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Influence of nutrient management on nutrient content, uptake and quality of wheat under sorghum + pearl millet – wheat cropping sequence

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Abstract

A field experiment was conducted at Research Farm of Fodder Section, CSK HPKV, Palampur during *Rabi* 2018-19 to assess the effect of different nutrient management practices on nutrient content, their uptake and quality of wheat in an ongoing study of sorghum + pearl millet – wheat cropping sequence initiated from *Kharif* 2018. Ten nutrient management treatments were tested in randomized block design with three replications. Integrated nutrient management i.e. 50 per cent recommended N + 10 t/ha FYM + 10 per cent *Jeevamrit* and 50 per cent recommended N + 10 t/ha FYM + 5 per cent Jeevamrit and recommended NPK through inorganic sources behaving alike resulted in higher nitrogen, phosphorus and potassium content and their uptake in grain and straw of wheat than other treatments comprised of organics (10 t/ha FYM + *Jeevamrit*) and natural farming (*Beejamrit* + *Jeevamrit* and *Jeevamrit*) systems of nutrition. Improvement in quality of wheat in respect of crude protein content and crude protein yield was also noticed with integrated nutrient management and recommended NPK over other treatments.

Key words: Nutrient uptake, wheat, nutrient management, natural farming.

Sorghum + pearl millet - wheat, a prominent fodder - food based cropping system is under practice in mid and low hill zone of Himachal Pradesh, to ensure forage availability for existing livestock population of 4.41 million (Anon. 2019) without compromising with yield of food crops. Being exhaustive, this cereal-cereal based cropping system is mainly grown under inorganic nutrition conditions. But, the low income of small and marginal hill farmers restricts the use of costly chemical fertilizers on one hand and on the other, concern about soil exhaustion; environmental deterioration and nutritional imbalance arising from continuous use of inorganic fertilizers necessitate the use of other sources of nutrition (Choudhary and Suri 2009). Under the situation use of organic manures has been found to be promising in arresting the decline in productivity through correction of deficiency of secondary and micro nutrients, and improving the physical and biological health of the soil as well (Patel *et al*. 2018). But limited availability of organics and their lower nutrient content are the major constraints in the use of these alternative sources of plant nutrients. These constraints can be overcome by the judicious use of manures and fertilizers in an integrated way for maintaining the economic crop production and soil fertility on long term basis (Singh *et al*. 2018). Recently a new concept of "Subhash Palekar Natural Farming" is being popularized by different sectors to sustain crop productivity and improve soil health using inputs like *Beejamrit, Ghanjeevamrit* and *Jeevamrit*. But this needs experimental testing on a long term basis. Therefore, an attempt has been made to study the comparative effect of different nutrient management in terms of nutrient content, their uptake and quality of wheat under sorghum + pearl millet – wheat cropping sequence.

Materials and Methods

The field experiment was conducted at Research Farm of Fodder Section, CSK HPKV, Palampur during *Rabi* 2018-19. Soil of the experimental field was acidic in reaction (pH 5.47), medium in organic carbon (0.70 %), low in available nitrogen (230 kg/ha), medium in available phosphorus (17.64 kg/ha) and available potassium (168 kg/ha). The experiment was laid out in randomized block design with three replications comprised of ten treatments *i.e.* absolute

control (T_1), 5 per cent *Jeevamrit* (T_2), 10 per cent *Jeevamrit* (T_3), seed treatment with *Beejamrit* followed by 5 per cent *Jeevamrit* (T_4), seed treatment with *Beejamrit* followed by 10 per cent *Jeevamrit* (T_5), 10 t/ha FYM + 5 per cent *Jeevamrit* (T_6), 10 t/ha FYM + 10 per cent *Jeevamrit* (T_7), 50 per cent of recommended N + 10 t/ha FYM + 5 per cent *Jeevamrit* (T_8), 50 per cent of recommended N + 10 t/ha FYM + 10 per cent *Jeevamrit* (T_9) and recommended dose of NPK through inorganic sources (T_{10}).

Prior to sowing, full dose of FYM on a dry weight basis was incorporated in the soil in all the treatments comprised of FYM application. Inorganic fertilizers were applied to crop as per treatments. Half dose of N as per treatments and whole of P and K was applied at the time of sowing and the remaining half dose of nitrogen was top dressed after 30 days of sowing of crop. *Beejamrit* was prepared on farm using local cow dung (5 kg), local cow urine (5 litres), lime (50 g), soil (0.1 g) and water (20 litres) for treating seeds (100 kg) as per treatments. *Jeevamrit* (2 litres) was also prepared on the farm itself using local cow dung (100 g), local cow urine (100 ml), jaggery (20 g), pulse flour (20 g), soil (0.1 g) and water (2 litres). Both the inputs of natural farming were prepared as per the procedure proposed by Subhash Palekar (Palekar 2006). After 48 hour of *Jeevamrit* fermentation, two dilutions of 5 and 10 per cent were prepared from the concentrated J*eevamrit* and used @500 l/ha as basal and at 4 weeks interval after sowing of crop in the respective treatments.

