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RESEARCH PAPER

Estimation of genetic parameters for fodder yield and yield components in lucerne (*Medicago sativa* L.)

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Abstract: In the present study, seventy lucerne (*Medicago sativa* L.) genotypes were evaluated to assess the genetic variability for ten morphological and yield traits. Besides, screening based on visual scoring was done against rust disease and aphid infestation during *Rabi* 2020-21 at IGFRI, SRRS, Dharwad. The genotypes were significantly different for all the traits studied, which indicated substantial variability. High heritability coupled with high genetic advance was recorded for green fodder yield, dry fodder yield, regeneration ability and leaf to stem ratio, indicating the predominance of additive effects in the inheritance of these characters. The phenotypic coefficients of variation (PCV) were invariably higher than their corresponding genotypic coefficient of variation (GCV), thereby suggesting the environmental influence. High estimates of GCV and PCV were observed for green fodder yield, dry fodder yield and regeneration ability, suggesting that selection for these characters would facilitate the successful isolation of desirable types whereas days to first flowering, days to 50 per cent flowering, days to maturity and plant height had low GCV and PCV, implying that the phenotypic selection for these traits is not desirable. Heritability coupled with genetic advance as a percent of mean was also low for aforementioned traits, indicating that environment had a greater influence on their expression. The study conducted helped to identify the genotypes with superior traits, which is vital in planning a sound breeding programme for developing superior populations or composites.

Key words: Fodder, Genetic advance, Heritability, Lucerne

Introduction

Lucerne is one of the oldest known fodder crops to mankind. Roman writers described its value as feeds for horses and others animals as early as 490 B.C. It is derived primarily from *M. coerulea*, a diploid 2n=16 that grows wild in grasslands of South West Iran, Caucasian region and eastern Anatolia. Lucerne is known as "Queen of forages" because it has high palatability for all kinds of livestock as it provides nutritious fodder and possess about approximately (16-25%) crude protein and (20–30%) fibre. Due to its high protein and vitamin A content, it is included as a feed component for poultry and piggery. It provides green fodder for a longer period (November-June) in northern parts and throughout the year in other parts of the country where winters are not severe.

Lucerne is India's third most significant fodder crop, after sorghum and berseem; as it covers one-million-hectare area and produces 60 to 130 million tonnes of green fodder per hectare per year.Although,Lucerne is originated from temperate region but it can be raised successfully in most of the countries of tropical and subtropical regions.In India it is mainly grown in irrigated areas of Gujarat (19,900 acres), Maharashtra (18,400 acres), Punjab and the western parts of Uttar Pradesh (13,554 acres), Tamil Nadu and West Bengal (Babu *et al*.,2014). It is a perennial herbaceous legume with blooms borne in loose racemes and petals in varying colours of purples and yellows with occasional whites. Each pod includes multiple small kidney-shaped seeds and is twisted with one to five spirals. The pinnately trifoliolate leaves are placed alternately on the stalk. The root system has a distinct taproot that can penetrate the soil up to 7-9 meters under ideal conditions. This quality makes this crop an ideal component of sustainable cropping system under the present conditions of the climate change scenario where the raising water table, soil salinity (Cocks, 2001; Latta *et al*., 2001) and declining productivity becomes the major problems in many countries.

It has high forage production potential coupled with abiotic stress tolerance and is of perennial nature that usually provides 8-10 cuts/year. Furthermore, it has an excellent regeneration potential along with its perennial growth behaviour which makes it highly favourable among the commercial dairy farmers. The efficacy of any breeding programme primarily depends on genetic variation present in the experimental material hence, this study was conducted to assess the existing variability in the experimental material.

Material and methods

The experiment was conducted during *rabi* 2020-21 at IGFRI, SRRS, Dharwad with seventy genotypes along with four checks (Table 1). The material was grown in Randomised Complete Block Design (RCBD), where each entry accommodated in 4 x4 sq. m. plot size containing 13 rows of 4 m length with inter row and plant to plant spacing of 30x 10 cm in two replications. The recommended package of practices was followed to raise a good crop stand. Observations were recorded on five randomly selected plants from each entry on ten morphological traits *viz.,* days to first flowering, days to 50 per cent flowering, days to maturity, plant height(cm), number of branches per plant, leaf to stem ratio, regeneration ability (days), dry matter percent, dry fodder yield (g/m row length) and green fodder yield (g/m row length). The data was analysed using Window Stat for genetic variability study. Genotypic and phenotypic coefficients were calculated using the formulae as used by Burton and De Vane (1953) and Johnson *et al*. (1955). Heritability in broad sense was estimated as suggested by Hanson *et al.* (1956). The expected genetic advance at 5% selection intensity was calculated by the formula as used by Johnson *et al.* (1955). Visual scoring was done to screen the genotypes under natural conditions against rust incidence and aphid infestation. Reaction to rust disease was visually scored by following 0 to 5 scale adopted by Stakman *et al*., 1962. Similarly, the infestation by aphids was also scored visually as per the standard scale 1 to 5 [AICRP (Forage Crop &Utilization)].

