Studies on the Environmental Stress of the Genotypes of Winged Bean [*Psophocarpus tetragonolobus* (L.) DC.] : their Productivity and Micro-structural Differences

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Abstract

Ten genotypes of winged bean [*Psohocarpus tetragonolobus* (L.) DC.] were procured from National Bureau of Plant Genetic Resource (NBPGR), New-Delhi for carrying out PhD programme of the first author in the Department of Botany, Burdwan University. These ten genotypes were grown at the Crop Research Farm (CRF) under this department following Randomized Block Design (RBD) in four replications in the month of May, 2011. Uniform agronomic measures were provided for the proper growth and development of the crop. In general, the legume crop like winged bean does not grow well during rainy season. If so, abundance of abnormalities are noticed in the standing crop. But, it could survive easily by agronomic management in the rainy season without showing any gross abnormalities. Various agro-metrical characters viz. (i) plant height (cm),(ii) branches plant^{-1} (no.), (iii) days to initiation of flower bud (d), (iv) appearance of first green pod (d), (v) fruits plant^{-1} (no. at 50% flowering stage), (vi) podsplant^{-1} (no. at pre-harvesting period), (vii) weight of 100 grains (g), (viii) seed weight plant^{-1} (g) and (ix) yield plant^{-1} were observed and recorded properly till harvesting. Besides these, a few biochemical parameters viz. (i) soluble carbohydrate, (ii) insoluble carbohydrate, (iii) protein, (iv) chlorophyll content, (v) DNA contents and (vi) RNA contents were also measured for assessing variations of biochemical components of the genotypes. This might be either due to good health of the crop i.e. uniform agronomic management technology or potentiality of genotypes which were grown at the location. The analyses of variances like component of variances, genotypic coefficient of variation, phenotypic coefficient of variation and their heritability have been calculated following Singh and Chaudhary (1985).

1. Introduction

The task of food production needs of the growing world population can be augmented by improving agronomic technique and by growing genetically improved cultivars of a wide range of crop. Several under exploited and under utilized plants which abound in tropical ecosystem may be useful in contributing this objective. Winged bean [*Psohocarpus tetragonolobus* (L.) DC.] is such a type of under utilized plant with a potential to be used as a source of protein rich pulse food, and forage.

Winged bean [*Psohocarpus tetragonolobus* (L.) DC.] is significantly important as a high protein, multipurpose legume, particularly, for the humid tropics, where the incidence of protein deficiency in human diet is often very difficult to ameliorate. The winged bean can be profitably used as a source of edible oil, if substantial commercial production is aimed. The plant also has an exceptional ability to fix atmospheric nitrogen. Plant is taller and larger than common bean. This tuberous-rooted twining annual vine bears clusters of purplish flowers and pods with four jagged wings. The plant bears large pale blue coloured flowers, beans similar to soya beans in both use and nutritional contents (protein=29.8-43%). Being a tropical plant, it is sensitive to frost. Most plants will not flower if the day length is less than 12 hrs. Seeds have a hard coat and it helps to soak them before planting to hasten germination.

Successful cultivation of winged bean in the tropic requires the availability of high quality planting seed. Local production

of such seed requires cultivars capable of enduring adverse climatic conditions usually present during the later stages desirable in the subtropics because high soil temperature at planting and crushing of the soil surface may result in poor stands. The aims and objects of this experimentation were to study the productivity, adaptability and the variations of biochemical components of each genotype along with disease occurrence of the produced crop prevailed in this particular location.

2. Materials and Methods

The seeds were sow atthe Crop Research Farm (CRF), Botany Department of The University of Burdwan, West Bengal, India in May, 2011. Ten accessions of the experimental crop were procured from NBPGR, in its Akola, (Maharashtra), the Regional Station.

These accessions viz.: EC38154, IC95226, IC95224, EC38825, EC38821B, EC38954, EC27886, IC95227, IC112417 and EC38955A were grown at the research field at CRF following Randomized Block Design (RBD) layout with four replications. Uniform agronomical measures were provided for proper growth and development.

