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Effect of Organic and Inorganic Nutrient Sources on Yield and Quality of Fodder Cowpea [*Vigna unguiculata* (L.) Walp.]

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ABSTRACT

A field experiment was conducted to ascertain the effect of organic and inorganic nutrient sources on yield and quality of fodder cowpea [*Vigna unguiculata* (L.) Walp.] during *kharif,* 2017 at Research Farm of Agronomy Section, ICAR- National Dairy Research Institute, Karnal. The experiment was laid out in Randomized Block Design with twelve nutrient combinations and replicated thrice. Nitrogen, phosphorus, potassium was applied in the form of urea, SSP and MOP, respectively and four different biofertilizers were used viz. rhizobium, phosphate solubilizing bacteria (PSB), potassium solubilizing bacteria (KSB) and zinc solubilizing bacteria (ZnSB). Application of RDF (N,P,K) along with biofertilizers (Rhizobium, Phosphorus Solubilizer Bacteria, Potassium Solubilizer Bacteria and Zinc Solubilizer Bacteria) Treatment [T_6] gave significantly (P<0.05) higher green fodder yield (334.5 q ha^{-1}), Dry matter content (17.80%) and dry matter yield (59.5 q ha^{-1}). Application of 2/3rd RDF along with biofertilizers (Rhizobium, PSB, KSB and ZnSB), [T_7] significantly (P=0.05) enhanced the quality parameters of fodder cowpea like crude protein (18.30 %), ether extract (3.48%) and total ash content (8.82%) while insoluble crude protein (NDICP and ADICP), organic matter and fiber fractions (NDF, ADF, ADL) were significantly (P<0.05) lowered. However, lignin content was comparable among the treatments. Therefore, it is concluded that reduction of one third RDF along with additional biofertilizers gave more improved quality fodder than rest of the treatments.

Keywords: Biofertilizers, Chemical composition, Fodder cowpea, Nutrient sources, Yields

INTRODUCTION

India has the largest livestock population of 512.05 million heads which is about 15 per cent of the world's livestock. India accounts for 57 per cent of world's buffaloes, 14 per cent of the world's cattle, 15 per cent of the world's goats and 5 per cent of world's sheep population (Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture. GOI, 2012). India faces an acute shortage of green fodder. To overcome this scarcity, dairy farmers' increases the use of costly concentrate feeds which ultimately increase the cost of production. Inadequate availability of forages both quantitatively and qualitatively had adversely affected the growth, health, reproduction and production potential of animals. Thus, improved productivity and qualitative fodder production are important issues to the farmers. Cowpea can grow as a sole and mixed crop with kharif cereals that may contribute to fulfillment of the nutrition requirement of the livestock by providing high protein supplement. Cowpea is the most important kharif leguminous fodder which has 15-18% protein and 18-22% crude fiber in their vegetative parts i.e. used as green fodder for the livestock.

Cowpea is one of the important kharif leguminous crop grown in India and is used for grain, fodder, green manuring purpose. The crop gives such a heavy vegetative growth and covers the ground so well that it checks the soil erosion in problematic areas and can later be ploughed in as a green manure. However, cowpea being a leguminous crop, it is a soil remunerative crop due to its atmospheric nitrogen fixing capacity by nodule formation. Because of that it requires minimum fertilization especially nitrogen as a starter dose for starting the nodulation process. However, yield potential of cowpea can be exploited by the application of adequate amount of nutrients required by the legumes. Next to nitrogen, phosphorus is also important plant nutrient which is needed by the leguminous crop for rapid and healthy root development. Micro nutrient like zinc is deficient in most part of India

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specifically western region (Singh *et al*., 2007). Some investigators reported that seed inoculation with nitrogen fixer like rhizobium could improve the growth, yield and yield attributes of legume crops (Saleh *et al*., 2000; El-Habbasha *et al*., 2007). They further reported that integration of bacterial inoculation (PGPR) with inorganic fertilizers improved the yield as well as chemical traits of the produce. Other than these, most easily available organic manure like farm yard manure (FYM) also plays a greater role in fodder production as a supplemental source with inorganic fertilizers. An appropriate fertilizer management schedule is of paramount importance to ensure maximum yield and quality of fodder cowpea. Hence, this investigation was undertaken to study the effect of different nutrient sources designed in RBD to assess the yield and quality of the fodder cowpea.

