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Genetic Variability and Heritability of Fodder Yield and its Contributing Traits in Rice Bean

A. P. Janjal[1*] and A. K. Mehta[2]

Department of Plant Breeding and Genetics, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur – 482004, Madhya Pradesh, India

**Corresponding author*

A B S T R A C T

An investigation was carried out to estimate the genetic parameters for twenty traits in 47 rice bean genotypes for fodder yield. The study revealed that phenotypic coefficient variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the traits. Higher GCV and PCV were recorded for dry matter yield per plant per day, dry matter yield per plant, green fodder yield per plant, green fodder yield per plant per day, dry root weight, crude protein yield per plant per day, crude protein yield per plant, root volume, fresh root weight, root nodules per plant, number of leaves per plant and leaf stem ratio. Whereas, root length, stem diameter, number of branches per plant, plant height reported moderate GCV and high PCV. High heritability coupled with high genetic advance as percentage of mean was observed for crude protein yield per plant, crude protein yield per plant per day, fresh root weight, dry root weight, number of leaves per plant, root nodules per plant, leaf stem ratio, root volume and plant height. Moderate heritability with high genetic advance was exerted by green fodder yield per plant, dry matter yield per plant per day, green fodder yield per plant per day, root length, number of branches per plant and stem diameter, indicating that heritability may be due to additive gene action and selection based on these characters may be effective.

Keywords

Vigna umbellate, Genetic variability, GCV, PCV, Heritability, Genetic advance

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Introduction

The rice bean (*Vigna umbellata* (Thunb.) Ohwi and Ohashi), a member of the leguminosae (Fabaceae) family, is an annual and self pollinated crop. It is a multipurpose and underutilized fodder legume.. It has an important role in human, animal and soil health improvement. It is a good source of protein, essential amino acids, essential fatty acids and minerals. The dried seeds make an excellent addition to cereal based diet. It is useful for livestock feeding. The vegetative parts can be feed fresh or made into hay. It is grown for green manure, as a cover crop and used as a living fence or biological barrier (Ecoport, 2014). Being a nitrogen fixing legume, it also improves the nitrogen status of the soil. Also, it is a lean period crop that provides subsistence to the farmers with fodder supply throughout growing season for animal population. It is best adapted to drought-prone sloping areas and flat rainfed conditions. The yield and its contributing characters of any crop are polygenetically controlled, environmentally influenced and its improvement through breeding progamme is determined by the magnitude and nature of their genetic variability and heritability (Fisher, 1981). Heritability reveals the degree to which a character is transmitted from parents to offspring. The magnitude of such estimates suggests the extent to which improvement is possible through selection. Since selection of superior genotypes is proportional to the amount of genetic variability present and the extent to which the characters are inherited, so it is necessary to obtain adequate information on the magnitude and type of genetic variability and their corresponding heritability

Materials and Methods

The experiment was conducted under All India Coordinated Research Project on forage crops, Department of Genetics & Plant Breeding at Seed Breeding Farm, College of Agriculture, JNKVV, Jabalpur (M.P) during 2017 situated in the semi-arid sub-tropics at 23.91˚ North latitude and 79.5˚ East longitudes with an altitude of 411.78 meters above the mean sea level.

The experiment was conducted in Randomized Complete Block Design (RCBD) with three replications in *kharif* season on 47 genotypes. Each entry was planted in 3.0 m X 0.9 m plot size and spacing between rows was kept 30 cm. Observations were recorded on randomly selected five competitive plants in each plot, excluding the border plants for twenty characters *viz.,* days to flower initiation, days to harvest, plant height (cm), number of leaves per plant, number of branches, stem diameter (mm), root length (cm), root volume (ml), number of root nodules per plant, leaf area (cm^2), fresh root weight (g), dry root weight (g), green fodder yield per plant (g), green fodder yield per plant per day (g), dry matter yield per plant (g), dry matter yield per plant per day (g), crude protein yield per plant (g), crude protein yield per plant per day (g), leaf stem ratio and chlorophyll content index. The statistical analysis of the data on the individual trait was analysed with INDOSTAT software.

Results and Discussion

The analysis of variances of 47 rice bean genotypes for all the characters studied showed that genotypes differed significantly indicating a substantial genetic variability in the material as presented in Table 1(a) and 1(b). These are in agreement with Udensi *et al.,* (2011) for number of leaves per plant and leaf area, Manggoel (2007) for days to harvest, Malarvizhi *et al.,* (2005) for days to harvest, plant height, number of branches per plant, number of leaves per plant, stem thickness, dry matter yield, green fodder yield, leaf stem ratio and crude protein content, Singh *et al.,* (1997) and Baraskar *et al.,* (2014) for plant height. Katoch *et al.,* (2007) for plant height and fresh fodder yield, Das *et al.,* (1997) for days to harvest and plant height and Bandopadhyay *et al.,* (2007) for leaf area.

