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Productivity and economics of fodder pearl millet as influenced by different nutrient management practices

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Abstract
The year-round green fodder supply for better health and productivity of the livestock animals can be ensured by green fodder production along with proper nutrient management. To work out precise nutrient management practices in fodder pearl millet production, a field experiment was undertaken during *kharif* season of 2019-20 at Agronomy research farm, ICAR-NDRI, Karnal, and laid out in Randomized Block Design with eight treatments, *viz*., $T_{1:}$ Absolute control; $T_{2:}$ 100% RDF; $T_{3:}$ 100% RDF + Cow urine foliar spray; $T_{4:}$ 100% RDF + PGPR; T_5: 100% RDF + PGPR + Cow urine foliar spray; $T_{6:}$ 75% RDF + Cow urine foliar spray; $T_{7:}$ 75% RDF + PGPR and T_8: 75% RDF + PGPR + Cow urine foliar spray. Each treatment had three replications. Study indicated that the yield as well as economics of fodder pearl millet cultivation significantly affected with different nutrient management practices. The yield of green (54.58 t/ha) and dry fodder yield (11.17 t/ha) at harvest significantly increase up to application of 100% RDF+PGPR and they further increase with application of 100% RDF+PGPR+CU, but doesn't reach up to significance level over 100% RDF+PGPR. However, both were remains statistically at par to each and found significantly higher than other treatments. Maximum net return recorded with T_4 followed by T_5, T_2 and T_7 treatment. However, maximum B:C ratio found with T_4, followed by T_7 and T_5 treatments. Which, will further strengthen and sustain crop productivity and profitability.

Keywords: Cow urine, economics, fodder, productivity, yield

Introduction
India has the highest number of livestock animals (536.76 million) with in the world's, according to 20th livestock census 2019, the population of major livestock animals *viz*., buffalo, cattle, sheep and goat in India is 109.85, 193.46, 74.26 and 148.88 million, respectively (Anonymous, 2020) [2]. Fodder demand increases for ever increasing population of livestock (Singh *et al*., 2021) [21] and its essential component for livestock production as it can cope up the cost of feeding (Kumar *et al*., 2014) [13, 14] because feeding accounts for 65 to 70 percent of the entire cost of livestock farming. The scarcity of green fodder is severe, and India alone faces a net deficiency 35.6, 10.95 and 44 percentage of green fodder, dry fodder and concentrate feeds (Kushwaha *et al*., 2018 and Gupta *et al*., 2019) [15, 9], respectively, that influence production levels as well as health of animals, which ultimately affect returns from livestock sector (Surve *et al*., 2011) [23]. The availability of good quality green fodder throughout the year to livestock is the major concern to developing a sustainable livestock farming (Chaudhary *et al*., 2016) [6]. Among the different fodder crops pearl millet (*Pennisetum glaucum*) is the gifted crops to tropical and sub-tropical regions that provide fodder, stover and food to millions of poor farmer and their livestock's. It has potential to grow in low fertility soils (Ali, 2010) [1], higher growth rate, water use efficiency, tillering potential and heat tolerance (Jukanti *et al*., 2016) [12], higher degree of tolerance to drought (Ibrahim *et al*, 2014) [10].

Green revolution scenario shows production and productivity of cereals largely increased through intensive agronomic practices, high yielding variety and Indiscriminate use of higher rate of chemical fertilizers with little or without use of organic source of nutrients to plant, that create adverse effect on soil properties *viz*., inadequacy in one or more nutrients and deterioration of soil fertility which leads to stagnating or even declining crop productivity (Shormy *et al*., 2013) [20]. Judicious use of organic and inorganic nutrients sources may sustain and enhance the crop quality and productivity. Cow urine and PGPR are great and vital sources of nutrients for plants among many organic sources. The cow urine contains; N, P, K, S, Na, Fe, Mn, Si, carbolic acid, hormones and phytohormones (Saunders, 1982) [19].

PGPR is a liquid consortium of microorganisms, which contains a wide range of genera *viz*., *Pseudomonas Azospirillum*, *Bacillus*, *Serratia* and *Azotobacter* (Bashan *et al*., 2004) [3] that actively colonize around roots of plant and enhances plant growth and yield (Wu *et al*., 2005) [26] due to their ability to produce various phytohormones (Auxins, gibberellins, cytokinin and ethylene), organic acids, siderophores, biologically fixation of atmospheric nitrogen, increase solubility and availability of insoluble inorganic soil phosphate, oxidation of sulphur, extra cellular production of antibiotics, increases root permeability leads to enhance essential plant nutrients uptake (Enebak and Carey, 2000 and Pal *et al*., 1999) [7, 17]. Perceiving above facts the present study was proposed to finds out a suitable combination of nutrients sources to enhance productivity and profitability of fodder pearl millet.