MATERIALS AND METHODS

This experiment was conducted in kharif season of 2017 at Research Farm of Agronomy Section, ICAR-National Dairy Research Institute, Karnal, located in north western zone of Haryana state. This region comes under trans-gangetic agro climatic zone and climate was subtropical with extreme temperature variation. This zone receives rainfall from both southwest and northeast monsoons and the mean annual rainfall is about 707 mm of which major portion (about 574 mm) is received during the monsoon season (July to September) and rest during winter and spring seasons. The soil of this experimental field was clay loam in nature and the fertility was described in neutral pH (7.1), medium in organic carbon (0.61%), low in available N (175.6 kg ha^{-1}), medium in available P (20.8 kg ha^{-1}), medium in available K (212.6 kg ha^{-1}) and low in Zn concentration (0.432 ppm). The experiment was laid out in Randomized Block Design with twelve nutrient combinations and replicated thrice with gross plot size of 6.5 m × 5.5 m and net plot size of 6 m × 5 m. Sowing was done in leveled plots at a row spacing of 30 cm. Forty kg/ha seed rate of cowpea variety C-152 was used and sown on 18th July, 2017 manually in furrow and covered. Fodder cowpea variety (C-152) taken as a test crop, Nitrogen, phosphorus and potassium was applied in the form of urea, SSP and MOP, respectively. Four different biofertilizers were used *viz.* rhizobium, phosphate solubilizing bacteria (PSB), potassium solubilizing bacteria (KSB) and zinc solubilizing bacteria (ZnSB). These biofertilizers were procured from Division of Microbiology, ICAR- Indian Agricultural Research Institute, New Delhi. The twelve treatments are: (Control ($N_0P_0K_0$) [T_1]; RDF ($N_{20}P_{60}K_{40}$) [T_2]; RDF+PSB [T_3]; RDF+KSB [T_4]; RDF+ZnSB [T_5]; RDF+Rhizobium+PSB+KSB+ZnSB [T_6]; 2/3rd RDF+Rhizobium+PSB+KSB+ZnSB [T_7]; 15 kg N+60 kg P_2O_5+40 kg K_2O ha^{-1}+Rhizobium [T_8]; 10 kg N+60 kg P_2O_5+40 kg K_2O ha^{-1} +Rhizobium [T_9]; 60 kg P_2O_5+40 kg K_2O ha^{-1}+Rhizobium [T_{10}]; 5 t ha^{-1} FYM+ Rhizobium+PSB+KSB+ZnSB [T_{11}]; and 10 t ha^{-1} FYM [T_{12}]). Rhizobium inoculation was used @ 200 g for 10 kg of seed. Prepared the slurry of required quantity of inoculant in sufficient water (generally 400 ml of water for 200 g inoculant) and boil 50 g of gur in one litre of water and cooled it. Finally, mixed the seeds with slurry thoroughly and sown in the field within 24 hours. The dose and procedure followed was same for PSB inoculation with seed as per recommendation given by Central Research Institute of Dry land Agriculture (CRIDA). For KSB (potassium solubilizer bacteria) and ZnSB (zinc solubilizer bacteria) inoculation, diluted 50 ml of formulation with 1 liter of water and applied on seeds required for one acre of field. After harvesting of fodder crop, fresh fodder yield was recorded and samples were taken for quality analysis like dry matter content, proximate principles (AOAC, 2005), cell wall constituents (Van Soest *et al*., 1991) and protein fraction (Licitra *et al.,* 1996) of fodder cowpea. Data obtained were subjected to analysis of variance (ANOVA) following procedures for randomized block design (Gomez and Gomez, 1984). Treatment means were separated by Duncan's multiple range test and were considered significant at $P<0.05$.

