www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(11): 1658-1662

www.thepharmajournal.com
Received: 07-09-2021
Accepted: 15-10-2021

Rahana SN
Ph.D. Scholar, Plant Breeding and Genetics, College of Agriculture, Vellayani, Trivandrum, Kerala, India

Beena Thomas
Assistant Professor, Plant Breeding and Genetics, College of Agriculture, Vellayani, Trivandrum, Kerala, India

Corresponding Author:
Rahana SN
Ph.D. Scholar, Plant Breeding and Genetics, College of Agriculture, Vellayani, Trivandrum, Kerala, India

Exploitation of heterosis for drought tolerance in snake bean

Rahana SN and Beena Thomas

Abstract
Snake bean is an important legume vegetable in Kerala but its production is affected by water stress. The present research was carried out to study the magnitude of heterosis for drought tolerant traits in snake bean, with the ultimate aim of selecting appropriate parents for hybridization in the development of drought tolerant varieties. The heterosis of twenty one hybrids produced by L x T mating of seven lines and three testers were estimated. The crosses L3 x T3 (Kattampally local x Vellayani Jyothika), L4 x T2 (Kulasekharapuram x Lola) and L6 x T2 (Nilamel local x Lola) were found to be superior for most of the traits studied. These crosses can be further utilized in hybridization programme to get desirable high yielding drought tolerant varieties.

Keywords: Heterosis, snake bean, hybrid vigour, moisture stress, drought tolerance

Introduction
Snake bean (*Vigna unguiculata* sub sp. sesquipedalis) belonging to the family Fabaceae is an important leguminous vegetable. The crop is grown for its green tender pods. The pods are highly nutritive and good source of micronutrient. Being a legume, it enriches the soil by nitrogen fixation. For its long, slender pods it is also known as Chinese long beans, pea-bean, asparagus bean, body bean and yardlong bean. The crop is cultivated in parts of China, Indonesia, India, Philippines, Thailand and Taiwan. In Kerala snake bean is a highly demanded and remunerative vegetable. The crop is grown throughout the year. But its production is affected by a range of biotic and abiotic constraints. Water stress is the major abiotic stress that adversely affect the crop development and production. The development of drought tolerant high yielding varieties is of immense importance to the farmers for its sustainable production (Ravelombola *et al*., 2020) [11].

Balanced gene combinations which were more adaptive to environmental conditions and useful from the agriculture point can be obtained through heterosis breeding. Heterosis, also known as hybrid vigour, describes the phenomenon in which an F1 population obtained by crossing of two genetically different individuals, with enhanced or decreased vigour compared to the parents. Thomas Fairchild was the first to identify and report this improved vigour of hybrids in 1716. Joseph Koelreuter was the first to conduct plant hybridization in a scientifically sound manner and to report on the benefits of outcrossing. G.H. Shull developed the concept of heterosis in 1914 as a consequence of evidences on the prevalence of hybrid vigour in several crops. Being a self-pollinated crop, heterosis breeding is considered to be one of the most effective ways to obtain variability in snake bean. George and Sarada (2019) [4] emphasized the scope of heterosis breeding and hybridization followed by selection for exploitation of hybrid vigour in snake bean. With this background the present study was carried out to study the heterosis for drought tolerant traits in snake bean with the ultimate aim of choosing the right parents for hybridization.

Materials and Method
In the present study line x tester analysis was employed for analyzing the combining ability of the genotype and to identify parents for developing heterotic combinations. Seven drought tolerant genotypes selected from germplasm screening and three high yielding commercial varieties (Gitika, Vellayani Jyothika and Lola) were selected as lines and testers respectively. The ten parents were crossed in line x tester pattern. The details of the parental materials utilised in the study are presented in Table 1. Twenty one hybrids along with their parents and check (Arka Mangala) were evaluated for moisture stress tolerance in the field.

The field work was carried out at the Plant Breeding and Genetics Department farm, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala, India. Water stress was imposed at flowering stage by restricting the irrigation to once in four days at 10mm depth. To assess drought stress tolerance, 7 biometric traits were used.

Table 1: Details of lines and testers in L X T cross

No.	Parents		
Lines		Testers	
L_1	Anchal local II	T1	Gitika
L_2	Aranmula local	T2	Lola
L_3	Kattampally local	T3	Vellayani Jyothika
L_4	Kulasekharapuram		
L_5	Muttathukonam local		
L_6	Nilamel local		
L_7	Pongamoodu local		

All the entries were raised in a randomized block design with 3 replications during summer season. In each replication, all the entries were sown in a row with a spacing of 1.5x0.45 m. Recommended fertilizers and agronomic measures were followed throughout the crop period. Observations were recorded for seven traits *viz*., days to 50% flowering, pod length (cm), pod width (mm), pod weight (g), pods per plant, yield per plant (g) and crop duration. The data were submitted to the analysis of variance (ANOVA).

