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Impact of integrated nutrient management practices on nutrient content and uptake of wheat

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Abstract
To study the effect of *Azotobacter* and vermicompost on nutrient content and uptake of *desi* wheat an experiment was conducted during the *rabi* season of 2017-2018 at the Agronomy Research Farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar. The soil of the experimental field is sandy loam in texture, slightly alkaline in reaction, low in nitrogen and organic carbon, medium in available phosphorus and potassium. The experiment was laid out in Randomized Block *Design* replicated thrice with ten treatments viz. T_1 (Control), T_2 (Vermicompost @ 6 t ha^{-1}), T_3 (*Azotobacter* + Vermicompost @ 6 t ha^{-1}), T_4 (30 kg N ha^{-1} + *Vermicompost* @ 3 t ha^{-1}), T_5 (40 kg N ha^{-1} + Vermicompost @ 2 t ha^{-1}), T_6 (50 kg N ha^{-1} + Vermicompost @ 1 t ha^{-1}), T_7 (30 kg N ha^{-1} + *Azotobacter* + Vermicompost @ 3 t ha^{-1}), T_8 (40 kg N ha^{-1} + *Azotobacter* + Vermicompost @ 2 t ha^{-1}), T_9 (50 kg N ha^{-1} + *Azotobacter* + Vermicompost @ 1 t ha^{-1}) and T_{10} (60 kg N ha^{-1}). Three irrigations were given at different critical stages of the crop. Results showed that except P content in straw, various combinations of nitrogen fertilizer, vermicompost and *Azotobacter* significantly influenced the N, P and K content, its uptake in grain and straw and total N, P and K uptake. Increasing levels of fertilizer resulted in significant increase in nutrient content and its uptake in grain and straw. Treatments, T_{10} being at par with T_9 and T_8 recorded significantly higher N, P and K content and uptake in grain and straw, total N, P and K uptake of *desi* wheat.

Keywords: Integrated nutrient management practices, nutrient content, uptake, wheat

Introduction

Wheat (*Triticum* Spp.) is the second most important food has also been described as "King of cereals or staff of life" and one of the most important staple food crops of the world. It has its own outstanding importance as a human food; it is rich in carbohydrates and protein. Wheat is cultivated in about 43 countries of the world. China, India, Thailand, Indonesia and U.S.A are the leading countries in wheat cultivation.

Due to intensive cultivation and imbalanced and indiscriminate use fertilizer, the soils of the Indian subcontinent have become deficient in several nutrients and are also impoverished in organic matter. Therefore this region has started emphasizing a shift from inorganic to organic farming to manage soil quality. However, owing to the steadily increasing demands for food by the ever increasing populations of this region, a complete shift to an organic farming system is not possible.

Combined application of organic and inorganic nutrient to the crop not only increases the production and profitability but also helps in maintaining the soil fertility status. Combine use of organic manure and bio-fertilizers are needed along with chemical fertilizers for better yield and good soil health. It is evident that bio-fertilizers like *Azotobacter* in combination have great prospect for increasing productivity of wheat (Kumar and Ahlawat, 2004) [3]. Integration of inorganic fertilizers with organic manures and bio-fertilizers will not only help sustain the crop productivity but also will be effective in improving soil health and hastening the nutrient-use efficiency. INM approach is based on the maintenance of plant nutrition supply to attain a certain level of crop production by enhancing the benefits from all potential sources of plant nutrition in a cohesive manner, applicable to each cropping pattern and farming scenario (Mahajan and Sharma, 2005) [4]. The inclusion of organic manures regulates the uptake of nutrients, positively affecting production, improving soil quality (physical, chemical, and biological), and producing a synergistic effect on crops (Yadav and Kumar, 2000) [9]. Nutrient uptake by any crops is largely dependent on the biomass production by plants. However, concentration of various nutrients in the plant system also affects their total uptake.

Keeping above-stated aspects in the view, the present experiment was conducted with the aim to investigate benefits of integrated nutrient management on nutrient content and uptake of *desi* wheat under Hisar condition.