RESULTS AND DISCUSSION

Green fodder yield was significantly influenced by different nutrient sources as shown in Fig.1. Maximum green fodder yield was obtained with treatment [T_6] (334.5 q ha^{-1}) followed by [T_7] (331.5 q

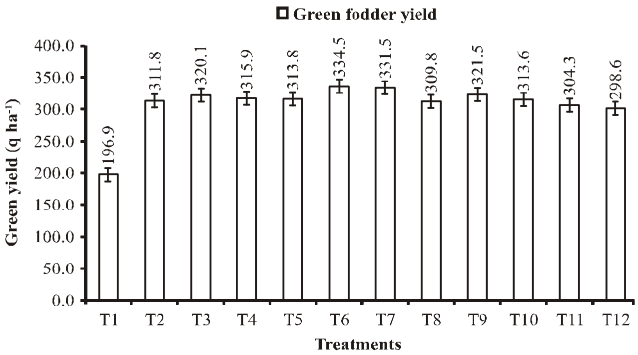

Fig 1. Effect of organic and inorganic sources of nutrients application on green fodder yield

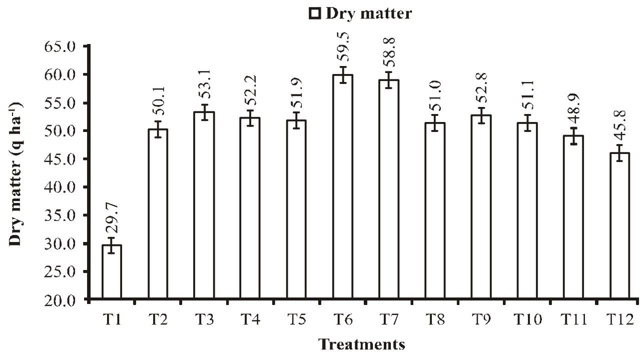

Fig 2. Effect of organic and inorganic sources of nutrients application on DM yield

ha^{-1}). All the treatments differed significantly ($P<0.05$) as compared to control [T_1] (196.9 q ha^{-1}). The increased supply of nitrogen and its higher uptake plants might have stimulated the rate of various physiological processes in plant that led to increased growth and yield parameters. These results are in close conformity with the findings of Patel *et al.* (2003) and Singh *et al.* (2007).

Phosphorus plays an important role in nitrogen-fixation in legumes and in energy metabolism during early formation of roots and their proliferation. Increased in yield parameters could be ascribed due to the overall improvement in plant growth and vigour with Rhizobium inoculation. The beneficial effect of these inoculations on yield attributes were seen due to better availability of nutrients and their translocation, which was reflected in terms of increased green fodder yield of cowpea.

DM yield as influenced by different nutrient sources are shown in Fig.2. Highest dry matter yield was recorded in treatment [T_6] (59.5 q ha^{-1}), followed by [T_7] (58.8 q ha^{-1}). All the treatments differed significantly ($P<0.05$) as compared to control [T_1]. Dry matter yield is influenced by nutrient accumulation in plant. Use of rhizobium and solubilizer might have facilitated the accumulation of the major nutrients. Significantly higher dry matter percentage was observed in treatment [T_6] (17.80 %) as compared to control [T_1] (15.07 %), followed by [T_7] (17.73 %). Higher dry matter accumulation in these groups could be attributed

Table 1. Effect of organic and inorganic sources of nutrients application on DM, Ash, OM, CP (%) content and CP yield (q ha^{-1})

Treatments	DM	Ash	OM	CP	CP yield
T_1	15.07^{d}	7.87^{b}	92.13^{a}	16.47^{h}	4.89^{g}
T_2	16.08^{c}	8.65^{a}	91.35^{b}	17.50^{e}	8.78^{d}
T_3	16.58^{b}	8.76^{a}	91.24^{b}	18.10^{bc}	9.61^{b}
T_4	16.51^{b}	8.74^{a}	91.26^{b}	18.09^{bc}	9.43^{b}
T_5	16.54^{b}	8.72^{a}	91.28^{b}	17.99^{cd}	9.33^{bc}
T_6	17.80^{a}	8.79^{a}	91.21^{b}	18.11^{b}	10.64^{a}
T_7	17.73^{a}	8.82^{a}	91.18^{b}	18.30^{a}	10.89^{a}
T_8	16.47^{b}	8.63^{a}	91.37^{b}	17.44^{ef}	8.90^{cd}
T_9	16.43^{bc}	8.60^{a}	91.40^{b}	17.37^{f}	9.17^{bcd}
T_{10}	16.28^{bc}	8.67^{a}	91.33^{b}	17.96^{d}	9.17^{bcd}
T_{11}	16.06^{c}	8.44^{b}	91.56^{a}	16.85^{g}	8.24^{e}
T_{12}	15.34^{d}	7.96^{b}	92.04^{a}	16.55^{h}	7.59^{f}
SEm ±	0.12	0.18	0.18	0.07	0.16