The magnitude of heterosis was estimated using the following formula and expressed as percentage.

Average or relative heterosis

When heterosis is estimated over mid parental value i.e., average of two parents it is Referred as average or relative heterosis.

Average heterosis = ⟦(F1-MP)/MP⟧X 100

Where,
F1 = Value of F1.
MP = Mean value of two parents.

Heterobeltiosis

When heterosis is estimated over better parent it is called as heterobeltiosis.

Heterobeltiosis = ⟦(F1-BP)/BP⟧X 100

Where,
F1 = Value of F1.
BP = Value of better parent.

Standard heterosis

When heterosis is estimated over standard commercial hybrid it is called as standard heterosis. It is also referred as useful or economic heterosis.

Standard heterosis = ⟦(F1-SH)/SH⟧X 100

Where,
F1 = Value of F1.
SH = Standard commercial hybrid.

Result and discussion

The analysis of variance revealed significant difference among the 21 F_1's for all the traits studied *viz*., days to 50% flowering, pod length (cm), pod width (mm), pod weight (g), pods per plant, yield per plant (g) and crop duration. The significant difference indicates the existence of sufficient genetic variability among the hybrids to improve yield in snake bean under moisture stress. This is in line with the findings of Ajayi *et al*. (2018) [1] who indicate that water stress causes significant difference across genotypes.

The heterosis percentage expressed by twenty one hybrids for seven characters were estimated as its superiority over mid parent (relative heterosis), standard check (standard heterosis) and better parent (heterobeltiosis) values. Manifestation of heterosis was found in both positive and negative directions. Except for days to 50% flowering and crop duration, positive heterosis was preferred in rest of the parameters. This is in accordance with the earlier reports of Asoontha (2017) [2], Litty (2015) [8] and Madhukumar (2006) [10].

Yield is an important trait considered for the selection of drought tolerant genotypes. Pod yield showed remarkable variation among the hybrids. For superior recombinants in heterosis breeding, a high heterosis for yield combined with a high heterosis for yield contributing traits need to be considered (Kadam *et al*., 2013) [6]. Significant pod yield variation among genotypes were reported by Sultana *et al*. (2020) [13], George and Sarada (2019) [4] and Asoontha and Abraham (2017) [2]. High heritability combined with high genetic advance is indicative of additive gene action and selection based on these parameters would be more reliable (Johnson *et al*., 1955) [5]. In snake bean high heritability and genetic advance were reported for number of pods per plant, yield, pod weight and pod length (Asoontha (2017) [2], Vidya *et al*. (2002) [14] and Resmi (1998)) [12] indicate the scope for crop improvement based on these characteristics.

Out of twenty one crosses, eighteen crosses showed positive and significant relative heterosis for yield. The relative heterosis percentage is presented in table 2. The best five F_1's showing relative heterosis in positive direction were L6xT2 (83.26), L3xT3 (82.02), L4xT2 (80.76), L5xT2 (73.77) and L5xT1 (63.81). The hybrid L3xT3 recorded positive significant relative heterosis for pod length, pod girth, pod weight and pods per plant. The hybrid L4xT2 also recorded positive significant relative heterosis for days to 50% flowering, pod girth, pod weight and pods per plant. These traits are important in determining the yield performance of snake bean under moisture stress condition. Earlier studies on the direct effect of pod length, pod weight (George and Sarada (2019) [4] and pod girth (Resmi (1998) [12], Vidya *et al*. (2002)) [14] on yield support the selection of hybrids based on these parameters. The crosses L4xT2 (Kulashegarapuram x Lola) and L3xT3 (Kattampally local x Vellayani Jyothika) were revealed to be the best for water stress tolerance based on the relative heterosis.

