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Assessment of Organic, Inorganic, Integrated Nutrient Management and Subhash Palekar's Natural Farming Practices in Fodder Oat and Sarson Mixture

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ABSTRACT

Background: Concern about environmental degradation and nutritional imbalance caused by continuous use of inorganic fertilizers have led to the need for studies comparing organic, inorganic and integrated nutrient management as well as Subhash Palekar's natural farming in fodder crops through natural farming.

Methods: The present investigation was conducted at the CSK HPKV, Palampur research farm, during the *Rabi* 2018-19 and 2019-20. Ten nutrient management treatments and three replications were included in the randomized block design of the trial.

Result: Treatments comprised of recommended NPK through inorganic sources and integrated nutrient management (50 per cent recommended N + FYM + *Jeevamrit*) behaving alike resulted in better crop growth (plant height and shoot number), fodder yields (green and dry), nutrient uptake (N, P and K) and crude protein yield compared to organic (FYM @10 t/ha+*Jeevamrit*) and natural farming (*Jeevamrit*/*Beejamrit* + *Jeevamrit*) nutrient management treatments. Application of recommended NPK proved most profitable with highest net returns (₹ 1, 13,347 /ha) and net returns per rupee invested (2.95) followed by integrated nutrient management. The present work suggests that fodder oat + sarson mixture can be more productive and remunerative with the adoption of integrated nutrient management next to inorganic nutrient management.

Key words: Integrated nutrient management, Natural farming, Oat and sarson mixture, Organic farming.

INTRODUCTION

India has a livestock population of 536.76 million (Anonymous, 2023). However, the available forage resources are in sufficient to meet the fodder requirements, resulting in a net deficit of 23.40% in dry fodder and 11.24% in green fodder (Roy *et al.,* 2019). Due to economic constraints, feeding livestock with concentrates is not always feasible for farmers. Green forage, which can replace concentrates, is limited during summer and winter seasons, highlighting the need to increase green and dry fodder production. With a production of 30-45 t/ha, oats (*Avena sativa* L.) are a valuable fodder crop for the Rabi season in India, covering over one million ha. Oats are renowned for having a high nutritional content and for giving cattle vital elements like energy, fiber and protein. Because of its capacity to flourish in colder regions, farmers in India frequently choose it during the *Rabi* season.

A mixed cropping of oat and fodder sarson (*Brassica rapa* L.) can improve land usage efficiency and overall herbage output in order to meet the need for green feed. The tall, dense canopy of oats creates a complementary relationship between the two crops, which can sustain the growth of the shorter fodder sarson plants. By increasing the amount of organic matter added to the soil, this mixed cropping strategy also aids in lowering weed competition and enhancing soil health. Fodder crops like oat and sarson require significant nutrients, especially nitrogen (N), to produce high-quality herbage. While chemical fertilizers are effective in providing nutrients, their cost limits their use among small and marginal farmers. Organic manures offer a promising solution by improving soil health and correcting nutrient deficiencies. Integrating organic manures with chemical fertilizers through an integrated nutrient management system can optimize productivity while reducing chemical inputs. Subhash Palekar's Natural Farming (SPNF) promotes sustainable production and ecological balance by emphasizing the use of indigenous cattle for preparing natural fertilizers like *Beejamrit*, *Jeevamrit* and *Ghanjeevamrit*. This study compares different nutrient management practices in a mixture of fodder oat and sarson in terms of growth characteristics, green and dry fodder yields, profitability,

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nutrient content and uptake (N, phosphorus 'P' and potassium 'K'), crude protein content and yield.

MATERIALS AND METHODS

A field experiment was conducted during the *Rabi* seasons of 2018-19 and 2019-20 at research farm of fodder section, CSK HPKV, Palampur. The soil of the experimental field was acidic in reaction (pH 5.47), medium in organic carbon (0.70%), low in available N (230 kg/ha), medium in available P (17.64 kg/ha) and available K (168 kg/ha). The experiment was laid out in a randomized block design with three replications, consisting of ten nutrient management treatments, *i.e.,* absolute control (T_1), 5% *Jeevamrit* (T_2), 10% *Jeevamrit* (T_3), *Beejamrit* + 5% *Jeevamrit* (T_4), *Beejamrit* + 10% *Jeevamrit* (T_5), 10 t/ha FYM + 5% *Jeevamrit* (T_6), 10 t/ha FYM + 10% *Jeevamrit* (T_7), 50% recommended N+10 t/ha FYM+5% *Jeevamrit* (T_8), 50% recommended N+10 t/ha FYM +10% *Jeevamrit* (T_9) and recommended dose of NPK through inorganic sources (T_{10}).

