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EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON YIELD, QUALITY AND UPTAKE OF NUTRIENTS IN WHEAT (*TRITICUM AESTIVUM* L.) CROP IN AGRA REGION OF INDIA

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ABSTRACT

A field experiment was conducted during rabi season (2021-22 and 2022-23) at agricultural research farm, R.B.S. College, Bichpuri, Agra (U.P.) to study the effect of integrated nutrient management on yield, quality, and uptake of nutrients in wheat The experiment was laid out in randomized block design with ten (nine treatments and one control) treatments combinations and three replications. The results revealed that the plant height and dry matter yields of wheat crop increased significantly by all the treatments over control. The maximum values of plant height (77.58 cm), grain weight (q ha^{-1}) and dry matter yield (60.69 q ha^{-1}) were recorded with 75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1} closely followed by 50% RDF + 5 t FYM + 5 Kg Zn ha^{-1}. Use of farmyard manure was also found to be more beneficial in terms of growth and yield of wheat. The maximum content of protein (15.03 %) and protein yield (776.60 kg ha-1) were recorded with 75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}. The uptake of N, P, K, S, and Zn by wheat crop was highest at 75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1} and lowest in control. The amounts of available N, P, K, S and Zn in post-harvest soil were maximum with the application of 75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}. The minimum amounts of available nutrients in post-harvest soil were recorded under control treatment.

Keywords: Oat, INM, quality, uptake of nutrients, soil fertility, yield.

Introduction

Wheat is the main cereal crop in India. The total area under the crop is about 29.8 million hectares in the country. The production of wheat in the country has increased significantly from 75.81 million MT in 2006-07 to an all-time record high of 112.74 million MT in 202-23. The national wheat production accounts for approximately 13% of global wheat production. Wheat is an important source of carbohydrates. Globally, it is the leading source of vegetable proteins in human food, having a protein content of about 13%, which is relatively high compared to other major cereals but relatively low in protein quality (supplying essential amino acids). When eaten as the whole grain, wheat is a source of multiple nutrients and dietary fiber. Wheat and its various products play an increasingly important role in managing India's food security and India became the wheat surplus nation as against the wheat deficient nation during 1960's. The tremendous progress in area, production and productivity of wheat to the tune of 2.9, 12.2 and 4.2 times respectively as compared to 1950 has made India the member of elite group of wheat exporting countries. About 91.5% of the wheat produced in six states viz. Uttar Pradesh, Punjab, Haryana. Madhya Pradesh, Rajasthan and Bihar.

The pressure of population per unit area is a major driving force behind the quest for high yields. It is a common knowledge that high yields can only be produced and sustained through use of fertilizers and

organic matter resources like green manures, farmyard manures, legume straw, paddy straw etc. a further increase and sustain in food/fodder production would definitely require greater use of fertilizers with organic sources to chur out the much required crop production, the country is going to need 45 million tons of nutrients from various sources of plants nutrients, *i.e.* fertilizers, organic manures and biofertilizers. Integrated nutrient management (INM) is an approach in which inorganic and organic manures applied together to improve the soil fertility. Integrated nutrient management is not only vital for sustainable productivity (Verma *et al.,* 2010) but also improves soil physical, chemical and biological properties to prevent environmental degradation. Hence, integrated nutrient management (INM) is the best approach for better utilization of available resources and to produce crops with less expenditure. The basic concept of integrated nutrient management (INM) or integrated plant nutrition management (IPNM) is the adjustment of plant nutrient supply to an optimum level for sustaining the desired crop productivity. It involves proper combination of chemical fertilizers, organic manure, crop residues, green manure and bio-fertilizers to maintain soil quality in terms of physical, chemical and biological properties. Proper and optimum application of fertilizers not only increases the yield but also favorably affects the quality of the produce. To curb this trend of declining yield, there is need to adopt the concept of integrated nutrient management. Organic manure is important components of an integrated nutrient management and may help to recover soil health. Besides, organic manures also supply the traces of micronutrients, which are not supplied by chemical fertilizers. Therefore, it is needed to compare various organic manures with chemical fertilizers to find out the most effective combination. Integrated system approach is not only a reliable way of obtaining high productivity with, substantial fertilizer economy, but also a concept of ecological soundness leading to sustainable agriculture. The basic concept of integrated plant nutrient system is maintenance and improvement of soil fertility for sustaining crop productivity on longterm basis. Application of different organic and inorganic sources was found very effective in realizing high yield, better economy (Singh, 2017) and improved residual fertility of the soil. The present experiment comprising different levels of inorganic and organic fertilizers was undertaken to study their effects on wheat crop.