Table 2: Relative Heterosis under water stress

Hybrids		Days to 50% flowering	Pod length	Pod girth	Pod weight	Pods per plant	Yield per plant	Crop Duration
L1 X T1		21.06**	-31.97**	-19.15**	13.94**	-1.53 ns	13.96**	-8.75**
L1 X T2		24.48**	-35.01**	1.94 ns	21.85**	-5.74**	17.35**	-9.68**
L1 X T3		-1.01 ns	-4.15 ns	9.50*	29.68**	19.25**	58.23**	-2.59**
L2 X T1		9.33**	-28.34**	-19.10**	26.81**	-1.72 ns	24.73**	-4.67**
L2 X T2		16.12**	-24.35**	15.13**	35.18**	18.45**	60.76**	0.77*
L2 X T3		18.87**	-40.49**	-17.79**	31.39**	-26.40**	-2.26 ns	-6.36**
L3 X T1		-0.32 ns	27.87**	2.77 ns	21.11**	22.86**	47.86**	-3.66**
L3 X T2		-3.48*	22.66**	12.50**	25.83**	3.95**	30.28**	0.71*
L3 X T3		2.28 ns	51.58**	20.50**	46.06**	24.78**	82.02**	-4.38**
L4 X T1		10.54**	-48.80**	-16.33**	36.01**	1.68 ns	37.28**	-0.51 ns
L4 X T2		-9.59**	-19.01**	12.61**	46.81**	24.03**	80.76**	-3.36**
L4 X T3		-3.81**	-12.69**	-16.46**	38.38**	14.99**	58.79**	-0.67 ns
L5 X T1		-7.06**	-31.73**	-13.91**	41.41**	19.03**	63.81**	-3.83**
L5 X T2		-10.23**	-41.82**	7.46 ns	45.44**	22.53**	73.77**	-0.15 ns
L5 X T3		-5.08**	-45.90**	-16.67**	36.25**	2.65*	37.03**	-0.34 ns
L6 X T1		15.48**	-25.65**	-28.96**	3.91**	7.84**	12.38**	-5.79**
L6 X T2		-11.14**	37.38**	7.83 ns	34.57**	35.38**	83.26**	-4.80**
L6 X T3		0.39 ns	12.90**	-5.31 ns	-0.32 ns	14.25**	15.46**	1.10*
L7 X T1		1.94 ns	-15.60**	-17.16**	10.60**	15.53**	28.65**	4.00**
L7 X T2		10.25**	-25.92**	-3.77 ns	-1.34 ns	-1.98 ns	-1.87 ns	7.56**
L7 X T3		10.33**	-28.84**	-11.02**	-1.53 ns	-2.78*	-2.09 ns	5.02**
CD	5%	1.11	2.19	0.66	0.41	1.06	23.42	0.61
	1%	1.47	2.91	0.88	0.55	1.41	31.07	0.81

The range of standard heterosis for yield under moisture stress was from -34.72 (L2xT3) to 24.18 (L3xT3). The check used in the study of standard heterosis was Arka Mangala. The standard heterosis percentage is presented in table 3. Out of twenty one crosses, nine crosses showed positive and significant standard heterosis for yield under moisture stress condition. The best crosses showing significant heterosis over check in positive directions were L3xT3 (24.18), L6xT2 (20.35), L4xT2 (19.10), L5xT2 (9.05) and L4xT3 (8.77). Suitability of heterosis breeding for the improvement of yield were also reported by George and Sarada (2019) [4], Lovely *et al*. (2017) [9] and Lakshmi (2016) [7].

The hybrid L4xT2 recorded favorable heterosis for days to 50% flowering, pod girth, pod weight, pods per plant and crop duration. While the hybrid L3xT3 registered favorable standard heterosis for pod girth, pod weight, pods per plant and crop duration. The cross combination L6xT2 proved favorable heterosis for days to 50% flowering, pod length, pod weight, pods per plant and crop duration. Based on the standard heterosis the crosses L4xT2, L3xT3 and L6xT2 (Nilamel local x Lola) were found to be superior for most of the traits studied.

