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Lalit Krishna Yadav
Ph.D. Scholar, Department of Soil Science and Agril. Chemistry, CSAUAT, Kanpur, Uttar Pradesh, India

Suresh Kumar
Assistant Professor, Department of Soil Science and Agril. Chemistry, NDUAT, Faizabad, Uttar Pradesh, India

Pramod Kumar
Ph.D. Scholar, Department of Agronomy, CSAUAT, Kanpur, Uttar Pradesh, India

Yogesh
Ph.D. Scholar, Department of Agronomy, NDUAT, Faizabad, Uttar Pradesh, India

Ashok Kumar
Ph.D. Scholar, Department of Soil Science and Agril. Chemistry, CSAUAT, Kanpur, Uttar Pradesh, India

Rajesh Kumar
Ph.D. Scholar, Department of Soil Science and Agril. Chemistry, CSAUAT, Kanpur, Uttar Pradesh, India

Correspondence
Lalit Krishna Yadav
Ph.D. Scholar, Department of Soil Science and Agril. Chemistry, CSAUAT, Kanpur, Uttar Pradesh, India

Studies on effect of different doses of single super phosphate on growth, forage yield and economics of cowpea (*Vigna Unguiculata* L.) entries in eastern Utter Pradesh

Lalit Krishna Yadav, Suresh Kumar, Pramod Kumar, Yogesh, Ashok Kumar and Rajesh Kumar

Abstract
An experiment consisting of four entries(E_1-TNFC-0926, E_2-Bundel lobia-1, E_3-UPC-5286 and E_4-UPC-622) and three single super phosphate levels (F_1-190, F_2-375 and F_3-560 kg ha^{-1} SSP) was laid out in randomized block design in factorial mode to find out the response of ''Studies on effect of entries and different doses of single super phosphate on growth, forage yield and economics of cowpea (*Vigna Unguiculata* L.)''. The maximum growth attributes *viz*., plant height, number of branches $plant^{-1}$, dry matter production and yield (Green forage yield 175.91 and dry matter yield 27.27q ha^{-1}) were recorded with application of 560 kg SSP ha^{-1}(F_3)which was significantly superior over F_1 and being statistically at par with application of 375 kg SSP ha^{-1} (F_2). Among the entries maximum growth attributes *viz*., plant height, number of branches $plant^{-1}$, dry matter production and yield (Green forage yield 170 q ha^{-1} and dry matter yield 22.67 q ha^{-1}) were recorded with UPC-5286 (E_3) entry which was significantly superior over E_1 and E_2 and being statistically at par with E_4. The maximum gross income was calculated with E_3F_3: 28065 and net income with E_3F_2: 13289. However, highest benefit cost ratio (0.84) was obtained with treatment combinations E_3F_2: UPC- 5286+ 375kg SSP ha^{-1}.
Thus, the recommendation of F_2 (375 kg SSP ha^{-1}) and E_3 (UPC-5286) be made to the farmers of eastern (U.P.) for successful cultivation of forage crop cowpea in *kharif* season.

Keywords: Single super phosphate, cowpea, forage yield and entries

1. Introduction
India sustains about 15% of the world's livestock population and 17% of world human population from 2.3% of world geographical area and 4.2% of world's water resources (Kumar *et al*, 2012) [9]. Livestock production is backbone of Indian agriculture contributing 7% to national GDP and source of employment and livelihood for 70% population in rural areas (Kumar *et al*, 2012) [9].
Among cultivated forage crops Cowpea (*Vigna unguiculata* L.) is the most important leguminous forage crop suitable for both summer and rainy season, due to its-quick growing habit, high yielding ability and energy rich nutrition forage, is a valuable forage crop. Cowpea commonly known as 'lobia'is used as a pulse, fodder and green manure crop.
Cowpea forage is usually superior to other forage legumes in terms of both quantity and quality. It is also referred as the crop of hungry season owing to its harvesting before cereals during summer. Cowpea has been reported to yield significantly less green biomass in comparison with cereal forages which is not sufficient to feed dairy animals during summer. However, cowpea forage is superior in quality (higher protein contents and dry matter digestibility), therefore enhances fattening of animals along with improving milk production. The crop also plays an important role in biological nitrogen fixation, by fixing considerable amounts of nitrogen (N) biologically in the range of 11-25 kg N ha^{-1} $year^{-1}$ (Sanginga *et al*., 2000) [14] with subsequent residual effect of nitrogen on succeeding crops.
Legumes are phosphorus loving plants; they require phosphorus for growth and seed development and most especially in nitrogen fixation which is an energy-driving process. Phosphorus is a necessary nutrient for the biosynthesis of chlorophyll. Phosphorus as a constituent of cell nucleus is essential for cell division and development of meristematic tissue. Phosphorus deficiencies lead to a reduction in the rate of leaf expansion and photosynthesis