Materials and Methods

Description of experimental site

The experiment was carried out during *kharif*, 2019 at Agronomy Research Farm, ICAR-NDRI, Karnal (Haryana) located at 29º45' North latitude and 76º58' East longitude and at an altitude of 245 m above mean sea level. The area's climate is semi-arid, with an average annual rainfall of 707mm, 70-80 percent of it falling between July and September. During this investigation, the average minimum and maximum temperatures were 20.49°C and 34.54°C, respectively. The soil texture at the experimental site was clay loam (Piper, 1942) [18], electrical conductivity (EC) 0.37 dS/m (Jackson, 1967) [11], organic carbon (OC) 0.49 percent (Walkley and Black's, 1934), available nitrogen 215 kg/ha (Subbiah and Asija, 1956) [22], available phosphorus (P) 24.70 kg/ha (Olsen *et al*., 1954) [16], and available potassium 285 kg/ha (Jackson, 1967) [11].

Treatments details and inputs application

The experiment was laid out in Randomized Complete Block Design with eight treatments, *i.e*., T_1 (Absolute control), T_2 (100% RDF), T_3 (100% RDF + Cow urine foliar spray), T_4 (100% RDF + PGPR), T_5 (100% RDF + PGPR + Cow urine foliar spray), T_6 (75% RDF + Cow urine foliar spray), T_7 (75% RDF + PGPR) and T_8 (75% RDF + PGPR + Cow urine foliar spray) with three replications. The land preparation involved one deep ploughing with disc plough followed by two cross harrowing with disc harrow and planking. The recommended dose of fertilizers (80:30:30 kg/ha, N: P_2O_5: K_2O, respectively) were applied according to treatments. The half of N and full doses of P and K were applied before final harrowing and remaining half dose of nitrogen was top-dressed in two split doses as per the treatment. The PGPR (100 ml/10 kg seeds) liquid culture was diluted in one litres of water, and applied on seeds. Thereafter, inoculated seeds were dried in shade for 60-90 minutes, after drying seeds was manually sown. Nutrifeed variety of fodder pearl millet was sown using 10 kg seed per hectare with maintaining row to row spacing 30 cm and plant to plant spacing 10 cm. Other package of practices was followed as per standard for cultivation of fodder pearl millet. The 10% cow urine was applied as foliar spray in early morning hours, when the dew has been evaporated at 30 and 45 DAS as per treatments.

Observations at harvest

Green fodder yield was recorded at harvest. The crop was harvested manually at 50% flowering stage. Net plot area was harvested separately from each plot, weighed as kg/plot, and then converted into tonnes/ha for estimation of final fresh green fodder yield. Dry fodder yield of pearl millet estimated by Multiplying dry matter content to green fodder yield.

$$\text{Leaf to stem ratio} = \frac{\text{Mean fresh leaves weight of five tagged plants}}{\text{Mean fresh stem weight of five tagged plants}}$$

Statistical analysis

All the data was analysed using analysis of variance (Gomez and Gomez 1984) [8] at a 5% level of significance (p<0.05). Simple Pearson's correlation coefficient was computed by using mean values of different growth and yield parameters.

Results and Discussion

Effect of nutrient management practices on leaf to stem ratio

The leaf to stem ratio (0.44) at harvest (Table 1) significantly increase up to application of 100% RDF+PGPR (T_4) and they further increase with application of 100% RDF+PGPR+CU (T_5) but does not reach up to significance level over 100% RDF+PGPR (T_4). However, both were remains statistically at par to each and found significantly higher than other treatments. According to data, growth parameters increase due to optimum and balanced supply of essential nutrients to plant throughout the growth period by RDF, PGPR and cow urine. Optimum and balanced supply of phosphorus in early stage of plant from fertiliser and PGPR that responsible for early and well establishments of rooting system of plant that acquire more water and nutrients from different strata of soil and supply to plant for profuse and healthy growth. Optimum availability of nitrogen in soil solution, increase uptake, utilization and assimilation leads to increase chlorophyll synthesis in plant because nitrogen is an integral and important component of porphyrin ring for formation of chlorophyll. Higher chlorophyll molecules per unit area of leaf, intercept more solar radiation and it convert into organic compound through photosynthesis mechanism with the help of water, carbon dioxide (CO_2). Photosynthates that synthesized during photosynthesis process accumulate mostly in leaves and stem with the help of phloem, resulted increases cell size, cell division, expansion, and differentiation leads to increase leaf to stem ratio.