Material and Method

Field experiment was conducted during *rabi* 2017-2018 at the Agronomy Research Farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar which is situated at latitude of 29°10' North, longitude of 75°46' East and elevation of 215.2 m above mean sea level in the semi-arid, subtropical climate zone of India. The experiment was laid out in Randomized Block on sandy loam (63.5% sand, 17.3% silt and 19.2% clay) soil which is slightly alkaline in reaction, low in organic carbon and nitrogen, medium in available phosphorus and potassium. The treatment were comprised of ten treatments viz. T_1 (Control), T_2 (Vermicompost @ 6 t ha^{-1}), T_3 (*Azotobacter* + Vermicompost @ 6 t ha^{-1}), T_4 (30 kg N ha^{-1} + *Vermicompost* @ 3 t ha^{-1}), T_5 (40 kg N ha^{-1} + *Vermicompost* @ 2 t ha^{-1}), T_6 (50 kg N ha^{-1} + *Vermicompost* @ 1 t ha^{-1}), T_7 (30 kg N ha^{-1} + *Azotobacter* + Vermicompost @ 3 t ha^{-1}), T_8 (40 kg N ha^{-1} + *Azotobacter* + Vermicompost @ 2 t ha^{-1}), T_9 (50 kg N ha^{-1} + *Azotobacter* + Vermicompost @ 1 t ha^{-1}) and T_{10} (60 kg N ha^{-1}). *Azotobacter* was. Prior to sowing, the seed pertaining to inoculated plots was treated with *Azotobacter* culture obtained from Department of Microbiology, CCS Haryana Agricultural University, Hisar, as per treatment. The seed was wetted with sugar solution and 50 ml of bio inoculants was used as per the recommendation. The treated seed was kept in shade for the completion of inoculation. Both treated and untreated seeds were sown as per the treatments. The *desi* wheat variety C 306 was sown on 10th November 2017 at about 5.0 cm depth by drilling in rows using 120 kg seed $ha^{-1}$and spacing of 20 cm between rows. Pre-sown irrigation of 5 cm depth was given on 3rd November 2017. Three irrigations were given at critical stages of crop growth and other all the recommended packages of practices were adopted during the crop-growth period. Harvesting of crop was done with the help of sickles manually by cutting the plants from the net area of each plot separately on 11th April 2018. Full dose of phosphorus (62.5 kg P_2O_5 ha^{-1}) and half nitrogen as per treatments were applied at the time of sowing and remaining half of the nitrogen was top dressed at 23 DAS.

Full dose of P and half dose of N as per treatments were applied to the field before sowing and rest of N was top dressed after first irrigation. Urea (46%), Diammonium phosphate (18% N, 46% P_2O_5), and *Azotobacter* were used as source of N and P. Five representative plants from each plot were selected randomly and tagged for recording the effect of different treatments on yield attributes. All yield attributes were recorded periodically on these randomly selected and tagged plants. The uptake of nitrogen, phosphorous and potassium (kg/ha) was calculated on the basis of nutrient content on dry weight basis of grain and straw. Oven dried grain and straw samples weighed 0.2 and 0.5 g, respectively were digested in diacid mixture of H_2SO_4 and $HClO_4$ in the ratio of 9:1 for nutrients (N, P) estimation. After the digestion, a known volume was made with distilled water and stored in well washed plastic bottles after filtration through Whatman filter paper No. 42. Nitrogen content in digested plant material was determined by Nessler's reagent method. Phosphorus content was determined by Vanadomolybdo phosphoric acid yellow colour method (Koening and Jackson, 1942) [1], respectively.

Nutrient uptake was computed as below:

$$\text{Nutrient uptake by grain (kg per ha)} = \frac{\text{Per cent nutrient content in grain x grain yield (kg per ha)}}{100}$$

$$\text{Nutrient uptake by straw (kg per ha)} = \frac{\text{Per cent nutrient content in straw x straw yield (kg per ha)}}{100}$$

The total uptake of nitrogen and phosphorus at harvest was computed by adding the nutrient uptake by grain and straw.

Results and Discussion

Among various integrated nutrient management approach, treatment T_{10} produced significantly higher N content and uptake in grain and straw and total N uptake of *desi* wheat followed by treatment T_9 and T_8. Similarily highest value of P content in grain and uptake in grain and straw and total P uptake was recorded in treatment $T_{10,}$ followed by treatment T_9 and $T_{8.}$ Treatment T_2 being at par with T_7 and T_8 resulted in significantly higher K content in grain over rest of the treatments while straw K content was highest in treatment $T_{7,}$ being statistically at par with treatment T_2 to T_{10} but, significantly higher than T_1. But, potassium uptake by straw and total K uptake was significantly higher in treatment $T_{10.}$ Due to the combined application of chemical fertilizers, and organic manures more nutrients availability might have increased the cation exchange capacity of roots thereby increasing the nutrient absorption and nutrient contents in grain and straw (Kumar *et al.* 2002) [2]. It may also be due to the fact that nutrient uptake followed the yield pattern which increased due to seed inoculation with *Azotobacter* and vermicompost application. Because of better root proliferation and growth in INM treatment higher total uptake of N, P and K was observed. Similar results for higher total N, P and K uptake by were reported by Malik (2017). Sayed *et al.* (2000) [5, 7] also reported that *Azospirillum* inoculation alone or in combination with *PSB* significantly increased N, P and K uptake. The findings are in conformity with that of Sharma and Mittra (1991) and Paikaray *et.al.* (2001) [8, 6]

Table 1: Effect of various combinations of nitrogen fertilizer, vermicompost and *Azotobacter* on N content (%) and its uptake (kg ha^{-1}) by *desi* wheat

