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Effect of nutrient management practices on performance of fodder pearl millet

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Abstract
The experiment was carried out during *kharif* season (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 growth and yield parameters of fodder pearl millet significantly affected with different nutrient management practices and found plant height (178.3 and 307.5 cm), leaf length (86.5 and 110.4 cm), no. of leaves/plant (11.4 and 15.3), no. of tillers/plant (11.3 and 13.1), leaf width (4.3 and 5.1 cm) and stem girth (2.2 and 3.7 cm) at 40 DAS and harvest respectively, 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.

Keywords: Cow urine, fodder, growth, pearl millet, yield

Introduction
Livestock production is important pillar of Indian agriculture and About 20.5 million people rely on livestock for a living, and animals contributed 16 percent of small farm households' income, compared to 14 percent for all rural households. 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) [4]. Fodder demand increases for ever increasing population of livestock (Singh et al., 2021) [29] and its essential component for livestock production as it can cope up the cost of feeding (Kumar et al., 2014) [20-21] 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) [22, 14], respectively, that influence production levels as well as health of animals, which ultimately affect returns from livestock sector (Surve et al., 2011) [31]. 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) [19]. 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) [3], higher growth rate, water use efficiency, tillering potential and heat tolerance (Jukanti et al., 2016) [18], higher degree of tolerance to drought (Ibrahim et al, 2014) [15].
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) [28]. 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) [27].

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) [15] that actively colonize around roots of plant and enhances plant growth and yield (Wu et al., 2005) [34] 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) [11, 24]. 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) [25], electrical conductivity (EC) 0.37 dS/m (Jackson, 1967) [17], organic carbon (OC) 0.49 percent (Walkley and Black's, 1934) [32], available nitrogen 215 kg/ha (Subbiah and Asija, 1956) [30], available phosphorus (P) 24.70 kg/ha (Olsen et al., 1954) [23], and available potassium 285 kg/ha (Jackson, 1967) [17].

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.

Morphological observations

Five plants were chosen at random and tagged in the net plot area to capture morphological parameters across treatments. Plant height, leaf width and length of middle leaf, number of leaves/plants, number of tillers/plants and stem girth were measured at 40 days after sowing and harvest.

Statistical analysis

All the data was analysed using analysis of variance (Gomez and Gomez 1984) [13] 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 morphological traits

Growth parameters *i.e*., plant height, number of leaves and tiller per plant, leaf width, leaf length and stem girth are trustworthy indicator of growth and development of any plant, especially for fodder crops, which directly or indirectly represents final yield of fodder crops. Study indicated (Table 1 and 2) that plant growth parameters of fodder pearl millet were significantly influenced with different nutrient management practices and recorded significantly higher in all the treatments at 40 days after sowing and harvest over absolute control. Plant height (178.3 and 307.5 cm), leaf length (86.5 and 110.4 cm), no. of leaves/plant (11.4 and 15.3), no. of tillers/plant (11.3 and 13.1), leaf width (4.3 and 5.1 cm) and stem girth (2.2 and 3.7 cm) at 40 DAS and harvest respectively, 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 improved plant height by 11.25, 13.66 and 55.85%; leaf length by 6.91, 7.81 and 27.88%; leaf width by 6.77, 10.79, and 36.9%; no. of tillers/plant by 11.90, 14.49 and 61.22%; no. of leaves/plant by 13.02, 15.32 and 53.33% and stem girth by 12.21, 15.83 and 69.00% over 100% RDF+CU, 100% RDF and absolute control at harvest, respectively.

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. Cell division increase number of cells leads to produce a greater number of nodes, which responsible to emerge a greater number of tillers, internodes and leaves per plants. Higher accumulation of photosynthate in cells, which responsible to increase cell size leads to increase leaf length and width; and internodes length and diameters. Higher internodes length and diameters attributed to increase plant height and stem girth (Iqbal et al., 2017) [16]. Potassium protects to plant from diseases, pests and play important role in plant to maintain water status. The similar results also reported by Chattha et al. (2017) [8] and Bhakar et al. (2021) [6].