The plant and grain samples were collected at harvest of wheat crop for chemical analysis *viz*. nitrogen, phosphorus and potassium content (%) following standard methods of modified Kjeldahl's method (AOAC 1970), vanado-molybdate phosphoric method (Jackson 1967) and flame photometer technique (Jackson 1967), respectively. The per cent crude protein content in grain and straw was calculated by multiplying per cent nitrogen with a constant factor of 6.25. The nutrient uptake by grain and straw of wheat was computed with the help of following relationship:

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content (\%)} \times \text{grain yield/straw yield (kg/ha)}}{100}$$

The crude protein yield (q/ha) was calculated by the following formula:

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Crude protein content (\%)} \times \text{grain yield/straw yield (q/ha)}}{100}$$

The data recorded on various aspects in the present study were subjected to the statistical analysis using analysis of variance as per procedure suggested by Gomez and Gomez (1984).

Results and Discussion

Nutrient content and uptake

Maximum content of nitrogen, phosphorus and potassium in grain as well as straw of wheat (Table 1) and therefore, the uptake of respective nutrient (Table 2) was observed with the application of 50 per cent recommended N + 10 t/ha FYM + 10 per cent *Jeevamrit*, which was statistically at par with the application of 50 per cent recommended N + 10 t/ha FYM + 5 per cent J*eevamrit* and recommended NPK through inorganic sources. Babli *et al*. (2017) and Singh *et al*. (2019) also reported higher NPK content in grain and straw of wheat with integrated nutrient management practices. Better availability of nutrients with integrated nutrient management and recommended NPK in the soil on one hand and improved root system accompanied with higher absorbing capacity might have helped to accumulate more NPK in the plants. Lowest nitrogen, phosphorus and potassium content as well as uptake in grain and straw was recorded in absolute control where no manures and fertilizers were applied, however, it remained statistically at par with treatments comprising of natural farming systems of nutrition i.e. 5 per cent *Jeevamrit*, 10 per cent *Jeevamrit, Beejamrit* + 5 per cent *Jeevamrit* and *Beejamrit* + 10 per cent *Jeevamrit*.

Nutrient uptake is a function of grain or straw yield and content of respective nutrients. Therefore, improvement in both these factors resulted in higher uptake of added nutrients. The nitrogen sufficiency in the soil solution and higher grain or straw yield might be responsible for higher nitrogen uptake in integrated nutrient management and recommended NPK through inorganic sources (Ghodpage and Datke 2005). Vidyavathi *et al*. (2012) reported higher uptake of phosphorus with the integrated nutrient management due to the addition of FYM which decreased the phosphorus fixation due to the formation of phosphohumic complexes that easily assimilated by plants. Further, Kumar *et al*. (2014) also found that integrated nutrient management in maize-wheat sequence increased the potassium uptake because of additive effect of FYM resulted in solubilisation of insoluble potassium and more availability to plants.

Table 1. Effect of nutrient management treatment on nitrogen, phosphorus and potassium content (%) in grain and straw of wheat crop

Treatments	Nitrogen		Phosphorus		Potassium	
	Grain	Straw	Grain	Straw	Grain	Straw
Control	0.94	0.23	0.15	0.03	0.29	0.80
5% *Jeevamrit*	0.96	0.24	0.17	0.03	0.30	0.83
10% *Jeevamrit*	0.97	0.25	0.17	0.03	0.30	0.85
Beejamrit + 5% *Jeevamrit*	0.98	0.23	0.17	0.04	0.31	0.87
Beejamrit + 10% *Jeevamrit*	0.99	0.23	0.18	0.04	0.32	0.88
10 t/ha FYM + 5% *Jeevamrit*	1.06	0.27	0.18	0.05	0.34	1.00
10 t/ha FYM + 10% *Jeevamrit*	1.07	0.29	0.18	0.06	0.34	1.03
50% recommended N + 10 t/ha FYM + 5% *Jeevamrit*	1.12	0.35	0.24	0.07	0.40	1.06
50% recommended N + 10 t/ha FYM + 10% *Jeevamrit*	1.15	0.38	0.25	0.07	0.43	1.09
Recommended NPK	1.10	0.34	0.22	0.07	0.39	1.03
SEm+	0.06	0.02	0.01	0.00	0.02	0.07
LSD (P=0.05)	0.14	0.06	0.03	0.01	0.04	0.14

Table 2. Effect of nutrient management treatments on nitrogen, phosphorus and potassium uptake (kg/ha) in grain and straw of wheat crop

