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INFLUENCE OF INTEGRATED NUTRIENT MANAGEMENT ON PERFORMANCE OF WHEAT (*TRITICUM AESTIVUML.*) UNDER BHABAR REGION OF UTTARAKHAND

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ABSTRACT

A field experiment was conducted during 2019-20 and 2020-21 at farmers field in Haridwar district, Uttarakhand. The objective of the experiment was to study the effect of different sources of nutrients on growth and productivity of wheat. The experiment consisted of nine treatments *viz.* control (T_1), 100 % RDF (T_2), FYM @ 10 t/ha (T_3), VC @ 5t/ha (T_4), 75 % RDF + FYM @ 10t/ha (T_5), 75 % RDF + VC @ 5 t/ha (T_6), 50 % RDF + FYM @ 10t/ha (T_7), 50 % RDF + VC @ 5 t/ha (T_8), 50 % RDF + FYM @ 10t/ha + VC @ 5t/ha (T_9) , 75 % RDF + FYM @ 10 t/ha+ Azotobacter + PSB (T_{10}), 75 % RDF + VC @ 5 t/ha+ Azotobacter + PSB (T_{11}). The treatments were replicated thrice and were laid out in randomized block design (RBD). Wheat variety used for the experimentation was PBW 343. The net plot size was 5 m X 5 m and crop geometry adopted was 20 cm X 10 cm. The results reported that wheat crop with the application of 75 % RDF + VC @ 5 t/ha+ *Azotobacter* + PSB (T_{11}) performed better in terms of growth parameters and yield under field condition compared to some of the treatments. Significantly higher B: C (2.9) ratio was calculated for 75 % RDF + FYM @ 10 t/ha+ Azotobacter + PSB (T_{10}). Percent increase of 5.5 % and 3.6 % was recorded during 2019-20 and 2020-21, respectively in grain yield with the application of 75 % RDF + VC @ 5 t/ha+ Azotobacter + PSB (T_{11}) over 100 % RDF (T_2). Significantly higher B: C (2.9) ratio was calculated for 75 % RDF + FYM @ 10 t/ha+ Azotobacter + PSB (T_{10}).

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Keywords: Nutrient, Vermicompost, Azotobacter, FYM, PSB, Yield.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops in the world. It belongs to the Poaceae family and is cultivated for its edible grains, which serve as a primary source of dietary energy and nutrients. Wheat is a staple food for a significant portion of the global population, providing a major source of carbohydrates, proteins, and many other essential nutrients. It's a versatile crop that can be processed into various food products, including flour, bread, pasta, cereals, and more. Due to its nutritional value and adaptability, wheat is grown in diverse climates around the world, from temperate to semi-arid regions. Wheat is known as king of cereals owing to its widespread cultivation all over the world. In India, wheat is grown over an area of 31.13 million hectares with annul grain production of 109.6 million tons and average productivity of 3.5 t/ha (Directorate of economics and statistics, MoA& FW, India, 2021). Green revolution in India has no doubt brought self-sufficiency in food grain production. But currently, there is a concern about the sustainability of the growth rates of wheat yields which have either become stagnant or declined in wheat growing states like Punjab, Haryana, Uttar Pradesh, Madhya Pradesh, Bihar, Himachal Pradesh, Uttarakhand, Rajasthan, Jammu and Kashmir as well as other states. Wheat cultivation faces various challenges, including multi