In addition to RDF, PGPR is another source of nutrient to plant, that actively colonize around plant roots (Wu et al., 2005) [34] and increase native phosphorus availability by solubilization of insoluble inorganic soil phosphate into soluble form, supplement additional nitrogen by biological fixation of atmospheric nitrogen throughout the growth period (Enebak and Carey, 2000) [11], release ammonia into soil subsequence increase soil nitrate (Abbasi et al., 2011) [1], increase K^+/Na^+ ratio in plant by suppressing Na^+ uptake (Ahmad et al., 2014) [2] and increase metal nutrients availability in soil to plant by organic acid production (Cakmakci et al., 2007) [17] these all mechanism recharge soil fertility status as well as increase essential plant nutrients in available form to plant use. At same time cow urine additionally supplement N, K, S, P and micronutrients to plant foliage in latter stage of crop for quick recovery (Sadhukhan et al., 2018) [26]. In another way PGPR synthesis phytohormones (Auxin, gibberellin and cytokinin) (Kumar et al., 2014) [20-21]; secrete ACC- deaminase that leads to decrease ethylene levels in plant (Ahmad et al., 2014) [2]; and produce HCN secondary metabolites that suppress germination of pathogen spores (Kumar et al., 2014) [20-21]; control bacterial diseases through extra cellular production of antibiotic (Pal et al., 1999) [24]; increase nutrient and water uptake due to increases in root permeability (Glick, 1995) [12]; eliminate deleterious rhizobacteria from the rhizosphere by niche exclusion (Weller, 1988) [33]; and cow urine contains hormones and enzymes (Kishore et al., 2015) [19]; cow urine foliar spray control fungal and bacterial diseases (Devakumar et al., 2014) [10] these all stimulatory mechanism increase physiological process of plant attributed to increase growth by decreasing stress and deleterious effect from different factor's on plant.

Table 1: Effects of nutrient management practices on morphological characteristics of fodder pearl millet

Treatments	Plant height (cm)		Leaf length (cm)		No. of leaves/plant	
	40 DAS	Harvest	40 DAS	Harvest	40 DAS	Harvest
T_1: Absolute control	107.4	197.3	59.2	86.3	7.3	10.0
T_2: 100% RDF	155.5	270.5	77.5	102.4	10.0	13.3
T_3: 100% RDF+CU	158.5	276.4	78.0	103.2	10.2	13.5
T_4: 100% RDF+PGPR	178.3	307.5	86.5	110.4	11.4	15.3
T_5: 100% RDF+PGPR+CU	181.0	308.7	86.7	111.4	11.5	15.7
T_6: 75% RDF+CU	127.1	228.9	68.0	94.2	8.5	11.4
T_7: 75% RDF+PGPR	147.2	261.9	76.6	101.6	9.8	12.9
T_8: 75% RDF+PGPR+CU	150.7	267.0	76.9	102.1	9.9	13.1
SEm (±)	6.42	9.91	2.67	2.39	0.36	0.46
CD (P=0.05)	19.47	30.05	8.11	7.25	1.10	1.40

Note: CU: Cow urine; DAS: Day after sowing; RDF: Recommended dose of fertiliser and PGPR: Plant growth promoting rhizobacteria

Table 2: Effects of nutrient management practices on leaf width, number of tillers and stem girth of fodder pearl millet

Treatments	Leaf width (cm)		No. of tillers/plant		Stem girth (cm)	
	40 DAS	Harvest	40 DAS	Harvest	40 DAS	Harvest
T_1: Absolute control	3.0	3.7	6.8	8.1	1.2	2.1
T_2: 100% RDF	3.9	4.6	9.8	11.5	1.8	3.2
T_3: 100% RDF+CU	3.9	4.7	9.9	11.7	1.9	3.3
T_4: 100% RDF+PGPR	4.3	5.1	11.3	13.1	2.2	3.7
T_5: 100% RDF+PGPR+CU	4.4	5.3	11.4	13.4	2.3	3.8
T_6: 75% RDF+CU	3.4	4.1	8.5	9.9	1.5	2.6
T_7: 75% RDF+PGPR	3.8	4.5	9.6	11.1	1.7	3.0
T_8: 75% RDF+PGPR+CU	3.8	4.5	9.7	11.4	1.8	3.1
SEm (±)	0.09	0.10	0.34	0.39	0.07	0.11
CD (P=0.05)	0.29	0.31	1.04	1.18	0.21	0.34

Conclusion

Nutrient management is an important aspect, where intensive cropping system are dominates. Furthermore, the better nutrient management is pre-requisite to sustain crop productivity Judicious use of inorganic and organic sources of nutrients sustains and enhance crop productivity and positive effect of integration was noticed on growth and yield of fodder pearl millet cultivation. In summary cultivation of fodder pearl millet with application of 100% RDF+PGPR can successfully sustained crop productivity. For future line of work, as like pearl millet, different cereal fodder crops can be explored location wise along with proper dose and sources (inorganic and organic) of nutrients for better productivity and profitability.

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