Table 3: Standard Heterosis under water stress

Hybrids		Days to 50% flowering	Pod length	Pod girth	Pod weight	Pods per plant	Yield per plant	Crop Duration
L1 X T1		4.56**	-31.78**	-4.04 ns	-7.80**	-20.21**	-26.24**	-1.76**
L1 X T2		6.92**	-39.69**	6.06 ns	-4.09**	-22.34**	-25.40**	-3.22**
L1 X T3		-18.40**	-12.01**	22.22**	3.43**	1.42 ns	4.71**	3.60**
L2 X T1		-1.94 ns	-36.44**	9.09 ns	-3.39**	-15.72**	-18.51**	0.00 ns
L2 X T2		3.60**	-38.56**	38.38**	0.01 ns	3.19**	3.17**	5.21**
L2 X T3		1.94 ns	-52.26**	5.05 ns	-1.42 ns	-33.92**	-34.72**	-2.99**
L3 X T1		-14.25**	-6.36*	31.31**	-10.65**	10.52**	-1.27 ns	-1.15**
L3 X T2		-17.43**	-19.35**	27.27**	-9.94**	-5.08**	-14.52**	2.83**
L3 X T3		-16.04**	-1.84**	45.45**	6.06**	17.26**	24.18**	-3.14**
L4 X T1		-1.38 ns	-59.46**	6.06 ns	-0.93 ns	-7.09**	-7.96**	-1.99**
L4 X T2		-19.78**	-41.95**	26.26**	3.70**	15.01**	19.10**	-5.28**
L4 X T3		-17.98**	-38.28**	0.00 ns	-0.81 ns	9.69**	8.77**	-3.45**
L5 X T1		-15.35**	-37.71**	0.00 ns	0.81 ns	3.90**	4.70**	-0.92*
L5 X T2		-18.67**	-51.27**	9.09*	0.49 ns	8.63**	9.05**	2.37**
L5 X T3		-17.29**	-55.23**	-9.09*	-4.45**	-6.26**	-10.43**	1.38**
L6 X T1		7.33**	-33.05**	-7.07 ns	-18.25**	-8.16**	-24.89**	-3.37**
L6 X T2		-17.84**	13.42**	25.25**	2.91*	17.14**	20.35**	-2.83**
L6 X T3		-10.65**	-7.91**	17.17**	-22.74**	1.89 ns	-21.16**	2.37**
L7 X T1		-5.26**	-15.96**	12.12*	3.08*	-1.54 ns	1.51**	0.54 ns
L7 X T2		1.94 ns	-31.78**	16.16**	-10.23**	-15.13**	-23.71**	3.45**
L7 X T3		-1.80 ns	-35.17**	14.14*	-9.38**	-13.24**	-21.32**	0.15 ns
CD	5%	1.28	2.53	0.76	0.48	1.23	27.05	0.71
	1%	1.70	3.36	1.01	0.63	1.63	35.87	0.94

Table 4: Heterobeltiosis under water stress

Hybrids		Days to 50% flowering	Pod length	Pod girth	Pod weight	Pods per plant	Yield per plant	Crop Duration
L1 X T1		27.27**	-37.92**	-30.15**	-5.20**	-8.78**	1.45 ns	-4.25**
L1 X T2		30.14**	-45.12**	-1.87 ns	-1.38 ns	-13.89**	2.60 ns	-4.75**
L1 X T3		-0.67 ns	-19.92**	-0.82 ns	6.34**	6.19**	44.02**	3.60**
L2 X T1		10.44**	-29.91**	-20.59**	10.05**	-3.65**	10.23**	-2.54**
L2 X T2		16.67**	-29.15**	4.58 ns	13.92**	14.42**	39.55**	3.54**
L2 X T3		23.24**	-44.95**	-20.61**	12.28**	-30.82**	-11.70**	-2.99**
L3 X T1		5.26**	3.27 ns	-4.41 ns	7.69**	19.57**	28.55**	-3.66**
L3 X T2		1.36 ns	6.53**	7.69 ns	8.54**	2.69*	11.30**	1.21**
L3 X T3		3.06*	33.14**	18.03**	27.83**	22.77**	61.70**	-3.14**
L4 X T1		12.28**	-55.30**	-22.79**	22.16**	-2.48**	19.00**	3.81**
L4 X T2		-8.66**	-23.32**	8.70 ns	27.87**	20.72**	53.97**	0.32**
L4 X T3		-0.84 ns	-16.28**	-18.85**	22.31**	14.85**	40.62**	2.27**
L5 X T1		-6.57**	-32.15**	-27.21**	29.24**	18.78**	47.29**	-3.43**
L5 X T2		-9.26**	-46.92**	0.93 ns	28.82**	20.45**	53.40**	0.75**
L5 X T3		0.00 ns	-51.23**	-26.23**	22.49**	-1.86 ns	26.01**	1.38**
L6 X T1		18.47**	-26.17**	-32.35**	-11.88**	5.00**	-2.36 ns	-5.75**
L6 X T2		-8.33**	26.86**	0.81 ns	10.93**	29.88**	56.46**	-4.37**
L6 X T3		8.03**	3.00**	-5.69 ns	-16.72**	6.68**	2.50 ns	2.37**
L7 X T1		4.58**	-22.53**	-18.38**	-15.38**	12.57**	0.45 ns	10.80**
L7 X T2		13.74**	-37.11**	-12.88**	-26.30**	-5.90**	-24.51**	14.01**
L7 X T3		18.73**	-40.23**	-14.39**	-25.60**	-9.16**	-22.15**	10.38**
CD	5%	1.28	2.53	0.76	0.48	1.23	27.05	0.71
	1%	1.70	3.36	1.01	0.63	1.63	35.87	0.94

The range of heterobeltiosis was from -24.51 (L7xT2) to 61.70 (L3xT3). The heterobeltiosis percentage is presented in table 4. Out of twenty one crosses, twelve crosses showed positive and significant heterosis for yield. The best three F1's showing heterobeltiosis in positive direction and superior for most of the drought tolerant traits were L6xT2, L4xT2 and L3xT3.