^{a,b,c} values with different subscript within a column represent significant difference to increasing availability of phosphorus and rhizobium inoculation in these treatment (Bohra *et al.*, 1990).

Ash is the inorganic content after removing the water and organic matter of the sample, which provide a measure of total mineral in the sample. Ash content of the fodder sample was significantly higher in all treatments except [T_{11} and T_{12}] over the unfertilized plot *i.e.* control (Table 1) which could be attributed to nutrient assimilation by plant grown on fertilized plots. Higher organic matter (92.13 %) of the fodder sample was found in control plot as listed in Table-1 A declining trend in OM content was observed with increasing application of inorganic fertilizer.

Data pertaining to CP (%) and CP yield of cowpea are presented in Table 1. Both the parameters were influenced by nutrient sources. Significantly higher CP content of fodder cowpea was obtained in treatment T_7 followed by T_6 (18.30 and 18.11%, respectively) over control (T_1, 16.47%). However, other treatments also significantly differed from the control except [T_{12}]. On the basis of CP (%), DM and CP yield (q ha^{-1}) also varied accordingly and significantly higher CP yield was calculated in treatment [T_7] followed by [T_6] (10.89 and 10.64 q ha^{-1}, respectively) in comparison to control (4.89 q ha^{-1}). Increased in protein by seed inoculation may be attributed to increase availability of nitrogen and phosphorus because of that nitrogen is the main component of the protein fraction (Magani and Kuchinda, 2009).

The data pertaining to ether extract and total carbohydrate contents are furnished in Table2. Content of Ether extract and Total carbohydrate were higher in treatment group as compared to control group, best response was obtained in T_7 followed by T_6. Lower ether extract and total carbohydrate in samples collected from control (T_1) could be attributed to fact that the soil of the studies area was deficient in Zn. Zn deficiency is known to induce stress in crops (Cakmak, 2000). Both the treatment T_6 and T_7 contained Zn solublising bacteria. As a result, availability and uptake of Zn was increased (Dutta, 2018). This might have relieved that plants from stress and improved metabolism and synthetic activity, causing an improvement in ether extract and total carbohydrate content. Further if we make a comparison of T_6 and T_7 with T_4, even though all these three groups contained Zn solubilizing bacteria response obtained in T_4 was lower. Although, T_4 contained Zn solubilising bacteria, but did not contained

Table 2. Effect of organic and inorganic sources of nutrients application on EE, T-CHO, NDF, ADF, ADL and hemicellulose content (%)

Treatments	EE	T-CHO	NDF	ADF	Hemi cellulose	ADL
T_1	2.82^{e}	74.74^{a}	41.66^{a}	31.07^{a}	10.59^{a}	8.54^{a}
T_2	3.36^{b}	71.09^{cd}	39.63^{bcd}	29.84^{b}	9.79^{c}	8.24^{a}
T_3	3.09^{d}	70.65^{def}	39.53^{cd}	29.77^{b}	9.75^{c}	8.24^{a}
T_4	3.19^{c}	70.59^{def}	39.59^{bcd}	29.81^{b}	9.78^{c}	8.26^{a}
T_5	3.23^{c}	70.66^{def}	39.55^{cd}	29.79^{b}	9.77^{c}	8.19^{a}
T_6	3.44^{a}	70.26^{ef}	39.50^{cd}	29.75^{b}	9.75^{c}	7.98^{a}
T_7	3.48^{a}	70.00^{f}	39.47^{d}	29.75^{b}	9.71^{c}	8.00^{a}
T_8	3.36^{b}	71.17^{cd}	39.69^{bcd}	29.87^{b}	9.82^{c}	8.30^{a}
T_9	3.19^{c}	71.44^{c}	39.77^{bcd}	29.88^{b}	9.89^{bc}	8.33^{a}
T_{10}	3.10^{d}	70.87^{cde}	39.50^{d}	29.73^{b}	9.77^{c}	8.12^{a}
T_{11}	2.86^{e}	72.77^{b}	40.25^{bc}	30.03^{b}	10.20^{abc}	8.36^{a}
T_{12}	2.86^{e}	74.10^{a}	40.51^{b}	30.13^{b}	10.39^{ab}	8.50^{a}
SEm ±	0.04	0.22	0.16	0.16	0.17	0.17^{a}