Results and discussion

Estimation of genetic parameters

Heritability and GAM: It is evident from the range of mean values for different traits among the genotypes (Table 2) that there is substantial genetic variability. The traits like days to first flowering (58.0- 74.5 days), days to 50 per cent flowering (68.0- 82.0 days), days to maturity (93.0- 111.5 days), plant height (70.0 - 97.3 cm), number of branches per plant (9.25-20.80), leaf stem ratio (0.83-1.68), dry matter percent (19-27%), regeneration ability(1-3days), dry fodder yield(13-77g) and green fodder yield (58.5-369.0 g) showed a wide range of mean values. Genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), broad sense heritability (h^2) and genetic advance as percent of mean (GAM) values are presented in Table2. It was observed that GCV and PCV values were high for traits like green fodder yield, dry fodder yield and regeneration ability, suggesting that phenotypic selection would facilitate successful isolation of superior types. Also, moderate estimates of GCV and PCV values was observed for number of branches per plant, leaf to stem ratio, dry matter yield and green fodder yield, indicating that these traits are primarily controlled by the genetic parameters rather than environment effect. The traits *viz*, days to first flowering, days to 50 per cent flowering, days to maturity and plant height exhibited low GCV values, indicating little scope for improvement of these traits in the material studied.

However, the genetic variability together with heritability estimates would give a better idea on the amount of genetic advance (GAM) expected from selection (Burton 1952). High heritability along with high GAM was recorded for regeneration ability, dry fodder yield and green fodder yield. Langade *et al*., (2013) found that traits having high heritability and high GAM are supposed to be under control of additive genes; hence, these can be improved by selection based on phenotypic performance in berseem for green yield and dry fodder yield. Dry matter percent showed lowest heritability (55.0) followed by plant height (57.57), and hence it is difficult to improve these traits by phenotype guided selection. Traits like days to first flowering and days to maturity recorded high heritability but low values of GAM suggesting the involvement of non-additive gene action in their inheritance (Kumar *et al*., 2015). The study indicated that important traits like dry fodder yield and green fodder yield exhibited high heritability coupled with high PCV suggesting greater scope for selection of these traits on phenotypic basis.

Table 1. List of local populations and F_3 progenies of lucerne

Genotypes	pedigree	source	code
05 lines	Local collections	MAHARASHTRA	G1. G2. G3. G4.G5
15 lines	Local collections	RAJASTHAN	G6, G7, G8, G9, G10, G11, G12, G13, G14, G15,G16, G17, G18, G19, G20
F3 progeny	RL-88 x Weevil Chek	IGFRI, SRRS, Dharwad	G23
F3 progeny	Anand-2 x Weevl Chek (2 lines)	IGFRI, SRRS, Dharwad	G36, G55
F3 progeny	Crau x RL-88 (2 lines)	IGFRI, SRRS, Dharwad	G69, G26
F3 progeny	Dharwar-1x Crau (2 lines)	IGFRI, SRRS, Dharwad	G31, G68
F3 progeny	Maris Kabul x RL-88 (2 lines)	IGFRI, SRRS, Dharwad	G59, G48
F3 progeny	RL-88 x Dry Lander Alfalfa (3 lines)	IGFRI, SRRS, Dharwad	G67, G37, G34
F3 progeny	Anand-2 x Vernal (4 lines)	IGFRI, SRRS, Dharwad	G44, G54, G61, G66
F3 progeny	Crau x Anand-2 (6 lines)	IGFRI, SRRS, Dharwad	G21, G28, G33, G50, G58, G70
F3 progeny	RL-88 x Crau (6 lines)	IGFRI, SRRS, Dharwad	G22, G30, G35, G45, G52, G60
F3 progeny	Crau x Dharwar-1 (8 lines)	IGFRI, SRRS, Dharwad	G24, G29, G42, G46, G49, G51, G56, G65
F3 progeny	Anand-2 x Ohoho (10 lines)	IGFRI, SRRS, Dharwad	G25, G32, G39, G40, G41, G43, G47, G53, G64, G67
DWR-1	Accession	IGFRI, SRRS, Dharwad	G62
Moopa	Accession	IGFRI, SRRS, Dharwad	G27
Polish Ecotype	Accession	IGFRI, SRRS, Dharwad	G38
Crau (OP)	Accession	IGFRI, SRRS, Dharwad	G53
Checks			
Anand-2	Selection from perennial type Lucerne (from Bhuj area of Kutch district)	IGFRI, SRRS, Dharwad	G71
Alamdar-51	Selection from Kutchi lucerne	IGFRI, SRRS, Dharwad	G72
CO-4	Polycross derivative involving CO-1 as one of the parents	IGFRI, SRRS, Dharwad	G73
RL-88	Selection from local Ahmednagar lucerne	IGFRI, SRRS, Dharwad	G74

Rust infection: Visual screening of the genotypes for rust disease revealed, forty-one genotypes were categorized as moderately susceptible and sixteen were categorized as susceptible, whereas nine genotypes are in the moderately resistant category and six are in highly resistant category. Two genotypes were found to be highly susceptible, whereas six were highly resistant. Checks RL-88 and CO-4 had fallen into the category of moderately susceptible, where Anand-2 and Alamdar-51 were moderately resistant (Table 3).

