



Genetic variability and character association studies in Jack bean [*Canavalia ensiformis* (L.) Dc.] for quality characters

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ABSTRACT

The experiment was conducted at NBPGR Regional Station, Rajendranagar during 2013-14 (August 2013 to February 2014) to study the genetic variability and association among the quality characters in jack bean. The results revealed that significant variation was observed for all the characters. Among the characters studied, the highest heritability coupled with genetic advance as percent of mean was observed for magnesium followed by calcium and iron contents. However, heritability alone was found to be highest for iron content followed by magnesium, calcium and protein contents. Calcium content had significant positive association with protein content whereas magnesium, calcium and iron content recorded the positive direct effect on protein content while sodium content have negative effect.

Key words: Correlation, Jack bean, Path analysis, Variability.

INTRODUCTION

Jack bean [*Canavalia ensiformis* (L.) DC.] belongs to the family leguminaceae is one of the underexploited tropical dry beans however, fairly widely distributed from West Indies (origin) to Central and South America (Anonymous, 1950). The Genus *Canavalia* consisting of 48 species of which, four species are reported from India, viz., *C. ensiformis*, *C. gladiata*, *C. maritima* and *C. virosa*. Out of these four species, *C. ensiformis* (Jack bean) and *C. gladiata* (Sword bean) were reported in North East region of India and are being cultivated for the edible pods (Bose *et al.* 2003). Pulses meet only about 20% of protein requirement facing the scarcity of protein and so the exploitation of wild legumes is necessary to combat Protein-Energy-Malnutrition (PEM), especially among children below the age of 5 years in India (Bhagya *et al.* 2009). Dada *et al.* (2013) reported 15.45-21.85% and Marimuthu and Gurumoorthi (2013) reported 24.32 ± 0.11 g/100 g protein content in *Canavalia ensiformis* seeds. The jack bean pods contain 27.22 mg/100g protein, 338.32 mg/kg magnesium, 131.75 mg/kg calcium, 369.75 mg/kg sodium and 23.37 mg/kg potassium (Gabriel-Ajobiwe *et al.* 2012). Hence, the search for alternate wild legumes as a cost effective source of energy and nutrition is highly essential. The exploitation of variability is a pre-requisite for the effective screening of superior genotypes. The progress in breeding for the yield and its contributing characters of any crop is polygenically controlled, environmentally influenced and determined by the magnitude and nature of their genetic variability. Hence, it is essential to partition the overall variability into its

heritable and non-heritable components with the help of genetic parameters like variability, heritability and genetic advance. Knowledge of correlations among different characters and further partitioning them into direct and indirect effects is a rational approach to understand the nature and extent of such relationship. Therefore, study of genetic variability, correlation and path coefficient are pre-requisite for improvement of any crop. The literature available on correlation and path studies of quality characters is very meager. Keeping in view the importance of above biometrical approaches, an experiment was conducted to know genetic variability, character association and path coefficient among quality characters in Jack bean.

MATERIALS AND METHODS

The present study was carried out at National Bureau of Plant Genetic Resources, Regional Station, Rajendranagar, Hyderabad in a randomized block design with three replications during 2013-14 (August 2013 to February 2014). The seeds of fifteen genotypes were sown in rows with spacing of 3.0 'm' between rows and 0.5 'm' between plants. The climate of Hyderabad is semi arid tropical climate and it lies at latitude of 17.19° N and longitude of 79.23° E, with an altitude of 542.3 'm' above the Mean Sea Level. All the package of practices recommended for dolichos bean was followed to raise the crop as Jack bean is under exploited vegetable. The need based plant protection measures were taken to raise the healthy crop. Data were collected on randomly selected five plants in each genotype for seven parameters viz., protein, sodium, potassium, calcium, magnesium, iron and

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phosphorus content of pod and was subjected to following statistical analysis to estimate different components. The genotypic and phenotypic coefficients of variation were calculated according to Falconer (1981). Heritability (h^2) in broad sense was calculated according to the formula given by Allard (1960). From the heritability estimates, the genetic advance was calculated by the formula given by Burton (1952). Phenotypic and genotypic correlation coefficients were calculated using the formulae suggested by Al-Jibouri *et al.* (1958). Path coefficient analysis as suggested by Wright (1921) and elaborated by Dewey and Lu (1959) at both phenotypic and genotypic levels was used.

