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Effect of fertility levels and varieties on growth and forage yield of cluster bean (*Cyamopsis tetragonolobus* L.)

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Abstract
Improper nutrient management under limited moisture condition is considered as major limiting factor for achieving higher productivity of fodder crops. Use of improved varieties in addition to adequate nutrient management has been reported effective in improving the productivity of cluster bean hence an experiment on cluster bean was carried out at the Research Farm, College of Agriculture, R.V.S.K.V.V., Gwalior (M.P.). The experiment was laid out in R.B.D. with 6 fertility levels and two varieties BG-1 and BG-2. Green fodder yield and total green fodder yield were maximum in Variety BG-2 Similarly BG-2 showed higher plant N, P, K and moisture content in green fodder and available N, P, and K in soil over BG-1. 100 % N: 125 % P: 100% K recorded significantly higher plant height, produced higher number of branches, significantly maximum green fodder yield and organic carbon (gm/kg) than rest of other fertility levels. Higher value of available N and P(Kg/ha) in surface soil were noted in 100 % N: 125 % P: 100% K level in surface soil and in fodder. The level125 % N: 125 % P: 100% K recorded maximum N, P and moisture content in green fodder in both cuttings. Maximum potassium content (%) was recorded in 100 % N: 125 % P: 125% K, which is statistically significant over other levels.

Keywords: Productivity, fertility levels, fodder, available N, P and K

Introduction
Clusterbean [*Cyamopsis tetragonoloba* (L.) Taub.] Commonly known as guar, is an annual *kharif arid legume* grown for green fodder, vegetable, green manuring, gum and seed purpose. Being drought tolerant and hardy, the crop is cultivated under rainfed condition in India since ancient time. Agro-ecological condition of India is ideal for guar cultivation. In India, it is grown on an area of 2.23 million hectare with the production of 1.69 million tonnes and the productivity is 491 kg/ha. India is the largest grower and producer country of guar in the world, and the same is grown in the north-western states of India, namely, Rajasthan, Gujarat, Haryana, Punjab and some parts of Uttar Pradesh and Madhya Pradesh. The agro-ecological condition of M.P. is ideal for guar cultivation. In M.P. guar is cultivated as pure crop in 12576 ha and productivity is 316 kg/ha and also as a mixed crop in an area of 54782 ha (C.L.R.S., 2010) [4].

In order to have a good pickup in its early growth, it is essential to apply nitrogen artificially as a starter dose. Cluster bean has a system which can extract the moisture and nutrient from the deeper layer of soil profile in one way and the crop needs only starter dose of nitrogenous fertilizers by having the capacity of fixing atmospheric nitrogen through nitrogen fixing *Rhizobium* bacteria present in their root nodules in other way. Nitrogen improves the yield of cluster bean cultivars by increasing their yield components but non-significant effect on dry matter % was recorded (Modaihsh *et al*., 2007) [6]. Application of phosphorus influences symbiotic nitrogen fixation and increases yield and quality of green pods of cluster bean. Improper nutrient management under limited moisture condition is considered as major limiting factor for achieving higher productivity. Use of improved varieties in addition to adequate nutrient management has been reported effective in improving the productivity of clusterbean in arid zone (Singh *et al.*, 2004). The yield potential of different clusterbean varieties may differ under different agro-climatic conditions because of their inherent capacity. The potassium is the third most important essential nutrient after nitrogen and phosphorus. The

need for potassium to include in fertilization programme was felt after the results of doctrine study of Von Liebig in 1840

