



Research Article

Quantitative inheritance for fruit traits in inter varietal crosses of okra (*Abelmoschus esculentus* L. Moench)

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Abstract:

Gene effects for important fruit traits of four inter-varietal crosses of okra were estimated by partitioning the means and variances of means of six basic generations from each cross into their genetic components to assess the gene action governing the inheritance of fruit yield and earliness related traits in spring and rainy season. The additive, dominance and digenic non-allelic gene interactions were observed to govern most of the fruit traits. The non-additive gene effects were more pronounced than additive ones for most of the traits in both the environments. The evidence of duplicate type of epistasis has been obtained for all the characters in different crosses in both the seasons. Thus for developing high yielding okra cultivars, recurrent selection in biparental progenies would help in exploiting the duplicate type of non-allelic interactions and allow recombination and concentration of genes having cumulative effects in population.

Key Words: okra, gene effects, fruit traits, epistasis, scales, recurrent selection

Introduction

Okra (*Abelmoschus esculentus* L. Moench), or Ladies finger, which is also known as 'Bhindi', is one of the important vegetables of India. It is grown throughout the tropical and sub-tropical regions and also in the warmer parts of the temperate regions. Owing to its easy cultivability, dependable and regular yield, wider adaptability and round the year cultivation, okra enjoys prominent position among Indian vegetables. Moreover, being a short duration crop, okra fits well into multiple cropping systems. In India it is cultivated in 376.1 thousand hectares area with the production of 3684 thousand mt and productivity of 9.79 mt/ha (www. tradejunction.apeda.com, 2006). However, the average productivity of okra in India is still not as good as that of other okra growing countries of the world like 15.71 mt/ha of Egypt and 11.53 mt/ha of Saudi Arabia. In order to increase the yielding potential, it is imperative to utilize the available genetic potential efficiently. The nature and magnitude of genetic variation present in population is elucidated by genetic analysis of quantitative traits. Moreover, to decide the type of breeding procedure to be followed, it is an essentiality to estimate the type of gene effects in plant population. The predominance of additive gene

effects signifies the development of pure lines while dominance and epistatic gene effects are used for exploitation of hybrid vigour. The generation mean analysis is the most common tool employed for the estimation of gene effects and components of genetic variance (Hayman and Mather, 1955). In the present studies, additive, dominance and epistatic gene effects along with epistatic interactions were estimated by using generation mean analysis for yield and component traits in the four inter-varietal crosses among distant genotypes of okra.

Material and methods

Six basic sets of generations namely P_1 , P_2 , F_1 , F_2 , B_1 and B_2 were derived from four crosses involving eight contrasting genotypes of okra. The crosses were referred as Cross-I (Punjab -8 X Parbhani Kranti), Cross -II (Punjab -8 X Pusa Sawani), Cross -III (Parbhani Kranti X Pusa Makhmali) and Cross -IV (Pusa Sawani X Pusa Makhmali). The six generations of each cross were sown in a compact family block design with three replications during rainy season, 2005 and spring season, 2006 at Experimental Farm of the Department of Vegetable Crops, Punjab Agricultural University, Ludhiana (Punjab). All the crosses were treated as separate experiments i.e. the

randomization was done within the crosses between the rows. The number of rows assigned to P₁, P₂, F₁, F₂, B₁ and B₂ generations in each replication was 5, 5, 5, 20, 7 and 7, respectively. A spacing of 45 X 30 cm was adopted with 10 plants per row. The rainy season crop was grown during June-September in rows on the flat beds and the spring season crop was grown during February-May on the ridges. A spacing of 45 X 30 cm was adopted with 10 plants per row. Data were collected for earliness and four related traits viz., fruit length (cm), fruit breadth (mm), fruit weight (g), number of fruits per plant and total fruit yield per plant (g). The means and variances of means for these five traits were computed for each generation as per Panse and Sukhatme (1978). The gene effects were estimated using the models suggested by Mather (1949), Cavalli (1952) and Mather and Jinks (1982).

