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Effect of integrated nutrient management on growth and yield of wheat (*Triticum aestivum* L.)

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Abstract
The present investigation entitled "Effect of Integrated Nutrient Management on Growth and Yield of Wheat (*Triticum aestivum* L.)'' was carried out at Crop Research Farm of National Post Graduate College, Barhalganj, Gorakhpur, (U P.) During Rabi season on 2023 with the objective to study the effect of Integrated Nutrient Management on growth, yield and quality of wheat (*Triticum aestivum* L.).
The soil of the experimental field was silty loan in texture with low, medium and high in N, P and K respectively. The experimental site is situated in subtropical zone in indo gang tic planes. The experiment was laid out in Randomized Block Design with 7 treatment combinations and 3 replications. Wheat was shown on 11th November 2022 with treatment combinations *viz*. T_1 - Control (R D F 120: 60: 40), T_2 - R D F 50% + F Y M 50%, T_3 - R D F 50% +Vermicompost 50%, T_4 - R D F 50% + Poultry Manure 50%, T_5 - R D F 75% + F Y M 25%, T_6 – R D F 75% + Vermicompost 25% and T_7 - R D F 75% + Poultry manure 25%, respectively. The crop was harvested on 24th March 2023. The result indicated that the treatment combination T_6 - R D F 75% + Vermicompost 25% was registered significantly superior in terms of plant height, number of tillers, dry weight, leaf area index, test weight, grain yield, straw yield, gross return (Rs/ ha) and net return (Rs / ha.), respectively over rest of the treatments. Integrated use of organic manures along with optimum doses of chemical fertilizers increased the growth parameters and yield of wheat.

Keywords: Wheat, inorganic fertilizer, organic fertilizer, F Y M, vermicompost, poultry manure, growth attributing character, yield attributing character, yield, stover yield

Introduction
Wheat (*Triticum aestivum* L.) is an imperative staple food around the world. In India, Wheat is a major cereal crops, belongs to family panacea and firmly occupying the second position among the Wheat producing countries in the world after China. The foundation of our country's food security system is Wheat, a significant pre-historic crop. In India, wheat are cultivated on 33.64 m ha area, producing 86 m ton and yielding 1206.30 kg per ha in 2019-20. In India, Uttar Pradesh is leading Wheat growing state with an area of 9.65 m ha (36.6%), production of 26.87 m ton (39.3), productivity of 2785 kg /ha. Wheat productivity in the state is however far lower than that in Punjab (4.3 t/ha) and Haryana (4 t/ha) accounted to late sowing after long duration rice varieties, poor seed replacement rate, lack of quality seed, imbalanced fertilization, unscientific water management and poor mechanization etc. In eastern U.P. Wheat sowing is delayed up to end of December and sometimes even to 1st week of January leading to severe yield reduction. Delayed sowing enforces maturity under the influence of high temperature and farmers attempt to make amend it by excessive application of nutrients particularly nitrogen ignoring yield physiology in constrained environment.
The use of inorganic fertilizers for the past 50 years without any addition of organic manures resulted in large scale deficiency of micro nutrients which play an important role in enhancing the quality and quantity of the agriculture produce. Further, nutrient losses in inorganic fertilizer are very high and loss of nutrients like NO_3 Some Time leads to water pollution. Looking at all the above facts it is very much essential to find out the alternative to the chemical fertilizers which maintain the soil fertility and enhance the productivity of crops.

Under such situation the use of organic manures in agriculture play an important role. Due to depletion of soil fertility the demand for organic manure is growing day by day. In India, sufficient amount of organic manures like crop residues (603.5 mt), animal dung manure (791.6 mt), rural compost (148.3 mt), green manure (4.50 m ha-1), city compost (12.2 mt) and bio-fertilizer (0.41mt) are available (Bhattacharya and Chakraborthy, 2005) [3]. Therefore, for maintaining soil fertility, producing healthy food, keeping the environment clean and sustaining crop productivity these organic wastes can be a good substitute for chemical fertilizers. Joshi and Prabhakarasetty (2006) [4] reported that application of farm yard manure results in improved crop yields, microbial activity, soil physical properties, nutrient availability, and had direct residual effects to succeeding crops.