Material Method

A field experiment was carried out to evaluate the effect of different fertility levels on forage yield and quality of cluster bean at the Agricultural Research Area, RVSKVV, College of Agriculture, Gwalior in 2016 and 17.Gwalior is situated in Gird zone at the latitude of 26°.13' North and longitude 76°.14' east with an altitude of 211.52 meters from mean sea level in Madhya Pradesh. This region comes under semi-arid sub-tropical climate with extreme weather condition having hot and dry summer and cold winter. Generally, monsoon sets in during the last week of June. Annual rainfall ranges from 700 to 800 mm, most of which falls during last June to the middle of September. The maximum temperature goes up 45°C during summer and minimum as low at 3.8° C during winter. The experiment was laid out in randomized block design (RBD) with three replications, measuring a plot size of 5.0 m x 3.0 m. The soils are very deep, developed on plain to moderately sloping lands rooting depth is better for the purpose of the plant growth, with deeper solum owing to their aeolian nature. Profile study of Agriculture farm was carried out and a composite sample of 20 cm deep soil was used for physical and chemical analysis. The site of the experimental site was sandy clay loam in texture, having 55.6 % sand, 23.8% silt and 20.6 % clay, pH (7.9), EC (0.3 dsm^{-1}), O.C. (3.7 g/kg), Avail N (185kg ha^{-1}), and available P (15kg ha^{-1}) and K (204 kg ha^{-1}). The seed of the cluster bean cv. "BG-1 and BG-2 was obtained from IGFRI Jhansi. The seeds were sown in irrigated soil in well prepared seed bed in 30 cm apart rows. The fertility levels were: 100% NPK; 125% N : 100 % P : 100% K; 125% N : 100 % P : 100% K; 100% N : 100 % P : 125% K; 125% N : 125 % P : 100% K; 100% N : 125 % P : 125% K with two varieties *viz,* BG-1 and BG-2. Phosphorus and potassium were applied in the form of single super phosphate [Ca $(H_2PO_4)_2$ + $CaSO_4$] and potassium sulphate (K_2SO_4), and nitrogen as urea respectively at the time of sowing. A basal dose of 25 kg N ha^{-1} was also applied in the form of urea at the time of seed bed preparation. The total three irrigations were applied to the crop from sowing to harvesting. All other cultural practices were kept normal and uniform for all treatments. The crop was harvested 75 days after sowing at pod formation. The observations like plant height, stem diameter and number of branches per plant were recorded by selecting ten plants randomly from each plot. The plant height was measured with the help of measuring tape from ground level to highest leaf tip.

The stem diameter was measured at bottom, middle and top portions of plant with the help of vernier calliper and then averages were calculated. The leaf area per plant was determined by measuring the leaf area of sub sample (5g) from total leaf mass. The value obtained was then converted to unit mass and was multiplied to measure the total leaf area of the sample. For dry matter % age, the sample was dried in shade and shifted to electric oven at 70°C up to a period till a constant weight was achieved. The dry matter % age was used as tool for measuring the total dry matter yield. A fraction of dry mass was taken and the grinded material was preserved in polythene bags for quality analysis. The well grinded material was passed through a sieve having a pore size of 0.50 mm for quality analysis.

Results and Discussion

Soil properties of the experimental site

The soils of Agriculture farm in RVSKVV, Gwalior were sandy clay loam in texture, its light yellowish brown colour indicate that these were overburden due to aeolion activity. The sand on surface and relatively finer texture in the subsurface might be attributed to the contribution of both Aeolian and fluvial cycle. The structure of the surface horizons in the regions was single grain-granular with weak to moderate strength indicating better association with Aeolian character (Kolarkar *et al.*, 1989) [5]. The subsurface horizons show sub angular blocky structure of weak to moderate strength.

These soils are under cultivation and leaves plentiful of stubble at the surface which are ploughed before sowing of every crop. As such, surface horizons are therefore designated as A_P horizon i.e. plough layer. A mark of pedogenic activity is noted in these soils in the form of structural development reinforced their placement of as B as $Bw_{1, 2, 3}$ due to accumulation of calcium carbonate as nodular forms but not to the extent to Ck horizon. These horizon were designated as C horizons. An irregular soil boundary occasionally wavy is noted between C horizons. This feature indicates the presence of carbonate material and differential dissolution pattern of dissolved lime in these soils. A thorough analysis of data of the soils led to conclusion that parent material is transported and due to its topography it contributed slight amount of carbonate is these soils. The effervescence increased down the depth in these soil pedons.

No effervescence was recorded in surface layer. The subsurface soils have effervescence and are increasing down the depth. These observations implicated an accumulation of calcium carbonate in lower layers. The bulk density varied from 1.36 –1.42 Mgm^{-3}. An increasing trend in bulk density with depth was observed in the present work. In general, the values lower than 1.60 Mgm^{-3} provide a suitable environment for the development of profuse roots and a favourable condition for the movement of air and water within the soil body. The bulk density increases with increase in amount of illuviated clays. High bulk density values of lower horizons were attributed to the accumulation of finer fraction from surface horizons and low organic matter content (Sangwan, 1978). Its increase with depth is apparently associated with decrease in organic carbon, less aggregation, root penetration and compaction caused by overlying burden. Secondary accumulation or orientation of clay in pore space increased bulk density of sub surface horizons.