'PLP-1' of oat and 'FOS-902' of *sarson* varieties were grown. Oat seeds were sown in lines 20 cm apart using seed rate of 100 kg/ha. In oat crop; *sarson* was oversown by broadcast using seed rate of 3 kg/ha. 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. The crop was fertilized with recommended dose of nitrogen, phosphorus and potassium *i.e.* 120, 40 and 30 kg/ha as per treatments. *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). Two dilutions of 5 and 10 per cent were prepared from the concentrated *Jeevamrit* and used @500 l/ha as basal and at 4 weeks interval after sowing of crop in the respective treatments.

Using established techniques, the observations on crop production and growth parameters were documented. Following conventional procedures of modified Kjeldahl's method (A.O.A.C., 1970), vanado-molybdate phosphoric method (Jackson, 1967) and flame photometer technique (Jackson, 1967), plant samples were collected at the harvest of each crop for chemical analysis, *i.e.*, N, P and K content (%). The per cent crude protein content was assessed by multiplying per cent N with a constant factor of 6.25. For economic analysis, net returns (₹/ha) and net returns per rupee invested was calculated on the basis of prevailing market prices. The data pertaining to various parameters were analyzed by the method of analysis of variance as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Growth attributes

Plant height and shoot/plant number of oat and *sarson* at both the cuts was significantly influenced by different nutrient management treatments (Table 1).

In oat, at both the cuts, application of recommended NPK through inorganic sources resulted in significantly taller plants and higher number of shoots, which remained statistically at par with the application of 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.* In *sarson*, integrated nutrient management treatments comprised of 50 per cent recommended N + 10 t/ha FYM+*Jeevamrit* at first cut and recommended NPK at second cut resulted in significantly more height and shoot number of plants, however the treatments remained statistically at par with each other at both the cuts. The

Table 1: Effect of nutrient management treatments on growth parameters of oat and *sarson* (mean of two years).

Treatments	Plant height (cm)				Shoot number (per m^2)			
	Oat		*Sarson*		Oat		*Sarson*	
	Cut I	Cut II	Cut I	Cut II	Cut I	Cut II	Cut I	Cut II
Absolute control	27.45	50.95	33.85	67.10	298	203	65	46
5% *Jeevamrit*	28.50	53.20	37.20	70.40	311	214	69	49
10% *Jeevamrit*	28.65	54.85	37.25	70.90	314	224	70	52
Beejamrit + 5% *Jeevamrit*	29.90	54.00	40.20	74.50	325	220	75	57
Beejamrit + 10% *Jeevamrit*	29.90	55.05	40.50	75.40	323	223	75	58
10 t/ha FYM + 5% *Jeevamrit*	36.35	65.60	46.35	84.00	348	277	69	60
10 t/ha FYM + 10% *Jeevamrit*	36.60	64.65	48.05	82.75	347	269	73	58
50% recommended N + 10 t/ha FYM + 5% *Jeevamrit*	54.75	78.50	60.40	91.55	412	325	89	65
50% recommended N + 10 t/ha FYM + 10% *Jeevamrit*	54.95	78.55	59.60	95.35	410	323	87	67
Recommended NPK	56.30	86.15	56.65	100.00	421	348	84	69
SEm ±	2.14	3.17	2.60	5.09	18	14	3	3
CD (P=0.05)	6.40	9.51	7.85	15.28	55	41	10	10

beneficial effects of N on photosynthetic activity, protein synthesis, cell division, cell elongation and better vegetative growth can be ascribed as the possible reasons for better plant height and more number of shoots of crops with the application of N through inorganic and integrated nutrient management practices (Singh *et al.,* 2002; Kharlukhi *et al.* 2023). Organic nutrient management treatments *i.e.* 10 t/ha FYM+10 per cent *Jeevamrit* and 10 t/ha FYM + 5 per cent *Jeevamrit* were next in place in recording taller plants and more number of shoots/plant of oat and *sarson* at both the cuts. Significantly minimum plant height and lower number of shoots/plant of oat and *sarson* was recorded under absolute control which was statistically at par with *Jeevamrit* (5 or 10%) treatments at both the cuts.

Yield

Total green and dry fodder yields of oat+*sarson* was significantly influenced by different treatments at first cut, second cut and total of two cuts (Table 2). Integrated nutrient management treatments *i.e.* 50 per cent recommended N + 10 t/ha FYM+5 per cent *Jeevamrit* and 50 per cent recommended N + 10 t/ha FYM + 10 per cent *Jeevamrit* at first cut and recommended NPK through inorganic sources at second cut and total of two cuts resulted in significantly highest total green and dry fodder yields. All inorganic and integrated nutrient management treatments remained at par with each other at the first cut. Organic nutrient management treatments comprised of 10 t/ha FYM + *Jeevamrit* were next in place followed by natural farming nutrient management (*Beejamrit* + *Jeevamrit*) and *Jeevamrit* (5 or 10 per cent) treatments which remained at par with each other at both the cuts and total of two cuts. Recommended NPK through inorganic sources at total of two cuts resulted in 69.63, 65.37, 62.44, 48.21 and 5.62 per cent more total green fodder yield and 66.46, 62.95, 61.08, 45.37 and 5.76 per cent more total dry fodder yield over absolute control, *Jeevamrit*, natural farming, organic and integrated nutrient management, respectively.