The Vermicompost is bio-oxidation and stabilization of organic material involving the joint action of earthworm and micro-organisms. Although microbes are the responsible for the biological degradation of the organic matter, earthworms are the important drivers of the process, conditioning the substrate and alerting biological activity (Aira *et al*. 2002) [1]. Suthar (2008) [8] reported that Vermicompost may be potential sources of nutrients for field crops if applied in suitable ratios with synthetic fertilizers.

Judicious use of FYM and Vermicompost with chemical fertilizers improves soil physical, chemical and biological properties and improves the crop productivity (Sharma *et al*. 2007) [6]. In this Endeavour proper blend of organic and inorganic fertilizer is important not only for increasing yield but also for resulting soil health (Weber *et al*. 2007) [10]. To build ecologically sound and economically viable farming systems integrated nutrient management (INM) is a viable option for wheat production as it utilizes available organic and inorganic nutrients. Keeping this in view of above facts, an attempt was made to study the effect of integrated nutrient management on growth, yield attributes, yield and quality of wheat.

Materials and Methods

The field experiment was carried out at the Crop Research Farm of National Post Graduate College, Barhalganj, Gorakhpur, U.P. During Rabi season 2022-23. The experimental site is situated in a subtropical zone in Indo - genetic plains and lies between 260471 North latitude, 820101 East longitude and 1130 m above sea level. The soil of the experimental field was silty loam in texture and slightly alkaline in reaction with PH, 7.6, EC 0.20 dsm^{-1} organic carbon 0.40% and available Nitrogen 196 kg ha^{-1}, Phosphorus 18.9 kg ha^{-1} and Potassium 260.50 kg ha^{-1} at 0 -15 Cm soil depth. The experiment was laid out in Randomized Block Design, keeping 7 treatment combinations *viz*. T_1 - Control (R D F 120: 60: 40), T_2 - R D F 50% + F Y M 50%, T_3 - R D F 50% + Vermi compost 50%, T_4 - R D F 50% + Poultry Manure 50%, T_5 - R D F 75% + F Y M 25%, T_6 - R D F 75% + Vermicompost 25% and T7 - R D F 75% + Poultry manure 25%, respectively. The sowing was done on the 11 November 2022. The crop was sown by using seed rate of 120 kg per ha. And Nitrogen, Phosphorus and Potash were applied to the crops as per treatment of the experimental crops. The other agronomical cultural practices such as irrigation, weeding and plant protection measures have been performed as per requisite. The crop was harvested manually at the maturity dated on 24 March 2023 and grain and straw were recorded.

Results and Discussion

Growth Parameters

As experiment was conducted to observe the influence of Integrated Nutrient Management on growth and yield of Wheat. The data pertaining to growth, yield and quality along with statistical interpretations are presented and discussed.

Different combinations of Integrated Nutrient Management had a significant effect on plant growth characters *viz*. plant height, number of tillers $plant^{-1}$, dry weight and leaf area index during the year of study given in Table - 1 clearly indicates that the maximum plant height, number of tillers $plant^{-1}$, dry weight and leaf area index (98.53, 14.33, 108.80 and 6.80 respectively) were recorded with the Treatment T_6 i. e 75% R D F + 25%. Of Vermi compost which were significantly superior over the rest of the treatment except the treatment T_7 i.e. 75% of R D F + 25% of Poultry manure which were at par to each other, while the lowest values were observed (plant height - 93.20 cm, number of tillers $plant^{-1}$ - 10.73, dry weight - 85.23 g and leaf area index 5.28, respectively) with the Treatment T_1 i.e. R D F (Control). The reason for higher values of growth parameter can be discussed in the light of fact that crop under these treatments had comparatively make easily extractable and more availability of nutrients than other treatments which resulted in better crop growth like plant height, number of tillers per plant, leaf area index and ultimately more dry matter accumulation. It might due to application of organic and inorganic fertilizer help in higher nutrient mobility and therefore, plant uptake more nutrients by reducing nutrient losses through leaching, runoff etc. Application of various organic manures stimulated the plant growth, microbial activity and higher activity of soil enzymes. The higher plant height and dry matter accumulate with the application of Vermi compost may also be due to the fact that in Vermicompost mineralization is rapid, large portion of nitrogen, phosphorus and potassium in Vermicompost is inorganic fractions. The addition of organic manure significantly influenced the beneficial micro- organisms to colonize in rhizosphere and stimulate plant growth by providing necessary nutrients besides synthesis some plant hormone (Ventkatasalam, *et al*. 2012) [9]. Significantly improvement in chlorophyll content in leaves might have resulted in better interception and utilization of solar energy leading to higher photosynthetic rate and finally more accumulation of dry matter by the crop. These results are in line with the Bhagwati *et al*. (1992) [2]