Results and discussion

The scaling tests were applied to the data to detect the presence or absence of non-allelic interactions. The estimates of genetic parameters m , $[d]$, $[h]$, $[i]$, $[j]$ and $[l]$ were obtained for all the five traits in four crosses over both the environments

Fruit length (cm)

Scale 'A' was observed to be non-significant for all the crosses in both the seasons (Table 1). Scale 'B' was found significant for cross I and III in rainy season indicating the presence of all three types of non-allelic gene interactions viz., additive x additive $[i]$, additive x dominance $[j]$ and dominance x dominance $[l]$ for these crosses. Scale 'C' was observed to be significant for cross I in both rainy and spring seasons, which revealed the dominance x dominance $[l]$ type of gene interactions.

The chi-square value for additive-dominance model was significant for cross I in both the seasons and cross III in spring season which indicated the presence of epistasis and hence it was detected for these crosses. However, for cross II and IV the chi-square value was non-significant for both the seasons and for cross III in rainy season, which suggested the absence of epistasis in these crosses. So, for these crosses the additive-dominance model was sufficient to explain the variation. For the rest of the crosses, the joint scaling tests were carried out using six-parameter model. The three parameter model showed that the values of $[d]$ were significant for cross -III in both the seasons and for cross-II in spring season and for cross-IV in rainy season. Thus there was

preponderance of additive gene effects for these traits.

The six parameter model explained that for cross I, the values of $[d]$ i.e. additive, $[l]$ i.e. dominance x dominance and $[i]$ i.e. additive x additive gene effects were significant in both rainy and spring seasons, which indicated the presence of these types of gene effects. For cross III in spring season, the values of $[d]$ were significant which indicated presence of additive gene interactions. For all the crosses in both seasons, the values of $[h]$ and $[l]$ attained opposite sign which indicated the presence of duplicate type of epistasis. These results are in conformity with Elangovan *et al*, (1981), Veeragevathatham and Irulappan (1990) and Poshiya and Vashi (1995).

Fruit breadth (mm)

For this trait, scale 'A' was found to be non-significant for all the crosses in both the seasons (Table 2). Scale 'B' was significant for cross I in spring season only. Thus, all the three types of non-allelic gene interactions were present for this cross. The scale 'C' was significant for cross I and III in spring season and for cross IV in both the seasons, which revealed the dominance x dominance $[l]$ type of non-allelic gene interactions.

The chi-square values for additive-dominance model were significant for cross-I and III in spring season and for cross-IV in rainy season. This indicated the presence of epistasis and it was detected using the 6 parameter model. For rest of the crosses, the genetic variation was sufficiently explained using joint scaling tests, which showed that the values of $[d]$ were significant for cross-I and III in rainy season. The best fit model carried out to identify epistatic gene interactions showed that for only the values of $[d]$ were significant for cross I in spring. The opposite signs of $[h]$ and $[l]$ for most of the cross combinations revealed the presence of duplicate type of epistasis.

Fruit weight (g)

The scale 'A' was found to be non-significant for all the crosses in both the seasons (Table 3). The scale 'B' was found to be significant for cross-III in rainy season only. The scale 'C' was found significant for all four crosses in rainy as well as spring season except for cross-III in spring season. Thus, it signifies the presence of $[l]$ type i.e. dominance x dominance non-allelic gene interactions.

The chi-square values for fruit weight were found to be significant for all the crosses in rainy season. In spring season all but cross III had significant chi-square value. For this cross, the three parameter model was considered adequate as epistasis was observed to be absent and only additive gene action was found to be governing inheritance of this trait as shown by significant expression of [d]. For rest of the crosses, epistasis was detected using 6-parameter best fit model.

