GENOTYPIC X ENVIRONMENTAL INTERACTION EFFECT ON YIELD AND OTHER RELATED TRAITS IN RICEBEAN [*VIGNA UMBELLATA* (THUNB.) OHWI AND OHASHI] LANDRACES OF NAGALAND

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Abstract :

The effect of genotype (G), environment (E) and G × E interactions on days to 50% flowering, primary branches, number of pods per plant, pod length, plant height, 80% maturity,100 seed weight, protein % and seed yield per plant were found significant at P=0.05. The highest mean seed yield was obtained from RbnG8 (37.82g). The genotype Rbng5, Rbng6 and RbnG8 recorded less number of days for 50 per cent flowering and 80% maturity across the six environments. Correlation studies indicated that yield/plant was significantly positively associated with pod length, number of seeds per pod, 100 seed weight at both phenotypic and genotypic level. The best genotype for seed yield across the environments was RbnG5, RbnG8 and RbnG12 and RbnG4 and RbnG5 were intermediate and RbnG13 was the least. Thus, partitioning G × E into adaptability and phenotypic stability will positively address the information gap on association of traits to yield

Key words: G x E interaction, Correlation, Genotypes, Yield

I. Introduction

Rice bean [(*Vigna umbellata* (Thunb.)] Ohwi and Ohashi, has been used since long as pulse and fodder crop (Chandel *et al*. 1988). It is considered as underutilized grain legume. Rice bean *[Vigna umbellata* (Thunb.) Ohwi and Ohashi] is also known as climbing mountain bean, mambi bean, oriental bean and red bean. In India, it is known by different vernacular names such as moth, rajmoong and satrangi mash. The seeds are highly nutritious and as the protein is high in lysine they make an excellent addition to a cereal based diet. The seeds are also high in mineral content and in vitamins including thymine, riboflavin, niacin and ascorbic acid. In India its distribution is mainly confined to tribal regions of North-Eastern hills, Western and Eastern Ghats in peninsular India, often in hill tracts Arora *et al*. (1988). In North Eastern Region Rice bean is grown predominantly under rainfed condition in mixed cropping system, shifting cultivation or in the kitchen garden particularly in Assam, Meghalaya, Manipur, Mizoram, Arunachal Pradesh and Nagaland and also in the hill region of North Bengal and Sikkim. In Nagaland, rice bean is a traditional and indigenous crop, cultivating since time immemorial and considered as minor legumes grown by subsidence farmers' area of Nagaland. It is grown under diverse conditions with no additional input, which thrives well in rainfed condition which is generally grown as mixed crop in jhum cultivation, inter crop with maize and cultivated along rice bunds and terrace. All cultivated varieties of rice bean in Nagaland are landraces which have disseminated from one village to another and from generation to generation through an informal distribution system, with farmers solely responsible for management and seed supply. This association is of great importance to define selection criteria for yield improvement. Seed yield is a complex trait determined by several traits having positive or negative effects on yield. As such, it is important to examine the contribution of each of the traits in order to give more attention to those having the greatest influence on seed yield. According to Soldati *et al*. (1995) the expression of the traits is determined by genetic and environmental factors and their interaction. Therefore, to determine both qualitative and quantitative traits variability caused by genetic, environmental and genotype × environment interaction under Nagaland condition; the current study was undertaken to:

i. Assess the genotype × environment and variability of the genotype effect on yield and other related traits

2. MATERIALS AND METHODS

The experiments included thirteen landraces of rice bean genotypes which collected from different parts of Nagaland and were studied under Six different sowing dates in 2016 and 2017. Field experiments were conducted at the experimental farm, SASRD, Medziphema, Nagaland. In each of the six environments each genotypes was planted in Randomized block design (RBD) with three replication ,the following six environments were created by the following growing season, Environment one (Env-1): 1st July, 2016, Environment two (Env-2): 1st August, 2016, Environment three (Env-3): 15th August, 2016, Environment four (Env-4): 1st June, 2017, Environment five (Env-5): 15th June, 2017, Environment six (Env-6): 15th July, 2017. Observations were recorded on five randomly selected plants from each genotype in all the three replications for days to 50% flowering, primary branches, pods per cluster, number of seeds per pod, pod length, numbers of seeds per pod, plant height, 80% maturity, 100-seed weight (g) and plant seed yield per plant (g). The data were statistically analyzed and the genotypes were assessed for their stability of performance across environments following the method described by Eberhart and Russell (1966) and correlation coefficient at genotypic and phenotypic levels was determined according to the formula given by Johanson *et al.* (1955).