Yadav *et al.* (2000) analyzed the yield trends and effect of fertilizer NPK application, alone or in combination with farmyard manure, green manure on wheat crop residue incorporation in rice-wheat cropping system, reported that rice or wheat yield trends in the treatments receiving complete doses of fertilizer NPK were generally not significant but treatment having fertilizer manure was found significant. Aulakh (2004) investigated the role of integrated nutrient management on different cropping system. He reported that INM increased the yield potential of crop in long run over the achievable yield with recommended dose of fertilizer. Further, he also reported that slow mineralization of organic nitrogen reduces the losses of nitrogen, enhanced the nutrient use efficiency, overall, for sustainable production of different cropping system can achieve through INM.

Om Sharan *et al.* (2004) evaluated the direct effect of applied Sulphur on hybrid rice and residual effect on wheat crop for two consecutive years in rice-wheat cropping system. Application of S up to 60 kg ha^{-1} enhanced the average grain yield of hybrid rice by 10.5 percent with gypsum and 11.6 percent with Sulphur-95. Similarly, the residual effect of 60 kg ha^{-1} increased the wheat grain yield by 10.9 percent with gypsum and 12.0 percent with sulfer-95 over the control. The optimum dose of hybrid rice was found to be 52 kg ha^{-1} , yielding 89.4 q ha^{-1} grain yields. The optimum dose of S for wheat was found to be 48 kg S ha^{-1} for gaining 52.5 q ha^{-1} grain yield. Similar trend of response of sulphur on straw yield was recorded. Total sulphur uptake by both the crops progressively increased with its increasing levels. A phenomenal increase in N, P and K uptake was recorded in both the crops due to increasing levels of sulphur. Crude protein content in rice and wheat also increased with S application. Singh (2006) found that 25 or 50% of recommended N through FYM, pressmud and paddy straw and the rest of recommended N through inorganic fertilizers gave significantly higher grain and straw yields of both rice and wheat over 75% of recommended N through organic sources and 25% recommended N through inorganic fertilizers.

Kumar *et al.* (2007) conducted a field experiment on rice-wheat system on the combined effect of pressmud and recommended dose of fertilizer (RDF) over RDF alone and concluded that the combined effect of pressmud and RDF enhances the yield attributes over RDF alone.

Rasool *et al.* (2007) studied the long term effect of the application of FYM and inorganic fertilizers in rice-wheat system. They used six treatments during both rice and wheat crops viz (1) farm yard manure @ 20 t ha^{-1} (FYM); (ii) nitrogen @ 120 kg ha^{-1} (N120); (iii) nitrogen and phosphorus @ 120 and 30 kg ha^{-1} (N120 P30) and (iv) nitrogen, phosphorus and potassium @ 120, 30 and 30 kg ha^{-1} (N120 130 K30)

in addition to (iv) control treatment, i.e. without any fertilizer and/or FYM addition. They observed the average mean weight diameter (MWD) was highest in FYM-plots both in rice (0.237 mm) and wheat (0.249 mm) closely followed by that in N120 P30 K30 plots. The effect of FYM in increasing the mean weight diameter (MWD) decreased with soil depth. The addition of both FYM and N120 P30 K30 increased the organic carbon by 44 and 37%, respectively in rice. The total porosity of soil increased with the application of both FYM and N120 P30 K30 from that in control plots.

