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Variability and Genetic Control of Some Inorganic Elements and Pigments in Leaves of *Prosopis cineraria* (L.) MacBride

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Abstract: Variability for inorganic elements and leaf pigments was studied in forty accessions of *Prosopis cineraria* (L.) MacBride collected from different districts of Rajasthan, Gujarat and Haryana. Significant differences were observed for chlorophyll *a*, chlorophyll *b*, crude protein, sodium, potassium, calcium and phosphorus. Sodium (23.00) and carotenoids (22.91) had high values of phenotypic coefficients of variation. Genotypic coefficient of variation was highest for carotenoids (20.34). Estimates of heritability in broad sense were highest for potassium (0.88), closely followed by crude protein (0.81), sodium (0.80) and chlorophyll *a* (0.80). Genetic advance expressed as per cent of mean was highest (37.26%) for carotenoids followed by sodium, potassium and calcium. Chlorophyll *a*, *b*, and total chlorophyll had moderate values of genetic advance. Accessions showing high protein content, low to moderate sodium and high phosphorus were, NIC-1936, NIC-1937, NIC-1840, NIC-1961, NIC-1920, NIC-13555 and NIC-13570.

Key words: *Prosopis cineraria*, variability, inorganic elements, chlorophyll carotenoids, crude protein.

Prosopis cineraria, an important tree of the arid region of western Rajasthan, is a source of fuel, timber and vegetable to human beings and green fodder to animals. It is drought hardy and can grow against all odds of climatic conditions.

Chlorophyll plays the lead role in transforming radiant energy into chemical energy. Increased chlorophyll concentration has been related to the increased photosynthetic potential (Yoder and Waring, 1994) and reduced chlorophyll concentration might lead to depressed photosynthetic rate (Heath, 1969; Sestak *et al.*,1971). The variation in chlorophyll content may occur as a result of genotype, temperature (Troughton, 1975), or water stress (Nautiyal *et al.*,1993), hence the importance of genotypes supporting higher chlorophyll content.

Leaves of this species, fed to animals green or after drying, are a good source of protein and inorganic elements such as sodium, potassium, calcium and phosphorus, which perform essential functions in the body. Sodium and potassium help in maintaining osmotic pressure and acid base equilibrium in controlling the passage of nutrients into cells and in water metabolism in general. Calcium and phosphorus occur combined with each other and form 70% of the ash of the body. The present study was conducted to investigate presence of genetic variability for various physiological and quality traits for their better exploitation for afforestation

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as well as source of quality feed for the animals.

Materials and Methods

Materials for the present study consisted of seeds of 40 accessions of *Prosopis cineraria* (L.) MacBride, from different districts of Rajasthan, Haryana and Gujarat. The experiment was conducted in a randomized complete block design with three replications. Thirty bags of each accession were seeded in each replication. The bags were irrigated daily in summer, and as and when required in rainy and winter seasons. Crude protein (%) was estimated in the leaves of one-year-old seedlings by microkjeldahl method as described by Peach and Tracy (1955). Na^+, K^+, and Ca^{++} were estimated by using flame photometer with respective filters. Percentage of element was calculated by using formula of Allen *et al.* (1976). Phosphorus was estimated by spectrophotometer (Allen *et al.*, 1976). Leaf pigments (chlorophyll *a, b* and carotenoids) were estimated according to the method suggested by Arnon (1949) and Robbelen (1957).

Results and Discussion

Analysis of variance (Table 1) revealed highly significant differences among the genotypes for chlorophyll *a*, chlorophyll *b*, crude protein, sodium, potassium, calcium and phosphorus. Chlorophyll *a* among genotypes varied from 5.47 to 10.15 mg L^{-1}, while chlorophyll *b* ranged from 4.77 to 10.01 mg L^{-1} (Table 2). NIC-1968 had the maximum chlorophyll *a* (10.15) and was followed by NIC-1961 (10.01) and NIC-1953 (9.93), while NIC-1961 had the highest content (10.01) of chlorophyll *b* followed by NIC-1953 (9.15) and NIC-1968 (8.38). Total chlorophyll had a wider range as compared to range for chlorophyll *a* and *b*. It varied among genotypes from 10.25 mg L^{-1} to 19.31 mg L^{-1}. NIC-1953 had the highest value (19.31) for total chlorophyll followed by NIC-1961 (18.68) and NIC-1968 (18.53). It was interesting to note that the same genotypes (NIC-1953, NIC-1961 and NIC-1968) with slight change in ranks had higher chlorophyll *a, b* and total chlorophyll. Similarly, IC-104175 had the lowest values of chlorophyll *a, b* and total chlorophyll.

