Electronic Journal of Plant Breeding, 9 (3) : 908 - 915 (Sep 2018) DOI: 10.5958/0975-928X.2018.00113.8
ISSN 0975-928X

Research Article

Combining ability analysis and gene action studies in pearl millet [*Pennisetum glaucum* (L.) R Br.]

R. K. Gavali[1], N. S. Kute[2], V. Y. Pawar[3] and H. T. Patil[4]
[1,2]Department of Botany, Mahatma Phule Krishi Vidyapeeth, Rahuri-413722 (MS) India
[3, 4] Bajra Research Scheme, College of Agriculture Dhule-424 004 (MPKV), (M.S.), India.
E-Mail: ravigavali0766@gmail.com

(Received:21 Apr 2018; Revised:05 Sep 2018; Accepted:09 Sep 2018)

Abstract
The experiment was conducted with 48 hybrids which were developed through line x tester mating design using four male sterile line and twelve restores as parental material along with two hybrids as standard checks, *viz.*, Aadishakti and 86 M 86. The parents, hybrids and two standard checks were evaluated during *Kharif*, 2016 season for 10 characters. Significant differences were observed for all the ten characters studied. Among the females, DHLB-25A was found best general combiner for grain yield and had significant GCA effects for six other characters. For earliness, DHLB-21A was good general combiner as it had significant GCA effects. The lines, DHLB-22A, DHLB-23A were good general combiner for grain iron content (ppm). Among male parents, S-16/105, S-16/85 and S-16/93 were found to be good general combiner for most of the characters under study. The cross DHLB-21 x S-16/107 was the best specific combiner for grain yield per plant followed by DHLB-25A x S-16/109 and DHLB-25A x S-16/93. The cross combination DHLB-22A x S-16/109 was the best specific combiner for grain iron content (ppm) followed by DHLB-23 x S-16/89. They produced significant and desirable SCA effects for most of the traits studied, including potential for exploiting hybrid vigour in breeding programme.

Key words
Pearl millet, GCA, SCA, gene action, grain yield, grain iron content.

Introduction

Pearl millet (*Pennisetum glaucum* (L.) R. Br.) is a highly cross pollinated crop with protogynous flowering and wind borne pollination mechanism, which fulfils one of the essential biological requirements for hybrid development. India is a major producer of pearl millet both in terms of area (7.5 million ha) and production (9.73 million ton), with an average productivity is 1305 kg/ha (Anonymous, 2018).

Combining ability provides useful information regarding the selection of suitable parents for effective hybridization programme and at the same time elucidates the nature and magnitude of gene action varies with genetic architecture of population involve in hybridization therefore, it is necessary to evaluate the parents for their combining ability. This information enables the breeder to their utility in development of high yielding F_1 hybrids in pearl millet, where hybrids are being cultivated on commercial scale.

Keeping the above fact in mind, the present investigation was conducted to assess the combining ability for yield and its contributing traits. To determine the nature and magnitude of gene action, line x tester mating design was utilized with a view to identify good combiners including CMS lines and restorers.

Materials and Methods

The present investigation was carried at Post Graduate Institute Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri during *Kharif*, 2016. The experimental material consisting of four male sterile lines *viz.*, DHLB-21A, DHLB-22A, DHLB-23A and DHLB-25A and twelve testers *viz.*, S-16/85, S-16/87, S-16/89, S-16/93, S-16/99, S-16/102, S-16/105, S-16/107, S-16/109, S-16/117, S-16/118 and S-16/123 which were obtained from Pearl Millet Research Scheme, College of Agriculture, Dhule. All sixteen parents were crossed to produced 48 F_1 hybrids according to the Line x Tester mating design developed by Kempthorne (1957). A total 66 treatments comprising 4 male sterile lines (female parents), 12 restorers (male parents), 48 F_1s and 2 check hybrids *viz.*, Aadishakti and 86 M 86 were grown in a randomized block design with three replications. Each entry planted in 4.5 meter row with spacing of 50 x 15 cm and two row of each entry was planted in each replication. Ten competitive plants were randomly selected to record the observations on 10 characters *viz.,* days to 50% flowering,