Pandey (2018) in oat crop and Meitei and Bajpay (2019) in *sarson* crop also observed significant improvement in green fodder yield with the application of chemical fertilizers alone and in integration with FYM. Improvement in fodder yield with the application of recommended NPK through inorganic sources might be ascribed to adequate availability of N to the crop which is the constituent of amino acid and chlorophyll thus enhanced the photosynthetic activity and growth attributes (Table 1) and ultimately the yield of the crop (Sharma, 2009). Use of FYM with inorganic fertilizers might have attributed to increased supply of major and micro nutrients and increase in the activities of heterotrophic bacteria and fungi in soil, which in turn increased the activity of enzymes responsible for conversion of unavailable form of nutrients to available form leading to higher nutrient uptake and improvement in crop yield (Devi *et al.,* 2014; Monicaa *et al.,* 2023).

Economics

Significantly higher net returns of ₹ 1,13,347 per ha and net returns per rupee invested (2.95) were obtained with the application of recommended NPK through inorganic sources which was followed by integrated nutrient management (50 per cent recommended N + 10 t/ha FYM + *Jeevamrit*) practices (Table 2). Lowest net returns and net returns per rupee invested were obtained from absolute control and organic nutrient management (10 t/ha FYM + 5 or 10% *Jeevamrit*), respectively which did not differ significantly from each other.

The enhanced yield under recommended NPK resulted in higher net returns and net returns per rupee invested. Higher cost of FYM application made integrated nutrient

Table 2: Effect of nutrient management treatments on yield and economics of oat + *sarson* mixture (mean of two years).

Treatments	Green fodder yield(t/ha)			Dry fodder yield(t/ha)			Economics	
	Cut I	Cut II	Total	Cut I	Cut II	Total	Net returns (Rs./ha)	Net returns per rupee invested
Absolute control	4.74	9.65	14.39	0.75	1.94	2.68	13450	0.42
5% *Jeevamrit*	5.41	10.64	16.05	0.81	2.10	2.90	16690	0.48
10% *Jeevamrit*	5.48	11.28	16.77	0.82	2.20	3.02	18228	0.52
Beejamrit + 5% *Jeevamrit*	6.36	11.39	17.76	0.90	2.20	3.10	21898	0.63
Beejamrit + 10% *Jeevamrit*	6.25	11.59	17.84	0.89	2.24	3.12	21404	0.60
10 t/ha FYM + 5% *Jeevamrit*	8.84	15.90	24.74	1.22	3.21	4.43	22059	0.39
10 t/ha FYM + 10% *Jeevamrit*	9.06	15.29	24.35	1.26	3.03	4.30	20077	0.35
50% recommended N + 10 t/ha FYM + 5% *Jeevamrit*	19.57	25.18	44.81	2.32	5.20	7.52	81494	1.32
50% recommended N + 10 t/ha FYM + 10% *Jeevamrit*	19.50	25.14	44.64	2.32	5.22	7.54	80392	1.29
Recommended NPK	19.23	28.21	47.39	2.28	5.71	7.99	113347	2.95
SEm ±	0.32	0.76	0.80	0.04	0.17	0.18	2572	0.08
CD (P=0.05)	0.95	2.27	2.41	0.13	0.52	0.54	7715	0.25

Table 3: Effect of nutrient management treatments on nutrient content (%), nutrient uptake (kg/ha), crude protein content (%) and crude protein yield (q/ha) of oat + *sarson* mixture (mean of two years).