Mukherji *et al.* (2013) reported that the highest dry matter accumulation was obtained in NPK + Mo followed by organic + Zn and NPK with no significant difference among them. Plant height was found highest in NPK followed by NPK + Mo and organic + B without any significant difference. The grain yield, harvest index and number of pods plant^{-1} were influenced significantly by various nutrient management whereas number of grains pod^{-1} and test weight did not show any significant effect. Highest grain yield and harvest index were recorded in NPK + Mo followed by NPK + Zn and organic +Mo. Kumar *et al.* (2014) concluded that combined use of inorganic fertilizers, FYM and vermicompost produced higher grain and straw yields of wheat. The mean increases in grain production due to 10 t ha^{-1} FYM and 2.5 t ha^{-1} vermicompost over control were 28.0 and 26.2 per cent, respectively. Combined application of NPK fertilizers, $ZnSO_4$ and sulphur proved markedly beneficial in improving the wheat production.

Srivatsava *et al.* (2015) assessed the twelve nutrient management treatments to identify a superior treatment for pearl millet and wheat crops grown in rotation at Agra under semi-arid Inceptisols. Among different treatments, the application of 100% NPK + FYM @10 ton ha^{-1} $ZnSO_4$ at 25 kg ha^{-1} + S at 25 kg ha^{-1}, was significantly superior for attaining maximum pearl millet grain yield of 2885 kg ha^{-1}, straw yield of 7185 kg ha^{-1}. In the case of wheat, above treatment was also superior for attaining grain yield (5215 kg ha^{-1}), straw yield (7220 kg ha^{-1}). Islam *et al.* (2016) suggested that the integrated use of organic and inorganic fertilizers significantly increased the yield attributes as well as grain and straw yields of wheat. The treatment Soil Test Based-Chemical Fertilizer (High Yielding Goal) + Poultry manure (3 t ha^{-1}) produced the highest grain yield of 3554 kg ha^{-1} (69.67% increase over control) and straw yield of 3635 kg ha^{-1} (62.83% increase over control). The lowest grain yield (2094 kg ha^{-1}) and straw yield (2232 kg ha^{-1}) were found in control treatment. Shukla *et al.* (2016) conducted a field experiment on rice at agricultural research farm, B.H.U. and revealed that the application of RDF + vermicompost @5 t ha^{-1} + Trichoderma compost @ 7.5 kg ha^{-1} significantly increased the yield attributes viz., panicle length (25.05 cm), Panicle weight (3.50 g), number of panicle (133.20 m^{-2}), test weight (22.93 g), grain yield (54.0 q ha^{-1}), straw yield (70.0 q ha^{-1}) and harvest index (43.56%).

Saharan *et al.* (2022) have conducted an experiment during 2014–15 and 2015–16 at Swami Keshwanand Rajasthan Agriculture University, Bikaner, Rajasthan, to evaluate the effect of integrated nutrient management on yield of wheat (*Triticum aestivum* L.) and succeeding pearl millet [*Pennisetum glaucum* (L.) R. Br.] crop. The experiment was laid out in a split-plot design with 3 replications comprising different treatment combinations. Incorporation of 75% recommended dose of fertilizer (RDF) + 5 t farmyard manure (FYM)/ha + Azotobacter + phosphate-solubilizing bacteria (PSB) in wheat, significantly increased yield attributes and yield (4.12 t ha^{-1}) of wheat and uptake of nutrients (N, P, K) in both grain and straw of wheat, but remained at par with 100% RDF + 5 t FYM ha^{-1} + Azotobacter + PSB.

Materials and Methods

The experiment was carried out at R. B. S. College Research Farm Bichpuri, Agra (U.P.) during the session 2021-22 and 2022-23. The farm is situated at 27^0 2' N latitude, 77^0 9' E longitudes and in on altitude of 163.4 meter above mean sea level in Uttar Pradesh state of India in a silty-clay loam soil under randomized block design replicated thrice with nine treatment combinations (T1-50% RDF, T2-75% RDF, T3-50% RDF + 5 Kg Zn ha^{-1},T4- 50% RDF + 5 t FYM ha^{-1}, T5-100 % RDF ($N_{120}P_{60}K_{40}$ ha^{-1}),T6- 50% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}, T7-75% RDF + 5 Kg Zn ha^{-1}, T8-75% RDF + 5 t FYM ha^{-1}, T9-75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}) along with one absolute control. Gross plot size in wheat was kept 16.00 m^2. Soil chemical properties, viz. soil pH, organic carbon, total nitrogen, available N, P and K were determined initially, after first year of experimentation and at the end of the experimentation by standard methods. N, P, and K content in grain and straw were determined by the standard procedures suggested by Jackson (1967) in order to estimate total N, P, and K uptake. On the basis of chemical analysis, soil was categorized as medium in organic carbon, available nitrogen (173.1 kg ha^{-1}) and available phosphorus (9.7 kg ha^{-1}), and high in available potassium (225.3 kg ha^{-1}) before experimentation. The pH was recorded as 8.2 while EC was 0.19. Statistical analysis was done by the standard procedures