Treatments	N content (%)		N uptake (kg ha^{-1})		
	Grain	Straw	Grain	Straw	Total
T_1 : Control	1.68	0.30	25.36	11.55	36.91
T_2 : Vermicompost @ 6t/ha	1.88	0.31	39.10	15.58	54.68
T_3 : *Azotobacter* + Vermicompost @ 6 t/ha	1.92	0.33	40.90	17.50	58.40
T_4 : 30 kg N /ha + Vermicompost @ 3 t/ha	1.96	0.34	44.51	21.15	65.66
T_5 : 40 kg N /ha + Vermicompost @ 2 t/ha	2.00	0.36	48.80	24.37	73.17
T_6 : 50 kg N /ha + Vermicompost @ 1 t/ha	2.02	0.36	51.51	25.65	77.16
T_7 : 30 kg N /ha + *Azotobacter* + Vermicompost @ 3 t/ha	2.04	0.37	50.18	25.42	75.60
T_8 : 40 kg N /ha + *Azotobacter*+ Vermicompost @ 2 t/ha	2.05	0.38	53.92	26.82	80.74
T_9 : 50 kg N /ha + *Azotobacter*+ Vermicompost @ 1 t/ha	2.08	0.38	57.70	28.60	86.30
T_{10} : RDN (60 kg N ha^{-1})	2.09	0.39	58.94	30.05	88.99
SEm ±	0.04	0.01	1.60	0.81	1.38
CD at 5%	0.10	0.03	4.81	2.44	4.23

Table 2: Effect of various combinations of nitrogen fertilizer, vermicompost and *Azotobacter* on P content (%) and its uptake (kg ha^{-1}) by *desi* wheat

Treatments	P content (%)		P uptake (kg ha^{-1})		
	Grain	Straw	Grain	Straw	Total
T_1 : Control	0.32	0.088	4.83	3.39	8.22
T_2 : Vermicompost @ 6t/ha	0.34	0.089	7.07	4.48	11.55
T_3 : *Azotobacter* + Vermicompost @ 6t/ha	0.37	0.091	7.88	4.78	12.66
T_4 : 30 kg N /ha + Vermicompost @ 3t/ha	0.37	0.093	8.40	5.78	14.18
T_5 : 40 kg N /ha + Vermicompost @ 2t/ha	0.38	0.095	9.27	6.49	15.76
T_6 : 50 kg N /ha + Vermicompost @ 1t/ha	0.37	0.096	9.44	6.78	16.21
T_7 : 30 kg N /ha + *Azotobacter* + Vermicompost @ 3t/ha	0.38	0.098	9.35	6.73	16.08
T_8 : 40 kg N /ha + *Azotobacter*+ Vermicompost @ 2t/ha	0.38	0.096	9.99	6.84	16.83
T_9 : 50 kg N /ha + *Azotobacter*+ Vermicompost @ 1t/ha	0.39	0.098	10.84	7.31	18.15
T_{10} : RDN (60 kg N ha^{-1})	0.39	0.097	11.01	7.41	18.41
SEm ±	0.01	0.007	0.49	0.19	0.63
CD at 5%	0.03	N.S.	1.47	0.60	1.90

Table 3: Effect of various combinations of nitrogen fertilizer, vermicompost and *Azotobacter* on K content (%) and its uptake (kg ha^{-1}) by *desi* wheat

Treatments	K content (%)		K uptake (kg ha^{-1})		
	Grain	Straw	Grain	Straw	Total
T_1 : Control	0.31	1.11	4.68	42.74	47.42
T_2 : Vermicompost @ 6 t/ha	0.40	1.28	8.32	64.38	72.70
T_3 : *Azotobacter* + Vermicompost @ 6 t/ha	0.41	1.29	8.73	67.73	76.46
T_4 : 30 kg N /ha + Vermicompost @ 3 t/ha	0.37	1.27	8.40	78.99	87.39
T_5 : 40 kg N /ha + Vermicompost @ 2 t/ha	0.36	1.27	8.78	86.74	95.53
T_6 : 50 kg N /ha + Vermicompost @ 1 t/ha	0.36	1.29	9.18	91.07	100.25
T_7 : 30 kg N /ha + *Azotobacter* + Vermicompost @ 3 t/ha	0.39	1.30	9.59	89.31	98.90
T_8 : 40 kg N /ha + *Azotobacter*+ Vermicompost @ 2 t/ha	0.38	1.28	9.99	91.14	101.13
T_9 : 50 kg N /ha + *Azotobacter*+ Vermicompost @ 1 t/ha	0.37	1.28	10.29	95.49	105.77
T_{10} : RDN (60 kg N ha^{-1})	0.36	1.26	10.15	96.26	106.42
SEm ±	0.01	0.01	0.40	1.95	1.89
CD at 5%	0.02	0.05	1.21	5.70	5.68

Conclusion

From the obtained results it can be concluded that application of 50 kg N ha^{-1} + *Azotobacter* + Vermicompost @ 1 t ha^{-1} or 40 kg N ha^{-1} + *Azotobacter* + vermicompost @ 2 t ha^{-1} or 100% RDN to sandy loam results in significantly higher N, P and K content and uptake in grain and straw, total N, P and K uptake of *desi* wheat.

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