The genetic parameters viz., genotypic and phenotypic coefficients of variation, heritability in broad sense and genetic advance along with mean and range of different characters are presented in Table 2.

The genotypic and phenotypic coefficients of variation were computed to assess the existing variability in the material. In general phenotypic coefficient of variation was higher than the corresponding genotypic coefficient of variation for almost all the traits which indicates role of environment for these characters.

Genotypic coefficient of variation

Highest GCV was observed for crude protein yield per plant per day, dry root weight, crude protein yield per plant, dry matter yield per plant per day, dry matter yield per plant, green fodder yield per plant, green fodder yield per plant per day, fresh root weight, root volume, number of root nodules per plant, number of leaves per plant and leaf stem ratio. The moderate value was recorded for root length, stem diameter, number of branches per plant and plant height. This indicates the presence of sufficient amount of genetic variability for these traits and can be exploited by breeding procedure for improvement of these characters. While, leaf area, chlorophyll content index, days to harvest and days to flower initiation had lowest values.

The results were comparable with Kohli and Agarwal (2012) and Roquib and Patnaik (1990) for green fodder yield per plant. Borah and Khan (2000) for number of leaves per plant, leaf stem ratio, dry fodder yield and green fodder yield. Nath and Tajane (2014) for green fodder yield per plant, dry matter yield per plant and branches per plant and Sharma *et al.,* (2017) for branches per plant and plant height. Dodake and Dahat (2011) for number of number of root nodules per plant and days to harvest.

Phenotypic coefficient of variation

Dry matter yield per plant per day recorded the highest PCV followed by dry matter yield per plant, green fodder yield per plant, green fodder yield per plant per day, dry root weight, crude protein yield per plant per day, crude protein yield per plant, root volume, fresh root weight, number of root nodules per plant, number of leaves per plant, root length, stem diameter, leaf stem ratio, number of branches per plant and plant height. The moderate value of PCV was recorded for leaf area and the lowest value was observed for chlorophyll content index, days to harvest and days to flower initiation. It indicates the selection based on these characters would facilitate the successful isolation of desirable fodder type.

These results are in conformation with reports of Roquib and Patnaik (1990), Kohli and Agarwal (2012) and Kohli (2002) for green fodder yield per plant and plant height, Das *et al.,* (1997) for plant height and Sharma *et al.,* (2017) for number of branches per plant and plant height, Borah and Khan (2000) for number of branches per plant, number of leaves per plant, leaf stem ratio, dry fodder yield and green fodder yield, Nath and Tajane (2014) for green fodder yield per plant, dry matter yield per plant, branches per plant, Dodake and Dahat (2011) for number of number of root nodules per plant, number of branches per plant and days to harvest.

Heritability and genetic advance

Heritability estimates along with the genetic advance are normally more helpful in predicting the genetic gain under selection than heritability estimates alone. However, it is not necessary that the character showing high heritability will also exhibit high genetic advance.

High heritability with high genetic advance was exhibited by crude protein yield per plant followed by crude protein yield per plant per day, fresh root weight, dry root weight, number of leaves per plant, number of root nodules per plant, leaf stem ratio, root volume and plant height indicating lesser influence of environment in expression of these characters and preponderance of additive gene action, hence amenable for simple selection.

Table.1(a) Analysis of variance for fodder yield and its components in *Vigna umbellate*

Sources of variation	Degree of freedom	Mean Sum of Squares									
		Days to flower initiation	Days to harvest	Plant Height (cm)	No. of leaves / plant	No. of branches / plant	Stem diameter (mm)	Root length (cm)	Root volume (ml)	No. of root nodules / plant	Leaf area (cm^2)
Replication	2	93.28	586.64*	18.29	13.36	0.44	0.59	251.03*	6.04	29.04	2019.42**
Treatment	46	72.22*	94.73*	3071.56**	2314.73**	5.33**	2.94**	404.25**	64.27**	2484.06**	531.58**
Error	92	10.58	15.42	364.33	168.54	1.02	0.80	80.40	7.15	197.26	185.03

Table.1(b) Analysis of variance for fodder yield and its components in *Vigna umbellate*