3. RESULTS AND DISCUSSION

Combined ANOVA for Rice bean seed yield and its components across six environment obtained from this study are presented on (Table 1). All the traits showed significant interactions between genotype × environment had significant differences at (P=0.05) for all traits.

Table 1. combined analysis of variance for studied traits of 13 genotypes under six environments

SOV	df	Days to 50% flowering	Primary branches	Pods/cluster	No. of pods/plant	Pod length (cm)
Env	5	11836.09*	10.12*	10.018*	3535*	50.26*
Rep (Env)	12	279.07	0.36	0.379	100.52	1.83
Genotype	12	3451.22*	3.46*	4.94*	1983.90*	27.13*
Env x Gen	60	567.82*	0.280	0.373	16.48*	3.35*
Error	144	158.63	0.132	0.151	24.148	0.86

Contd...

SOV	df	No. of seeds/pod	plant height (cm)	80% maturity	100 seeds weight (gm)	Protein content (%)	seed yield/plant (gm)
Env	5	31.34*	52171.07*	7102.75*	95.88*	228.16*	779.30*
Rep (Env)	12	1.026	782.97	17.95	1.69	8.03	20.14
Genotype	12	36.79*	15021.48*	317.33*	912.77*	246.44*	411.47*
Env x Gen	60	1.323*	265.32*	85.61*	7.21*	15.75*	35.02*
Error	144	0.513	95.082	3.054	0.615	3.86	2.13

*** Significant at 0.05 level of probability**

3.1. Response of various Rice bean genotypes to different environments

Means of performances of seed yield on different genotype is shown in (Fig .1). Seed yield per gram were higher in E6 (32.04g) and 13.48g) and lower in E3 (25.95g and 11.48g). Similar trend was observed in relation to 100-seed weight with heaviest 100-seed weight in E4, E5 and E6 and lowest in E2 and E3. (Table. 2).

The genotype RbnG8 (83.61 days) was earliest than rest of all genotypes over six environments followed by RbnG5 (90.78 days) which was at par with RbnG6 (91.78 days). On the other hand the highest number of days (118.33) to produce first flowering was taken by landrace RbnG3 followed by RbnG2 (117.67). The genotype RbnG4 (2.85) which was at par with RbnG10 (2.84) recorded maximum number of primary branches per plant over the six environments. The minimum number of primary branches was observed in genotype RbnG9 (2.27). The genotype RbnG4 (3.22) which was at par with RbnG10 (3.18), RbnG1 and RbnG8 (3.00) recorded maximum number of pods per cluster over the six environments. On the other hand a minimum pod per cluster was recorded in RbnG11 (2.33). On overall mean performance basis, the genotype RbnG1 (61.63) followed by RbnG8 (59.86) and RbnG10 (58.93) produced maximum number of pods per plant. The minimum was observed in