The procedures adopted for the analysis of phosphorus, sodium, potassium, calcium, magnesium and iron are briefly outlined below (Piper, 1966). The collected pod samples were decontaminated by washing thoroughly with ordinary water, 0.2% detergent (Teepol laboratory grade), 0.1 N HCl, distilled water and finally by using deionised water. These samples were dried in oven at 60°C till the constant weights were obtained. The dried pods were pounded using the pestle and mortar. For the determination of phosphorus, the plant samples were digested with a diacid mixture consisting of HNO_3 : HClO_4 (9:5). The digest was made upto 50 ml volume. The phosphorus content in the diacid digest was determined by developing yellow colour with Barton's reagent. The intensity of yellow colour was determined using UV visible spectrophotometer (ELICO SL 171 Minispec) at 420 nm. For the determination of sodium and potassium, the plant samples were digested with a diacid mixture consisting of HNO_3 : HClO_4 (9:5). The digest was made upto 50 ml volume. The sodium and potassium content in diacid extract was determined using Flame photometer (ELICO CL 361) at 589.0 nm and 766.5 nm respectively. Calcium, magnesium and iron were determined in Atomic absorption spectrophotometer (Agilent Tech 200 Spectra AA) with respective hollow cathode lamps at appropriate wavelengths (422.7 nm, 280 nm and 248.3 nm respectively).

RESULTS AND DISCUSSION

Among the components studied, magnesium content followed by calcium and iron contents have recorded highest heritability coupled with genetic advance as per cent mean.

Results from correlation and path analysis revealed that the calcium content has significant positive association as well as direct effect on protein content. These results indicated that more emphasis should be given for selection of plants with high calcium, magnesium and iron contents to improve the protein content in jack bean.

The Estimates of variability, heritability and genetic advance as percent of mean for different characters were presented in Table 1. The phenotypic and genotypic variances were higher for the iron content. Similar findings were reported by Singh *et al.* (2013) in Cabbage. However, low phenotypic and genotypic variances were observed for protein, magnesium, calcium, sodium, potassium and phosphorus content. Arivalagan *et al.* (2013) in eggplant reported the low phenotypic and genotypic variances for magnesium content. Phenotypic Coefficient of Variation and Genotypic Coefficient of Variation were high for the traits viz., magnesium, calcium, iron, sodium, potassium and phosphorus content. However, low PCV and GCV were recorded for protein content. Bhargava *et al.* (2010) reported high PCV and GCV values for potassium and sodium content in *Chenopodium* species. In the present study the values of Phenotypic Coefficient of Variation were higher than corresponding genotypic coefficient of variation but the differences were narrow suggesting their relative resistance to environmental alteration.

With the help of GCV alone it is not possible to determine the extent of variation which is heritable. Hence, the knowledge of heritability helps plant breeder in predicting the genetic advance for any quantitative character and aids in exercising necessary selection procedure. According to Burton and De Vane (1953) GCV along with heritability estimate would give the best scope for selection. Highest heritability values were found for iron content followed by magnesium, calcium, protein and sodium contents in the present study. High heritability for these characters might be useful to plant breeder for making effective selection. Similar findings were reported by Singh *et al.* (2013) in Cabbage and Arivalagan *et al.* (2013) in eggplant.

Johanson *et al.* (1955) suggested that the heritability estimate along with the genetic advance is more useful than

TABLE 1: Estimates of genetic parameters for quality characters in Jack bean

Character	Variance		PCV (%)	GCV (%)	h^2 (%) (Broad sense)	Genetic Advance	GA as percent of mean
	Phenotypic	Genotypic					
Protein (%)	2.52	2.18	8.65	8.04	86	2.82	15.39
Magnesium (%)	0.0069	0.0064	42.34	40.75	92	0.15	80.79
Calcium (%)	0.0179	0.0157	40.12	37.60	87	0.24	72.59
Iron (ppm)	268.02	263.79	26.16	25.96	98	33.19	53.05
Sodium (%)	0.0001	0.0001	22.36	20.35	82	0.01	38.18
Potassium (%)	0.37	0.28	21.79	18.89	75	0.95	33.74
Phosphorus (%)	0.0051	0.0033	28.53	23.06	65	0.09	38.41