For cross I, the values of [d], [h] and [j] were found to be significant in rainy season. But in spring season, the values of [d], [h], [j] and [l] were significant. In cross II, the additive gene effects i.e. [d] and [i] i.e. additive x additive gene effects were significant for spring. In rainy season, additionally [l] i.e. dominance x dominance was also found significant. For cross III in rainy season, only values of [d] were found to be significant. In cross IV, both the rainy and spring seasons had significant values for [d] and [i] type of effects. The duplicate type of epistasis was also found to be present for this trait.

Number of fruits per plant

For this trait, scale 'A' was found to be significant for cross IV in rainy season and for cross I and III in spring indicating the preponderance of all the three types of non-allelic gene interactions (Table 4). Scale 'B' was found significant for cross I and II in rainy season. The scale 'C' was found significant for all the crosses in both the seasons except for cross IV in spring season. Thus for these crosses, dominance x dominance gene interactions i.e. [l] type were significant.

The chi-square value for this trait was significant, all the crosses in both the seasons except for cross III in rainy season and for cross IV in spring season. For these crosses only the joint scaling tests were sufficient to explain the variation which showed that for both these crosses additive gene effects i.e. [d] were significant. For rest of the cross-combinations the additive-dominance model was a failure and epistasis was present, which was partitioned using 6-parameter model.

For cross I, in rainy season the expression of [d], [i] and [j] were significant and in spring season all the gene effects were observed to be significant. For cross II, additive effects i.e. [d] was found significant for both rainy and spring seasons. In rainy season dominance i.e. [h] and dominance x dominance i.e.

[l] were significant. For cross III, in spring season [d] and [j] type of gene effects were significant. Thus, there was presence of the above mentioned gene effects. Similarly, as for other traits discussed above, the values of [h] and [l] attained opposite signs, indicating the presence of duplicate type of epistasis. Similar reports of gene effects regarding genetic control of fruit yield in okra have been given by Wankhade *et al*, (1995), Rani and Arora (2003), Ghai and Mahajan (2004) and Panda and Singh (2004).

Marketable yield per plant (g)

The scale 'A' for this trait was significant for cross III in rainy season and for cross I in spring season (Table 5). The values of scale 'B' differed significantly from zero for cross I in rainy season and for cross II in spring season. The significance of scales 'A' and 'B' revealed the presence of all three types of non-allelic gene interactions for marketable yield per plant. The scale 'C' was significant for cross I, II and III in rainy season and for cross IV in spring season.

The chi-square values for this trait were significant for the crosses I, III and IV in rainy season and for cross II and IV in spring season. Thus, the presence of epistasis was confirmed for these crosses. However, for the cross I and III in spring season and for cross II in rainy season the additive-dominance model was a good fit and epistasis was found to be absent. For these crosses [d] type of gene effects were significant which signifies that their inheritance was under the control of additive gene effects.

The best fit model showed that the values of [d] i.e. additive gene effects and [i] i.e. additive x additive gene effects were found significant for all the crosses which revealed the presence of these types of gene effects. In addition [j] and [l] type of gene interactions were also significant. Thus, these types of gene effects were present for marketable yield per plant. The values of [h] and [l] attained opposite signs, indicating the presence of duplicate type of epistasis.

The present studies coincides with the work of Singh and Singh (1979), Partap *et al* (1981) Partap and Dhankar (1983), Arora (1993), Poshia and Vashi (1995), Panda and Singh (1998), Ahmad *et al* (2004) and Deo *et al* (2004) who reported the significance of additive gene effects for the control of marketable yield per plant. But the significance of dominance gene effects for yield per plant has been reported by

Wankhade *et al* (1995), Singh *et al* (2001), Aher *et al* (2003) and Ghai and Mahajan (2004).