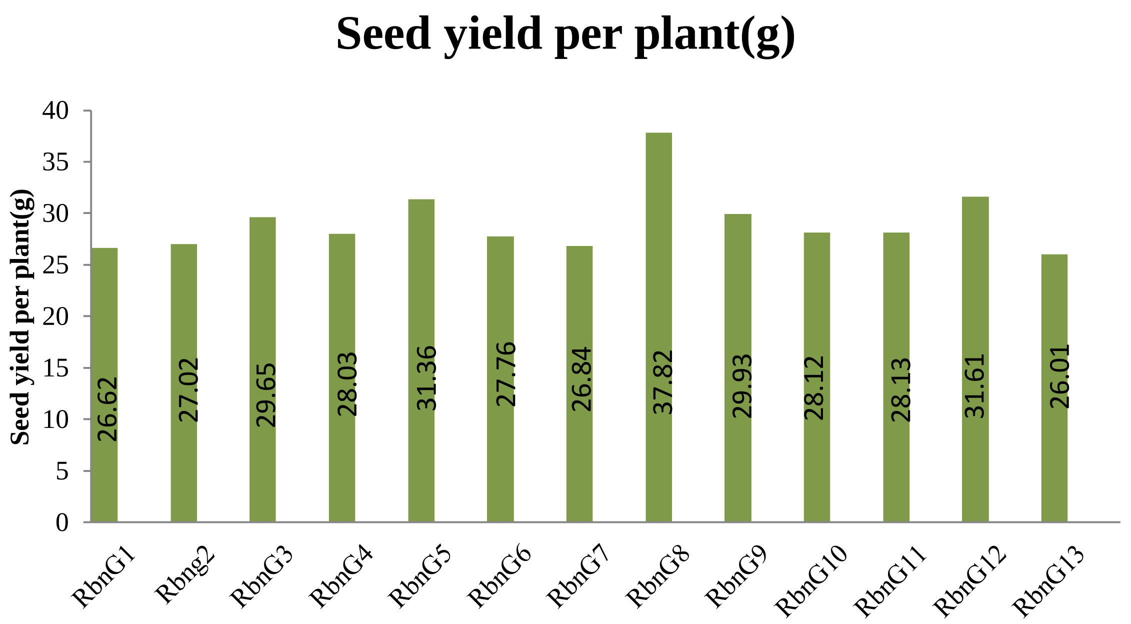

Figure.1. Mean performance of Seed yield per plant

RbnG11 (36.63) and RbnG2 (39.97). The longest pod length recorded was 9.41 cm in RbnG5 followed by RbnG11 (8.94) and lowest pod length recorded is 7.40 cm in RbnG7 and RbnG1 (7.52). The highest number of seeds per pod over the six environments, genotype RbnG4 (6.93) recorded the highest seeds per pod followed by RbnG1 (6.45) which was at par with RbnG8 (6.43) and RbnG10 (6.28). The highest plant height was recorded in RbnG10 (167.58cm) followed by RbnG8 (154.76) while RbnG2 (98.06 cm) recorded lowest plant height followed by RbnG7 (100.27cm). The RbnG8 matures earliest in 121.05 days followed by RbnG6 in 124.55 days and RbnG5 in 125.61 days while the highest number of days (196.50) to 80% maturity was taken by RbnG13 in 135.83 days followed by RbnG3 in 133.33 days and RbnG1 in 133.22 days.

3.2. Correlation coefficients

Correlation studies indicated that yield/plant was significantly positively associated with pod length, number of seeds per pod, 100 seed weight at both phenotypic and genotypic level. Negative significant was recorded for 50% flowering with seed yield per plant (Table 3). 50 per cent flowering was recorded highly significant and positive correlation with days to 80% maturity (0.7957*, 0.7436*) at both genotypic and phenotypic level. Days to 50% flowering showed significant negative genotypic correlation with seed yield per plant. Association of primary branches with others characters revealed low correlation at both phenotypic and genotypic level. At both genotypic and phenotypic level the correlation coefficient of pods per cluster was found significant and positive correlation with number of pods per plant (0.7394*, 0.6800*). It is recorded negative significant correlation with 100 seed weight at genotypic level. Number of pods per plant exhibited high positive signification correlation with number of seeds per pod (0.776*, 0.742*) and plant height (0.779*, 0.739*) at both genotypic and phenotypic level. Negative significant association with 100 seed weight (-0.646*,-0.625*) was recorded at both genotypic and phenotypic level. At phenotypic level pod length exhibited high positive significant association with seed yield (0.689*).Number of seeds per pod exhibited high positive significant correlation with plant height (0.7255*, 0.682*) and seed yield (0.5825*, 0.689*) at both genotypic and phenotypic level. High negative significant association with 100 seed weight (-0.775*,-0.754*) at both the level was recorded. Plant height showed negative significant association with 100 seed weight (-0.531*,-0.516*) at both genotypic and phenotypic level. Association of seed yield with plant height revealed positive correlation. 80 % maturity did not exhibit any significant positive and negative correlation with the rest of the characters both at genotypic and phenotypic level. Association at both genotypic and phenotypic correlation revealed positive significant association with seed yield per plant (0.679, 0.678).