Treatments	Nitrogen			Phosphorus			Potassium		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Control	15.89	7.31	23.20	2.54	0.95	3.49	4.90	25.43	30.33
5% *Jeevamrit*	18.10	8.51	26.61	3.19	1.06	4.27	5.66	29.43	35.09
10% *Jeevamrit*	18.81	9.06	27.87	3.30	1.09	4.38	5.82	30.80	36.61
Beejamrit + 5% *Jeevamrit*	19.49	8.54	28.03	3.38	1.49	4.87	6.17	32.31	38.48
Beejamrit + 10% *Jeevamrit*	20.05	8.70	28.75	3.65	1.51	5.16	6.48	33.30	39.78
10 t/ha FYM + 5% *Jeevamrit*	24.30	11.76	36.05	4.13	2.18	6.30	7.79	43.54	51.33
10 t/ha FYM + 10% *Jeevamrit*	25.11	12.90	38.01	4.22	2.67	6.89	7.98	45.81	53.79
50% recommended N + 10 t/ha FYM + 5% *Jeevamrit*	36.31	22.85	59.16	7.78	4.57	12.35	12.97	69.20	82.16
50% recommended N + 10 t/ha FYM + 10% *Jeevamrit*	37.57	25.06	62.63	8.17	4.62	12.78	14.05	71.87	85.92
Recommended NPK	35.41	22.01	57.42	7.08	4.53	11.61	12.55	66.68	79.24
SEm+	2.90	1.60	3.71	0.49	0.22	0.65	0.94	4.49	4.75
LSD (P=0.05)	6.10	3.35	7.80	1.13	0.46	1.36	2.08	9.43	9.97

Table 3. Effect of nutrient management treatments on crude protein content (%) and crude protein yield (q/ha)

Treatments	Crude protein content (%)		Crude protein yield (q/ha)	
	Grain	Straw	Grain	Straw
Control	5.88	1.44	0.99	0.46
5% Jeevamrit	6.00	1.50	1.13	0.53
10% Jeevamrit	6.06	1.56	1.18	0.57
Beejamrit + 5% Jeevamrit	6.13	1.44	1.22	0.53
Beejamrit + 10% Jeevamrit	6.19	1.44	1.25	0.54
10 t/ha FYM + 5% Jeevamrit	6.63	1.69	1.52	0.73
10 t/ha FYM + 10% Jeevamrit	6.69	1.81	1.57	0.81
50% recommended N + 10 t/ha FYM + 5% Jeevamrit	7.00	2.19	2.27	1.43
50% recommended N + 10 t/ha FYM + 10% Jeevamrit	7.19	2.36	2.35	1.57
Recommended NPK	6.88	2.13	2.21	1.38
SEm+	0.41	0.11	0.18	0.10
LSD (P=0.05)	0.85	0.23	0.38	0.21

Crude protein content and crude protein yield

Application of 50 per cent recommended N + 10 t/ha FYM + 10 per cent *Jeevamrit*, 50 per cent recommended N + 10 t/ha FYM + 5 per cent *Jeevamrit* and recommended NPK, remaining at par, recorded significantly higher crude protein content in grain and straw of wheat over rest of the treatments (Table 3). Increase in crude protein content of wheat with integrated and inorganic nutrition could be attributed to the fact that nitrogen is the main constituent of protein and it is involved in the synthesis of amino acids and accumulation of protein in grain and straw. Verma et al. (2005) and Yadav et al. (2013) also reported maximum crude protein content with the application of nitrogen under integrated and inorganic practices.

The data presented in table 3 indicated that crude protein yield of grain and straw was significantly influenced by different nutrient management treatments. Application of 50 per cent recommended N + 10 t/ha FYM + 10 per cent *Jeevamrit* also resulted in significantly higher crude protein yield of grain and straw which remained statistically at par with 50 per cent recommended N + 10 t/ha FYM + 5 per cent *Jeevamrit* and recommended NPK through inorganic sources. Thereafter, organic treatments of 10 t/ha FYM + 10 per cent *Jeevamrit* and 10 t/ha FYM + 5 per cent *Jeevamrit* resulted in significantly higher crude protein yield of grain and straw, however remained statistically at par with *Beejamrit* + 10 per cent *Jeevamrit* and *Beejamrit* + 5 per cent *Jeevamrit* for crude protein yield of grain. Significantly lowest crude protein yield of grain and straw was obtained with absolute control which was statistically at par with 5 per cent *Jeevamrit*, 10 per cent *Jeevamrit*, Beejamrit + 5 per cent *Jeeevamrit* and *Beejamrit* + 10 per cent *Jeeevamrit* treatments.

The increase in crude protein yield of grain/straw was due to increase in protein content in grain/straw and grain/straw yield of wheat crop because the protein yield proportionally increased with the increase in grain or straw yield of wheat. Fazily and Hunshal (2019) reported highest crude content and protein yield with the integrated use of FYM and inorganic fertilizers in wheat crop.

Conclusion

The study conclusively indicated that integrated nutrient management (50 per cent recommended N + 10 t/ha FYM + Jeevamrit) and recommended NPK through inorganic sources helped in enhancing the

nutrient content (nitrogen, phosphorus and potassium), their uptake and quality (crude protein content and protein yield) of wheat crop than the organic and natural farming systems of nutrition.

Conflict of interest : The authors declare that there is no conflict of interest.

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