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Effect of Different Organic and Inorganic Fertility Sources on Protein Content in Pearl Millet Crop Grown in Sandy Soils

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment carried out at the S.K.N. College of Agriculture, Jobner, Agronomy farm. The six treatments include four levels of liquid organic manures (control, panchgavya, vermiwash, and cow urine), which are given to the main and sub plots, respectively, and are replicated three times in the Split Plot Design. The integrated nitrogen management treatments include control, 100% RDN, 75% RDN + 25% N through FYM, 50% RDN + 50% N through FYM, 25% RDN + 75% N through FYM, and 100% N through FYM. As a test crop, the pearl millet variety "RHB 223" was used. The findings showed that integrated nitrogen management improved the performance of the pearl millet crop before having a residual effect on the mustard variety Giriraj (DRMR IJ-31). In addition to improved soil health in terms of physical and chemical properties, coordinated nitrogen management significantly raised soil organic carbon and improved crop routine. The application of 25% RDN + 75% N through FYM to pearl millet and 50% RDN + 50% N through FYM to mustard crop, among other treatments, had a residual effect that improved crop performance and quality content while also enhancing the physico-chemical properties of the soil. These methods demonstrate a viable approach to enhancing soil nutrient availability on a sustainable basis.

Keywords: Integrated nitrogen management,;liquid organic manures; protein content; pearl millet; residual effect; mustard.

1. INTRODUCTION

India is the world's largest producer of pearl millet, covering 6.70 million hectares (mha) and producing 9.62 million tonnes (mt) on average in 2021–2022, with a productivity of 1436 kg/ha [1]. Further down Pearl millet, more than 80% of the land is in an arid or semi-arid section of the country. More than 90% of the total area and output is accounted for by Rajasthan, Uttar Pradesh, Maharashtra, Haryana, and Gujarat. When it came to pearl mill area and production, Rajasthan was in first position. The Indian states of Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh, and Gujarat are the main locations for mustard cultivation. By 2021–2022, it produced 11.75 mt and had a productivity of 1458 kg/ha on an 8.06 mha area [1].

The state of Rajasthan provided the majority of the 3.37 m ha, 5.48 mt of production, and 1627 kg/ha of productivity. The districts of Rajasthan that grow it the most include Ganganagar, Hanumangarh, Bharatpur, Tonk, Jaipur, Swaimadhopur, Sikar, Nagaur, and Jalore [2]. The largest pearl millet-mustard crop sequence, with maximum productivity and profitability, is found in North-Western India, specifically in Rajasthan, Uttar Pradesh, Haryana, and Madhya Pradesh. Compared to other pearl millet-based systems, this crop sequence is more popular since it requires less labour, water, and inputs [3,4]. In terms of the major and minor components limiting agricultural productivity, our soils are depleted. In addition to increasing yield, optimal and appropriate fertilizer application also improves crop quality parameters. Towards restraint this trend of declining yield, there is need to implement the concept of included nitrogen management. In order to maintain soil fertility and crop productivity—which calls for the best possible utilization of organic, inorganic, and bio-source plant nutrients—integrated nitrogen management has become a crucial instrument [5,6].

The highest yield of pearl millet and mustard crops may be achieved by using a balanced amount of inorganic and organic fertilizers. The highest yield of inorganic fertilizers may be found in the presence of adequate organic manures. Through the use of RDF, this agricultural system's potential output has reached a location where soil health has decreased, especially in terms of organic matter depletion. Additionally, micronutrients found in straight fertilizers are supplied by organic manures [3,5,7]. The biofertilizers obligate also emerged hopeful modules of integrated nutrient supply arrangement which are atmosphere approachable and minimum cost inputs. Use of all the recommended nutrients through urea has adversely effect on soil health, leading to lower crop production. Consequently, there is need to improve nutrient supply system for enhancing production potential of this very imperative crop sequence. Therefore, a study was assumed to estimate the effect of integrated nitrogen management on protein content in pearl millet crop under mustard based cropping system.

2. METHODS AND MATERIALS

2.1 Experimental Site and Details

In Jobner, Rajasthan, at the Agronomy Farm of S.K.N. College of Agriculture, a field trial was carried out in 2021–2022 and 2022–2023. Agroclimatic zone IIIa, or the semi-arid Eastern Plain Zone, describes the experiment site. The area experiences 400–500 mm of rainfall on average, with the South-West rainy season's July–August contributions accounting for the majority of this total. Split Plot Design (SPD) was used to plan the experiment. During the kharif season, various treatments were applied (Table 1), and in the rabi season, the mustard variety Giriraj (DRMR IJ-31) increased residual fertility levels [8].