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nutrient deficiencies, pest and disease management, changing climate patterns affecting yields. To obtain high annual productivity of crops substantial amount of nutrients are removed by the crops from the soil that after exceed replenishment through chemical fertilizer and manures ultimately leading to poor soil health. Farmers have started to apply higher doses of fertilizers to maintain crop productivity. Such indiscriminate use of fertilizer without use of organic sources of nutrients are responsible for deterioration of soil health and system productivity.A nutrient imbalance can lead to reduced yields, poor crop quality, increased susceptibility to diseases, and inefficient use of resources. Hence, soils runs into a diversity constraints because of poor soil quality and ultimately end up with deficient functional capacity. This has resulted in nutrient imbalances and its major causes are excessive use NPK fertilizers, inadequate soil preparation, improper drainage, and lack of organic matter can lead to poor nutrient availability and uptake by wheat plants. It has been reported by Amsal*et al.* (2000) that nutrient deficiency is a major constraint to wheat. These problems call for more attention towards the integrated nutrient management system (Sharma *et al.,* 2004). Integrated nutrient management is the combination of both organic and inorganic sources of nutrients. In the recent past, INM has gained more attention with a desire of meeting farmers profitability furthermore maintaining soil health. Essential nutrients are required for optimal growth and development of plants provided in the appropriate proportions. Macronutrients and micronutrients, play a crucial role in various physiological processes of the plant. Organic matter content in the soil should be maintained to an optimum level, as it helps improve nutrient retention and availability. The poor use efficiency of applied nutrients by crop of the applied fertilizer may be due to several reasons, i.e., nutrient may be lost from the soil-plant continuum through run-off, leaching, fixation, denitrification and volatilization. Therefore, the fertilizer use efficiency needs to be increased to maintain the productivity of crops. This can be attained only if application rates consistently surpass decomposition rates. Apart from this, the limitations in the fertilizer production are increased costs, and low fertilizer use efficiency. So, we have to think about the cheap and easily available alternate source of nutrients, which not only supply the nutrients to the soil but also improve the physico-chemical properties of the soil. To enhance crop yields, increase nutrient use efficiency and to reinstate soil fertility, nutrient scheduling along with balanced use of fertilizers using both organic and inorganic sources of fertilizers is considered as a promising agro-technique. Yield increment and better economic returns have been obtained with the adoption of INM practices (Sarma*et al.,* 2007).Combined application of FYM@ 10 t/ha and vermicompost 5 t/ha with 60 kg P_2O_5/ha or 40 kg P_2O_5/ha + PSB and 40 kg S/ha resulted in maximum grain and straw yield in wheat (Patel *et al.,* 2014). Similarly,100 % RDF + vermicompost @ 2 t/ha + PSB and 75 % RDF + vermicompost @ 2 t/ha + PSB were at par and gave significantly higher yields (Singh *et al.,* 2018).

MATERIAL AND METHODS

A field experiment was conducted during rabi season 2019-20 and 2020-21 at farmers field at village Telpura in Haridwar district to study the effect of integrated nutrient management on growth and productivity of wheat. The soil of the experiment site is silty clay loam in texture and slightly alkaline in reaction. Soil is medium in organic carbon content, low in available nitrogen and phosphorus, potassium The experiment consisted of nine treatments viz. control (T_1), 100 % RDF (T_2), FYM @ 10 t/ha (T_3), VC @ 5t/ha (T_4), 75 % RDF + FYM @ 10t/ha (T_5), 75 % RDF + VC @ 5 t/ha (T_6), 50 % RDF + FYM @ 10t/ha (T_7), 50 % RDF + VC @ 5 t/ha (T_8), 50 % RDF + FYM @ 10t/ha + VC @ 5t/ha (T_9) , 75 % RDF + FYM @ 10t/ha+ Azotobacter + PSB (T_{10}), 75 % RDF + VC @ 5 t/ha+ Azotobacter + PSB (T_{11}). The treatments were replicated thrice and were laid out in randomized block design (RBD). Wheat variety used for the experimentation was PBW 343. The net plot size was 5 m X 5 m and crop geometry adopted was 20 cm X 10 cm. To supply nitrogen, phosphorus and potassium fertilizers used were urea, DAP and MOP. Full dose of phosphorus and potassium and half dose of nitrogen were applied as basal and remaining half dose of nitrogen was split into twoapplications one at 30 DAS and another at 60 DAS. Irrigation was applied as and when required. Farm yard manure @ 10 t/ha and vermicompost @ 5t/ha was applied at the time of field preparation as per the treatments. Similarly, seed were primed with *Azotobacter* @ 20g/kg seeds and PSB (Phosphorus solubilising bacteria) as per the treatments.

