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Research Article

EFFECT OF INTEGRATED USE OF INORGANIC AND ORGANIC SOURCES OF NITROGEN ON NUTRIENT UPTAKE BY WHEAT AND SOIL FERTILITY

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A B S T R A C T

A field experiment was conducted at Agronomy Research Farm of CCS Haryana Agricultural University, Hisar during Rabi seasons of 2017-18 and 2018-19 to Effect of integrated use of inorganic and organic sources of nitrogen on nutrient uptake and soil fertility of wheat. The experiment was laid out in randomized block design with three replications consisting of ten treatments combinations i.e. T_1-Control; T_2-100% recommended dose of nitrogen (RDN) + 25% N through FYM; T_3-100% RDN + 25% N through vermicompost; T_4-75% RDN + 25% N through FYM; T_5-75% RDN + 25% N through vermicompost; T_6-50% RDN + 50% N through FYM, T_7-50% RDN + 50% N through vermicompost; T_8-25% RDN + 75% N through FYM; T_9-25% RDN + 75% N through vermicompost and T_{10}-100% RDN through chemical fertilizer (RDN). Application of 100% RDN + 25% N through vermicompost increased 207.36 and 215.79 percent nitrogen uptake by grain , 258.11 percent and 278.74 percent nitrogen uptake by straw, 307.17 and 332.26 percent higher phosphorus uptake by grain and 256.90 percent and 280.41 percent higher phosphorus uptake by straw and 288.08 and 319.69 percent higher potassium uptake by grain and 209.18 percent and 211.51 percent higher potassium uptake by straw of wheat with application of 100% RDN + 25% N through vermicompost over control treatment during both the consecutive years, respectively. Similarly application of 100% RDN + 25% N through FYM had 32.00 and 44.13 percent higher nitrogen, 86.77 and 144.26 percent higher phosphorus and 17.77 and 20.36 percent higher potassium over control treatment during both the consecutive years, respectively.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the world's leading cereal crop, which can be grown in broad range of altitudes and latitudes. Wheat is one of the good sources of carbohydrates and unique protein, which is consumed as human as well as animal feed. Wheat is the staple food of nearly 35% of world population. The total area under wheat cultivation in the world during 208-19 was 218.22 million hectares with an annual production of 765.53 million tons and average productivity of 3.51 tons ha^{1} (USDA, 2019). Wheat is globally second to rice in terms of total production. In India wheat is a major crop of north-western zone and center zone and is the second most important crop next to rice, which contributes nearly 35% to the national food basket. India is the second largest producer of wheat next to china, which produces about 99.87 million tons of wheat from an area of 29.65 million hectare with an average productivity of 3.37 t ha^{1}.

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The states which produce considerable amount of wheat are Haryana, Uttar Pradesh, Punjab, Rajasthan, Gujarat, Madhya Pradesh, Bihar and Maharashtra. Haryana produces 10.77 m t of wheat from 2.44 m ha area with an average productivity of 4.41 t ha^{-1} (ICCR-IIWBR on Wheat and Barley, Director's Report 2018-19).

During past three decades, intensive agriculture involving exhaustive high yielding varieties has led to heavy withdrawal of nutrients from soil and caused nutrient deficiency for crop production. Wheat is generally grown in intensive cropping system with higher use of inorganic especially nitrogenous fertilizers (Yadav *et al*., 2018). Chemical fertilizers supply adequate nutrients timely to the wheat crop, but its high cost, non-availability and lower efficiency causes limitations to its application. Therefore in recent years use of organic manures has gained priority over the chemical fertilizers in order to meet food demands of the growing population of the world. In order to improve soil organic carbon to sustain soil quality and future agricultural productivity, application of organic manures is the best option (Jan and Boswal 2015).

The productivity of crop is controlled by various factors, and the mineral nutrition is the main, especially nitrogen. Nitrogen is an essential constituent of protein, and it is associated in all the vital process of the plants, which is generally taken in inorganic form by crop plants. Therefore, to obtain maximum crop production, addition of nitrogen in form of chemical fertilizer is important. Synthesis of chemical fertilizers consumes a large amount of energy and money. Whereas integrated use of organic sources and chemical sources of nutrients not only supply essential nutrients of the crops but also have some positive interactions leading to increase efficiency and thereby, reduce environmental hazards (Hafiz *etal.*, 2011 Application of vermicompost and FYM can reduce the ill effect of chemical fertilizers and their incorporation improves the nutrient status and uptake in soil. However these organic manures contains nutrient in small proportions as compared to chemical fertilizers but besides plant nutrients, presence of growth promoting substances such as enzymes and hormones make them unique for improvement of soil fertility and productivity (Srivastava,1988). Farmyard manure and vermicompost are most valuable organic manures, which are used as good sources of nutrient for crop production since long. Both these organic sources besides supply macro and micro nutrient to the crop, they also improve soil structure, increase water holding capacity of soil and sustain the soil fertility and crop productivity. Further, these manures stimulate the activity of microorganisms that make the plants to get the macro and micronutrients throughout the biological decomposition.