suggested by Gomez and Gomez (1984). Before application and incorporation into the soil, different organic sources of plant nutrients were analyzed for their chemical composition with reference to N, P, and K on dry weight basis during both the years of experimentation.

Results and Discussion

Plant height, grain weight, and dry matter yield

The plant height of wheat crop ranged from 73.35 to 77.58 cm. Mean height of wheat crop was highest (77.58 cm) under T9 (75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}), followed by T7 (75% RDF + 5 Kg Zn ha^{-1}), followed by T8 (75% RDF + 5 t FYM ha^{-1}). The minimum height of plants was recorded under control (Table 1). The highest grain weight of wheat was obtained by T9 (75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}) as compared to other treatments. Application of T9 (75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}) to wheat increased the dry matter yields significantly over all other treatments except T6 (50% RDF + 5 t FYM + 5 Kg Zn ha^{-1}), T7 (75% RDF + 5 Kg Zn ha^{-1}) and T8 (75% RDF + 5 t FYM ha^{-1}). The beneficial effect of FYM on yields might be due to additional supply of nutrients as well as improvement in physical and biological properties of soil. The results clearly indicate that the highest yield was obtained with balanced use of fertilizers.

Protein content and protein yield

Protein content is an essential part of wheat crop which govern the quality of a crop. There was significantly higher percentage of protein in plants under all the treatments as compared to control except T3 (50% RDF + 5 Kg Zn ha^{-1}). The protein content in wheat plants ranged from 12.18 to 15.03 per cent, the minimum being in control. Application of T9 (75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}) being at par with T5 (100 % RDF ($N_{120}P_{60}K_{40\ ha^{-1}}$) and T6 (50% RDF + 5 t FYM + 5 Kg Zn ha^{-1}) and proved significantly superior to other treatments in respect of protein content. This may be due to accumulation of more nitrogen with these treatments and ultimately showing more protein content. The protein yield in wheat plants ranged from 509 kg ha^{-1} to 776 kg ha^{-1} with T9 (75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}). The minimum protein yield was noted under T3 (50% RDF + 5 Kg Zn ha^{-1}). Application of T9 (75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}) improved the protein yield and found superior to all other treatments.

Table 1: Effect of integrated nutrient management on plant height (cm), grain weight (q ha^{-1}), dry matter yield (q ha^{-1}), protein content (%) and protein yield (kg ha^{-1}) (mean of two years)

Treatments	Plant Height	Grain Weight	Dry Matter Yield	Protein Content	Protein Yield
T1	75.70	3.21	53.25	13.28	576.78
T2	76.08	3.22	52.74	13.20	535.50
T3	75.34	3.28	52.13	12.57	509.18
T4	74.38	3.35	54.30	13.95	634.97
T5	74.79	3.35	57.80	14.33	553.45
T6	75.74	3.48	59.31	14.38	754.00
T7	77.05	3.43	57.41	14.15	708.43
T8	76.26	3.35	59.09	14.18	748.27
T9	77.58	3.73	60.69	15.03	776.60
T10	73.35	3.06	50.26	12.18	572.68
CD	1.51772	0.52463	3.75825	0.83544	5.90606
Sem	0.51082	0.17658	1.26491	0.28118	1.98780
Sed	0.72241	0.24972	1.78886	0.39766	2.81117
CV(%)	1.16994	9.13951	3.93356	3.54803	0.54051