days to maturity, plant height (cm), number of effective tillers/plant, earhead length (cm), earhead girth (cm), grain yield/plant (g), fodder yield/plant (g), 1000 - grain weight (g) and grain iron content (ppm) and statistical analysis was done. Data was subjected to analysis of variance to find significant differences among genotypes for the recorded data. After obtaining, the significance, data recorded on parents and their $F_{1,}$s were subjected to combining ability analysis and the testing of significance of different genotypes was based on procedure given by Kempthorne (1957).

Results and Discussion

Analysis of variance for combining ability was done for ten characters and presented in **Table 1**. The mean due to lines were significant for all the traits except grain yield/plant and fodder yield/plant. Variations due to testers were significant for all the traits under study. Mean squares due to line x tester were significant for all characters except days to maturity. Significant differences were found among the parents for all the traits indicating that the materials selected were diverse and resulted in certain of substantial genetic variability in the crosses.

Combining ability analysis **(Table 2)** revealed that GCA was highly significant for all the studied characters except 1000 - grain weight indicated that additive variance is predominant for these characters. These results were in conformity with Lakshmana *et al.,* (2003), Patil *et al.,* (2005) and Badurkar *et.al.,* (2018). While SCA varinces were highly significant for all the traits indicated epistatic gene action is predominant for the characters. Similar results were also reported by Yadav *et al.,* (2002) and Patel *et al.,* (2008). Analysis also revealed higher magnitude of mean sum of squares for SCA for the plant height, number of tillers/plant, earhead length, earhead girth, grain yield/plant, fodder yield/plant, 1000 - grain weight and grain iron content that indicated the preponderance of non- additive gene action to control these characters Dhuppe *et al.,* (2006) and Karvar *et al*., (2017) and therefore, heterosis breeding will be rewarding.

Estimates of gca and sca effects for ten characters are presented in **Table 3** and **Table 4**, respectively. In the present investigation the parent, DHLB-25A showed significant positive GCA effect for grain yield per plant, 1000 - grain weight, number of tillers per plant, earhead length, earhead girth and grain iron content (ppm). Therefore, DHLB-25A proved to be good general combiner for grain yield per plant, 1000 - grain weight, number of tillers per plant, earhead length, earhead girth and grain iron content (ppm). While, DHLB-21A exhibited desirable negative significant general combining ability effect for earliness days to 50% flowering, days to maturity and plant height and proved to be good parent for developing early maturing varieties. The parents DHLB-22A, DHLB-23A and DHLB-25A showed positive gca effect for grain iron content which prove their potential to be good parent for grain iron content.

Parents S-16/105 was showed significant positive gca effects for grain yield, earhead girth, number of effective tillers/plant, fodder yield, grain iron content and desirable negative gca effect for days to 50 % flowering, days to maturity and plant height and the parent S-16/109 for grain yield, 1000 - grain weight, number of tillers/plant, earhead length, earhead girth grain iron content and fodder yield/plant. The parent S-16/85 recorded significant gca effects for grain yield/plant, earhead length, grain iron content and desirable and negative gca effects for days to 50% flowering days to maturity and plant height while the tester, S-16/107 for grain yield, numbers of effective tillers/plant, earhead length, earhead girth and fodder yield. The parent S-16/93 was good general combiner for days to 50% flowering, days to maturity, number of tillers per plant, earhead girth and 1000 - grain weight. S-16/105 were identified as a good general combiner for grain yield, earhead girth, number of effective tillers, fodder yield, grain iron content and desirable negative gca effect for days to 50 % flowering, days to maturity and plant height, parent S-16/109 was good general combiner for grain yield, 1000 - grain weight, number of tillers, earhead length, earhead girth grain iron content and fodder yield, parent S-16/85 were also good general combiner for grain yield, earhead length, grain iron content, days to 50% flowering days to maturity and plant height, parent S-16/93 proved to be a good general combiner for days to 50% flowering, days to maturity, number of tillers per plant, earhead girth and 1000 - grain weight and S-16/107 were showed good general combiner for the grain yield, number of effective tillers, earhead length, earhead girth and fodder yield.