3.3. Discussion

Apparently, the mean square of analysis of variance showed significant difference at (P=0.05) among the genotypes and sowing date for all traits except for number of seeds per pod. Dobhal & Gautam (1994) observed that ricebean lines showed differential response when grown in different environment. Genotype x Environment interaction was significant for all the traits indicating that the genotypes were markedly interacting with environments for all the traits. This interaction was validated by the highly significant difference at (P=0.05) for days to 50% flowering, primary branches, pods per cluster, plant height, number of pods per plant, pod length,80% maturity, 100 seed weight(g) and seed yield per plant(g). These results confirm the findings of Gebeyehu and Assefa, (2003) who reported that selection based on the highest yielding genotypes appeared less stable than the average of all lines. Furthermore, they reported that selection solely for seed yield could result in rejection of several stable genotypes. RbnG8 out yielded others because of its yield components such as, number of pods per plant and number of seeds per pod and some other growth traits like days to 50% flowering that do contribute to the highest yield. The non-significant variation exhibited by genotype and environment interaction on various other traits indicates their response to climatic condition, and planting date do influence seed yield. From the findings of this study, it was very evident that seed yield and 100-seed weight declined in the same trend. Thus, early planting was observed to be essential. Salem, (2004) confirmed the finding by reporting that date plays an important role in the crop productivity as the seed yield of genotypes decreased with delayed sowing date. The mean performance analysis revealed that high yielding genotypes across the sowing revealed that the best genotype for seed yield across the environments was RbnG5, RbnG8 and RbnG12 and RbnG4 and RbnG5 were intermediate and RbnG13 was the least. These conform to Egli, (1998) explanation for soybean performance that yield variation across environments and years was associated with changes in number of seeds per unit area. The exhibited non-significance by seed per pod, on G × E interaction was confirmed by Backer, (1998) who defined the non-significant difference as failure of genotypes to achieve the same relative performance in different environment.

Thus, the G × E interaction might have made it difficult for breeder to identify the best genotypes, during selection and recommendation.

Correlation studies indicated that yield/plant was significantly positively associated with pod length, number of seeds per pod, 100 seed weight at both phenotypic and genotypic level. Similar finding were reported on genotypic and phenotypic correlation coefficients observed that seed yield/ plant was significantly positively correlated with pod length and number of seeds/pod at both genotypic and phenotypic level Gupta *et al*. (2014), Sharma and Hore.(1994), Singh *et al*, (1992)**.** This implies that selections aimed at increasing seed yield would invariably select pod length, number of seeds per pod 100 seed weight. This finding was in agreement Chaudhari et al. (2000). Plant height showed negative significant association with 100 seed weight at both genotypic and phenotypic level, the result are in conformity with Singh *et al.*(2009) observed a negative and significant correlation between plant height and 100 seed weight. Therefore, it can be validated from investigation that correlation studies indicated that yield/plant was significantly positively associated with pod length, number of seeds per pod, 100 seed weight at both phenotypic and genotypic level. Similar finding were reported on genotypic and phenotypic correlation coefficients observed that seed yield/ plant was significantly positively correlated with pod length and number of seeds/pod at both genotypic and phenotypic level, Gupta *et al*.(2014)**.** These result are also in confrontation with Geeta *etal* (2015) in their correlation studies which indicates that yield/plant was significantly positively associated with field germination percent, number of pods/plant, number of seeds/pod and pod length at both phenotypic and genotypic levels and exhibited that these characters were the principle yield components of rice bean.

4.CONCLUSION

In conclusion, this study showed the presence of GE interactions among the 13rice bean genotypes and their yield components. The variance due to GxE (linear) was significantly different for days to 50% flowering, number of pods per plant, plant height, 80% maturity and seed yield and non-significant for primary branches, pods per cluster, pod lenght, number of seeds per pod, 100 seed weight and protein content. Environment were highly significant for characters like number of 50% flowering, number of pods per plant, plant height, 80% maturity, 100 seed weight and seed yield per plant under study, which indicated the genetic control of response to the environment High-yielding genotypes with broad adaptation and some genotypes with specific adaptation were identified. Further investigations on GE interactions at important crop growth stages for yield components would help to develop strategies that integrate traditional plant breeding with modern molecular marker-based selection for tailoring rice bean genotypes for high yield and target environments. The maximum seed yield per plant was produced by the genotype RbnG5, RbnG8 and RbnG12 followed by RbnG4 and RbnG3. The maximum seed yield was recorded in Env1, Env 4, Env 5 and Env 6 and minimum for Env2 and env3 and therefore, could be used in the breeding programme for the development of high yielding stable genotypes over environments for future use.

