Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; SP1: 1061-1064

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Evaluation of performance of blends of green gram *Vigna radiata* (L.) Wilczek relative to their component cultivars in pure stands

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Abstract
The present work was carried out during 2016 at ICR Farm (Instructional Cum Research), Assam Agricultural University, Jorhat, Assam. Four green gram "[*Vigna radiata* (L.) Wilczek]" varieties viz.,Pratap (V1), K851 (V2), SGC 16 (V3), SGC 20 (V4) and their six equiproportional blends B1 (Pratap and K851), B2 (Pratap and SGC 16), B3 (Pratap and SGC20), B4 (K851 and SGC16), B5 (K851 and SGC 20), B6 (SGC16 and SGC 20) were studied in six environments to accesses the performance of blends relative to their component cultivars in pure stands. The twelve different characters viz., days to first flower bud initiation, days to first pod initiation, 75 % pod maturity, plant height, primary branches, secondary branches, clusters per plant, pods per plant, seeds per pod, hundred grain weight, grain yield per plant and number of nodules were observed at different growth stages. The mean performance of the genotypes under study revealed that blends performed better than the pure stand cultivar for different characters except seeds per pod and plant height. The blend cultivar B4 (K851 and SGC16) produced highest seed yield per plant. Other genotype such as Pratap (V1), Pratap and 851 (B1), Pratap and SGC16 (B2), SGC 16 and SGC20 (B6) were found promising for seed yield. The information generated from the study helpful for the pulse breeders to address a few issues in order to enhance green gram productivity through an approach of developing appropriate varietal blends.

Keywords: Green gram, blends, component cultivars and Performance

Introduction

Green gram "[Vigna radiata (L.) Wilczek]" with diploid chromosome number of 2n=22 is a leguminous crop belonging to the Fabaceae family. India is the world's largest producer as well as consumer of green gram. It produces about 1.5 to 2.0 million tonnes of mung annually from about 3-4 million tonnes of area, with an average productivity of 500 kg per hectare. In Assam, green gram ranks second after black gram; covering an area of eleven thousand hectares producing seven thousand tonnes giving yield of 687 kg/ha. Green gram output accounts for about 10-12% of total pulse production in the country [Directorate of Economics and Statistics, Assam (2016-2017)]. However, per capita availability of pulses in Assam is far less than the recommended 60 gm/adult/day and also less than the national average. Green gram is a rich source of protein particularly leucine, phenyl alanine, lysine, valine, isoleucine. It contains about 25% protein which is almost three times that of cereals. It also plays an important role in sustainability of soil productivity by improving soil physical properties and fixing atmospheric nitrogen. It is a drought resistant crop suitable for dry land farming and used predominantly as inter crop with other crops. Yield potential of most of the present day cultivars of green gram are low. The reasons for low yield of the present day cultivars is mainly due to narrow genetic variability in the primary gene pools and this limited gene pool of the cultivated species of Vigna has restricted the conventional plant breeding programme to improve the yield of green gram. Genetic enrichment of the crop species from their wild relatives constitutes an important approach to broaden the base of genetic variability. Blends are defined as the mixture of seeds from two or more varieties. Varietal mixtures are presently a viable strategy for sustainable productivity in subsistence agriculture. Blends are an important resource for future global food production and may have an expanding role in modern agriculture. Such systems are claimed to promote diversity of diet and income source, stability of production, reduced insect and disease damage, intensification of production with limited resources and minimisation of risk. The blending of suitable varieties reduces the risk of crop failure, especially under unfavourable circumstances (Allard and Bradshow, 1964).

Smithson and Lenne (1996) studied agronomic and disease aspects of mixtures and observed that improved stability and decreased disease severity were common features of mixtures relative to their components in monoculture. Such advantages are of value to both modern and subsistence agriculture. They opined that varietal mixtures are presently a viable strategy for sustainable productivity in subsistence agriculture, in situations where qualitative uniformity is not the guiding priority. Keeping this point in mind, the present investigation designed with an objective to access the performance of blends of green gram relative to their component cultivars in pure stands.