The data on GCA effects indicated that the effects varied significantly for different characters and in different parents. The good general combiners had fixable component of variance like additive variance and additive x additive epistatic component; therefore, parent's *viz.*, DHLB-25A, DHLB-21A, DHLB-23A, DHLB-22A, S-16/105, S-16/109, S-16/85, S-16/107 and S-16/93 offered the best possibilities of exploitation for development of improved high yielding and grain iron content lines in pearl millet.

Sprague and Tatum (1942) reported that the SCA effect is due to non-additive genetic proportion. It is an important parameter for judging and selecting superior cross combinations, which might be exploited through heterosis breeding programme. The cross DHLB-21A x S-16/107 showed positive significant SCA effect for grain yield per plant, number of effective tillers per plant, earhead length, earhead girth, fodder yield per plant, 1000-grain weight and in negative direction for days to 50% flowering and plant height while, DHLB-25A x S-16/93 showed positive significant SCA effect for grain yield per plant, effective tillers per plant, earhead length, earhead girth, fodder yield per plant, 1000-grain weight and significant SCA effect in negative direction for plant height. The cross combination DHLB-22A x S-16/109 are showed positive significant SCA effect for grain iron content, similar results were also reported by Rathore *et al.*,(2004) and Bhandari *et al.*, (2007).

In the present investigation, DHLB-21A and S-16-107 were potential parents for grain yield/plant and DHLB-22A and S-16/109 were better for grain iron content. Therefore, it offered the best possibilities for cross DHLB-21A x S-16/107 was best specific combiner for grain yield per plant. They produced significant and desirable SCA effects and heterosis for most of the traits studied indicating potential for exploiting hybrid vigour in breeding programme.

References

Anonymous, 2018. Project Coordinators Review, 53nd Annual Group Meeting of All India Coordinated Research Project on Pearl Millet, Agriculture University, Jodhpur, Rajastan, March 22-24, 2018., 1-2.

Ashok, A., Sumathi, P., Veerabadhiran, P., Revathi, J. and Poornimajency, S. 2017. Development of heteroitic hybrids for quality, yield and its architectural traits in pearl millet [Pennisetum glaucum (L.) R. Br.] Range Management and Agroforestry, **37**(2)181-184.

Anarase, S. A. and Suryawanshi, N. N. 2005. Combining ability analysis for grain yield and its components in pearl millet (Pennisetum glaucum (L.) R. Br.). J. Maharashtra agric. Univ.,**30** (3): 330-332.

Badurkar, S. B., Pole, S. P., Toprope, V. N. and Ingle, N. P. 2018. Combining Ability for Grain Yield and Its Related Traits in Pearl Millet (Pennisetum glaucum) (L.) R. Br.] Int. J. Curr. Microbiol. App. Sci) Special Issue-**6:** 956-961

Bhandari, S. H., Dangaria, C. J. and Dhedhi, K. K. 2007 Diallel analysis for yield and yield components in pearl millet. Asian J. Bio. Sci., **2** (1): 162-166.

Dhuppe, M. V., Chavan, A. A., Phad, D. S. and Chandankar, G. D. 2006. Combining ability studies in pearl millet. J. Maharashtra Agric. Univ. **31**, 146-148.

Jethva, A. S., Lata, Raval, R. B. Madriya, D. R. Mehta, Chetana, Mandavia. 2011. Combining ability over environments for grain yield and its related trait in Pearl Millet Crop improvement journal., **38** (1): 92-96.

Karvar, S. H., Pawar, V. Y. and Patil, H. T. 2017. Heterosis and Combining Ability In Pearl Millet (Pennisetum glaucum (L.) R. Br.). Electronic Journal of Plant Breeding, **8** (4): 1197-1215.

Kempthorne, O. 1957. An Introduction to Genetic Statistic. John Willey and Sons. Inc., New York.