RESULT AND DISCUSSION

Growth Attributes

During both the years of the experiment the data presented in Table1. revealed that influence of integrated nutrient management was significant on growth parameters of wheat. At 30 DAS significantly higher plant height (40.2 cm and 43.2 cm in 2019 and 2020, respectively) was recorded with the application of 100% RDF. However, at 60 DAS, 90 DAS and at harvest maximum plant height (61.6 cm, 107.4 cm, and 112.7 cm, respectively) was recorded with the application of 75 % RDF + Vermicompost @ 5 t/ha + *Azotobacter* +PSB during 2019-2020. Similar trend was observed during 2020-2021 where plant height was significantly higher (65.6 cm, 109.6 cm and 116.7cm, respectively at 60 DAS, 90 DAS and at harvest) with the application of 75 % RDF + Vermicompost @ 5 t/ha + *Azotobacter* +PSB

Table 1: Plant height of wheat crop as influenced by different treatment combinations at different crop growth stages.

Treatments	Days after sowing							
	30 days		60 days		90 days		Harvest	
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
T1	27.7	29.1	43.3	44.6	73.4	73.6	77.7	80.1
T2	40.2	43.2	59.3	62.0	99.0	100.0	104.4	105.7
T3	30.7	31.8	48.2	49.7	80.9	81.6	76.1	79.5
T4	31.2	32.6	44.8	46.2	75.3	77.4	83.0	85.9
T5	35.7	37.4	56.0	57.9	94.1	95.7	98.2	102.2
T6	35.9	37.7	56.2	58.2	95.3	96.8	100.3	104.3
T7	31.1	32.6	49.0	51.1	81.8	83.0	84.3	86.4
T8	31.5	33.0	50.4	52.3	84.9	86.3	86.5	90.0
T9	32.1	33.2	51.4	53.2	89.4	90.9	90.8	94.1
T10	37.6	41.2	60.4	63.8	102.8	104.0	106.2	110.1
T11	38.9	42.5	61.9	65.6	107.4	109.6	112.7	116.7
Sem	1.4	1.4	1.7	1.7	2.7	2.6	2.7	2.8
CD at 5 %	4.2	4.1	5.1	5.2	7.9	7.7	7.9	8.2

Data pertaining to dry matter accumulation presented in Table 3. at 30 DAS (74.9g/m^2 and 79g/m^2 in 2019 and 2020) whereas at 60 DAS and 90 DAS dry matter accumulation was significantly higher with the application of 75 % RDF + Vermicompost @ 5 t/ha + Azo +PSB (238.1g/m^2 and 245.8g/m^2, respectivelyin2019 and 2020 and 998.6g/$m^2$and 1010.8g/m^2, respectively in 2019 and 2020). Data related to number of tillers/m^2presented in Table 2. Reveals that maximum number of tillers were obtained with 75 % RDF + Vermicompost@ 10 t/ha + Azo +PSB at 45 DAS, 90 DAS and at harvest stage (468.2/$m^2$and 474.4/m^2 in 2019 and 2020, respectively, 452.3/m^2 and 458.5/m^2, respectively in 2019 and 2020 437.5/m^2 and 446.3/m^2, respectively in 2019 and 2020). These findings are in line with Hadis *et al.* (2018) and Kumar *et al.* (2017) who concluded that, vermicompost is the source of different essential plant nutrients and hormones with low amount, and its application with inorganic fertilizer increases the growth attributes and yield of wheat.

Yield

The grain, straw and biological yields of wheat presented in Table 4. varied significantly under the influence of various treatments. Application of 75% RDF + Vermicompost @ 5 t/ha + *Azotobacter*+PSB significantly enhanced grain yield (51.4 q/ha and 54.4 q/ha in year 2019 and 2020, respectively), straw yield (73.1 q/ha and 77.3 q/ha in 2019 and 2020 respectively) and biological yield (124.5 q/ha and 131.7 q/ha in 2019 and 2020, respectively). These findings are in line with Mohan *et al.* (2018) and Tamim *et al.* (2021) who concluded that, significantly higher and grain and straw yield of wheat by application of 100% RDF+25% N through vermicompost/FYM followed by application of 100% RDF were due to due adequate quantities and balanced proportions of plant nutrients throughout the growth stages of the crop, which further increased the yield attributing characters and yield of wheat. Maurya *et al.* (2019) recorded the significantly recorded higher grain and straw yield of wheat with application of 125% RDF+25% N through

Table 2:Tillers count of wheat crop at different crop growth stages.