Materials and Methods

The experimental work was carried out during 2016 at ICR Farm (Instructional Cum Research), Assam Agricultural University, Jorhat with four green gram genotypes which were collected from the RARS, Assam Agricultural University, Shillongoni, Nagaon. The four cultivars of green gram were grown as pure stand along with their all possible equiproportional bi-blend amounting to a total of ten entries in randomized block design with three replications in two different conditions i.e. organic and inorganic. In organic, two different sowing times i.e., normal sowing (26th February, 2016) and late sowing (12th March, 2016) was done. Same sowing date was followed for inorganic condition. Hence total numbers of four different environments were adopted. Again all the ten entries were grown during kharif season of 2016 in randomised block design with three replications in two different conditions i.e. organic and inorganic. In both organic and inorganic condition, only late sowing (30th September, 2016) was done. Hence, two different environments were adopted. The total ten entries comprises four pure stands viz., V1: Pratap, V2: K851, V3: SGC 16, V4: SGC 20 and their possible combinations of 6 blends viz., B1: Pratap (V1) and K851 (V2), B2: Pratap (V1) and SGC 16 (V3), B3: Pratap (V1) and SGC 20 (V4), B4: K851 (V2) and SGC 16 (V3), B5: K851 (V2) and SGC 20 (V4) and B6: SGC 16 (V3) and SGC 20 (V4). The following morpho-physiological parameters such as Days to first flower bud initiation, Days to first pod initiation, Days to 75% pod maturity, Plant height, No. of branches per plant, No. of clusters per plant, No. of pods per plant, No. of seeds per pod, 100-grain weight, Seed yield per plant were recorded on the basis of five randomly sampled plants. Following established statistical procedure and the data thus obtained were used for computation of the performance of pure stand and their combinations.

Results and Discussion

Pooled analysis of variance (ANOVA) for the field experiment was carried out for each quantitative character in randomized block design (Singh and Chaudhary, 1995). The performances of pure stands and their equiproportional blends were evaluated under each environment. For comparison of means critical difference was calculated by adopting standard formula. It computed the performance of pure stand against blend genotype. Analysis of variance for the characters Table 1 revealed significant variation for all the characters except days to first flower bud initiation, secondary branches and pods per plant. So, these characters were not considered in further analysis.

Table 1: Pooled ANOVA for the 12 different characters of the pure stands and their equiproportional blends evaluated in 6 environments during summer and *kharif*, 2016

Source of Variations	DF	Mean squares											
		FBI	FPI	PM	PH	PB	SB	CPP	PPP	SPP	HGW	GYP	NOD
Replicate	2	0.07	0.26	1.27	0.63	0.09	0.11*	0.06	0.41	0.02	0.02	0.21	0.33
Environments	5	8.64**	11.91**	42.73**	324.06**	20.89**	0.94**	67.71**	200.93**	16.82**	0.05**	7.58**	17.72**
Interactions	10	0.63	0.31	0.33	1.14	0.22	0.07*	0.31	0.46	0.12	0.01	0.25	0.21
Overall Sum	17	2.92**	3.72**	12.91**	96.06**	6.28**	0.33**	20.10**	59.42**	5.02**	0.02	2.40	5.37**
Treatments	9	0.82	3.10**	5.59**	12.17**	0.49**	0.03	2.87**	20.27	3.31**	0.12**	12.16**	1.39**
Pure stand (PS)	3	1.13	0.46	7.97**	18.68**	0.37**	0.06	3.99**	18.86	7.32**	0.02	14.42**	2.45**
Blend (BL)	5	0.61	0.26	4.72*	10.26**	0.17	0.03	2.26**	24.98*	1.08	0.20**	13.17**	0.71
PS vs BL	1	0.88	25.20**	2.82	2.14	2.40**	0.01	2.50**	0.96	2.46*	0.05	0.32	1.61**
Error	153	0.65	0.81	2.14	3.03	0.14	0.03	0.54	12.23	0.67	0.03	2.23	0.39
* Significant at 1% level, ** Significant at 5% level.													

DF: Degree of freedom, FBI: Days to first flower bud initiation, FPI: Days to first pod initiation, PM: 75 % pod maturity, PH: Plant height, PB: Primary branches, SB: Secondary branches, CPP: Clusters per plant, PPP: Pods per plant, SPP: Seeds per pod, HGW: 100- grain weight, GYP: Grain yield per plant and NOD: Number of nodules.

For pod initiation, a significant difference was observed only for pure stands vs. blends at 1% significant level indicating that pure stands were different from the blends. For pod maturity, significant differences were observed for pure stands and blends. The genotypes showed significant differences ($P<0.01$) for plant height among the pure stands and the blends. Significant differences were registered for pure stands and pure stands vs. blends for primary branches. The genotypes exhibited significant differences for pure stands, blends and pure stands vs. blends at 1% significant level for clusters per plant. Seeds per pod showed significant mean squares for only pure stands and pure stands vs. blends at 1% significant level. Only blends showed significant differences at 1% level for 100-grain weights. For grain yield per plant, pure stands and blends showed significant differences. The character number of nodules showed significant mean squares for pure stands and pure stands vs. blends at 1% significant level. The mean performances of the ten genotypes (four pure stands and six blends) for twelve different characters are presented in Table 2.