The distribution of sand, silt and clay helps in evaluating the soils for their productivity potentialities and constraints. It can also be used as one of the criteria for establishing weathering intensity of the soils, as a consequence of weathering under the influence of soil forming processes i.e. as the weathering advances, there is an increase in the finer fractions of particle size class. Hence, information about the distribution of particle size class is essential to understand the pedogenesis and to bring out the most rational acceptable land use plan. Slight increase in silt content in Bw horizon has been recorded which might be due to better moisture storage, in sub-surface horizon of the soils.

The continuous increase in clay content with depth might be due to leaching of clay through percolating rainwater (other source) and partly due to *insitu* weathering. However, illuviation was not enough to mark a zone of illuviation. The pH of soils ranged from 7.8 -8.1, higher pH value in subsurface horizon may be due to high activity of carbonate in

solution as well as in exchange complex. The lower EC values is partially due to relatively lower weathering and partially due to lighter texture. The rating of available phosphorus in all the soils was medium, there is decrease in its availability with increase in pH and it increases with increase in organic carbon. The higher available phosphorus was found in surface soils that decreased with depth. This decrease with depth is ascribed to the increase in P fixation capacity as a result of increase in exchangeable cations and decrease in organic carbon with depth. The available K also showed a decreasing trend with depth. Its increase in surface horizon in ascribed to increase in organic carbon, addition through plant residue, manure and fertilizers. The soils are well supplied with potassium. The pedons were classified as member of mixed (calc.) hyperthermic Typic Haplusterts at family level

The plant height was more in the 1st cut during (55 DAS) as compared to 2nd cut 95 DAS in the fertility level (F5) 125%N: 125% P: 100%K. In first cutting i.e. 55 DAS Variety (BG-2) recorded highest plant height 67.67 cm and lowest plant height recorded was 45.03 cm. In the variety BG-1 highest plant height was 60.30 cm and lowest plant height was 43.57 cm. In second cutting95 DAS Variety BG-2 (V_2) was recorded higher plant height 56.77 cm and lowest plant height was 40.46 cm. In the variety V_1 (BG-1) (Bundel Guar- 1)) plant height was 54.38 cm and lowest plant height was 42.97 cm. (Table 1). Green fodder yield was recorded in 1st cut was done at 55 days after sowing (DAS) and 2nd cut was made 95 DAS. The data on green fodder yield at both cut of crop and total green fodder yield are given in (Table 2 and 3). The result indicated that, the maximum green fodder yield was recorded in Ist cut whereas minimum fodder yield was recorded in IInd cut in both the varieties.

Table 1: Effect of fertility levels and varieties on plant height at successive crop growth stages in green fodder of cluster bean

Treatments	Plant height cm					
	First cutting (55DAS)			Second cutting (95 DAS)		
Fertility Levels	V_1:B G -1	V_2:BG-2	Mean	V_1:BG-1	V_2:B G-2	Mean
F_1: 100% NPK	43.57	45.03	44.30	42.97	40.46	41.72
F_2: 125% N : 100 % P : 100% K	51.33	53.57	52.45	52.79	54.80	53.79
F_3: 100% N : 125 % P : 100% K	45.67	48.40	47.18	47.35	49.67	48.51
F_4: 100% N : 100 % P : 125% K	50.70	51.43	51.07	52.22	51.85	52.03
F_5: 125% N : 125 % P : 100% K	60.30	67.67	63.98	54.38	56.77	55.57
F_6: 100% N : 125 % P : 125% K	52.53	52.33	52.43	51.97	52.79	52.38
Mean	50.68	53.12		50.28	51.06	
	V	F	VXF	V	F	VXF
SEm (±)	0.482	0.834	1.180	0.323	0.560	0.792
CD at 5%	1.412	2.447	NS	NS	1.642	NS

Table 2: Effect of varieties and fertility levels on green fodder yield (t/ha) of cluster bean

Treatments	Green fodder yield (t/ha)					Mean
	First cutting (55 DAS)			Second cutting (95 DAS)		
Fertility Levels	V_1:B G -1	V_2:BG-2	Mean	V_1:BG-1	V_2:B G-2	
F_1: 100% NPK	11.11	13.38	12.25	11.91	12.58	12.24
F_2: 125% N : 100 % P : 100% K	17.70	17.91	17.81	14.78	14.87	14.83
F_3: 100% N : 125 % P : 100% K	14.08	14.11	14.10	12.43	12.85	12.64
F_4: 100% N : 100 % P : 125% K	13.82	14.06	13.94	14.13	14.39	14.26
F_5: 125% N : 125 % P : 100% K	18.04	19.46	18.75	15.80	18.23	17.02
F_6: 100% N : 125 % P : 125% K	15.16	15.24	15.20	14.55	14.59	14.57
Mean	14.99	15.69		13.93	14.59	
	V	F	V X F	V	F	VXF
SEm (±)	0.274	0.475	0.671	0.224	0.388	0.549
CD at 5%	NS	1.392	NS	NS	1.139	NS