References

[1] Arora, R. K., Chandel, K .P .S .and Pant, K. C. 1988. Rice bean a potential grain legume. NPBGR, ICAR, Pusa campus, New Delhi.

[2] Baker, R.J. 1988.Tests for crossover genotype environment interactions. Canadian Journal of Plant Science.68:405–410.

[3] Chauduari, G. B., Patil, J. V. and Barhate, K .K.2000.Character association in rice bean (Vigna umbellata) (Thumb, Ohwi and Ohashi). Legume Res. 23 (1): 25-28.

[4] Chandel, K .P. S., Arora, K .K,, Pant. K. C,. 1988. Ricebean- A potential grain legume. Science Monogram -12, National Bureau of Plant Genetic Resources, New Delhi.

[5] Dobhal, V. K. and Gautam, N. K. 1994. Stability analysis for yield and component characters in ricebean (Vigna umbellata). Indian Journal of Agricultural Sciences 64: 237-239

[6] Egli, D.B.1998 Seed biology and the yield of grain crops. CAB International, Oxford. 178.

[7] Eberhart, S. A and Russell, W. A. 1966. Stability parameters for comparing varieties. Crop Science, Madiso. 6(1): 36-40.

[8] Gebeyehu S, Assefa H.2003. Genotype x environment interaction and stability analysis of seed in navy bean genotypes. African Crop Science Journal.11:1-7.

[9] Geeta, P., Rajendra, P., Birendra, P. and Priyamvada, C. 2015. Genotypic and phenotypic correlation between seed yield and its components in Rice bean (Vigna Umbellata (Thunb.) Ohwi and Ohashi) International Journal of Agricultural Science and Research (IJASR) Vol. 6.2250-0057.

[10] Gupta, S., Pandey, A., Amit, K. and Pattanayak, A.2014. Evaluation of Genotypic variation and suitability of rice bean for mid-altitudes of Meghalaya, India. Legume Research-An International Journal, vol 37: 568-574.

[11] Johnson, H. W., Robinson, H .E. and Comstock, R. S. 1955. Estimates of genetic and environmental variability in soyabean. Agronomy Journal 47: 314-318.

[12] Singh, A., Singh, S.K., Sirohi, A. and Yadav, R. 2009.Genetic variability and correlation studies in green gram (Vigna radiata (L.)Wilczek). Progress. Agric. 9(1): 59-62.

[13] Singh, G., Singh, M. and Dhiman, K .R. 1992. Correlation and path analysis in rice bean under mid altitude conditions. Crop improvement .19(2): 152-154.

[14] Sharma, B .D and Hore, D .K. 1994. Association of yield attributes in ricebean (Vigna umbellata). Legume Research .17(2):135-137.

[15] Salem, S.A.2004. Yield Stability of Some Soybean Genotypes Across Diverse Environment. Pakistan Journal of Biological Science. 7(12):2109-2144.

[16] Soldati, I.A. Soybean International W Diepenbrock and HC. Becker (edition): Physiological Potentials for Yield Improvement of Annual Oil and Protein Crops. Advances in Plant Breeding 17, Berlin, Vienna.169–218.

Table 3. Estimates of genotypic and phenotypic correlation coefficients for yield and its component characters in rice bean