Table 2: Mean performance of the pure stands and their equiproportional blends for 12 different characters evaluated under six environments

Genotypes	FBI	PM	PH	PB	CPP	SPP	HGW	GYP	NOD
Pure Stands									
Pratap (V1)	41.13	68.75	42.31	3.59	8.15	8.90	3.08	7.25	10.69
K851 (V2)	41.38	69.54	41.02	3.84	9.24	8.67	3.03	6.00	10.86
SGC 16 (V3)	40.92	70.31	43.51	3.87	8.78	10.07	3.07	6.10	10.08
SGC 20 (V4)	40.81	69.93	42.18	3.90	9.04	9.58	3.01	6.98	10.86
Mean	41.06	69.63	42.25	3.80	8.80	9.30	3.05	6.58	10.62
Blends									
Pratap & K851(V1V2)	41.40	69.02	41.07	3.94	8.97	9.45	3.06	7.05	10.42
Pratap &SGC16(V1V3)	41.13	69.95	42.52	4.15	9.34	9.05	3.04	7.19	10.85
Pratap & SGC20 (V1V4)	41.24	70.52	42.12	4.11	8.47	9.18	3.02	5.99	10.91
K851 &SGC16 (V2V3)	41.37	70.17	42.55	4.00	10.45	8.93	3.04	8.50	10.96
K851 &SGC20 (V2V4)	41.15	69.65	41.13	4.08	9.14	9.08	3.29	6.40	10.83
SGC16 &SGC20 (V3V4)	40.90	70.03	42.80	3.91	8.87	8.71	3.01	6.92	10.91
Mean	41.20	69.89	42.03	4.03	9.21	9.07	3.07	7.01	10.81
Grand mean	41.14	69.79	42.12	3.94	8.95	9.16	3.06	6.97	10.74
S.E.	0.19	0.34	0.41	0.09	0.17	0.19	0.04	0.35	0.15
C.D. 5%	0.38	0.96	1.15	0.24	0.48	0.54	0.11	0.98	0.41

The genotypes showed differences for plant height in pure stands vs. blends which resulted in a higher level of inter genotypic competition in mixtures. Height of genotype V3 (SGC 16, 43.51 cm) was reduced to height 42.52 cm, 42.55 cm and 42.80 cm when grown in association with other genotypes such as, Pratap, K851 and SGC 20, respectively Table.2 On the other hand, some genotypes gained height when grown with blends such as pure stand V1 (Pratap, 42.31 cm) gaining height when grown with genotype SGC 16 (42.52 cm). Similarly variety K851 gained height when blended with Pratap and SGC 16. SGC 20 also gained height when blended with SGC 16 Table2. The increase in height of the varieties could be a cooperative effect of competition for light as reported by Donald (1963) in wheat. It could be because of the phenomenon of competitive influence by which genotype of one pure stand exerts competition to those of the others so that it performs better than its genetic potentiality.

The genotypes exhibited significant differences for pure stands, blends and pure stands vs. blends for clusters per plant Table1. Thus it is indicated that genotypes interacted considerably with each other. Considering the character seeds per pod, significant differences were observed only for pure stand and pure stand vs. blend. It indicated that intra genotypic competition of pure stands for resources were stronger than intergenotypic competition of blends.

The 100 grain weight ranged from 3.01 gram to 3.29 gram. Blending of genotypes showed significant differences for 100-grain weight Table1. But according to some earlier studies (Hodgson and Blackman, 1957), the grain weight was a more stable and least affected character in competition studies in spring wheat.

Considering the character grain yield per plant, significant differences were observed between pure stands and blends Table1. High variation was observed among the genotypes for grain yield per plant. The results revealed that certain genotypic combinations can utilize environmental resources more efficiently than their monocultures. Sharma and Prasad (1978) observed that the grain yield of wheat was significantly greater in some mixed stands than that in pure stands. Other workers also reported that mixtures had yielded slightly more than the mean of the components in monoculture (Shorter and Frey, 1979).

Table2 shows that the highest number of nodules per plant (10.96) was observed for B4 followed by B3 (10.91) and B6 (10.91). Blends produced slightly more number of nodules than pure stands. Thus N-fixing ability improved by blending of varieties.

The blend B4 (K851 and SGC 16) produced the highest grain yield per plant. Their component cultivar SGC 16 showed highest performance for plant height as well as seeds per pod in monoculture Table2. Mumaw and Weber (1957) and Schweitzer *et al*. (1986) in soybean concluded that components divergent in plant height and maturity produced the best yielding mixtures.

The area and production statistics clearly revealed that Assam is deficient in pulse production including green gram which is an important pulse crop of the state from the consumption point of view. So, it has become quite essential to address the approaches to increase the productivity of green gram. Although a number of varieties have been recommended for the state productivity, the varieties are not satisfactory as well as they are highly sensitive to different agro climatic situations. One of the approaches to enhance the green gram productivity could be through blending of pure stand varieties. For pod initiation, a significant difference was observed for pure stands vs. blends indicating that pure stands were different from the blends Table1. This is because; inter genotypic competition of blends for resources were different from intra genotypic competition of pure stands. Therefore, days to first pod initiation was not found to be same for pure stands and blends.

Acknowledgement

The author acknowledges that this work was possible by the financial assistance from Directorate of Post Graduate Studies and the support from the Department of Plant Breeding and Genetics, Assam Agricultural University, Jorhat, Assam during the conduct of experiment.

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