Table 3: Effect of varieties and fertility levels on total green fodder yield (t/ha) of cluster bean

Treatments	total green fodder yield (T/ha)		Mean
Fertility Levels	V_1:B G -1	V2: BG-2	
F_1: 100% NPK	23.02	25.95	24.49
F_2: 125% N : 100 % P : 100% K	32.48	32.79	32.64
F_3: 100% N : 125 % P : 100% K	26.51	26.96	26.74
F_4: 100% N : 100 % P : 125% K	27.95	28.45	28.20
F_5: 125% N : 125 % P : 100% K	33.84	37.69	35.77
F_6: 100% N : 125 % P : 125% K	29.71	29.83	29.77
Mean	28.92	30.28	
	V	F	VXF
SEm (±)	0.393	0.681	0.963
CD at 5%	1.154	1.998	NS

Effect of varieties

The green fodder yield was non significantly influenced due to variety at Ist and IInd cut (Table 3).Variety BG-2 (V_2) recorded significantly higher green fodder yield over variety BG-1 (V_1).With respect of total green fodder yield (Table 4), variety BG-2 (V_2) produced significantly higher yield (mean

value) 30.28 t/ha as compared to variety BG-1 (V_1) (28.92 t/ha). The green fodder yield was significantly influenced due to different fertility levels at I[st] and II[nd] cuts. In both cuts fertility level (F_5) 125% N: 125% P: 100%K resulted significantly maximum green fodder yield (mean value) 18.75 and 17.02 t/ha by I[st] and II[nd] cut, respectively than rest of the other fertility levels. Application of 100% NPK of (F_1) - produced minimum (mean value) green fodder yield 12.25 and 12.24 t/ha at I[st] and II[nd] cut, respectively, as compared to other levels. In respect of total forage yield (Table 4), fertility level (F_5) 125%N: 125%P: 100%K gave maximum total green fodder yield (35.77t/ha) which was significantly higher over rest of the fertility levels but statistically at par with (F_2)125% N: 100 % P: 100% K mean value (32.64 t/ha) and fertility level (F_1: 100% NPK) gave minimum total green fodder yield (24.49 t/ha). It is revealed from the results (Table 3) that the application of 125% N: 125 % P: 100% K (F_5) produced maximum green fodder yield (at both cuts, which was significantly superior over all other fertility level but statistically at par with 125% N: 100 % P: 100% K (F_2).The interaction effects due to varieties and fertility levels on green fodder yield of both cuttings were non-significant. Maximum green fodder yield of at both cut was recorded with V_2F_5 (BG-2): 125% N: 125 % P: 100% K followed by V_1F_5 (BG-1) 125% N: 125% P: 100% K which are statistically at par from each other and it was non-significantly influenced over the other combinations

Nitrogen content (%) in fodder

The data on nitrogen content in green fodder of cluster bean in I[st] and II[nd] cuttings were analyzed and are presented in Table 1. In first cutting 55 DAS- Variety BG-2 (Bundel Guar-2) (V_2) was recorded maximum nitrogen content 1.266 while lowest nitrogen content was 0.966 %. Variety BG-1 (Bundel Guar 1) (V_1) recorded maximum nitrogen content 1.217 % and lowest nitrogen content was 0.938 %. In second cutting 95 DAS- Variety BG-2 (Bundel Guar-2) (V_2) recorded maximum nitrogen content was 1.214 % and lowest nitrogen content was 0.904%. Variety BG-1 (Bundel Guar-1) (V_1) maximum nitrogen content was 1.212 % and. lowest nitrogen content was 0.902%. In both cuts variety Bundel Guar-2 (V_2) recorded maximum nitrogen content over to variety Bundel Guar-1 (V_1). It was observed that the nitrogen content %, was non-significant influenced due to variety at I[st] and 2[nd] cut. (Table 4).