Treatments	Nutrient content (%)			Nutrient uptake (kg/ha)			Crude protein content (%)		Crude protein yield (q/ha)		
	N	P	K	N	P	K	I Cut	II Cut	I Cut	II Cut	Total
Absolute control	0.86	0.19	0.87	23.27	5.38	23.73	5.22	5.53	0.39	1.07	1.46
5% *Jeevamrit*	0.88	0.20	0.90	26.03	5.94	26.05	5.32	5.63	0.44	1.18	1.61
10%*Jeevamrit*	0.92	0.20	0.92	27.83	6.41	27.77	5.66	5.77	0.46	1.27	1.74
Beejamrit + 5% *Jeevamrit*	0.93	0.21	0.94	28.63	6.76	29.70	5.72	5.80	0.52	1.27	1.78
Beejamrit+ 10% *Jeevamrit*	0.93	0.21	0.93	28.55	6.77	29.65	5.79	5.76	0.51	1.29	1.80
10 t/ha FYM + 5% *Jeevamrit*	1.03	0.25	1.02	45.75	10.99	46.13	6.35	6.52	0.77	2.09	2.86
10 t/ha FYM + 10% *Jeevamrit*	1.05	0.24	1.03	45.78	10.41	45.32	6.41	6.69	0.81	2.03	2.84
50% recommended N + 10 t/ha FYM + 5% *Jeevamrit*	1.20	0.28	1.17	90.61	21.47	89.24	7.21	7.72	1.68	4.01	5.68
50% recommended N + 10 t/ha FYM + 10% *Jeevamrit*	1.21	0.28	1.22	91.64	21.39	92.54	7.35	7.70	1.71	4.02	5.72
Recommended NPK	1.14	0.27	1.15	92.36	21.56	92.70	6.85	7.39	1.57	4.22	5.78
SEm ±	0.04	0.01	0.04	3.50	0.85	2.19	0.27	0.29	0.09	0.19	0.22
CD (P=0.05)	0.11	0.02	0.11	10.50	2.54	6.57	0.82	0.87	0.27	0.56	0.66

management less profitable. In natural farming nutrient management treatments, on farm preparation of *Beejamrit* and *Jeevamrit* reduced the cost of cultivation and made these treatments comparable with organic nutrient management treatments in terms of net returns and net returns per rupee invested. Significantly higher net returns per rupee invested with the *Jeevamrit* alone application as compared to 7.5 t/ha FYM + *Jeevamrit* was also reported by Manjunatha *et al.* (2009).

NPK content and uptake

Integrated nutrient management treatments *i.e.* 50 per cent recommended N + 10 t/ha FYM + 5 per cent *Jeevamrit* and 50 per cent recommended N + 10 t/ha FYM + 10 per cent *Jeevamrit* resulted in highest N, P and K content in herbage which remained statistically at par with the application of recommended NPK through inorganic sources (Table 3). Whereas, the application of recommended NPK through inorganic sources resulted in significantly highest uptake of N, P and K and remained statistically at par with the integrated nutrient management treatments comprised of 50 per cent recommended N+10 t/ha FYM+*Jeevamrit*. Lowest NPK content and its uptake was observed under absolute control, which was statistically at par with *Jeevamrit* (5 or 10%) and natural farming nutrient management (*Beejamrit* + 5% *Jeevamrit* and *Beejamrit* + 10% *Jeevamrit*) treatments.

The N sufficiency in the soil solution and higher dry matter yield (Table 2) might be responsible for higher nutrient uptake in treatment fertilized with recommended NPK through inorganic sources. Kumar and Dhar (2006) also observed highest uptake of nutrients with integrated nutrient management which was statistically at par with 100 per cent recommended NPK through inorganic sources.

Crude protein content and yield

At both the cuts, integrated nutrient management practices and recommended NPK remaining at par with each other resulted in higher crude protein content in the herbage compared to all other treatments having 10 t/ha FYM+ *Jeevamrit, Beejamrit+Jeevamrit, Jeevamrit* and no fertilizers or manure application (Table 3). Increased shoot dry weights and shoot N concentrations as a result of fertilizer-N applications might have helped to increase the crude protein content with integrated and inorganic nutrient management (Jarrell and Beverly, 1981; Naveen and Senthikumar, 2021).

A perusal of data in Table 3 further indicated that integrated nutrient management practices comprised of 50 per cent recommended N+10 t/ha FYM + *Jeevamrit* at first cut and recommended NPK through inorganic sources at second cut remaining at par with each other resulted in significantly higher crude protein yield as compared to rest of the treatments. Lowest crude protein yield was obtained under absolute control which remained statistically at par with *Jeevamrit* (5 or 10%) and natural farming nutrient management (*Beejamrit* + *Jeevamrit)* treatments at both the cuts. Total crude protein yield of both the cuts was significantly highest with the application of recommended NPK through inorganic sources, which was 74.74, 70.93, 69.03, 50.69 and 1.38 per cent higher over absolute control, *Jeevamrit*, natural farming, organic and integrated nutrient management, respectively.

The variation in crude protein yield in all the treatments is mainly because of the crude protein content (Table 3) and dry matter yield (Table 2) of oat and *sarson* crops obtained under respective treatments.

CONCLUSION

In fodder oat+*sarson* mixture, inorganic nutrient management (recommended NPK) and integrated nutrient management (50 per cent recommended N +10 t/ha FYM+ *Jeevamrit*) proved better than organic (10 t/ha FYM+ *Jeevamri)* and natural farming (*Beejamrit+Jeevamrit)* nutrient management practices in terms of growth characteristics, green and dry fodder yields, crude protein yield, nutrient uptake and monetary returns.

Conflict of interest: There is no conflict of interest.

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