Phosphorus deficiencies lead to a reduction in the rate of leaf expansion and photosynthesis per unit leaf area hence reduction in fodder yield.
It is considered to be the most important nutrient for growth, better nodulation and higher nitrogen fixation of legume like cowpea as reported by Ram and Dixit (2000) [13]. It is an important structural component of many bio-chemicals including nucleic acids. Nodulation and nitrogen fixation are also influenced by phosphatic fertilizers reported by Sharma and Singh (1990) [3]. Phosphorus is critical to cowpea yield because it is reported to stimulate growth, initiate nodule formation as well as influence the efficiency of the rhizobium-legume symbiosis (Haruna and Aliyu, 2011) [4].
The importance of phosphorus in the maintenance of the soil fertility and improving crop productivity is well recognized. Application of phosphorus is therefore recommended for cowpea production on soils low in phosphorus. Careful application of phosphorus fertilizer to legumes is geared towards enhancing not only their growth and yield, but also nitrogen fixation.
One of the options of reducing low yields due to soil phosphorus content is to determine the best level of phosphorus fertilizer; as single super phosphate (SSP) so as to increase yield and returns from cowpea.

2. Materials and Methods

A field experiment on ''Studies on effect of entries and different doses of single super phosphate on growth, forage yield and economics of cowpea (*Vigna Unguiculata* L.)'' was conducted during *Kharif* 2015 at Plant Breeding Research Farm, Narendra Deva University of Agricultural and Technology, Kumarganj, Faizabad (U.P.). The experimental site was silt-loam in texture andslightly alkaline in reaction (8.60 pH), high in organic carbon (2.9 %), low in available nitrogen (164.50 kg ha^{-1}), Medium in available phosphorus (16.5 kg ha^{-1}) and potassium (206.80 kg ha^{-1}). The experiment was laid out in factorial RBD with three different doses of SSP and four entries (varieties) and replicated thrice.
The recommended dose of phosphorus as per recommendation and 20 kg N was applied through urea and single super phosphate, respectively. The entire recommended dose of nitrogen @ 20 kg ha^{-1} was applied through urea on the basis of nitrogen content uniformly in all the treatments, basal application of SSP doses were applied as per treatments.

3. Results and Discussion

A Growth parameter

1) Plant height

The effect of entries and phosphorus fertilizer (SSP) had significant effect on plant height at all the growth stages of crop but non-significant effect observed in the relationship between the entries and SPP levels and is presented in Table-1. Plant height is a reliable index of growth of the plant particularly fodder crops, which represents the infrastructure build-up over a period of time. The highest plant height (42.53, 93.90 and 136.70 cm. respectively) was observed under F_3 (560 SSP kg ha^{-1}) being statically at par with F_2 (375 kg SSP ha^{-1}) at 30 DAS, 45 DAS and cutting stage and which was significantly superior over F_1 (190 kg SSP ha^{-1}) while among the entries the highest plant height was recorded with E_3 entry (UPC-5286) being statistically at par with E_4 (UPC-622) at 30, 45 DAS and at cutting (70 DAS) and significantly superior over the remaining entries E_1 (TNFC-0926) and E_2 (Bundel Lobia-1) at 30, 45 and 70 DAS of crop growth.
Plant height was significantly increased by the application of phosphorus fertilizer. The increase in plant height due to phosphorus application may be ascribed to its favourable effect on cell division and enlargement, which ultimately reflected in terms of increased plant height. Similar findings were also observed by Meena *et al.* (2014) [10].