PCV= Phenotypic coefficient of variation, GCV= Genotypic coefficient of variation, GA= Genetic advance, ppm= parts per million

TABLE 2: Phenotypic (P) and genotypic (G) correlation coefficients for quality characters in Jack bean

Character		Magnesium	Calcium	Iron	Sodium	Potassium	Phosphorus	Protein
Magnesium	P	1.0000	0.5459	0.5071	0.7504	0.4776	-0.2323	0.4148
	G	1.0000	0.5715	0.5222	0.8269	0.5612	-0.3888	0.4625
Calcium	P	0.5459	1.0000	0.1603	0.6814	0.5936	0.2597	0.5725*
	G	0.5715	1.0000	0.1445	0.7228	0.6225	0.1831	0.6352*
Iron	P	0.5071	0.1603	1.0000	0.4769	0.4202	-0.2354	0.2221
	G	0.5222	0.1445	1.0000	0.5103	0.4670	-0.3623	0.2328
Sodium	P	0.7504	0.6814	0.4769	1.0000	0.6404	0.0073	0.3501
	G	0.8269	0.7228	0.5103	1.0000	0.6606	-0.1796	0.3850
Potassium	P	0.4776	0.5936	0.4202	0.6404	1.0000	-0.1413	0.3216
	G	0.5612	0.6225	0.4670	0.6606	1.0000	-0.3164	0.3568
Phosphorus	P	-0.2323	0.2597	-0.2354	0.0073	-0.1413	1.0000	0.1035
	G	-0.3888	0.1831	-0.3623	-0.1796	-0.3164	1.0000	0.1217

*significant at 0.05 % probability

TABLE 3: Direct and indirect effects of quality characters on protein content in Jack bean

Character		Magnesium	Calcium	Iron	Sodium	Potassium	Phosphorus	Correlation coefficient
Magnesium	P	0.2517	0.1374	0.1276	0.1889	0.1202	-0.0585	0.4148
	G	0.5227	0.2987	0.2730	0.4322	0.2933	-0.2032	0.4625
Calcium	P	0.3591	0.6579	0.1054	0.4483	0.3905	0.1708	0.5725*
	G	0.4962	0.8683	0.1255	0.6276	0.5405	0.1590	0.6352*
Iron	P	0.0901	0.0285	0.1777	0.0848	0.0747	-0.0418	0.2221
	G	0.1554	0.0430	0.2976	0.1519	0.1390	-0.1078	0.2328
Sodium	P	-0.2619	-0.2378	-0.1665	-0.3490	-0.2235	-0.0026	0.3501
	G	-0.6207	-0.5426	-0.3831	-0.7507	-0.4959	0.1348	0.3850
Potassium	P	-0.0172	-0.0213	-0.0151	-0.0230	-0.0359	0.0051	0.3216
	G	-0.0475	-0.0527	-0.0396	-0.0559	-0.0847	0.0268	0.3568
Phosphorus	P	-0.0071	0.0079	-0.0072	0.0002	-0.0043	0.0304	0.1035
	G	-0.0436	0.0205	-0.0406	-0.0201	-0.0355	0.1121	0.1217

*significant at 0.05 % probability

the heritability alone in predicting the resultant effect for selection. In the present investigation, highest estimates of heritability coupled with genetic advance as per cent mean were found for magnesium followed by calcium and iron contents indicating the suitability of these characters for phenotypic selection. Similar results were reported by Singh *et al* (2013) in cabbage and Arivalgan *et al* (2013) in egg plant.

From the correlation studies (Table 2) it was apparent that all the components were positively associated

with protein content both at phenotypic and genotypic levels. Among the characters, calcium content had significant positive correlation with protein content. Thus it indicates that direct selection for calcium content would help in effective improvement in protein content of jack bean. Path analysis (Table 3) revealed that magnesium, calcium and iron content had positive high direct effect on protein content while sodium content had high negative effect. The calcium content had indirect effect on protein content through magnesium, sodium and potassium content.

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