Character	Primary branches	Pods/ cluster	No.ofpods /Plant	Pod length(cm)	No.0f seeds/pod	Plant height(cm)	80% maturity	100 seeds weight (gm	Seed Yield/Plant (gm)
50%flowering	-0.262	-0.008	-0.136	0.170	-0.205	-0.184	0.795*	0.058	-0.601*
	-0.207	-0.063	-0.118	0.156	-0.182	-0.194	0.743*	0.053	-0.569
Primary branches	(g)	0.269	0.176	-0.265	0.3724	0.411	-0.101	-0.353	0.274
	(p)	0.198	0.169	-0.301	0.354	0.369	-0.104	-0.327	0.234
Pods/cluster		(g)	0.739*	0.429	0.385	0.328	0.436	-0.535*	0.229
		(p)	0.680*	0.341	0.353	0.316	0.404	-0.494	0.245
No.ofpods /Plant			(g)	0.060	0.776*	0.772*	0.271	-0.646*	0.357
			(p)	0.054	0.742*	0.739*	0.253	-0.625*	0.340
Pod length(cm)				(g)	-0.038	0.018	-0.129	0.356	0.562*
				(p)	-0.019	0.016	-0.096	0.291	0.689*
No.0f seeds/pod					(g)	0.725*	-0.105	-0.775*	0.582*
					(p)	0.682*	-0.096	-0.754*	0.689*
Plant height(cm)						(g)	0.041	-0.531*	0.343
						(p)	0.046	-0.516*	0.336
80% maturity							(g)	-0.213	-0.516
							(p)	-0.204	-0.493
100 seeds weight (gm								(g)	0.6791*
								(p)	0.678*

***Significant at 5% level**

Table 2. Mean performance of 13 genotypes of rice bean for different traits at six environments

Genotypes	DAYS 50% FLOWER						Primary branches					
	E1	E2	E3	E4	E5	E6	E1	E2	E3	E4	E5	E6
RbnG1	103.33	97.333	76.00	104.67	102.67	97.33	3.067	2.267	2.07	3.13	3.27	3.133
RbnG2	96	83.667	71.33	117.67	95.33	96.00	2.2	2.2	2.27	2.53	2.27	2.333
RbnG3	98.67	97.667	83.67	118.33	106.00	98.66	2.267	2.533	2.53	3.13	2.60	2.4
RbnG4	101.67	83.333	77.67	104.00	98.33	99.33	2.933	2.2	2.40	3.20	3.27	3.133
RbnG5	89.33	81.667	73.00	105.33	100.00	95.33	2.733	2.333	2.53	2.40	2.40	2.6
RbnG6	93.67	87.667	72.00	107.33	96.67	93.33	2.6	2.533	2.40	2.40	3.13	3.333
RbnG7	96	99.333	82.33	104.67	102.67	102.33	2.467	2	2.20	3.13	3.27	2.6
RbnG8	83.67	80	78.67	98.00	81.33	80	2.133	2.133	2.13	3.00	3.27	3.267
RbnG9	98.33	85.33	70.00	110.33	97.67	100	2.267	1.467	2.33	2.00	2.33	3.267
RbnG10	100	94.67	76.67	104.67	100.67	97.33	3	2.333	2.53	3.00	3.20	3
RbnG11	102.33	97.33	73.33	108.33	97.33	99.33	2.467	2.533	2.60	3.13	2.40	2.667
RbnG12	101	99	73.67	108.33	97.33	101.33	2.733	2.133	2.33	2.47	3.13	3.267
RbnG13	103.33	97.333	78.00	104.67	100.67	97.33	2.667	2.4	2.40	3.13	3.07	3.333
mean	97.49	91.103	75.87	107.41	98.21	96.74	2.58	2.24	2.36	2.82	2.89	2.95
SEM	1.357	0.714	0.770	0.507	0.832	1.041	0.123	0.109	0.156	0.067	0.069	0.081
CV %	2.411	1.357	1.757	0.818	1.468	1.863	8.282	8.433	11.441	4.094	4.143	4.755
	pods/cluster						**N0.0f pods/plant**					
	E1	**E2**	**E3**	**E4**	**E5**	**E6**	**E1**	**E2**	**E3**	**E4**	**E5**	**E6**
RbnG1	2.467	2.8	2.67	3.47	3.53	3.2	64.867	57.733	55.40	65.33	62.67	63.8
RbnG2	2.6	2.6	2.60	2.67	2.27	2.6	38	24.2	36.80	54.00	45.13	41.733
RbnG3	3	2.933	2.53	3.00	3.00	3.267	47.067	39.067	54.13	53.20	65.07	55.867
RbnG4	3.067	3.2	3.13	3.67	3.00	3.267	62.533	40.6	56.00	61.47	56.00	66.333