2) Number of branches plant^{-1}

The effect of entries and phosphorus fertilizer (SSP) on plant height is presented in Table-1. Phosphorus fertilizer application to the cowpea entries had a positive effect on the number of branches plant^{-1} produced. There was a significant effect in the number of branches by the cowpea varieties and phosphorus treatments as affected by phosphorus fertilizer application in all the stages of the crop growth. The interaction between entries of cowpea used and phosphorus treatment was having non-significant effect at all the stages of crop growth.
The maximum number of branches plant^{-1} was recorded with F_3 (560 SSP kg ha^{-1}) being significantly superior over F_1 (190 SSP ha^{-1}) and statistically at par with F_2 (375 kg SSP ha^{-1}) at 30, 45 DAS and at cutting stage (70 DAS) while among the entries of cowpea forage crop the maximum number branches plant^{-1} (3.82, 6.00 and 6.34 respectively) was recorded with E_3 (UPC-5286) at 30, 45 and 70 DAS at cutting which was significantly higher over with E_1 (TNFC-0926) and E_2 (Bundel Lobia-1) and being statistically at par with E_4 (UPC-622) at all growth stages.
Number of branches plant^{-1}was significantly increased by the application of phosphorus fertilizer. This result is also conformity to the results observed by Krasilnikoff *et al*. (2003) [8] and Nyoki *et al*. (2013) [12]. This could be attributed to the fact that phosphorus is required in large quantities in shoot and root tips where metabolism is high and cell division is rapid (Ndakidemi and Dakora, 2007) [11]. The increased in number of branches in entry UPC-5286 might be due to its genetic character.

3) Dry matter accumulation plant^{-1} (g)

Data regarding dry matter accumulation plant^{-1} as affected by different doses of SSP and entries have been presented in Table-2. Phosphorus had positive effects on total aboveground dry matter, the interactions between cowpea varieties and phosphorus treatments on total aboveground dry matter were significant but interaction effect of entries and different doses of SSP on dry matter accumulation plant^{-1} was found non-significant at all stages of crop growth.
The maximum dry matter accumulation plant^{-1} was recorded F_3 (560 SSP kg ha^{-1}) which was significantly higher over F_1 (190 SSP ha^{-1}) at all stages of crop growth and being statistically at par with F_2 (375 kg SSP ha^{-1}) at 30, 45 DAS and at stage of cutting (70 DAS) while among the entries of cowpea forage crop the maximum dry matter accumulation plant^{-1} (22.81, 26.32 and 35.10, respectively) was recorded with E_3 (UPC-5286) at 30, 45 DAS and at cutting which was significantly higher over E_1 (TNFC-0926) and E_2 (Bundel Lobia-1) which was statistically at par with E_4 (UPC-622) at all growth stages of crop.
Crop dry matter is directly proportion to total biological yield. This might be due to higher collective contribution of various growth characters like plant height, number of branches plant^{-1}, leaf area index and yield of vegetative part. Similar findings were reported by Bhilare and Patil (2002) [2]. This was due to more assimilation and utilization of available phosphorus by the growing plants during the entire grand growth period.

B YIELD

1) Green forage yield (q ha^{-1})

The result of the effects of phosphorus fertilizer on green forage yield is presented on Table -2. Phosphorus fertilizer enhanced the green forage yield. There were variations among the cowpea entries in responses of green forage yield to phosphorus application have significant difference was observed in all varieties. The non-significant effect was also observed in the relationship between the entries and phosphorus treatments.

Green fodder yield is one of the most important factors to determine the efficacy of any agronomic management practices. Increasing the level of P2O5 from 0 to 60 kg/ha, significantly increased the green fodder yield of cowpea over 0 and 40 kg P2O5/ha. Maximum green fodder yield (Table 2) was observed with application of 80 kg P2O5/ ha (281.7 q/ha), which is statistically at par to 60 kg/ha (276.4 q/ha) application of P2O5, and the minimum yield was obtained in control (177.6 q/ha). This might be due to the fact that phosphorus is the key plant nutrient involved in energy transfer in the plant chemical reactions (Prasad, 2007).