Uptake of Nutrients

Nitrogen uptake by wheat plants increased significantly with different treatments over control (Table 2). The mean increase in N uptake was from 48.07 to 121.12 kg ha^{-1} by wheat crops. The highest N uptake by wheat crop was recorded with T9 (75% RDF + 5 t FYM ha^{-1} +5 Kg Zn ha^{-1}). This increase in N uptake may be attributed to increased dry matter yield. Application of T9 (75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}) improved the N uptake and found superior to all other treatments except T6 (50% RDF + 5 t FYM + 5 Kg Zn ha^{-1}). The P uptake by wheat crop ranged from 5.91 to 14.11 kg ha^{-1}. Application of FYM and RDF increased the P uptake by wheat crop, which may be ascribed to increased dry matter production and improvement in P content in crop. Application of T9 (75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}) improved the P uptake and found superior to all other treatments except T5 (100 % RDF ($N_{120}P_{60}K_{40}$ ha^{-1}) and T6 (50%

RDF + 5 t FYM + 5 Kg Zn ha^{-1}). The minimum (14.24 kg ha^{-1}) and maximum (31.10 kg ha^{-1}) values were recorded under T10 (control) and T9 (75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}) respectively for K uptake. T9 (75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}) was found statistically superior to all other treatments except T6 (50% RDF + 5 t FYM + 5 Kg Zn ha^{-1}). All the treatments proved beneficial in increasing the uptake of K by wheat over control (Table 2). The mean increase in S uptake was from 5.39 to 15.95 kg ha^{-1} by wheat crops. The highest S uptake by wheat crop was recorded with T9 (75% RDF + 5 t FYM ha^{-1} +5 Kg Zn ha^{-1}). Application of T9 (75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}) improved the S uptake and found superior to all other treatments. All the treatments proved beneficial in increasing the uptake of Zn by wheat crop over control (Table 2). The minimum (84.86 kg ha^{-1}) and maximum (158.54 kg ha^{-1}) values were recorded under T10 (control) and T9 (75% RDF + 5 t FYM ha^{-1} +5 Kg Zn ha^{-1}) respectively. T9 (75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}) was found statistically superior to all other treatments except T6 (50% RDF + 5 t FYM + 5 Kg Zn ha^{-1}).

Table 2: Effect of integrated nutrient management on uptake of nutrients by wheat crop (mean of two years)

Treatments	N	P	K	S	Zn
T1	89.88	9.95	19.52	8.91	112.72
T2	83.54	9.07	18.45	8.07	107.94
T3	79.60	7.83	18.20	7.16	107.47
T4	105.93	11.76	22.85	12.08	119.15
T5	113.24	13.45	24.81	13.09	138.65
T6	117.94	13.62	30.01	14.28	152.18
T7	99.64	11.11	22.31	10.05	120.02
T8	110.97	13.56	26.70	13.42	144.76
T9	121.12	14.11	31.10	15.95	158.54
T10	48.07	5.91	14.24	5.39	84.86
CD	7.56656	0.86013	1.81799	0.88918	9.73089
Sem	2.54668	0.28949	0.61188	0.29927	3.27512
Sed	3.60154	0.40941	0.86533	0.42323	4.63172
CV(%)	4.54773	4.54349	4.64471	4.7819	4.55164

Soil fertility

Use of different nutrient management practices caused a marked change in the organic carbon (OC) content. The maximum amount of organic carbon in post-harvest soil was noted with T9 (75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}). This increase in organic carbon content may be attributed to addition of FYM. The available N status exhibited marked difference due to various nutrient management practices. The highest available nitrogen contents were obtained under T9 (75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}) followed by T6 (50% RDF + 5 t FYM + 5 Kg Zn ha^{-1}). The lowest available N content was recorded in T10 (control).