The physico-chemical characteristics of the soil of the experimental plot is as pH 6.8, conductivity (TSS) 0.12 millimhos cm^{-1}, organic Carbon (%) 0.38, available phosphorus 74.5 kg ha^{-1} (medium), available potassium 141.4 kg ha^{-1} (low). Various metrical characters viz. plant height (in 45 days),number of branches$plant^{-1}$ (in 45 days), days to initiation of flower bud, appearance of first green pod (days), number of fruit $plant^{-1}$ (at 50% flowering stage), number of fruit $plant^{-1}$ (pre harvesting), weight of 100 grains, and seed weight $plant^{-1}$ were studied during experimentation, and data were recorded on five randomly selected plants from each replication. For statistical analysis of genetic parameters, we considered the critical difference, coefficient of variances, components of variances, phenotypic coefficient of variance, genotypic coefficient of variance and broad sense heritability. Mean values are subjected to analysis of variance (ANOVA) to test the significance. Phenotypic and Genotypic variances were estimated according to Lush (1940) .

All the biochemical estimations were carried out at 50% flowering stage. Healthy and disease free mature leaves of *Psophocarpustetragonolobus* (L.)DC. were selected for biochemical estimations.. Freshly collected leaves were cleaned with water and surface water was wiped out with paper towel.

Dried mature leaves were mounted on stubs using double sided adhesive tape for scanning electron microscopy. Samples were coated with 12.5-15 mm. of gold with IB-2 ion coater; coated leaves were examined and photographed with S-530 HITACHI-JAPAN scanning electron microscope.

3. Results and Discussion

The primary result to report is that *Psophocarpus* tetragonolobus (L.) DC. does not grow and thrive during the rainy season. In our case, we have sown the seeds before rainy season, 2011. On two occasions during the growth phase, there was an incidence of flooding of the experimental plot where winged bean plants were grown. The floods were caused by a manual error in the irrigation system supplying water to an adjacentrice plot. The winged bean plot was inundated by water for a couple of days. Based on the yield and nutritional characteristics the results appeared to be considered as an affected by flood.

In this investigation the two-way data tables and their respective ANOVA tables of eight agronomical characters were done. A combined ANOVA table has been exhibited in which the degree of freedom, MS and Value of variance, the values of Critical Difference (CD) and Coefficient of variation (CV) were tabulated (Table 1). The estimation of genotypic (δ^2g) and phenotypic (δ^2p) variance, genotypic coefficient of variation (GCV) and phenotypic (PCV) coefficient of variation, broad sense heritability (h^2) of the ten accessions are given (Table 2&3). A wide range of variation was observed with regard to different traits.

In this investigation, all studied agronomical characters showed significant differences in the ten accessions .The value of variance ratio towards plant height were 4.90 and 120.52 respectively in replication and variety source of variance. Obviously, the values are significant at 0.01 level .The value of variance against variety source was remarkably significant. The value of variance ratio against replication (3.67) and variety (29.63) source of variance ,in case of phenotypic character number of branches $plant^{-1.}$ Similar results have also been cited in case of metrical characters days to initiation of flower bud .In both the cases the value of Critical Difference at p=0.01 level was 0.6385 and 9.1480 respectively. It is biometrically evident that replication source of variance for the character number of branches$plant^{-1}$ and days to initiation of flower bud was less significant than variety source of variation . In case of the phenotypic characters like appearance of first green pod, numbers of fruits $plant^{-1}$ at 50% flowering stage, number of pod $plant^{-1}$, number of grains pod^{-1}, seed weight $plant^{-1}$, the value of variance ratio against variety source of variance was significant at p=0.01 level, where the replication value was not significant. In all these cases, it is most appropriate and proved the efficiency of these accessions over the location, in this particular season of the year. In all these cases, Critical Difference value is very much up to the mark and within the significant limitation in view of biometrical points. The

Table 2: Components of genetic variability for eight agrometrical characters among ten accessions of *P. tetragonolobus* (L.) DC.

Sl. No.	Character	δ^2 g	δ^2 p	δ^2 e
1	Plant height (cm)	10.6409	10.9970	0.3561
2	No. of branches plant^{-1}	0.7602	0.8664	0.1062
3	Days to initiation of flower bud	145.5	167.3	21.80
4	Appearance of first green pod (days)	230.704	239.837	9.133
5	No. of Fruits plant^{-1} (50% flowering stage)	71.70	90.997	19.297
6	No. of pod plant^{-1} (pre-harvesting)	2304.82	2322.749	17.92
7	Weight of 100 grains	41712.57	41727.26	14.69
8	Seed weight plant^{-1} (post-harvesting)	9.124	9.135	0.011
9	Yield plant^{-1} (green pod vegetable) in g	195344.46	195356.11	11.653

Table 3: Coefficients of variances for eight agrometrical characters among ten accessions of *P. tetragonolobus* (L.) DC.