Khandagale, S. G., Sharma, V., Lone, R. P., Khandagale, V. G. and Kumar Swamy, R.V. 2014. Combining ability analysis and gene action in pearl millet (Pennisetum glaucum (L.) R. Br.). Electronic Journal of Plant Breeding, **5** (3): 445-450.

Lakshmana, D., Surendra, P. and Gurumurty, R. 2003. Combining ability studies in Pearl millet (Pennisetum glaucum (L.) R. Br.) Res. On Crops**. 4** (3):358-362.

Patel, M. A., Yadavendra, J. P., Patel,D. H., Upahyaya, N.V. and Shaikh, J. A., 2008. Studies on heterosis for green fodder yield its contributing traits in pearl millet (Pennisetum glaucum (L.) R. Br.). Forage Res. **34** (3): 149-155.

Rai, K. N., Govindaraj, M. and Rao, A. S. 2012. Genetic enhancement of grain iron And zinc content in pearl millet (Pennisetum glaucum (L.) R. Br.). Quality Assurance and Safety of Crop and Foods**. 4** (3): 119-125.

Rai, K. N., Yadav, O. P., Govindaraj, M., Pfeiffer, W. H., Yadav, H. P., Rajpurohit, B.S., Patil, H. T., Kanatti, A., Rathore, A., Rao, A. S. and Shivade, H. 2016.Grain iron and zinc densities in released and commercial cultivars of pearl millet(Pennisetum glaucum (L.) (R. Br.). Indian J. of Agril. Sciences **86** (3) 291–6.

Rathore, V. S., Singhania, D. L. and Jakhar, M. L. 2004. Combining ability of diverserestorers of pearl millet (Pennisetum glaucum (L.) (R. Br.) Indian J. Genet., **64**(3): 239-240

Sprague, G. F. and Taum, L. A. 1942. General vs specific combining ability in single cross of corn. Journ. Amer. Soc. Agron., **34**:923-32.

Thakare, D.S., Patil, H.T., Pawar, V.Y. and Gavali, R.K. 2014. Heterosis and Combining Ability in Pearl Millet (Pennisetum glaucum (L.) R. Br.). J. Agric. Researchand Technology., **39** (2): 193-198.

Yadav, H. P., Sabharwal, P. S. and Beniwal, C. R. 2002. Combining ability study for some newly developed male sterile lines for forage attributes in pearl millet (Pennim (L.) R. Br.). Forage Res., **27**(4): 277-280.

Electronic Journal of Plant Breeding, 9 (3) : 908 - 915 (Sep 2018) DOI: 10.5958/0975-928X.2018.00113.8
ISSN 0975-928X

Table 1. Analysis of variance for different characters in L x T mating in pearl millet.

Sources	d. f.	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of tillers / plant	Ear head length (cm)	Ear head girth (cm)	Grain yield /Plant (g)	Fodder yield /plant (g)	1000 grain weight (g)	Iron content (ppm)
Replications	2	1.73	8.77	0.44	0.01	0.17	0.06	23.14	18.43	0.02	0.02
Treatments	63	27.88**	29.35**	877.68**	0.55**	9.23**	0.82**	479.95**	1308.47**	11.39**	701.05**
Females	3	46.97**	34.97**	447.60**	1.34**	27.79**	2.65**	3.37	20.09	17.66**	295.03**
Males	11	16.18**	25.00**	237.56**	0.07**	3.61**	0.55**	85.00**	107.99*	9.96**	412.80**
Females vs Males	1	27.56**	5.06	4262.62**	1.41**	17.08**	1.21**	133.88**	805.28**	0.21**	21.90**
Error	126	9.61	4.03	18.85	0.00	0.64	0.10	13.39	51.25	0.38	0.01

*,**significant at 5 and 1% level respectively

Table 2. Estimate of gca, sca, additive and dominance variances, gene action and heritability for different characters in pearl millet.