2.2 Treatment Application and Soil Properties

The FYM was sprayed one month prior to the pearl millet crop's crow sowing. At the time of seeding, the full dosages of potassium and phosphorus as well as half of the prescribed amount of nitrogen were administered. The remaining nitrogen was top-dressed during the initial irrigation. Separate sources of nitrogen were employed, including urea. The first week of July was when pearl millet seed (4 kg ha^{-1}) was sown in both years. The mustard crop was then sowed in the current layout during the second week of November, following the harvest of pearl millet. As advised by the crop, two irrigations were given to the mustard crop. To measure the potential for mustard seed yield, stover and seed were gathered after the crop was harvested. The soil had a texture similar to loamy sand and had a pH rate of 8.4. It had low available N (128 kg ha^{-1}), medium available K (148 kg ha^{-1}), and medium phosphorus (14 kg ha^{-1}).

2.3 Plant Analysis

A di acid mixture of HNO3: HClO4 (10: 4 ratio) was used to digest the grain, seed, and stover samples. Acid extract was used to decompose the phosphorus and K nutritional contents, which were then measured using a flame photometer and the vanadomolydo phosphoric yellow colour technique, respectively [9,10].

2.3.1 Nitrogen content (%)

Nitrogen content in both grain and stover was estimated by modified Kjeldahl‟s method using Nessler‟s reagent Snell and Snell [11].

2.3.2 Protein content

The per cent crude protein content in grain was calculated by multiplying per cent nitrogen of grain with a factor 6.25 A.O.A.C. [12].

2.4 Statistical Analysis

The experimental data were statistically analysed for analysis of variance and test of significance through the procedure appropriate to the split plot design, as described by Gomez and Gomez [13].

Table 1. Treatment details and their symbols of pearl millet-mustard

Treatments	Symbols
(A) Integrated nitrogen management (main plots)	
Control	N_0
100% RDN	N_1
75% RDN + 25% N through FYM	N_2
50% RDN + 50% N through FYM	N_3
25% RDN + 75% N through FYM	N_4
100% N through FYM	N_5
(B) Liquid organic manures (sub plots)	
i. Control	L_0
ii. Panchgavya (foliar spray at vegetative and pre flowering stages)	L_1
iii. Vermiwash (foliar spray at vegetative and pre flowering stages)	L_2
iv. Cow urine (foliar spray at vegetative and pre flowering stages)	L_3

3. RESULTS AND DISCUSSION

3.1 Integrated Nitrogen Management Effect on Protein Content

The protein content in grain was also better-quality significantly due to altered integrated nitrogen management treatments during together the years of investigation as well as in pooled analysis of pearl millet crop (Table 2). The maximum value of protein content (12.60%) was recorded under 25% RDN + 75% N through FYM which was closely followed by 50% RDN + 50% N through FYM (12.51%) and 75% RDN + 25% N through FYM (12.26%). Remaining at par among themselves, these 3 treatments enhanced the protein content in pearl millet grain by 20.6, 19.7 or 17.3 per cent, individually over control. Use of 100% RDN and 100% N through FYM also recorded 9.6 and 8.3 per cent higher protein content than control.

Table 2. Impact of liquid organic manures and integrated nitrogen management on protein content of pearl millet grain

Treatments	Protein content (%)		
	2021	2022	Pooled
Integrated nitrogen management			
N_0 - Control	10.63	10.26	10.45
N_1 - 100% RDN	11.69	11.20	11.45
N_2 - 75% RDN + 25% N through FYM	12.51	12.02	12.26
N_3 - 50% RDN + 50% N through FYM	12.69	12.33	12.51
N_4 - 25% RDN + 75% N through FYM	12.82	12.39	12.60
N_5 - 100% N through FYM	11.57	11.08	11.32
SEm ±	0.23	0.24	0.16
lsd (p=0.05)	0.71	0.75	0.49
Liquid organic manures			
L_0 - Control	11.25	10.75	11.00
L_1 - Panchagavya	12.75	12.31	12.53
L_2 - Vermiwash	12.06	11.75	11.91
L_3 - Cow urine	11.88	11.38	11.63
SEm ±	0.14	0.14	0.12
lsd (p=0.05)	0.41	0.42	0.35