Sl. No.	Character	Phenotypic Coefficient of Variance (PCV)	Genotypic Coefficient of Variance (GCV)	Broad Sense Heritability (h^2_{bs})
1	Plant Height(cm)	30.4430	29.9434	0.9676
2	Noof Branches. Plant^{-1}	41.73	39.09	0.8774
3	Days to Initiation of Flower Bud	10.823	10.094	0.8696
4	Appearance of First Green Pod (Days)	9.807	9.619	0.9619
5	No.of Fruits.Plant^{-1} (50% flowering stage)	55.380	49.158	0.7879
6	No of Pod Plant^{-1}- (Pre harvesting)	26.656	26.55	0.9922
7	Weight of 100 Grains	37.57	37.56	0.99
8	Seed Weight Plant^{-1} (Post harvesting)	9.030	9.028	0.998
9	Yield Plant^{-1} (green pod vegetable) gms	25.901	25.900	0.999

maximum genotypic and phenotypic variations were obtained for seed weight plant^{-1} and number of pod plant^{-1} (harvesting); while moderate variations were obtained for appearance of first green pod and days to initiation of flower bud. This indicated that the environment did not significantly (p=0.05) influence these characters. There was a very close difference between phenotypic and genotypic variance for weight of 100 grains (0.011) and plant height (0.357). The character with almost equal value of phenotypic variance can be considered stable (Yadav et al., 2010). Lower values of genotypic and phenotypic variances were noticed in number of branches plant^{-1}, which is indicative of the stable nature of this character.

Table 4: Biochemical estimations from mature leaves of *P. tetragonolobus* (L.) DC. among ten accessions

Variety	Protein (mg g^{-1})	Carbohydrate		Chlorophyll (mg g^{-1})	DNA (mg^{-1}g)	RNA (mg g^{-1})
		Soluble (mg g^{-1})	Insoluble (mg g^{-1})			
EC38154	7.963	.0045	0.116	0.649	1.20	6.23
IC95226	7.597	.0053	0.107	0.852	1.13	6.12
IC95224	3.203	.0040	0.103	1.252	1.03	5.79
EC38825	4.210	.0057	0.037	1.039	1.10	5.89
EC38821B	7.139	.0050	0.068	1.047	0.98	5.28
EC38954	8.970	.0035	0.053	1.686	1.33	5.95
EC27886	8.512	.0028	0.073	0.753	1.25	5.38
IC95227	6.773	.0021	0.082	1.217	1.38	5.40
IC112417	11.716	.0024	0.071	1.448	1.40	5.67
EC38955A	11.990	.0039	0.057	2.086	1.45	6.93

In general, the phenotypic coefficient of variation (PCV) was higher than its genotypic counterpart (GCV) for all the characters studied (Table 3). This resemblance between PCV and GCV in almost all the characters studied suggests that the environment had little effect on those characters expression and was consistent with Jalgaonkar et al. (1990) observation. The GCV provides a measure for comparing genetic variability in various metrical characters. The highest GCV value was recorded for number of fruitplant^{-1} at 50% flowering stage (49.158); moderate for seed weight plant^{-1} (37.56), number of branches plant^{-1} (39.09); and the lowest for weight for 100 grains (9.028). The higher value (49.158) for number of fruitplant^{-1}at 50% flowering stage indicated a high degree of genotypic variability. PCV which measures total relative variation was the highest for number of fruit plant^{-1} (55.380), moderate for number of branchesplant^{-1} (41.73), seed weight plant^{-1} (37.57), plant height (30.443) and the lowest for weight of 100 grains (9.030),appearance of first green pod (9.807) Broad sense heritability ranged from 0.787 for number of fruits plant^{-1} at 50% flowering stage to 0.998 for weight of 100 grains.

4. Conclusion

The crop requires well drainage condition particularly in rainy months and specific critical day length for flowering. The total yield plant^{-1} depends on plant canopy. In this study the crop was sown before rainy season and plant canopy was profuse. The results indicated adequate quantity of crop yield. It can be standardized by manipulation of plant spacing and fertilizer regimes which requires further experimentation.

5. References

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