RbnG5	2.8	2.333	2.20	2.87	3.27	3.2	64.467	27.467	65.67	39.07	65.67	66.533
RbnG6	2.333	2.467	2.00	2.67	3.00	2.533	61.733	36.067	35.60	57.87	51.60	53.6
RbnG7	2.4	2.333	2.00	2.67	2.27	2.467	62.533	64	41.93	54.33	54.93	38.133
RbnG8	2.533	3	3.00	3.47	3.00	3	50.8	64.867	64.80	64.53	64.20	49.933
RbnG9	2.533	2	2.00	3.20	3.60	3.267	43.533	27.2	38.67	45.73	42.40	43.333
RbnG10	3.067	2.533	3.07	3.33	3.53	3.533	64	32.867	63.80	65.60	63.33	64
RbnG11	2.667	2.4	2.33	2.00	2.00	2.6	35.067	23.667	37.60	43.40	36.40	43.667
RbnG12	2.733	2	2.00	2.47	2.73	2.8	43.667	35.2	48.07	55.03	45.67	43.467
RbnG13	3.133	2.533	2.27	3.40	3.27	3.267	56.333	46.4	66.60	62.47	55.80	56.4
mean	2.72	2.549	2.45	2.99	2.96	3.00	53.43	39.949	51.16	55.54	54.53	52.83
SEM	0.180	0.145	0.111	0.122	0.067	0.076	0.165	1.903	3.106	1.546	1.744	1.388
CV %	11.480	9.827	7.828	7.058	3.902	4.412	5.049	8.249	10.515	4.820	5.541	4.550
	Pod length(cm)						**No. Of seeds/pod**					
	E1	**E2**	**E3**	**E4**	**E5**	**E6**	**E1**	**E2**	**E3**	**E4**	**E5**	**E6**
RbnG1	7.48	7.747	7.51	7.53	7.51	7.36	5.4	5.633	6.20	6.60	7.40	7.467
RbnG2	8.353	8.327	8.36	8.67	8.40	8.627	4.4	3.733	3.47	3.20	4.60	3.533
RbnG3	8.3	7.313	8.40	8.54	8.55	8.547	5.667	5.067	5.40	6.33	6.60	5.533
RbnG4	7.707	7.34	7.57	7.61	7.68	8.46	7.2	7.2	6.13	6.40	7.07	7.6
RbnG5	9.527	9.413	9.35	9.49	9.39	9.333	6.6	4.333	5.53	6.53	5.53	7.2
RbnG6	7.347	6.387	7.45	8.31	8.17	8.64	6.333	6.533	5.13	6.40	5.47	7.2
RbnG7	7.52	7.46	7.22	6.39	7.43	8.387	6	4.4	5.60	5.53	6.67	6.2
RbnG8	8.207	7.38	7.43	7.39	7.38	7.667	6.733	6.533	6.60	6.47	6.07	6.2
RbnG9	8.5	8.673	8.43	8.25	8.16	9.427	3.333	3.6	3.20	3.73	4.33	4.333
RbnG10	8.733	7.253	8.45	8.56	8.29	8.48	6.267	6.6	6.20	6.67	5.67	6.333
RbnG11	8.74	9.467	9.67	9.87	8.40	7.587	3.533	3.4	4.20	3.53	3.40	3.733
RbnG12	8.36	7.573	8.25	8.06	8.59	7.713	3.533	4.333	5.13	4.73	5.07	4.733

