)	43.8** (0.69)	1.7 (1.20)	-9.3* (3.86)	-5.8 (3.67)	0.7 (1.37)	10.2 (6.03)	
9	Yield per plant (kg)	2** (0.11)	-0.04 (0.20)	-1.15 (0.62)	-1.2* (0.59)	-0.05 (0.25)	2.3* (0.99)	D

*, ** Significant at 5 & 1% levels

Table- 5: Gene effect and standard error for yield and related traits in cross Pusa Uphar x Pusa Sadabahar (pooled over two locations).

S.No.	Characters	m	d	h	i	j	l	Epistasis
1	Days to first flowering	57.7** (0.23)	2.9** (0.41)	-5.55** (1.29)	-5** (1.24)	-2.55** (0.50)	6.7** (2.01)	D
2	Days to 50% flowering	64.1** (0.65)	-1.6 (1.06)	-7.9* (3.54)	-4.8 (3.36)	-5.7** (1.24)	13.4* (5.46)	D
3	Number of flowers per truss	5.3** (0.15)	-0.5* (0.25)	-0.47 (0.81)	-0.6 (0.78)	-0.3 (0.26)	2.0 (1.23)	D
4	Number of fruits per truss	3.1** (0.14)	-0.9** (0.26)	-2.0* (0.81)	-1.8* (0.77)	-0.2 (0.29)	1.2 (1.28)	D
5	Number of fruits per plant	57.7** (1.13)	1.6 (2.0)	-32.45** (6.23)	-41.2** (6.01)	1.55 (2.27)	54.5** (9.71)	D
6	Number of branches per plant	8.6** (0.12)	-0.10 (0.21)	-4.7** (0.66)	-5.4** (0.64)	-1.0 (0.22)	9.0** (1.02)	D
7	Plant height (cm)	108** (1.15)	6.1** (1.97)	-1.65 (6.32)	-28.2** (6.05)	-13.75** (2.15)	-12.7 (9.81)	C
8	Average fruit weight (g)	44.8** (0.98)	-5.0* (1.93)	-1.25 (5.70)	-5.6 (5.53)	-2.95 (2.05)	25.7** (9.13)	D
9	Yield per plant (kg)	2.2** (0.17)	0.40 (0.31)	-0.95 (0.96)	-0.8 (0.93)	0.55 (0.33)	1.1 (1.50)	

*, ** Significant at 5 & 1% levels

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