The values of [h] and [l] attained the opposite signs for all the characters in both the seasons which are the evidence of duplicate type of epistasis. Thus the genetic improvement through conventional selection procedure will be cumbersome and fruitless. This kind of epistasis generally hinders the improvement through selection and hence, a higher magnitude of dominance and [l] type of interaction effects would not be expected. It also indicated that selection should be delayed after several generations of selection (single seed descent) until a high level of gene fixation is attained. The prevalence of duplicate epistasis in the inheritance of certain traits including yield indicated that these traits might be improved through recurrent selection in biparental progenies that would help in exploiting the duplicate type of non-allelic interaction and allow recombination and concentration of genes having cumulative effects in population as this method is helpful in breaking up undesirable linkages (Ganesh and Sakila, 1999). Kulkarni *et al* (1978), Panda and Singh (1998) and Tripathi (2001) have also reported the prevalence of duplicate type of epistasis in okra.

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Table 1. Estimates of different scaling tests, joint scaling tests and genetic components in the best fit model for fruit length (cm) in okra

Parameter	Season	Cross-I	Cross-II	Cross-III	Cross-IV
Scaling test					
A	R	0.18 ± 0.41	0.53 ± 0.52	-0.02 ± 0.61	0.80 ± 0.50
	S	-0.15 ± 0.42	0.38 ± 0.92	0.75 ± 1.04	0.42 ± 0.92
B	R	0.40* ± 0.44	0.40 ± 0.59	-0.07* ± 0.36	0.02 ± 0.65
	S	0.57 ± 0.55	-0.25 ± 0.43	1.05 ± 0.48	-0.08 ± 0.63
C	R	2.33** ± 0.77	0.98 ± 0.91	2.05 ± 0.99	-0.32 ± 1.33
	S	2.47 **± 0.90	0.97 ± 1.39	3.40 ± 1.45	0.80 ± 0.97
Joint scaling test					
m	R	7.15 **± 0.14	8.72** ± 0.16	7.06** ± 0.14	5.90 **± 0.18
	S	6.93 **± 0.15	7.59 **± 0.25	6.57** ± 0.27	4.97 **± 0.19
[d]	R	-1.50 **± 0.13	-0.07 ± 0.16	1.36 **± 0.13	0.51 **± 0.17
	S	-1.23 **± 0.15	0.59** ± 0.21	0.99 **± 0.24	0.19 ± 0.19
[h]	R	0.21 ± 0.24	-0.17 ± 0.26	0.02 ± 0.24	-0.51 ± 0.35
	S	0.64* ± 0.27	-0.07 ± 0.40	0.38 ± 0.43	0.16 ± 0.36
χ ²	R	9.89**	1.83	5.37	3.45
	S	9.51**	1.49	7.42*	1.01
Best fit model					
m	R	8.71** ± 0.76	--	--	--
	S	8.81 **± 0.89	--	7.77** ± 1.42	--
[d]	R	-1.46** ± 0.17	--	--	--
	S	-1.06 **± 0.18	--	1.00 **± 0.34	--
[h]	R	-2.71 ± 1.84	--	--	--
	S	-3.04 ± 2.16	--	-1.15 ± 3.47	--
[i]	R	-1.75* ± 0.74	--	--	--
	S	-2.05* ± 0.87	--	-1.60 ± 1.38	--
[j]	R	-0.23 ± 0.55	--	--	--
	S	-0.72 ± 0.62	--	-0.30 ± 1.06	--
[l]	R	1.17 ± 1.15	--	--	--
	S	1.63 ± 1.36	--	0.20 ± 2.17	--

*, ** Significant at 5% and 1% level of significance, respectively.
R- Rainy Season S- Spring Season



Table 2. Estimates of different scaling tests, joint scaling tests and genetic components in the best fit model for fruit breadth (mm) in okra