Table 4: Effect of varieties and fertility level (NPK) (interaction effect) on nitrogen content (%) in green fodder cluster bean

Treatments	Nitrogen content (%) in fodder					Mean
	First cutting 55 DAS			Second cutting 95 DAS		
Fertility Levels	V_1:B G -1	V_2:BG-2	Mean	V_1:BG-1	V_2:B G-2	
F_1: 100% NPK	0.938	0.966	0.952	0.902	0.904	0.903
F_2: 125% N : 100 % P : 100% K	1.217	1.217	1.217	1.199	1.204	1.202
F_3: 100% N : 125 % P : 100% K	0.945	0.954	0.949	0.904	0.904	0.904
F_4: 100% N : 100 % P : 125% K	0.999	0.978	0.989	0.918	0.921	0.920
F_5: 125% N : 125 % P : 100% K	1.208	1.266	1.237	1.212	1.214	1.213
F_6: 100% N : 125 % P : 125% K	1.122	1.124	1.123	1.147	1.126	1.136
Mean	1.072	1.084		1.047	1.046	
	V	F	VXF	V	F	VXF
SEm (±)	0.005	0.009	0.013	0.003	0.006	0.008
CD at 5%	NS	0.027	NS	NS	0.016	NS

Fertility level (F_5) 125%N: 125%P: 100% K recorded maximum nitrogen content (%) in green fodder over fertility level F_1, i.e. F_1: 100% NPK. Fertility level (F_5) 125%N: 125%P: 100% K resulted significantly maximum percent of nitrogen content in green fodder mean range of 1.237 and 1.213 % at I[st] and II[nd] cut, respectively as compared to other levels. Application of 100% NPK (F_1) showed minimum nitrogen content (%) in green fodder mean range of 0.952 and 0.903 % at I[st] and II[nd] cut, respectively as compared to other levels. It revealed from the results (Table 4) that the application of 125% N: 125 % P: 100% K (F_5):) observed maximum nitrogen content (%) in both cuts, which was significantly superior over all other fertility levels. The interaction effect due to varieties and fertility (NPK) levels on nitrogen content were non-significant. Data (Table – 1) revealed that the 1[st] cutting contained higher value of nitrogen content (%) than 2[nd] cutting in all the fertility levels. The results also collaborate with the findings of (Ayub *et al*. 2010) [2].

Phosphorus content (%) in fodder

In first cutting55 DAS- Variety BG-2 (V_2) recorded maximum phosphorus content 0.279 % while lowest phosphorus content was 0.200%. Variety BG-1 (Bundel Guar 1) (V_1) recorded maximum phosphorus content 0.277 % and lowest phosphorus content was 0.198 %. In second cutting95 DAS- Variety BG-2 (V_2) was recorded maximum phosphorus content was 0.259% while lowest phosphorus content was 0.185%. Variety BG-1 (V_1) recorded maximum phosphorus content was 0.257 % and. lowest phosphorus content was 0.181 %. In all two cuts variety Bundel Guar-2 (V_2) recorded maximum phosphorus content over to variety Bundel Guar-1 (V_1). It was observed that the phosphorus content % was non-significant influenced due to variety at I[st], and2[nd] cut respectively. Fertility levels (F_5) 125%N: 125%P: 100% K recorded maximum phosphorus content (%) in green fodder over fertility levels F_1, i.e. F_1: 100% NPK. Fertility levels (F_5) 125%N: 125%P: 100% K resulted significantly maximum the per cent of phosphorus content in green fodder mean value of 0.278 % and 0.260% at I[st] and II[nd] cut, respectively as compared to other levels. Application of 100% NPK (F_1) showed minimum phosphorus content (%) in mean value of green fodder 0.199% and 0.183 % at I[st] and II[nd] cut, respectively as compared to other levels. It revealed from the results (Table 2) that the application of 125% N: 125 % P: 100% K (F_5) observed maximum phosphorus content % in both cuts, which was significantly superior over all other treatments. At both cut, maximum phosphorus content was recorded with V_2F_5 (BG-2: 125% N: 125 % P: 100% K) followed by V_1F_5 (BG-1: 125% N: 125 % P: 100% K).The intraction effect due to varieties and fertility (NPK) levels on phosphorus content were non-significant. Data (Table 5)

revealed that the phosphorus content (%) was highest was 1st cutting contained was higher than 2nd cutting in all the treatments. Similar results in respect of the effect of nutrients have been reported by (Bhadoria and Kushwah 2005 and Yadav *et al.,* 2014) [3, 10].