Treatments	Days after sowing					
	45 days		90 days		Harvest	
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
T1	290.3	279.5	276.4	271.0	212.9	214.9
T2	447.6	451.1	434.2	437.9	408.1	413.0
T3	310.3	312.0	294.8	297.5	263.9	264.9
T4	360.2	362.4	349.0	352.3	309.0	310.0
T5	440.4	442.9	426.7	429.8	388.3	391.9
T6	449.2	452.5	434.6	436.8	398.5	402.3
T7	388.5	390.3	371.5	373.0	334.6	336.1
T8	415.4	419.7	402.6	405.5	364.2	367.2
T9	387.2	390.6	373.4	375.3	342.5	344.2
T10	456.7	461.5	443.9	447.9	426.4	431.3
T11	468.2	474.4	452.3	458.5	437.5	446.3
SEm±	11.6	12.6	11.2	11.1	11.5	11.6
CD at 5 %	34.3	37.2	33.0	32.8	33.9	34.1

Table 3: Dry matter accumulation (g/m2) of wheat crop at different crop growth stages.

Treatments	Days after sowing					
	30 days		60 days		90 days	
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
T1	38.6	39.6	126.8	127.9	713.4	715.9
T2	74.2	79.0	225.8	230.1	961.9	961.7
T3	43.4	44.3	138.7	140.5	756.7	758.4
T4	45.0	46.6	141.2	143.6	768.3	770.3
T5	58.9	61.7	204.1	207.8	918.6	922.4
T6	61.8	65.2	217.9	221.3	941.3	945.5
T7	46.9	49.1	166.0	169.6	799.6	803.0
T8	56.8	60.2	181.0	183.6	910.5	913.9
T9	54.1	56.5	172.3	174.5	869.0	872.2
T10	69.3	73.7	233.2	239.2	973.3	980.1
T11	71.8	75.7	238.1	245.8	998.6	1010.8
SEm±	1.6	1.7	5.6	5.7	25.4	25.3
CD at 5 %	4.8	5.0	16.4	16.8	74.9	74.8

vermicompost/ FYM followed by application of 100% RDF+25% through vermicompost/FYM and application of 100% RDF. They concluded that, greater availability photosynthates and nutrients to developing reproductive structures of the crop increased all the yield attributing characters, which ultimately improved the final yield of wheat. It also indicated that the sink capacity of a plant depends mainly on vegetative growth that is positively affected by application of nitrogen fertilizers and supply of photosynthesis for the formation of yield components. The grain and straw yield of wheat significantly decreased with replacement of each 25% RDN through chemical fertilizer with 25% N through organic manures, this might be due to direct and rapid supply nutrients through chemical fertilizer for crop growth and slow mineralization and release of nutrients through organic manures throughout growing period of the crop, that would have increased the availability of nutrients in soil in later stage and brought improvement to soil properties.

Table 4: Yield and harvest index of wheat crop.

Treatments	Grainyield(q/h)		Strawyield(q/ha)		Biological yield		Harvest index	
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
T1	27.5	28.0	39.7	42.2	67.2	70.2	37.4	37.5
T2	48.7	50.8	69.9	72.5	118.6	123.3	41.0	41.2
T3	31.8	32.5	50.1	51.0	81.8	83.5	38.5	39.0
T4	36.8	37.9	60.3	61.5	97.1	99.4	37.9	38.1
T5	46.5	47.9	66.6	68.8	113.1	116.7	40.6	41.0
T6	47.8	49.1	69.6	71.4	117.4	120.6	40.6	40.8
T7	43.4	44.6	62.3	63.5	105.7	108.1	41.1	41.2
T8	45.7	46.8	65.6	67.4	111.3	114.2	40.3	41.0
T9	44.5	45.7	63.9	65.9	108.4	111.6	40.1	41.0
T10	50.9	52.4	73.0	75.3	123.9	127.7	40.7	41.0
T11	51.4	54.4	73.1	77.3	124.5	131.7	41.2	41.3
SEm±	1.3	1.2	1.8	1.9	2.0	2.0	1.2	1.1
CD at 5 %	3.8	3.6	5.2	5.6	5.8	6.0	3.6	3.2

CONCLUSION

Based on the results of the present study it can be concluded that combined application of 75 % RDF + vermicompost @ 5 t/ha+ *Azospirillum* + PSB can significantly increase growth parameters and yield of wheat. However, there is a need to further study the influence of combined application of organic and inorganic manures on performance of wheat under various climatic, soil and crop conditions and its effect on soil properties.

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