Range for carotenoids among genotypes was narrow and it varied from 1.54 to 3.47 mg L^{-1} with overall mean of 2.50 mg L^{-1}. NIC-1937 had maximum (3.47 mg L^{-1}) carotenoids followed by NIC-1983 (3.44 mg L^{-1}) and NIC-1961 (3.26 mg L^{-1}).

Crude protein contents among genotypes varied from 18.02 to 22.71%. NIC-1866 had the maximum (22.71%) crude protein

Table 1. Analysis of variance for various physico-chemical traits in P. cineraria

Source of variation	df	Mean squares								
		Crude protein	Chl *a*	Chl *b*	Total chl.	Carot-enoids	Sodium	Potass-ium	Calcium	Phos-phorus
Replication	2	0.402	0.225	0.145	1.285	0.103	0.243	0.830	1.25*	0.009
Genotype	39	4.716*	4.575*	3.453*	14.993*	0.848*	2.591*	12.103*	23.98*	0.091*
Error	78	0.329	0.338	0.490	1.252	0.069	0.394	0.509	2.067	0.008

* Significant at P = 0.01.

and was followed by NIC-1937 (22.60%) and NIC-13580 (22.50%). Different concentrations of crude protein in the leaves of *P. cineraria* have been reported (Ganguli *et al.*, 1964, 13.9%; Bhimaya *et al.*, 1964, 14.34% to 17.49%, and Gupta and Mathur, 1974, 6%).

Sodium in *Prosopis* leaves ranged from 2.45 to 7.08 mg g^{-1}. Genotype with lowest values for this trait was NIC-1936, while genotype having highest sodium content was NIC-1921. Sharma (1966) reported a range of 30.5 to 43.5 mg g^{-1} in samples collected at five different sites in Rajasthan. Due to intake of saline water, sodium content in the bodies of animals is already high, consequently they require feed which is low in sodium. Since large amount of variability is present among genotypes for sodium, it should be possible to select low sodium containing genotypes.

Potassium content among genotypes varied from 6.46 to 15.73 mg g^{-1}, NIC-1864 had the highest potassium content (15.73 mg g^{-1}) followed by NIC-1931 (14.58 mg g^{-1}) and NIC-1868 (14.58 mg g^{-1}). Sharma (1966) reported a range of 21.9 to 30.4 mg g^{-1} dry weight in leaves of *P. cineraria*.

A high range of variability existed for calcium among different genotypes of *P. cineraria*. It varied from 10.42 to 22.08 mg g^{-1} with overall mean of 15.92 mg g^{-1} NIC-1864 had the highest calcium content in its leaves. Different values of calcium in leaves of *P. cineraria* have been reported by different workers (Ganguli *et al.*, 1964,

Table 2. Mean, range and top five accessions for various physico-chemical traits in Prosopis cineraria

Trait	Mean	Range	Top five accessions
Chlorophyll *a* mg L^{-1}	8.0	5.47-10.15	NIC (10.15), NIC 1961 (10.0), NIC 1953 (9.93), NIC 1966 (9.64), NIC 1983 (9.61)
Chlorophyll *b* mg L^{-1}	7.13	4.77-10.01	NIC 1961 (10.1), NIC 1953 (9.15), NIC 1983 (8.55), NIC 1968 (8.38), NIC 1969 (8.37)
Total chlorophyll mg L^{-1}	15.09	10.25-19.31	NIC 1953 (19.31), NIC 1961 (18.68), NIC (18.38), NIC 1983 (18.14), NIC 1931 (17.80)
Carotenoids mg L^{-1}	2.50	1.54-3.47	NIC1937 (3.47), NIC 1983 (3.44), NIC 1961 (3.26), NIC 1969 (3.21), NIC 1968 (3.16)
Crude protein (%)	20.78	18.02-22.71	NIC 1866 (22.71), NIC 1937 (22.60), NIC 13580 (22.50), NIC 1935 (22.29), NIC 1936 (22.19)
Sodium mg g^{-1}*	4.61	2.47-7.08	NIC 1936 (2.45), NIC 13549 (3.02), NIC 1931 (3.23), HARIJ (3.75), NIC 1969 (3.77)
Potassium mg g^{-1}	11.31	6.46-15.73	NIC 1864 (15.73), NIC 1931 (14.58), NIC 1868 (14.58), NIC 1904 (14.17), NIC 1848 (13.96)
Calcium mg g^{-1}	15.92	10.42-22.08	NIC 1864 (22.08), NIC 1983 (21.04), NIC 1916 (21.04), NIC 1921 (20.00), NIC 1968 (19.79)
Phosphorus mg g^{-1}	3.09	2.60-3.46	NIC 1965 (3.46), NIC 1904 (3.39), NIC 1961 (3.38), NIC 1878 (3.36), NIC 1920 (3.24)