Parameter	Season	Cross-I	Cross-II	Cross-III	Cross-IV
Scaling test					
A	R	0.42 ± 1.14	0.60 ± 0.82	0.22 ± 1.05	2.03 ± 1.19
	S	0.02 ± 0.76	0.80 ± 1.33	1.05 ± 0.99	0.45 ± 0.80
B	R	0.05 ± 0.90	0.67 ± 0.85	0.78 ± 0.88	1.85 ± 1.35
	S	1.47* ± 0.63	0.88 ± 1.22	0.53 ± 0.88	0.65 ± 1.25
C	R	3.13 ± 1.66	1.88 ± 1.48	3.70 ± 2.12	4.98 *± 2.02
	S	3.70 **± 1.23	2.58 ± 2.34	3.53 *± 1.42	3.25 *± 1.58
Joint scaling test					
m	R	16.55** ± 0.20	16.28** ± 0.27	16.61** ± 0.28	17.59 **± 0.42
	S	14.34 **± 0.20	14.31** ± 0.36	13.80** ± 0.29	13.06 **± 0.24
[d]	R	0.77 **± 0.20	-0.30 ± 0.27	-1.31** ± 0.27	-0.18 ± 0.38
	S	-0.74** ± 0.20	0.13 ± 0.35	0.84 **± 0.30	0.09 ± 0.24
[h]	R	0.35 ± 0.37	-0.26 ± 0.42	0.21 ± 0.52	0.09 ± 0.79
	S	0.55 ± 0.35	0.25 ± 0.64	-0.17 ± 0.47	0.46 ± 0.46
χ ²	R	3.61	1.91	3.25	6.35*
	S	12.69**	1.47	6.18*	4.28
Best fit model					
m	R	--	--	--	17.86** ± 1.79
	S	16.30** ± 1.28	--	15.26** ± 1.51	--
[d]	R	--	--	--	-0.39 ± 0.55
	S	-0.62 **± 0.23	--	0.66 ± 0.37	--
[h]	R	--	--	--	1.71 ± 4.63
	S	-2.55 ± 3.16	--	-2.31 ± 3.89	--
[i]	R	--	--	--	-1.10 ± 1.71
	S	-2.20 ± 1.26	--	-1.95 ± 1.47	---
[j]	R	--	--	--	0.18 ± 1.60
	S	-1.45 ± 0.91	--	0.53 ± 1.26	--
[l]	R	--	--	--	-2.77 ± 3.08
	S	0.70 ± 1.98	--	0.37 ± 2.48	--

*, ** Significant at 5% and 1% level of significance, respectively.
R- Rainy Season S- Spring Season

Table 3. Estimates of different scaling tests, joint scaling tests and genetic components in the best fit model for fruit weight (g) in okra

Parameter	Season	Cross-I	Cross-II	Cross-III	Cross-IV
Scaling test					
A	R	0.23 ± 0.58	0.90 ± 0.28	0.75 ± 0.85	0.75 ± 0.54
	S	-0.35 ± 0.40	0.28 ± 0.40	0.00 ± 0.91	0.52 ± 0.71
B	R	0.07 ± 0.44	0.30 ± 0.25	1.00** ± 0.46	0.62 ± 0.82
	S	0.08 ± 0.59	0.45 ± 0.36	0.35 ± 0.89	0.85 ± 0.66
C	R	2.00** ± 0.64	1.95** ± 0.51	3.20** ± 1.12	2.77** ± 0.98
	S	3.22** ± 0.89	2.88** ± 0.63	1.40 ± 1.41	2.78** ± 1.17
Joint scaling test					
m	R	8.30** ± 0.13	8.50** ± 0.10	7.79** ± 0.21	7.08** ± 0.21
	S	5.59** ± 0.13	6.66** ± 0.11	5.24** ± 0.23	4.62** ± 0.22
[d]	R	-0.24 ± 0.13	0.37** ± 0.07	0.74** ± 0.19	0.24 ± 0.21
	S	-1.03** ± 0.14	0.48** ± 0.11	0.75** ± 0.23	0.13 ± 0.23
[h]	R	0.19 ± 0.22	0.06 ± 0.19	0.31 ± 0.36	0.11 ± 0.34
	S	0.40* ± 0.20	0.15 ± 0.20	0.04 ± 0.43	-0.05 ± 0.34
χ ²	R	10.91**	18.24**	9.05*	8.37*
	S	16.87**	21.54**	1.17	5.99*
Best fit model					
m	R	9.80** ± 0.77	8.97** ± 0.42	8.87** ± 1.14	8.09** ± 1.05
	S	9.01** ± 1.01	8.59** ± 0.66	--	5.64** ± 1.22
[d]	R	-0.38** ± 0.16	0.18** ± 0.13	0.80** ± 0.25	0.34** ± 0.27
	S	-0.94** ± 0.16	0.46** ± 0.13	--	0.16 ** ± 0.29
[h]	R	-2.95 ± 2.08	-0.22 ± 0.99	-0.95 ± 2.89	-1.24 ± 2.77
	S	-6.86 ** ± 2.47	-3.49 ± 1.66	---	-1.29 ± 3.01
[i]	R	-1.70** ± 0.75	-0.75** ± 0.39	-1.45 ± 1.12	-1.40** ± 1.02
	S	-3.50** ± 1.00	-2.15** ± 0.65	--	-1.40 ** ± 1.19
[j]	R	0.15 ± 0.68	0.60 ± 0.33	-0.25 ± 0.89	0.13 ± 0.92
	S	-0.43 ± 0.69	-0.18 ± 0.50	--	-0.32 ± 0.93
[l]	R	1.40 ± 1.37	-0.45** ± 0.63	-0.30 ± 1.85	0.03 ± 1.80
	S	3.77** ± 1.51	1.43 ± 1.06	--	0.02 ± 1.87