It was observed that majority of the genotypes belonged to moderately susceptible (41) and susceptible (16) category for this disease. Webb and Nutter (1997) reported that prevailing warm moist weather is congineal for the development of rust in lucerne Leyrona *et al*., (2004) reported that powdery rust brown pustules first appear on the lower surface of the leaves, then over the entire leaf surface. In heavy attacks or at the end of the season, stems also gets affected. This disease can lead to significant defoliation and, consequently, affects the seed yield. *Uromyces striatus* spores and /or fungus carry over in live plant tissue to initiate new infections.

Aphid infestation: Lucerne is considered an insectary due to the large number of insects it attracts. The visual screening of the genotypes for aphid infestation showed that thirty-two genotypes were categorized as moderately tolerant and twelve genotypes were categorized as tolerant, whereas seventeen genotypes were in susceptible category and seven genotypes in highly susceptible category. Only two genotypes were categorized as highly tolerant. The checks Anand-2, Alamdar-51 and RL-88 were moderately tolerant and CO-4 found to be tolerant (Table 4).

It was observed that aphid infestation was found severe during the last week of February and entire March months due to favorable climatic condition. In the present study it was found that majority of the genotypes (46) possessed dense

Table 2. Estimation of genetic parameters for different traits in lucerne genotypes

Characters	Mean	Range	GCV (%)	PCV (%)	h^2 (b. s)	GAM (%)
Days to first flowering	64.83	58.0-74.5	5.98	6.78	77.81	10.86
Days to 50 per cent flowering	75.11	68-82	4.07	4.87	69.82	7.01
Days to maturity	101.38	93-111.5	4.28	4.61	85.47	8.17
Plant height (cm)	85.43	70-97.3	5.64	7.44	57.57	8.82
Number of branches per plants	14.9	9.25-20.80	11.8	14.63	65	19.62
Green fodder yield(g/m row length)	157.27	58.5-369.0	37.14	38.48	93.29	73.86
Dry fodder yield(g/m row length)	36.03	13-77	35.79	37.96	88.37	69.49
Dry matter percent	22.94	19-27	5.94	8.55	55	8.55
Leaf to stem ratio	1.24	0.83-1.68	12.98	13.44	92.2	25.85
Regeneration ability (days)	2.23	1-3	24.58	25.6	93.5	50.04

Abbreviations: PCV= Phenotypic coefficient of variation
GCV= Genotypic coefficient of variation
h^2 = heritability (broad sense)
GAM (%) = Genetic advance as percentof mean

Table 3. Reaction of lucerne genotypes to rust disease

Host reaction	Number of genotypes	Genotypes
Highly Resistant	6	G1, G4, G6, G8, G12, G14
Moderately Resistant	9	G9, G13, G19, G38, G44, G50, G68, Anand-2, Alamdar-51
Moderately Susceptible	41	G2, G3, G5, G10, G11, G15, G16, G17, G20, G22, G23, G26, G28, G29, G30, G31, G33, G36, G37, G39, G40, G42, G43, G45, G46, G48, G49, G51, G52, G54, G55, G57, G58, G59, G62, G64, G67, G69, G70, RL-88, CO-4
Susceptible	16	G7, G18, G24, G25, G32, G34, G35, G41, G47, G53, G56, G60, G61, G63, G65, G66
Highly Susceptible	2	G21, G27

Table 4. Reaction of lucerne genotypes to aphid infestation

Host reaction	Number of	Genotypes genotypes
Highly Tolerant	2	G13, G14
Tolerant	12	G4, G5, G8, G9, G10, G11, G12, G22, G23, G32, G62, G63, CO-4
Moderately Tolerant	32	G1, G2, G3, G6, G7, G15, G17, G20, G21, G24, G25, G26, G28, G29, G33, G34, G38, G39, G40, G41, G42, G48, G49, G50, G52, G54, G57, G58, G61, G65, G69, G70, Anand-2, RL-88, Alamdar-51
Susceptible	17	G16, G18, G19, G27, G30, G31, G35, G36, G37, G43, G44, G45, G56, G59, G60, G64, G68
Highly Susceptible	7	G46, G47, G51, G53, G55, G66, G67

glandular hairs on the stems and leaves as a mechanism for insect tolerance. Hence, the moderate infestation of the aphids was noticed in most of the genotypes scored.

Conclusion

The local collections *viz.,* G4, G13, G14, G15, G16, G17, G19 and F_3 lines of Crau x A-2(G21), RL-88 X Crau(G22), RL-88 x WeevlchekC(G23), A-2 x Ohoho(G25), Crau x A-2(G33) and RL-88 x DLA(G34) were found to be superior for yield and yield attributing traits. Selection for taller plants with more number of branches per plant, quick re-growth, high dry fodder yield and tolerance to rust and aphid infestation would be significant for the improvement of green fodder yield in the lucerne genotypes. Thus, selection based on any one of these traits either alone or in combination, could result in identifying high yielding genotypes. Further, the identified superior genotypes could be used in the development of composites or superior populations in future lucerne breeding programmes.

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