RbnG13	7.613	7.427	7.44	7.97	8.65	7.587	6.7	5.333	5.40	6.33	6.47	6.533
mean	8.18	7.828	8.12	8.20	8.20	8.29	5.52	5.13	5.25	5.57	5.72	5.89
SEM	1.997	0.123	0.164	0.172	0.138	0.223	0.165	0.155	0.153	0.146	0.163	0.158
CV %	2.591	2.726	3.488	3.626	2.909	4.656	5.184	5.238	5.040	4.530	4.928	4.641
	Plant height(cm)						**80% maturity**					
	E1	**E2**	**E3**	**E4**	**E5**	**E6**	**E1**	**E2**	**E3**	**E4**	**E5**	**E6**
RbnG1	153.47	104.2	93.867	172.93	141.60	163	139.667	120.333	107.33	141.333	146.00	144.667
RbnG2	93.86	73.333	52.2	98.47	160.00	110.533	130.667	116.667	102.00	145	140.67	137.333
RbnG3	151.93	94.733	91.467	154.07	115.73	123.8	137.333	124	108.00	144	143.33	143.333
RbnG4	166.47	86.8	98.2	165.07	166.53	158.933	140.333	116.667	108.67	138.667	146.00	143.333
RbnG5	175.93	86.667	128.4	182.93	149.13	166	128.667	112.667	100.67	137	137.33	137.333
RbnG6	91.733	84	83.6	224.07	163.27	182.067	128.333	114	103.00	132.667	139.33	130
RbnG7	94.333	84.267	88.067	109.67	106.33	119	138	120	107.33	130	136.67	135.333
RbnG8	106.73	136	136.667	204.60	207.13	137.467	113.667	120	121.67	126	123.33	121.667
RbnG9	100.13	81	63.933	174.20	152.27	125.8	138	118.667	103.33	144.667	143.00	140
RbnG10	175.67	85.2	125.4	230.40	213.80	175.067	139.333	116.667	111.33	137.667	144.00	146.667
RbnG11	105.33	77.467	51.467	137.07	133.53	143.667	137.333	122	107.67	137.333	142.33	144
RbnG12	165.13	88.2	77.733	145.80	137.60	123.267	138	120.667	107.00	140	146.67	144
RbnG13	154.4	94.133	95.933	168.87	153.87	144.8	139.333	138.667	105.67	140	146.00	145.333
mean	133.47	90.462	91.303	166.78	153.91	144.108	134.51	120.08	107.21	138.026	141.13	139.46
SEM	1.997	3.147	2.705	1.790	4.819	2.820	1.538	0.348	0.763	1.185	0.812	1.017
CV %	2.591	6.026	5.131	1.859	5.424	3.389	1.980	0.502	1.233	1.488	0.996	0.819

	100 seed weight(gm)						**seed yield/plant(gm)**					
	E1	**E2**	**E3**	**E4**	**E5**	**E6**	**E1**	**E2**	**E3**	**E4**	**E5**	**E6**
RbnG1	4	3.067	3.47	4.13	4.533	4.4	24.4	29.47	21.13	24.33	27.67	32.73
RbnG2	22	19.2	20.67	20.33	20.333	26.467	32.2	24.53	26.47	23.67	32.07	23.2
RbnG3	9.933	9.333	10.20	9.40	10.4	11.067	26.4	27.40	25.73	32.53	32.87	33
RbnG4	2.333	2.533	2.13	4.13	6.6	6.067	35.47	18.67	14.33	31.73	34.87	33.13
RbnG5	18.33	17.46	18.00	14.40	21.467	18.4	32.8	32.80	33.13	20.53	33.8	35.13
RbnG6	11.6	11.2	10.13	12.47	17.8	13.2	34.67	31.07	27.47	15.20	24.93	33.27
RbnG7	9.867	9.067	9.60	12.60	19.267	10.867	29.73	32.87	22.80	13.80	28.2	33.67
RbnG8	12.467	13.133	13.47	9.93	9.533	12.467	32.87	37.27	35.93	43.33	33.87	43.67
RbnG9	22.733	20.933	20.40	20.20	21.667	21.2	33	25.47	27.20	32.27	33.93	27.73
RbnG10	4.467	4	3.33	5.73	4.467	4.4	27.27	15.00	23.33	32.93	33.8	36.4
RbnG11	18.267	18.4	20.73	24.20	24.267	20.333	25.13	33.00	32.33	27.73	24.67	25.93
RbnG12	18.133	18.133	16.40	18.07	21.4	22.067	33.27	31.00	25.87	34.07	32.93	32.53
RbnG13	3	2.8	2.40	4.33	3.333	4.267	29.87	25.93	21.60	25.87	26.73	26.07
mean	12.09	11.482	11.61	12.30	14.236	13.48	30.54	28.04	25.95	27.54	30.79	32.04
SEM	0.464	0.567	0.443	0.221	0.394	0.373	0.911	1.761	1.134	0.599	0.685	0.911
CV %	6.653	8.546	6.607	3.111	4.790	4.789	5.166	10.880	7.572	3.766	3.854	4.927