Table 5: Effect of varieties and fertility level (NPK) (interaction effect) on Phosphorus content (%) in green fodder of cluster bean

Treatments	Phosphorus content (%) in fodder					Mean
	First cutting			Second cutting		
Fertility Levels	V_1:B G -1	V_2:BG-2	Mean	V_1:BG-1	V_2:B G-2	
F_1: 100% NPK	0.198	0.200	0.199	0.181	0.185	0.183
F_2: 125% N : 100 % P : 100% K	0.251	0.254	0.252	0.230	0.234	0.232
F_3: 100% N : 125 % P : 100% K	0.256	0.260	0.258	0.243	0.245	0.244
F_4: 100% N : 100 % P : 125% K	0.181	0.183	0.182	0.167	0.175	0.171
F_5: 125% N : 125 % P : 100% K	0.277	0.279	0.278	0.261	0.258	0.260
F_6: 100% N : 125 % P : 125% K	0.264	0.268	0.266	0.257	0.259	0.258
Mean	0.238	0.241		0.223	0.226	
	V	F	VXF	V	F	VXF
SEm (±)	0.001	0.002	0.003	0.001	0.002	0.003
CD at 5%	NS	0.006	NS	NS	0.005	NS

Potassium content (%) in fodder

In first cutting 55 DAS- Variety BG-2 (V_2) recorded maximum potassium content 1.139 % while lowest potassium content was 0.867 %.Variety BG-1 (V_1) recorded maximum potassium content 1.121% and lowest potassium content was 0.848 %. In second cutting95 DAS- Variety BG-2) (V_2) recorded maximum potassium content 1.089% while lowest potassium content was 0.825 %.Variety BG-1 (V_1) recorded maximum potassium content was1.088 % and lowest potassium content was 0.804 %.In both cuts variety. Bundel Guar-2 (V_2) recorded maximum potassium content over to variety Bundel Guar-1 (V_1). It was observed that the potassium content (%) showed significant difference due to variety at Ist and 2nd cut. Fertility level F_6: 100% N: 125 % P: 125% K maximum potassium (%) in green fodder over fertility level F_1, i.e. F_1: 100% NPK. Fertility levels F_6: 100% N : 125 % P : 125% K resulted significantly maximum the per cent of potassium content mean value of green fodder 1.130 % and 1.089 % at Ist and IInd cut, respectively as compared to other levels. Application of 100% NPK (F_1) showed minimum potassium content (%) mean value of green fodder 0.857 % and 0.815 % at Ist and IInd cut, respectively as compared to other levels. It revealed from the results (Table 6) that the application of F_6: 100% N: 125 % P: 125% K observed maximum potassium content (%) in both cuts, which was significantly superior over all other treatments. At both cut, maximum potassium content was recorded with V_2F_6 (BG-2: 100% N: 125 % P: 125% K) followed by V_1F_6 (BG-1 : 100% N : 125 % P : 125% K). The interaction effect due to varieties and fertility (NPK) levels on potassium content were non-significant by 1st cut, but it was showed that significant by 2nd cut. Data (Table –3) revealed that in 1st cutting contained higher value of potassium content (%) than 2nd cutting in all the treatments. Similar results in respect of the effect of nutrients have been reported by Ayub *et al.,* (2012) [1].

Table 6: Effect of varieties and fertility levels (NPK) (interaction effect) on Potassium content (%) in green fodder of cluster bean

Treatments	Potassium content (%) in fodder					Mean
	First cutting			Second cutting		
Fertility Levels	V_1:B G -1	V_2:BG-2	Mean	V_1:BG-1	V_2:B G-2	
F_1: 100% NPK	0.848	0.867	0.857	0.804	0.825	0.815
F_2: 125% N : 100 % P : 100% K	0.914	0.927	0.921	0.904	0.913	0.908
F_3: 100% N : 125 % P : 100% K	1.064	1.069	1.066	0.904	0.911	0.908
F_4: 100% N : 100 % P : 125% K	1.104	1.107	1.106	1.065	1.071	1.068
F_5: 125% N : 125 % P : 100% K	0.986	1.014	1.000	0.973	0.986	0.979
F_6: 100% N : 125 % P : 125% K	1.121	1.139	1.130	1.088	1.089	1.089
Mean	1.006	1.020		0.956	0.966	
	V	F	VXF	V	F	VXF
SEm (±)	0.002	0.003	0.005	0.001	0.001	0.002
CD at 5%	0.006	0.010	NS	0.002	0.004	0.005

Conclusion

The application of PK is essential for production of more dry matter from cluster bean with excellent forage quality traits. The K application must not be skipped from the fertilization programme as P alone is not sufficient to improve the dry matter production and forage quality. Among the forage quality, the protein was more responsive to PK application than others.

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