Effect of nutrient management practices on fodder yield

Study indicated (Table 1) that green and dry fodder yield of fodder pearl millet were significantly influenced with different nutrient management practices. Yield of green fodder (54.58 t/ha) and dry fodder (11.17 t/ha) at harvest significantly increase up to application of 100% RDF+PGPR (T_4) and they further increase with application of 100% RDF+PGPR+CU (T_5) but does not reach up to significance level over 100% RDF+PGPR (T_4). However, both were remains statistically at par to each and found significantly higher than other treatments. Nutrients supplied with 100% RDF+PGPR, increase green fodder yield by 5.65, 6.50 and 59.37% over 100% RDF+CU, 100% RDF and absolute control at harvest, respectively. Green fodder yield per unit area is out come from interaction of cultivar potential, agronomic management practices and environmental factors that are directly and indirectly contributes in final yield. The green fodder yield is the prominent factor to decide efficacy of applied input and agronomic management practices. Balanced and regular supply of essential plant nutrients increases plant physiological processes leads to increase plant height; higher no. of leaves and tillers/plant; higher leaf length, width and stem girth responsible to increase final green fodder yield. Yield of dry fodder increases due to higher accumulation of photosynthates in plant that leads to increase dry matter content (Chattha *et al.*, 2017) [5]. The similar findings also reported by Chattha *et al.* (2017) [5] and Bhakar *et al.* (2021) [4].

Effect of nutrient management practices on economic

The practical serviceability's of any treatment is judged by the net returns and returns gained per rupee invested, *i.e*., benefit cost ratio. So, with this objective, the economics of different treatments was worked out. Results depicted (Table 2) that the highest net returns found with application of 100% RDF+PGPR (Rs. 57124 ha^{-1}) followed by 100% RDF+PGPR+CU (Rs. 56099 ha^{-1}), 100% RDF (Rs. 52364 ha^{-1}) and 75% RDF+PGPR (Rs. 52351 ha^{-1}). However, maximum B:C ratio was found with application of 100% RDF+PGPR (2.31) followed by 75% RDF+PGPR (2.19), 100% RDF+PGPR+CU (2.15) and 100% RDF (2.14). Conjoint application of different source of nutrients to plants, found positively correlated and their higher efficacy gave higher fodder yield leads to achieve higher net return and returns gained per rupee invested. The similar findings also reported by Chattha *et al.* (2017) [5] and Bhakar *et al.* (2021) [4].

Correlation studies

The results showed on correlation (Table 3) indicates that the dry fodder yield (r=0.978), height of plant (r=0.923), length of leaf (r=0.935), width of leaf (r=0.894), no. of tillers/plant (r=0.932), no. of leaves/plant (r=0.897) and stem girth (r=0.906) were strongly and positively correlated with the yield of green fodder. Similar findings also reported by Bhakar *et al*. (2021) [4].

Table 1: Effects of nutrient management practices on fodder yield and leaf to stem ratio of fodder pearl millet

Treatments	Green fodder yield (t/ha)	Dry fodder yield (t/ha)	Leaf to stem ratio
T_1: Absolute control	34.25	5.56	0.37
T_2: 100% RDF	51.25	9.89	0.41
T_3: 100% RDF+CU	51.66	10.02	0.42
T_4: 100% RDF+PGPR	54.58	11.17	0.44
T_5: 100% RDF+PGPR+CU	54.83	11.33	0.44
T_6: 75% RDF+CU	47.41	8.23	0.39
T_7: 75% RDF+PGPR	50.85	9.40	0.41
T_8: 75% RDF+PGPR+CU	51.16	9.61	0.41
SEm (±)	8.39	1.90	0.003
CD (P=0.05)	25.44	5.77	0.010

Table 2: Effects of nutrient management practices on economics of fodder pearl millet production

Treatments	Cost of cultivation (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	B:C Ratio
T_1: Absolute control	20353	51375	31022	1.52
T_2: 100% RDF	24511	76875	52364	2.14
T_3: 100% RDF+CU	25911	77500	51589	1.99
T_4: 100% RDF+PGPR	24751	81875	57124	2.31
T_5: 100% RDF+PGPR+CU	26151	82250	56099	2.15
T_6: 75% RDF+CU	25096	71125	46029	1.83
T_7: 75% RDF+PGPR	23936	76288	52351	2.19
T_8: 75% RDF+PGPR+CU	25336	76750	51414	2.03

Table 3: Correlation coefficient (r) between fodder yield and morphological traits of pearl millet at harvest.

Pearson	Correlations							
	GFY	DFY	PH	LL	LW	TP	LP	SG
GFY	1							
DFY	.978**	1						
PH	.923**	.982**	1					
LL	.935**	.986**	.998**	1				
LW	.894**	.965**	.989**	.988**	1			
TP	.932**	.986**	.997**	.998**	.993**	1		
LP	.897**	.968**	.995**	.994**	.995**	.996**	1	
SG	.906**	.974**	.997**	.995**	.997**	.997**	.998**	1

Note: GFY: Green fodder yield; DFY: Dry fodder yield; PH: Plant height; LL: Leaf length; LW: Leaf width; TP: Tillers per plant; LP: Leaves per plant; SG: Stem girth and **=Correlation is significant at the 0.01 level.

Conclusion

Cultivation of fodder pearl millet with application of 100% RDF+PGPR successfully sustained crop productivity and profitability.

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