Conclusion
The development of drought tolerant varieties in snake bean is essential to increase production, particularly in water stressed areas. The success of heterosis depends on choice of morphological and easily scorable attributes which contribute to the trait of interest. The result indicates that traits namely days to 50% flowering, pod length, pod girth, pod weight, pods per plant, pod yield and crop duration can be effectively used as selection parameters for screening snake bean genotypes under water stress conditions. Existence of sufficient variability in the hybrids suggests that heterosis breeding is suitable for the improvement of drought tolerance in snake bean. The study could identify potential parents and crosses for breeding programmes aimed at enhancing water stress tolerance. Heterosis study revealed that L4xT2, L3xT3 and L6xT2 crosses were desirable recombinants for drought tolerance and yield. Hence these crosses can be advance further for developing drought tolerant snake bean varieties.

Acknowledgement
The grant and facilities provided by Kerala Agricultural University to carry out the research is gratefully acknowledged.

Reference
1. Ajayi AT, Gbadamosi AE, Victor OO. Screening for drought tolerance in cowpea (*Vigna unguiculata* L. Walp) at seedling stage under screen house condition. Int. J Bio Sci. Technol 2018;11(1):1-19.
2. Asoontha. Genetic variability for yield and resistance to legume pod borer, *Maruca vitrata* (Fab.) in yard long bean (*Vigna unguiculata* ssp. *sesquipedalis* (L.) Verdcourt). M.Sc. (Ag) thesis, Kerala Agricultural University, Thrissur 2017, 87.
3. Asoontha, Abraham M. Variability and Genetic Diversity in Yard Long Bean (*Vigna unguiculata* subsp. *sesquipedalis*). Int. J Curr. Microbiol. App. Sci 2017;6(9):3646-3654.
4. George ME, Sarada S. Genetic analysis of yard long bean (*Vigna unguiculata* subsp. *sesquipedalis* (L.) Verdcourt) for vegetative and yield characters. J Tropical Agric 2019;57(1):86-91.
5. Johnson HW, Robinson HD, Comstock RE. Estimates of genetical and environmental variability in soybeans. Agron. J 1955;47:314-318.
6. Kadam YR, Patel AI, Patel JM, Chaudhari PP, More SJ Heterosis study in vegetable cowpea (*Vigna unguiculata* (L.) Walp.). Crop Res 2013;45:202-205.
7. Lakshmi KM. Development of hybrids in yard long bean (*Vigna unguiculata* ssp. *sesquipedalis* (L.) Verdc.). M.Sc. (Hort.) thesis, Kerala Agricultural University, Thrissur 2016, 133.
8. Litty V. Identification of yard long bean (*Vigna unguiculata* sub sp. *sesquipedalis* (L.) Verdcourt) genotypes suitable or polyhouse cultivation. M.Sc. (Ag) thesis, Kerala Agricultural University, Thrissur 2015, 107.
9. Lovely B, Radhadevi DS, Kumar VR. Genetic divergence studies in vegetable cowpea (*Vigna unguiculata* ssp. *sesquipedalis* L. Verdc.). Int. J Genet 2017;9(8):296-297.
10. Madhukumar K. Genetic variability for yield and fusarium wilt resistance in yard long bean (*Vigna unguiculata* ssp. *sesquipedalis* L. Verdc.). M.Sc. (Ag) thesis, Kerala Agricultural University, Thrissur 2006, 121.
11. Ravelombola W, Shi A, Chen S, Xiong H, Yang Y, Cui Q *et al.* Evaluation of cowpea for drought tolerance at seedling stage. Euphytica 2020;216(8):123.
12. Resmi PS. Genetic variability in yard-long bean (*Vigna unguiculata* subsp. *sesquipedalis* (L.) Verdcourt). M.Sc. (Ag.) thesis. Kerala Agricultural University, Thrissur, India 1998, 94.

13. Sultana Z, Ahmed N, Islam MS, Rahim MA. Genetic variability and yield components of yard long bean (*Vigna unguiculata* subsp. *sesquipedalis* (L.) Verdcourt). Agronomski Glasnik 2020;3:107-122.
14. Vidya C, Oommen SK, Vijayaraghava Kumer. Genetic variability and heritability of yield and related characters in yard long bean. J Tropic. Agric 2002;40:11-13.