Variances	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of tillers /plant	Ear head length (cm)	Ear head girth (cm)	Grain yield / Plant (g)	Fodder yield /plant	1000 grain weight	Iron content (ppm)
gca	2.98**	2.58**	29.65**	0.04*	0.45**	0.04**	19.93**	33.81**	0.57	46.91**
sca	2.63**	1.60**	123.56**	0.20**	1.97**	0.19**	56.96**	92.67**	3.79**	195.10**
σ2A	5.96	5.16	59.29	0.08	0.90	0.09	35.87	67.62	1.15	93.82
σ2D	2.63	1.60	123.56	0.20	1.97	0.19	56.96	92.67	3.79	195.10
$\sigma^2A : \sigma^2D$	2.27	3.23	0.48	0.38	0.45	0.46	0.63	0.73	0.30	0.48
h^2 (n. s.)%	67.83	63.71	31.35	27.51	29.09	28.10	36.87	38.12	22.67	32.47

*,** significant at 5 and 1% level,

Electronic Journal of Plant Breeding, 9 (3) : 908 - 915 (Sep 2018) DOI: 10.5958/0975-928X.2018.00113.8
ISSN 0975-928X

Table 3. Estimates of General Combining ability effects for different characters in pearl millet.

Sr. No.	Parents	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of tillers / plant	Ear head length (cm)	Ear head girth (cm)	Grain yield /Plant (g)	Fodder yield /plant (g)	1000 grain weight (g)	Iron content (ppm)
	Lines										
1	DHLB 21 A	-1.34**	-1.32**	-5.49**	0.01	0.26	-0.29**	-1.68**	-1.30	-0.95**	-8.71**
2	DHLB 22 A	-1.09**	-0.65	-3.79**	-0.15**	0.08	0.10	-1.27*	-2.56*	-0.20	0.91**
3	DHLB 23 A	-0.29**	-0.63	2.42**	-0.15**	-0.92**	0.01	-3.38**	-4.43**	0.12	6.63**
4	DHLB 25A	2.72**	2.60**	6.85**	0.28**	0.58**	0.18**	6.33**	8.24**	1.03**	1.18**
	SE±	0.13	0.33	0.72	0.01	0.13	0.053	0.61	1.19	0.10	0.02
	Tester										
1	S-16/85	-1.51**	-1.35*	-13.36**	0.02	0.48*	0.15	4.73**	2.65	-0.80**	7.79**
2	S-16/87	0.24	0.07	-1.37	-0.30**	-1.04**	-0.47**	-8.67**	-13.49**	0.33	4.08**
3	S-16/89	-0.17	-0.76	5.06**	-0.06**	-0.29	0.01	-1.48	2.05	0.05	7.23**
4	S-16/93	-0.92**	-1.18*	1.69	0.28**	0.39	0.26**	-0.10	1.34	0.91**	-1.50**
5	S-16/99	2.33**	2.07**	2.42	-0.03	-0.41	-0.08	2.22*	2.15	0.36*	-17.46**
6	S-16/102	0.16	0.74	0.00	0.01	0.01	0.23*	-0.61	-2.50	0.20	-3.47**
7	S-16/105	-2.01**	-1.93**	-5.07**	0.08**	0.19	0.20*	2.89**	4.12*	-0.79**	3.39**
8	S-16/107	0.58*	0.49	1.18	0.22**	1.44**	0.22*	2.13*	4.56*	0.10	-7.10**
9	S-16/109	-0.01	0.74	1.64	0.21**	1.44**	0.19*	3.48**	4.81*	0.85**	3.03**
10	S-16/117	1.33**	0.99	2.29	-0.04	-0.06	-0.26**	2.14*	5.48**	-0.28	-8.31**
11	S-16/118	-1.17**	-1.43*	4.20**	-0.16**	-0.56*	-0.04	1.19	3.40	-0.07	0.78**
12	S-16/123	1.16**	1.57**	1.32	-0.25**	-1.31**	-0.41	-7.93**	-14.57**	-0.87**	11.54**
	SE±	0.22	0.58	1.25	0.02	0.23	0.09	1.06	2.07	0.18	0.02

*,** significant at 5 and 1% level, respectively.