* Low to high value for sodium.

Table 3. Phenotypic (PCV) and genotypic (GCV) coefficients of variation, heritability (h^2) and genetic advance (GA) for various physico-chemical traits in P. cineraria

Variance component	Characters								
	Crude protein	Chl *a*	Chl *b*	Total chlorophyll	Carote-noids	Sodium	Potassium	Calcium	Phos-phorus
PCV	6.44	16.54	17.05	16.00	22.91	23.00	18.45	19.23	6.13
GCV	5.82	14.85	13.94	14.17	20.34	18.55	17.34	16.97	5.37
h^2 (bs)	0.81	0.80	0.66	0.78	0.78	0.80	0.88	0.77	0.76
GA (%)	9.77	27.48	23.48	25.88	37.26	34.32	33.58	30.86	9.66

19.1 mg g^{-1}; Bhimaya *et al.*, 1964, 19.4 to 20.0 mg g^{-1} and Gupta and Mathur, 1974, 23.2 mg g^{-1}).

Phosphorus had the narrowest range (2.60 to 3.46 mg g^{-1}) with overall mean of 3.09 mg g^{-1}. Earlier reports on phosphorus in leaves of *P. cineraria* are: Ganguli *et al.* (1964) 2.0 mg g^{-1}; Bhimaya *et al.* (1964), 1.60 to 1.8 mg g^{-1}; and Gupta and Mathur (1974) 2.44 mg g^{-1}. In the present study NIC-1965 (3.46 mg g^{-1}) had the highest phosphorus in its leaves.

A look at values of phenotypic (PCV) and genotypic coefficients of variation (GCV), heritability (h^2) and genetic advance (GA) expressed as per cent of mean revealed that, sodium had the highest phenotypic coefficients of variation followed by carotenoids, while phosphorus and crude protein had low PCV (Table 3). Genotypic coefficients of variation was highest for carotenoids. Low values of GCV were observed for phosphorus and crude protein. Estimates of heritability were in general high for all traits, indicating that phenotype was the indicator of the genotype, and influence of environment was lesser on these traits. Genetic advance expressed as per cent of mean selecting the 5% best was highest for carotenoids followed by sodium, potassium and calcium, while other traits, viz., chlorophyll *a*, *b*, and total chlorophyll had moderate values of genetic advance. Genetic advance was somewhat low for crude protein and phosphorus, mainly because of low values of PCV. High heritability coupled with high genetic advance for sodium, potassium, calcium and carotenoids suggested the presence of additive gene action for these traits. Consequently, these traits can be improved by selection. Moderate genetic advance for chlorophyll *a, b* and total chlorophyll was due to low genetic variability for these traits. However, high values of heritability for these traits suggest that selection will be effective in improving these traits to some extent.

Based on the above study, the desirable genotypes would be the one showing high chl *a*, chl *b* and total chlorophyll for better stress tolerance and biomass production, under drought-prone environment, and with low sodium, moderate potassium and high calcium, phosphorus, crude protein and carotenoids for better fodder quality. Since most of the traits except crude protein and

phosphorus had high heritability and genetic advance, these traits and to some extent phosphorus and crude protein also could be improved by direct selection. There is however a need to generate new genetic variability for these traits through hybridization or mutation breeding. Some of the genotypes showing high protein content, low to moderate sodium and high phosphorus were NIC-1936, NIC-1937, NIC-1840, NIC-1961, NIC-1920, NIC-13555 and NIC-13570. Out of these NIC-13555, NIC-13570 and NIC-1961 possessed high calcium content also.

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