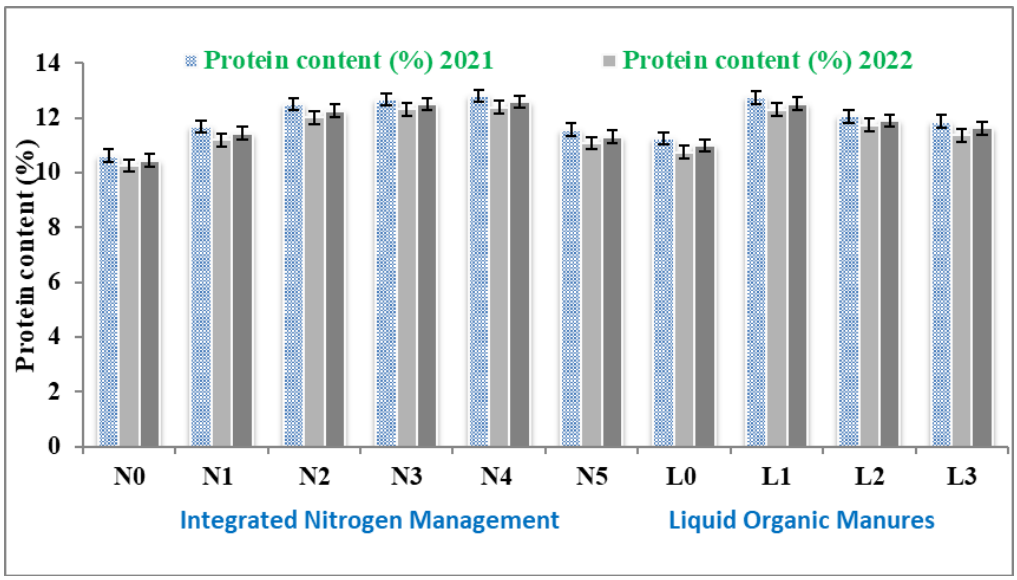

Fig. 1. Response of integrated nitrogen management and liquid organic manures on protein content of pearl millet grain

3.2 Liquid Organic Manures Effect on Protein Content

It is also apparent from the pooled data presented in Fig. 1 that two foliar sprays of 3% panchgavya at vegetative and pre- flowering stages attained the highest crude protein content in pearl millet grain (12.53%) indicating an growth of 5.2, 7.7 and 13.9 per cent as compared to two foliar spray of 10% vermiwash, 10% cow urine and control, respectively. Results further revealed that foliar spray of vermiwash and cow urine also enhanced the protein content through 8.3 and 5.7 per cent over control, but the difference in protein content observed under these two treatments was not of statistical significance.

The quality content in pearl millet grain was significantly improved over control by different integrated nitrogen management treatments (Table 2). 25% RDN + 75% N through FYM (12.60 %), 50% RDN + 50% N through FYM (12.51%), 75% RDN + 25% N through FYM (12.26%) and 100% RDN (11.45 %) were among the superior treatments wherein marked increase in protein content in comparison to control was noted [14,15]. However, these treatments were statistically similar and equally effective among themselves. Since the combined treatments of organic and inorganic sources of nutrients produce crop with higher quality under experiment, there was an improvement in the functional efficiencies of various macro and trace elements. Thus increase in protein content may be due to superior availability of all the quality nutrients to pearl millet plants through together organic and inorganic sources resulting higher protein production in the seeds. The increased nutrient uptake of nitrogen which in turn enhanced assimilation of amino acids leading to increased synthesis of quality. With a 100% NPK dose, the grain's quality content increased from 10.1% at control to 10.6% at the grain. The percentage of protein in pearl millet grain was considerably increased by the use of FYM both alone and in conjunction with fertilizers and biofertilizers. There could be a build-up of [16,17,12]. This investigation revealed a higher protein content in the mustard crop, which is an N-responsive crop [18]. In comparison to the control, the application of 10 t FYM ha^{-1} alone increased the pearl millet grain's quality content. Remarkable outcomes were documented by [19,6,20]. This increase in output can be attributed to a general improvement in plant growth characteristics that are linked to greater crop yields and improved crop quality when organic sources are still present. It complies with the findings outlined in [16]. The findings of other studies are corroborated by these data [21,13,10,18].

4. CONCLUSION

In conclusion, integrated nitrogen management application improved protein content in pearl millet crop under pearl millet-mustard cropping system over control. Application of 25% RDN + 75% N through FYM, 50% RDN + 50% N through FYM and 75% RDN + 25% N through FYM were the most superior and equally effective treatments in this regard. Being at par among themselves, these treatments also measured significantly higher quality content in pearl millet grain over control. Such findings are very much useful for improving the pearl millet protein content in pearl millet-mustard cropping system by integrated plant nutrient management approach.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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