Table 4. Estimates of Specific Combining ability effects for different characters in pearl millet.

Sr. No.	Parents	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of tillers /plant	Ear head length (cm)	Ear head girth (cm)	Grain yield /Plant (g)	Fodder yield /plant (g)	1000 grain weight (g)	Iron content (ppm)
1	**DHLB-21A** X S-16/85	-0.83	-0.85	-4.38	0.09	0.51	-0.07	6.24**	4.55	-0.91*	2.97**
2	X S-16/87	-1.24**	-1.26	-1.30	0.03	-0.34	-0.11	0.34	2.15	1.44**	-0.85**
3	X S-16/89	-2.16**	-1.43	-13.20**	-0.04	-0.16	0.38*	6.93**	6.58	0.28	13.56**
4	X S-16/93	-0.08	-1.35	17.51**	-0.68**	-1.11*	-0.57**	-13.34**	-16.46**	-0.81*	1.77**
5	X S-16/99	4.01**	3.40**	2.31	-0.24**	1.19*	-0.03	1.50	7.05	0.67	-0.20**
6	X S-16/102	1.17**	1.74	22.40**	-0.38**	-0.89	-0.37*	-6.72**	-4.01	0.15	15.65**
7	X S-16/105	2.01**	1.74	-0.90	-0.05	-0.80	-0.51**	-1.94	-5.15	-1.85**	-13.78**
8	X S-16/107	-1.91**	-0.01	-13.31**	1.45**	4.01**	1.07**	17.74**	21.97**	3.84**	-9.38**
9	X S-16/109	-0.33	-0.60	1.65	-0.28**	-1.19*	-0.17	5.30*	6.72	0.57	2.37**
10	X S-16/117	0.01	-0.51	-2.13	-0.03	-0.78	0.42*	-7.14**	-1.62	-2.03**	-8.11**
11	X S-16/118	-0.49	-0.76	9.56**	0.20**	0.01	0.03	0.16	0.80	-1.37**	-3.11**
12	X S-16/123	-0.16	-0.10	-18.22**	-0.06	-0.44	-0.07	-9.07**	-22.57**	0.03	-0.91**
13	**DHLB-22A** X S-16/85	0.92 *	0.15	4.02	0.14**	-0.9	0.12	-2.14	0.47	0.01	7 72**
14	X S-16/87	0.51	0.74	-17.24**	0.15 **	-0.53	-0.39 *	-8.73**	-22.40**	-1.92 **	-3.07**
15	X S-16/89	0.59	-0.10	-3.23	-0.01	0.29	-0.54 **	-3.35	-7.26	-1.00 **	-21.61**
16	X S-16/93	0.67	1.99	-0.02	-0.26**	-1.36**	0.14	-2.56	0.78	-0.42	0.48**
17	X S-16/99	0.42	1.40	-4.05	-0.05	0.04	-0.22	10.00**	4.97	-1.38**	-0.91**
18	X S-16/102	1.26**	1.07	-8.60**	0.08	-0.08	0.54 **	-2.06	-0.94	1.88**	-1.75**
19	X S-16/105	-1.24 **	-1.26	-3.53	0.18**	-0.62	0.31	1.03	4.12	-0.67	-8.05**
20	X S-16/107	-0.83	-1.35	7.89**	-0.30**	0.02	-0.52 **	0.03	4.22	-0.42	-0.04
21	X S-16/109	-2.24**	-2.26	20.35**	-0.16 **	0.82	-0.02	-4.70 *	-3.36	-1.53**	28.68**
22	X S-16/117	-1.58**	-1.85	6.77**	-0.04	1.53**	-0.03	0.02	3.31	-0.05	1.17*
23	X S-16/118	-0.08	0.24	-10.74**	0.05	0.22	0.31	4.41*	3.40	2.63**	-2.74**
24	X S-16/123	1.59**	1.24	8.38**	0.20**	0.57	0.29	8.04**	12.69**	2.85**	0.12 *
25	**DHLB-23A** X S-16/85	0.45	0.13	2.18	-0.23**	-0.78	0.38 *	-7.03 **	-10.32 *	2.99**	-2.49**
26	X S-16/87	1.04 *	0.38	15.79**	0.15 **	0.90	-0.13	4.73 *	8.81*	0.67	-7.12**
27	X S-16/89	-0.88	-0.79	5.79*	0.42**	0.78	0.05	2.05	6.61	1.18 **	23.11**