The maximum green forage yield (175.91 q ha^{-1}) was recorded with F_3 (560 SSP kg ha^{-1}) which was significantly higher over F_1 (190 SSP ha^{-1}) and being statistically at par with F_2 (375 kg SSP ha^{-1}) at cutting stage (70 DAS) while among the entries of cowpea forage crop the maximum green forage yield (175.50 q ha^{-1}) was recorded by E_3 (UPC-5286) at cutting stage (70 DAS) which was significantly higher over E_1 (TNFC-0926) and E_2 (Bundel Lobia-1) (160.00 and 154.48 respectively) and statistically at par with E_4 (UPC-622) (169.90) at cutting stage (70 DAS).

Application of phosphorus resulted better improvement of growth and development process which ultimately lead to higher yield of forage cowpea crop. These were found to be significantly different at 0.05 level of significance and this is in conformity with the findings of other workers (Haruna and Usman, 2013; Nyoki *et al*., 2013; Singh *et al*., 2011) [12] who also discovered significant increase in yield of cowpea in response to phosphorus application. The highest green and dry forage yield in entry UPC-5286 might be due to its genetic character and ability to utilize all the growth resources significantly.

2) Dry matter yield (q ha^{-1})

The result of the effects of phosphorus fertilizer on dry forage yield is presented on Table 2. Phosphorus fertilizer enhanced the dry forage yield. There were variations among the cowpea entries in responses of dry forage yield to phosphorus application have significant difference was observed in all varieties. The non-significant effect was also observed in the relationship between the entries and phosphorus treatments.

The highest dry matter yield was recorded with F_3 (560 SSP kg ha^{-1}) which was significantly higher over F_1 (190 SSP ha^{-1}) and statistically at par with F_2 (375 kg SSP ha^{-1}) at cutting stage (70 DAS) while among the entries of cowpea forage crop the maximum dry matter yield (27.20) was recorded with E_3 (UPC-5286) at cutting stage (70 DAS) which was significantly higher over E_1 (TNFC-0926) and E_2 (Bundel Lobia-1) (24.80 and 23.94 respectively) and statistically at par with E_4 (UPC-622) (26.33) at cutting stage (70 DAS).

C Economics

The economics of various treatment combinations was calculated and compared in term of net income per rupee invested. On average market rate of Rs. 150 q^{-1} of forage cowpea was used for calculating the gross income. Net income (`ha^{-1}) and benefit cost ratio have been presented in Table-3.

The data showed that the highest cost of cultivation E_4F_3 (Rs.16588) was calculated with the (UPC-622 and 560 kg SSP ha^{-1}) which closely followed by the treatment E_3F_3 (16388) and E_1F_3 (16188) whereas highest gross income Rs. 28065 ha^{-1} was noted with E_3F_3 (UPC-5286 and 560 kg SSP ha^{-1}) treatment. The net income Rs. 13289 was obtained due to the application of E_3F_2 (UPC-5286 entry and 375 kg SSP ha^{-1}). The maximum benefit-cost ratio (0.84) was observed in E_3F_2 (UPC-5286 entry and 375 kg SSP ha^{-1}) treatment whereas the minimum B-C ratio was observed in treatment E_2F_3 (0.52).

The variation in the cost of cultivation was found due to various SSP doses because it was the major input which caused differences in net income and net return per rupee invested (Benefit-Cost ratio).

Maximum gross income Rs. 28056 was found under the application of 560 kg SSP ha^{-1} and UPC-5286 (E_3F_3) followed by (Rs. 27827 and 27180 respectively) with the application of 190 kg SSP ha^{-1} and 560 kg SSP ha^{-1} (E_3F_2). This is due to higher production of forage yield.

The highest net return (Rs.13289) was found with the application of UPC-5286 and 375 kg SSP ha^{-1} closely followed by (Rs. 11677 and 11644 respectively) 190 kg SSP ha^{-1} and 560 kg SSP ha^{-1}. This might be due to higher cost of cultivation.