MATERIALS AND METHODS

A field experiment was conducted at Agronomy Research Farm of CCS Haryana Agricultural University, Hisar during *Rabi* seasons of 2017-18 and 2018-19 to study the effect of integrated use of inorganic and organic sources of nitrogen on nutrient uptake and soil fertility of wheat. The experiment was laid out in randomized block design with three replications consisting of ten treatments combinations i.e. T_1-Control; T_2-100% recommended dose of nitrogen (RDN) + 25% N through FYM; T_3-100% RDN + 25% N through vermicompost; T_4-75% RDN + 25% N through FYM; T_5-75% RDN + 25% N through vermicompost; T_6-50% RDN + 50% N through FYM, T_7-50% RDN + 50% N through vermicompost;

T_8-25% RDN + 75% N through FYM; T_9-25% RDN + 75% N through vermicompost and T_{10}-100% RDN through chemical fertilizer

(RDN). The initial status of soil fertility was 172:17:270 kg NPK ha^{-1} with 0.44 percent organic carbon. The variety Wh1105 used for sowing at rate of 120 kg/ha. Both the organic manures were analyzed for available nitrogen and were calculated on the basis of RDN (150 kg/ha) and applied as percent RDN two weeks prior sowing. The nitrogen through chemical fertilizer was used half as basal after sowing and remaining half as top dressing after first irrigation. The soil, grain and straw sample after harvest of wheat was collected from the field, properly dried and analyzed for nutrient content in laboratory. Later the nutrient in grain and straw of wheat was calculated by percent nutrient content in grain or straw multiplied by grain yield divided by 100.

RESULTS AND DISCUSSION

Among the treatments, the significantly higher nitrogen uptake by grain of wheat was recorded with application of 100% RDN + 25% N through vermicompost, followed being at par with 100% RDN + 25% N through FYM and application of 100% RDN during both the consecutive years, respectively (Table 1).

Table 1 Effect of integrated nutrient management on NPK uptake of wheat

Treatments	Nitrogen uptake (kg ha^{-1})				Phosphorus uptake (kg ha^{-1})				Potassium uptake (kg ha^{-1})			
	Grain		Straw		Grain		Straw		Grain		Straw	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
T_1. Control	35.32	36.42	9.62	10.02	5.16	5.27	2.39	2.45	6.88	7.01	46.63	48.04
T_2. 100% RDN + 25% N through FYM	105.45	110.75	33.25	35.76	19.57	21.12	8.22	8.51	25.17	26.88	139.75	144.94
T_3.100%RDN + 25% N through vermicompost	108.56	115.01	34.45	37.95	21.01	22.78	8.53	9.02	26.70	29.21	144.17	149.65
T_4. 75% RDN + 25% N through FYM	92.88	96.75	28.06	30.24	16.91	17.75	7.18	7.42	21.55	23.00	124.72	128.72
T_5. 75% RDN + 25% N through vermicompost	95.61	100.68	29.37	31.56	17.87	18.86	7.61	7.94	23.13	25.24	128.68	133.83
T_6. 50% RDN + 50% N through FYM	84.29	88.13	23.60	25.63	15.11	15.89	5.99	6.21	18.41	20.29	111.38	115.11
T_7. 50% RDN + 50% N through vermicompost	87.77	91.83	24.97	27.05	16.17	16.95	6.30	6.59	20.01	21.52	115.89	120.49
T_8. 25% RDN + 75% N through FYM	74.72	77.04	21.02	22.31	12.52	13.21	5.01	5.15	15.47	16.67	97.55	100.87
T_9. 25% RDN + 75% N through vermicompost	77.56	80.79	22.47	23.74	13.30	14.11	5.40	5.60	16.83	18.15	103.09	107.10
T_{10}. 100% RDN	103.16	107.25	31.15	33.68	18.76	19.63	7.89	8.19	24.79	26.37	135.30	140.49
SEm+	**2.78**	**3.10**	**1.04**	**1.06**	**0.58**	**0.66**	**0.27**	**0.25**	**0.76**	**0.97**	**3.77**	**3.92**
CD at 5%	**8.32**	**9.29**	**3.12**	**3.17**	**1.73**	**1.98**	**0.80**	**0.74**	**2.28**	**2.90**	**11.30**	**11.73**

It was found that, there were an increase of 207.36 percent and 215.79 percent nitrogen uptake by grain and 258.11 percent and 278.74 percent nitrogen uptake by straw of wheat with application of 100% RDN + 25% N through vermicompost over control treatment during both the consecutive years, respectively.

The higher nitrogen uptake by wheat with these treatments were due to higher availability of nitrogen in adequate amount, which supplied through chemical fertilizer during active growth stages of the crop and steadily supplied through organic manures at development and reproductive stages of the

crop. These findings are in the close with the conformity with Singh *et al.* (2016). Singh and Sharma (2016) stated that, application of adequate amount of nitrogen increases the nitrogen uptake by grain and straw of wheat.

and inorganic sources of fertilizer, the available NPK maintained greater value with replacement of each 25% RDN through chemical fertilizer with RDN through organic sources of the nutrient.