Sources of variation	Degree of freedom	Mean Sum of Squares									
		Fresh root weight (g)	Dry root weight (g)	Green fodder yield/ plant/ day (g)	Dry matter yield/ plant (g)	Dry matter yield/ plant/ day (g)	Leaf stem ratio	Crude protein yield/ plant	Crude protein yield/ plant/ day	Chlorophyll content index	Green fodder yield/ plant (g)
Replication	2	0.53	0.10	0.07*	70.66	0.002	0.001	1.08	0.000083	20.60	562.31
Treatment	46	43.77**	9.30**	0.95**	1138.08**	0.060**	0.060**	21.78**	0.001271**	11.95*	18434.08**
Error	92	1.54	0.47	0.20	266.11	0.012	0.005	0.45	0.000028	3.58	3799.00

*** Significant at 5%**
**** Significant at 1%**

Table.2 Genetic parameters for variation in fodder yield and its components in *Vigna umbellata*

Character	Range		Mean	Variance			GCV	PCV	Heritability broad sense (%) (h^2)	Genetic advance as % of mean
	Min	Max		Phenotypic	Genotypic	Environment				
Days to flower initiation	106.66	140.66	128.58	31.128	20.547	10.581	3.52	4.33	66.00	5.89
Days to harvest	113.66	148.66	137.04	41.865	26.437	15.428	3.75	4.72	63.14	6.14
Plant height(cm)	116.46	247.10	176.43	1266.741	902.410	364.330	17.02	20.17	71.23	29.60
No. of leaves/plant	49.00	166.33	112.57	883.940	715.397	168.543	23.75	26.41	80.93	44.03
No. of branches/plant	4.33	10.33	7.02	2.464	1.438	1.027	17.07	22.35	58.36	26.86
Stem diameter(mm)	3.18	7.69	4.86	1.515	0.713	0.801	17.35	25.29	47.06	24.53
Root length(cm)	33.30	83.96	53.23	188.355	107.952	80.403	19.51	25.77	57.31	30.43
Root volume(ml)	5.33	28.66	14.17	26.192	19.041	7.151	30.77	36.09	72.69	54.06
No. of root nodules/plant	57.72	186.09	104.73	959.532	762.269	197.263	26.36	29.57	79.44	48.40
Leaf area(cm^2)	103.29	154.56	129.17	300.552	115.517	185.035	8.32	13.42	38.43	10.62
Fresh root weight(g)	3.89	19.09	11.16	15.622	14.075	1.547	33.66	35.40	90.09	65.70
Dry root weight(g)	1.01	7.80	3.64	3.415	2.943	0.472	47.01	50.65	86.17	89.90
Green fodder yield/plant/day(g)	0.61	2.48	1.32	0.456	0.247	0.209	37.47	51.15	54.16	57.07
Dry matter yield/plant(g)	13.99	83.22	42.52	556.771	290.659	266.112	40.08	55.49	52.20	59.67
Dry matter yield/plant/day(g)	0.10	0.64	0.30	0.028	0.016	0.012	42.46	55.77	57.14	65.65
Leaf stem ratio	0.45	1.22	0.65	0.024	0.018	0.005	20.77	23.63	75.00	37.61
Crude protein yield/plant(g)	1.73	13.20	5.80	7.562	7.10	0.453	45.93	47.37	93.89	91.74
Crude protein yield/plant/day(g)	0.01	0.09	0.04	0.000	0.00	0.000	47.60	49.18	93.70	94.92
Chlorophyll content index	32.30	46.63	39.12	6.373	2.79	3.583	4.27	6.45	43.77	5.81
Green fodder yield/plant(g)	88.84	369.05	181.40	8677.363	4878.360	3799.003	38.50	51.35	56.21	59.46

The results are in close proximity with the findings of Kumar *et al.,* (1997), Lokesh *et al.,* (2003), Baraskar *et al.,* (2014), Sharma *et al.,* (2017) for plant height, Aditiya *et al.,* (2011) for dry matter yield per plant, Singh *et al.,* (2010) for plant height, dry matter yield and green fodder yield, Bhandari and Verma (2008) for plant height, number of leaves per plant, crude protein content and green fodder yield.

Moderate heritability with high genetic advance was exerted by green fodder yield per plant, dry matter yield per plant per day, green fodder yield per plant per day, root length, number of branches per plant and stem diameter. Whereas, leaf area exhibited low heritability with moderate genetic advance. This indicates the presence of additive gene action and selection of these characters may be rewarding.

Moderate heritability with low genetic advance was reported for days to harvest and days to flower initiation. While, low heritability with low genetic advance was observed for chlorophyll content index indicating that non-additive gene action play major role in the inheritance of these characters. Thus, the direct selection based on these characters may not be effective.

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