Table 3: Effect of integrated nutrient management on status of OC, available N, P, K, S and Zn (Kg h^{-1}) in post-harvest soil (mean of two years)

Treatment	OC	N	P	K	S	Zn
	g Kg^{-1}	Kg h^{-1}	Kg h^{-1}	Kg h^{-1}	Kg h^{-1}	Kg h^{-1}
T1	4.11	170.5	9.6	215.3	8.3	0.56
T2	4.11	170.6	10.3	215.7	8.3	0.57
T3	4.16	170.8	10.7	216.3	8.4	0.59
T4	4.26	174.3	12.2	230.5	9.5	0.65
T5	4.52	176.1	12.6	234.2	9.6	0.67
T6	4.66	183.2	13.5	244.0	10.6	0.71
T7	4.22	171.6	11.5	222.9	9.2	0.63
T8	4.55	180.5	12.7	236.5	10.4	0.71
T9	4.76	185.5	13.6	244.6	10.9	0.73
T10	4.10	163.5	9.1	213.1	8.2	0.54
CD	0.29	11.88	0.76	15.39	0.62	0.04
SEm	0.09	4.00	0.25	5.18	0.20	0.01
SEd	0.14	5.65	0.36	7.32	0.29	0.02
CV(%)	3.94	3.96	3.83	3.94	3.89	3.87

Available phosphorus status recorded significant variation due to treatment variations (Table 4). It ranged from 9.1 to 13.6 Kg h^{-1}. T9 (75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}) was found statistically superior to all other treatments except T6 (50% RDF + 5 t FYM + 5 Kg Zn ha^{-1}). The lowest available P content (9.1 Kg h^{-1}) was observed under T10 (control). Application of T9 (75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}) showed significantly higher available potassium (K) status except T6 (50% RDF + 5 t FYM + 5 Kg Zn ha^{-1}). The lowest available potassium was recorded in T10 (control) treatment. Available S content was affected significantly by variations in the treatments. Lowest and highest contents of Zn in post harvest soil were recorded under T10 (control) and T9 (75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1}) respectively. This increase in available Zn in post harvest soil may be attributed to apply FYM to the soil.

Conclusion

It may be concluded from the present investigation that 75% RDF + 5 t FYM ha^{-1} + 5 Kg Zn ha^{-1} might be beneficial under semi-arid condition of Agra region of Uttar Pradesh for achieving higher productivity of wheat besides improving quality of produce and maintaining soil fertility. It may also be concluded from the results that there was significant improvement in crop yields, nutrient uptake with balanced use of RDF and FYM.

References

Chaudhary, M. and Narwal, R. (2005). Effect of long-term application of farmyard manure on soil micronutrient status. *Archives of Agronomy and Soil Science*, **51**(3), 351–359.

Dixit, K.G. and Gupta, B.R. (2000) Effect of farmyard manures, chemical and biofertilizers on yield and quality of rice (*Oryza sativa* L.) and soil properties. *Journal of the Indian Society of Soil Science* **48**, 773- 780.

Hegde, D.M. and Katyal, V. (1999). Long term effect of fertilizer use on crop productivity and soil fertility in pearl millet–wheat cropping system in different agro-eco region. *Journal Maharashtra Agriculture University* **24** : 16-20.

Kumar, P., Singh, R., Singh, A., Paliwal, D. and Kumar, S. (2014). Integrated nutrient management in pearl millet (*Pennisetum glaucum*) - wheat (*Triticum aestivum*) cropping sequence in semi-arid condition of India. *International Journal of Agricultural Sciences*, **10** (1), 96-101.

Mathur, A.K., Sharma, S.N., Swami, B.N. and Singh, N. (1998). Direct and residual effect of FYM, phosphorus and zinc on major nutrients availability in wheat – pearl millet cropping sequence. *Crop Research* **16**: 296-299.

Rani, Y.S., Jamuna, P., Rao, P.J., Triveni, U., Patro, T.S.S.K. and Anuradha, N. (2020). Yield and quality of little millet (*Panicum sumatrense*) as influenced by organic manures and inorganic fertilizers. *Journal of Pharmacognosy and Phytochemistry,* **9**(5), 595-598.

Singh, D.V., Saxena, A. and Joshi, N.L. (1997). Response of pearl-millet of the biofertilizers under low and medium fertility conditions. In Proceedings: Recent Advances in Management of Arid Ecosystem held at Jodhpur during March, 3-5.