Electronic Journal of Plant Breeding, 9 (3) : 908 - 915 (Sep 2018) DOI: 10.5958/0975-928X.2018.00113.8
ISSN 0975-928X

28	X S-16/93	-1.13 *	-0.04	-8.23**	-0.02	-0.83	-0.13	4.14	3.74	0.24	8.04**
29	X S-16/99	-1.38 **	-0.96	-5.27*	-0.21**	-0.87	0.31	-5.78**	-7.15	1.52**	18.72**
30	X S-16/102	-1.22 **	-1.96	-4.22	-0.06	-0.08	0.67**	0.50	3.16	-2.75**	-23.69**
31	X S-16/105	-0.72	0.38	10.29**	0 22**	0.28	0.34	-2.53	0.87	2.84**	8.34**
32	X S-16/107	2.37**	0.63	5.71*	-0.46**	-1.52**	-0.82**	-6.23**	-12.24**	-4.54**	2.44**
33	X S-16/109	2.95**	3.71**	-12.39**	-0.06	-1.18 *	-0.09	-5.11 *	-7.15	0.26	-23.68**
34	X S-16/117	-0.38	0.13	-5.37*	0.30**	0.86	-0.44 *	12.89**	7.51	1.64**	-14.29**
35	X S-16/118	0.12	-0.46	2.55	0.22**	0.82	0.07	-3.37	-4.07	-0.81 *	2.75**
36	X S-16/123	-1.22**	-1.13	-6.83**	0.17**	1.63**	-0.19	5.75 **	10.23 *	-3.24**	7.89**
37	**DHLB-25A** X S-16/85	-0.55	0.57	-1.82	0.02	1.19*	-0.43*	2.93	5.30	-2.08**	-8.20**
38	X S-16/87	-0.30	0.15	2.76	-0.34**	-0.03	0.63**	3.66	11.43	-0.19	11.04**
39	X S-16/89	2.45**	2.32*	10.63**	-0.37**	-0.91	0.11	-5.63**	-5.93	-0.46	-15.07**
40	X S-16/93	0.55	-0.60	-9.26**	0.96**	3.30**	0.56**	11.77**	11.94**	0.98 **	-10.28**
41	X S-16/99	-3.05**	-3.85**	7.01**	0.50**	-0.36	-0.06	-5.73**	-4.87	-0.82 *	-17.61**
42	X S-16/102	-1.22 **	-0.85	-9.58**	0.36**	1.05*	-0.84**	8.28**	1.78	0.72 *	9.79**
43	X S-16/105	-0.05	-0.85	-5.87*	0.09	1.14*	-0.14	3.44	0.16	-0.32	13.49**
44	X S-16/107	0.37	0.74	-0.29	-0.69 **	-2.51**	0.27	-11.54**	-13.95**	1.12 **	6.98**
45	X S-16/109	-0.38	-0.85	-9.62**	0.49**	1.55**	0.27	4.51*	3.80	0.70	-7.38**
46	X S-16/117	1.95**	2.24	0.73	0 23**	-1.61**	0.05	-5.78**	-9.20*	0.43	21.23**
47	X S-16/118	0.45	0.99	-1.38	-0.47**	-1.05*	-0.40*	-1.20	-0.12	-0.45	3.10**
48	X S-16/123	-0.22	-0.01	16.67**	-0.32**	-1.76**	-0.03	-4.72*	-0.35	0.36	-7.10**
	SE$\pm$	0.45	1.16	2.51	0.046	0.46	0.18	2.11	4.13	0.36	0.59

*,** significant at 5 and 1% level, respectively.