Table 2 Effect of integrated nutrient management on available NPK in soil

Treatments	Nitrogen (kg/ha)		Phosphorus (kg/ha)		Potassium (kg/ha)	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
T_1. Control	155.20	151.34	12.40	10.28	247.27	247.41
T_2. 100% RDN + 25% N through FYM	204.87	218.12	23.16	25.11	291.22	297.78
T_3.100%RDN + 25% N through vermicompost	200.58	212.08	22.47	24.27	287.51	291.59
T_4. 75% RDN + 25% N through FYM	167.12	174.18	14.34	15.26	258.15	261.81
T_5. 75% RDN + 25% N through vermicompost	164.67	170.85	13.85	14.51	256.33	258.79
T_6. 50% RDN + 50% N through FYM	178.14	183.36	16.74	18.87	268.37	272.14
T_7. 50% RDN + 50% N through vermicompost	174.63	178.25	16.12	17.98	264.76	267.05
T_8. 25% RDN + 75% N through FYM	192.28	201.87	19.77	22.81	280.54	285.21
T_9. 25% RDN + 75% N through vermicompost	187.33	193.58	18.88	21.75	275.62	279.22
T_{10}. 100% RDN	165.35	169.57	13.68	13.85	256.27	257.33
SEm $\pm$	**1.85**	**3.02**	**0.36**	**0.40**	**2.16**	**2.56**
CD at 5%	**5.54**	**9.04**	**1.09**	**1.19**	**6.47**	**7.67**

Application of 100% RDN + 25% N through vermicompost/FYM significantly increased the phosphoruse uptake by grain and straw of wheat during both the years. It was observed that application of 100% RDN + 25% N through vermicompost had 307.17 percent and 332.26 percent higher phosphorus uptake by grain and 256.90 percent and 280.41 percent higher phosphorus uptake by straw of wheat over control treatment during both the consecutive years, respectively. These results are in accordance with the findings of Vandana *et al.* (2008), who revealed that integrated use of organic manures either through vermicompost or FYM with RDF enhanced the roots cation exchange capacity and increased the NPK absorption by wheat crop. Further this integration maintained the continuity of nutrient availability and increased the nutrient uptake of wheat. Among all treatments the significantly higher potassium uptake by grain and straw of wheat were recorded with application of 100% RDN + 25% N through vermicompost/FYM. It was noticed that application of 100% RDN + 25% N through vermicompost had 288.08 percent and 319.69 percent higher potassium uptake by grain and 209.18 percent and 211.51 percent higher potassium uptake by straw of wheat over control treatment during both the consecutive years, respectively. These results corroborate the findings of Vandana *et al.* (2008), who revealed that integrated use of RDF with either vermicompost or FYM increases the K absorption by crop. Further these integrations increases the K uptake in grain and straw of wheat through maintenance the continuity of nutrient. Similar results were reported by (Dahiya *et al.*, 2008;, Singh *et al*., 2011; Gupta and Laik. 2002) in wheat.

The amount of inorganic and organic fertilizer added in soil for wheat productivity and its content in post harvest soil determined the available nutrient in soil (Table 2). The available NPK in soil before sowing of crop was found to be non-significant among treatments. The availability of NPK in soil was significantly affected by various sources and combination of inorganic and organic fertilizers. During both the years the significantly higher available NPK after harvest of wheat was recorded with application of 100% RDN + 25% N through FYM/vermicompost. Among the treatments received only 100% RDN through integrated use of organic

This might be due to the rapid mineralization of plant nutrients through chemical fertilizer used for crop growth and slow decomposition of nutrient through organic sources throughout growing period of crop, which increased the availability of plant nutrients at the later stage and brought improvement in soil fertility. As a result, the fertility status of land might have increased the available NPK in soil. These findings are in the close conformity with Singh *et al.* (2017), who concluded that higher available NPK value in soil with INM treatments over RDN through chemical fertilizer (150 kg N ha^{-1}) were due to presence of supplemental nutrients through addition of organic manure. Shah and Ahmad (2006) reported that, the maximum available NPK value in soil was left with treatments received 100% N through FYM followed by application of 75% FYM + 25% N through urea. Rather and Sharma (2009) revealed that increase in N rate from 50 % to 100 % through organic sources of nitrogen increased the available NPK in soil over increased rate of N through chemical fertilizer, which was due to residual effect of organic manures (vermicompost and FYM) in the treatments. During both the years, application of N through FYM left more NPK in soil over application of vermicompost. This might be due faster mineralization of vermicompost which increased the nutrient availability to wheat crop and later decomposition of FYM which increased the available nutrient in soil. The available NPK in soil was depleted under control treatment over initial value during both the growing seasons. Therefore the bare minimum value of available NPK in soil was recorded with control treatment during both the years.

CONCLUSION

Application of 100% RDN + 25% nitrogen through vermicompost/FYM significantly increased the nitrogen, phosphorus and potassium content and uptake by grain and straw of wheat during both the experimental years. The available NPK in soil increased with increase of RDN through organic manures over increase of RDN through inorganic fertilizers. Integration of nitrogen through FYM with chemical fertilizer left more residual NPK in soil over integrated application of nitrogen through vermicompost with chemical fertilizer during both the consecutive years.

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