*, ** Significant at 5% and 1% level of significance, respectively.
R- Rainy Season S- Spring Season

Table 4. Estimates of different scaling tests, joint scaling tests and genetic components in the best fit model for number of fruits per plant in okra

Parameter	Season	Cross-I	Cross-II	Cross-III	Cross-IV
Scaling test					
A	R	0.25 ± 0.69	0.00 ± 0.82	0.25 ± 0.69	2.00** ± 0.82
	S	-1.75* ± 0.85	0.25 ± 1.03	3.00** ± 0.61	0.25 ± 0.63
B	R	1.75** ± 0.69	1.25* ± 0.63	0.25 ± 0.75	-1.00 ± 1.35
	S	0.75 ± 0.90	0.50 ± 0.98	0.50 ± 0.68	1.50 ± 0.76
C	R	6.00** ± 1.34	4.75** ± 1.82	4.00** ± 1.86	4.00** ± 1.29
	S	7.00** ± 2.00	6.75** ± 1.87	3.00* ± 1.17	3.25 ± 1.80
Joint scaling test					
m	R	16.69** ± 0.17	17.28** ± 0.23	16.06** ± 0.17	14.54** ± 0.23
	S	14.89** ± 0.28	15.32** ± 0.31	14.05** ± 0.16	12.14** ± 0.21
[d]	R	-1.40** ± 0.16	1.28** ± 0.22	1.25** ± 0.16	1.94** ± 0.24
	S	-2.24** ± 0.25	1.15** ± 0.31	1.75** ± 0.16	0.64** ± 0.20
[h]	R	1.30** ± 0.36	1.58** ± 0.39	0.24 ± 0.37	1.39* ± 0.40
	S	0.96 ± 0.55	0.63 ± 0.43	0.80** ± 0.30	0.65 ± 0.37
χ ²	R	24.14**	9.92**	4.77	12.87**
	S	25.06**	13.54**	25.83**	5.78
Best fit model					
m	R	20.50** ± 1.24	20.63** ± 1.82	--	17.00** ± 1.76
	S	22.75** ± 1.85	20.88** ± 2.03	13.25** ± 1.27	--
[d]	R	-1.25** ± 0.18	1.38** ± 0.28	--	1.50** ± 0.29
	S	-1.75** ± 0.32	1.13** ± 0.38	1.50** ± 0.18	--
[h]	R	-5.50 ± 2.99	-4.38 ± 4.09	--	-3.50 ± 4.78
	S	-16.00** ± 4.22	-10.38* ± 4.90	5.00 ± 3.10	--
[i]	R	-4.00** ± 1.22	-3.50 ± 1.80	--	-3.00 ± 1.73
	S	-8.00** ± 1.83	-6.00** ± 2.00	0.50 ± 1.26	--
[j]	R	-1.50* ± 0.79	-1.25 ± 0.95	--	3.00* ± 1.53
	S	-2.50* ± 1.04	-0.25 ± 1.38	2.50** ± 0.84	--
[l]	R	2.00 ± 1.95	2.25 ± 2.38	--	2.00 ± 3.11
	S	9.00** ± 2.58	5.25 ± 2.97	-4.00* ± 1.93	--