^{a,b,c} values with different subscript within a column represent significant difference

Table 3. Effect of organic and inorganic sources of nutrients application on NDICP and ADICP content (%)

Treatments	NDICP		ADICP	
	DM	CP	DM	CP
T_1	7.69[a]	50.85[a]	2.75[a]	18.18[a]
T_2	7.39[ab]	42.21[c]	2.56[ab]	14.64[cde]
T_3	7.20[bc]	39.79[cde]	2.46[b]	13.58[ef]
T_4	7.25[abc]	40.06[cde]	2.52[ab]	13.94[def]
T_5	7.39[ab]	41.07[cd]	2.60[ab]	14.48[cde]
T_6	7.04[bc]	38.89[de]	2.46[b]	13.58[ef]
T_7	6.84[c]	37.40[e]	2.40[b]	13.10[f]
T_8	7.33[abc]	42.01[c]	2.58[ab]	14.82[cd]
T_9	7.39[ab]	42.52[c]	2.65[ab]	15.23[c]
T_{10}	7.27[abc]	40.47[cd]	2.56[ab]	14.27[cde]
T_{11}	7.50[ab]	45.35[b]	2.69[ab]	16.26[b]
T_{12}	7.59[a]	48.55[a]	2.73[a]	17.45[a]
SEm ±	0.15	0.85	0.08	0.31

[a,b,c] values with different subscript within a column represent significant difference

rhizobium. Nitrogen uptake was lower in T_4 as compared to T_6 and T_7. Nitrogen is required for synthesis of amino acid and protein. Inadequate supply of nitrogen will have adverse impact on synthetic activity. Likewise, P helps in root nodule formation as well as play key role in energy transfer during different metabolic activities. Thus, a combination of rhizobium, P, K and Zn solubilizing bacteria along with RDF are the best nutrient strategy for fodder cowpea.

The data on NDF (%) content of cowpea fodder as influenced by different nutrient sources are presented in Table-2. Significantly lower NDF value was found in treatment [T_7] (39.47 %) over the control (41.66 %). Significantly lower ADF content was obtained in treatment [T_7] (29.75 %) and [T_6] (29.75%) with comparison to control (31.07 %). Lower fibre content in T_7 corroborates well with higher CP, EE and total carbohydrate content in that group. Content of cell wall fraction is known to inversely related with content of soluble fractions, particularly CP. Lower content of cell wall fractions in T_7 was thus expected and could be considered as an improvement in fodder quality due to provision of nutrients through rhizobium, P, K and Zn solubilizing bacteria.

Data pertaining to NDICP and ADICP content (%) of cowpea as influenced by organic and inorganic sources of nutrients are tabulated in Table 3. Significantly lower value of NDICP and ADICP were obtained in treatment T_7 as compared to control. Lower fibre bound CP in T_7 could be attributed to lower cell wall content in that group. It further implies that CP of cowpea fodder grown under nutrient management system of T_7 would be of superior quality as it would supply more available protein to ruminant animal as compared to those grown under other nutrient management system. As discussed before superiority of T_7 over other treatment group could be due to the fact that it contained a combination rhizobium, P, K and Zn solubilizing bacteria along with RDF. An appropriate supply of N. P, K and Zn is of paramount importance for quality production of fodder cowpea. Amongst all the treatments, T_7 supplied these nutrients for optimum production of quality fodder cowpea.

CONCLUSIONS

Based on the present investigation, it is concluded that reduction of one third RDF along with additional biofertilizers improved yield and quality of fodder cowpea.

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