Highest benefit-cost ratio (0.84) in UPC-5286 and 375 kg SSP (E_3F_2) might be because of comparatively higher gross and net return. These result also inlined with the findings of Sasode and Patil (2003) [15] and Chandrika*et al.* (2012).

Table 1: Effect of entries and SSP doses on growth parameters of forage cowpea crop

Treatments	Plant height (cm)			No. of branches $plant^{-1}$		
	30 DAS	45 DAS	70 DAS (at cutting)	30 DAS	45 DAS	70 DAS (at cutting)
Entries						
E_1 (TNFC-0926)	39.30	79.07	117.17	3.50	5.55	5.85
E_2 (Bundel Lobia-1)	37.73	71.63	107.42	3.40	5.38	5.65
E_3 (UPC-5286)	43.50	98.35	142.53	3. 82	6.00	6.34
E_4 (UPC-622)	40.90	90.93	132.83	3.70	5.85	6.18
SEm±	1.12	1.88	2.63	0.08	0.11	0.14
C D (P=0.05)	3.28	5.53	7.72	0.24	0.34	0.43
SSP dose (kg ha^{-1})						
F_1 190 (30)	38.70	76.10	113.29	3.45	5.44	5.75
F_2 375 (60)	40.60	84.99	124.98	3.60	5.70	6.01
F_3 560 (90)	42.53	93.90	136.70	3.76	5.95	6.26
SEm±	0.97	1.63	2.28	0.07	0.10	0.12
C D (P=0.05)	2.84	4.79	6.69	0.21	0.30	0.37
ExF	NS	NS	NS	NS	NS	NS

Table 2: Effect of entries and SSP doses on dry matter and yield of forage cowpea crop

Treatments	Dry matter accumulationplant^{-1} (g)			Yield (q ha^{-1})	
	30 DAS	45 DAS	70 DAS (at cutting)	Green forage yield	Dry forage yield
Entries					
E_1 (TNFC-0926)	20.8	24.00	32.00	160.00	24.80
E_2 (Bundel Lobia-1)	20.08	23.17	30.8	154.48	23.94
E_3 (UPC-5286)	22.81	26.32	35.10	175.50	27.20
E_4 (UPC-622)	22.08	25.48	33.98	169.90	26.33
SEm±	0.27	0.47	0.73	3.897	0.636
C D (P=0.05)	0.81	1.43	2.16	11.429	1.864
SSP dose (kg ha^{-1})					
F_1 190 (30)	19.61	22.63	30.18	150.90	23.39
F_2 375 (60)	21.85	25.21	33.62	168.10	26.06
F_3 560 (90)	22.86	26.38	35.18	175.91	27.27
SEm±	0.53	0.40	0.63	3.375	0.551
C D (P=0.05)	1.61	1.22	1.87	9.897	1.615
ExF	NS	NS	NS	NS	NS

Table 3: Economics of different treatment combinations

Treatment	Cost of Cultivation (ha^{-1})	Gross Income (ha^{-1})	Net income (`ha^{-1})	Benefit – Cost Ratio
E_1F_1	12488	22952	10464	0.75
E_1F_2	14338	25457	11119	0.70
E_1F_3	16188	25590	9402	0.58
E_2F_1	12488	21195	8707	0.69
E_2F_2	14338	23610	9272	0.64
E_2F_3	16188	25712	9524	0.52
E_3F_1	12688	24332	11644	0.83
E_3F_2	14538	27827	13289	0.84
E_3F_3	16388	28065	11677	0.71
E_4F_1	12888	23310	10422	0.80
E_4F_2	14738	25965	11227	0.76
E_4F_3	16588	27180	10592	0.63

4. Conclusion

From results of experiment, it may be concluded that application of 375 kgha^{-1} SSP with entry UPC-5286will better both in terms of growth, yield and economics of fodder cowpea. Use of balanced dose of single super phosphate is necessary for better quality, productivity and higher net returns of forage cowpea.

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