*, ** Significant at 5% and 1% level of significance, respectively.
R- Rainy Season S- Spring Season

Table 5. Estimates of different scaling tests, joint scaling tests and genetic components in the best fit model for total fruit yield per plant (g) in okra

Parameter	Season	Cross-I	Cross-II	Cross-III	Cross-IV
Scaling test					
A	R	17.08 ± 9.81	8.42 ± 8.90	20.50** ± 10.09	6.35 ± 14.14
	S	6.47* ± 6.94	-0.63 ± 13.88	11.55 ± 8.45	-1.55 ± 6.99
B	R	22.68* ± 10.01	-2.88 ± 10.04	9.78 ± 10.11	0.57 ± 11.24
	S	12.52 ± 1.14	48.93** ± 13.25	-0.80 ± 7.35	-0.33 ± 8.24
C	R	51.40** ± 18.00	17.00 ± 17.18	79.72** ± 26.42	38.67** ± 14.41
	S	41.65 ± 22.22	31.95 ± 27.31	23.45 ± 23.22	28.48** ± 9.41
Joint scaling test					
m	R	142.51** ± 2.94	152.29** ± 2.79	127.47** ± 3.02	113.41** ± 3.26
	S	81.52** ± 2.72	100.91** ± 3.30	73.69** ± 2.01	54.76** ± 1.64
[d]	R	-18.29** ± 2.98	6.54* ± 2.87	23.42** ± 3.00	5.30 ± 3.62
	S	-21.14** ± 2.68	3.68 ± 2.63	22.14** ± 1.97	2.35 ± 1.71
[h]	R	-2.20 ± 4.44	5.52 ± 3.79	5.17 ± 4.53	3.02 ± 5.24
	S	6.55 ± 4.27	1.51 ± 7.94	-3.91 ± 3.72	-1.03 ± 2.86
χ ²	R	11.81**	2.01	11.66**	8.04*
	S	4.37	26.36**	2.72	10.63**
Best fit model					
m	R	146.90** ± 19.47	--	171.73** ± 27.64	139.46** ± 18.60
	S	--	71.85** ± 17.75	--	83.41** ± 12.33
[d]	R	-14.82** ± 3.70	--	21.21** ± 3.52	3.24 ± 4.15
	S	--	20.10** ± 4.19	--	2.64 ± 1.84
[h]	R	17.55 ± 47.17	--	-61.71 ± 61.74	-51.44 ± 51.54
	S	--	77.67 ± 42.71	--	-64.39 ± 33.13
[i]	R	-11.65 ± 19.12	--	-49.45 ± 27.41	-31.75 ± 18.13
	S	--	16.35 ± 17.25	--	-30.35** ± 12.19
[j]	R	-5.60 ± 13.46	--	10.72 ± 13.67	5.77 ± 17.44
	S	--	-49.55** ± 11.96	--	-1.23 ± 10.34
[l]	R	-28.10 ± 28.81	--	19.17 ± 35.32	24.83 ± 33.87
	S	--	-64.65* ± 32.19	--	32.22 ± 21.50

*, ** Significant at 5% and 1% level of significance, respectively.
R- Rainy Season S- Spring Season