Table 1: Growth attributes of Wheat as affected by different combinations of Integrated Nutrient Management

Treatment	Plant Height (cm)	Number of $tillers^{-1}$	Dry Weight (q)	Leaf area index
T_1	93.20	10.73	85.23	5.28
T_2	94.20	11.40	86.43	6.01
T_3	94.27	11.47	88.12	6.06
T_4	95.00	11.80	88.20	6.10
T_5	96.07	12.40	96.10	6.15
T_6	98.53	14.33	108.80	6.80
T_7	97.63	13.23	108.20	6.48
S.Em	0.56	0.60	0.48	0.18
C.D	1.23	1.31	1.04	0.38

Yield parameters

Number of spikelets, Length of spikelets (Cm), number of grains spike^{-1}, test weight (g) yield (q ha^{-1}) and Stover yield (q ha^{-1}) as influenced by different combinations of Integrated Nutrient Management have been shown in Table - 2 clearly indicates that as number of spikelets, length of spikelets (Cm), number of grains spike $^{-1}$, test weight (g) yield (q ha^{-1}) and Stover yield (q ha^{-1}) as (23.87, 19.40 cm, 66.00, 41.00g, 43.50 q ha^{-1}, and 65.00 q ha^{-1}, respectively) were recorded highest with the Treatment T_6 i.e. 75% R D F + 25%. Of Vermi compost compost, while the lowest values were observed (21.07, 16.57 cm, 56.33, 38.00g 37.50 q ha^{-1}, and 60.33 q ha^{-1}%, respectively) with the Treatment T_1 - i.e. R D F. (Control). When the new Plant comes out of the seed, they do not have well root development and they need nutrients soon, which is obtained from chemical fertilizers instantly. Whereas, the organic manures are gradually decomposed, so that new plants do not have nutrients as needed, this is the main reason that the chemical fertilizers apply have higher nutrients in plants in the tillering stage. Greater availability of metabolites (photosynthetic) and nutrients to developing reproductive structures seems to have resulted in an increase in all the yield attributing characters which ultimately improved the yield of the crop. Similar findings were also reported by Singh *et al*. 2010 [7]. Sink capacity of a plant depends mainly on vegetative growth that is affected positively by application of Nitrogen fertilizers and supply of photosynthesis for the formation of yield components. These findings are closely conform with Zahoor, 2014 [11]. Patel *et al*. (2018) [5] reported that an adequate supply of nitrogen at a critical period of crop growth has a stimulatory impact on tillering of wheat through a synthesis of cytokines and rapid conversion of synthesized carbohydrates, which results in rapid multiplication and increase the size and number of growing cells thus results in increase yield attributing characters

Table 2: Yield attributes and yields of Wheat as affected by different combinations of Integrated Nutrient Management.

Treatment	No. of spikelets	Length of spikelets	No. of grains spike	Test weight(g)	Grain yield(q ha^{-1})	Straw yield(q ha^{-1})
T_1	21.07	16.57	56.33	38.00	37.50	60.33
T_2	21.53	16.70	58.00	38.33	39.60	60.40
T_3	21.87	17.57	58.67	38.67	41.40	62.05
T_4	21.93	17.73	60.33	39.00	39.80	62.99
T_5	21.98	18.03	60.67	39.00	40.90	63.23
T_6	23.87	19.40	66.00	41.00	43.50	65.00
T_7	23.27	18.80	63.20	40.00	43.01	64.90
S.Em	0.49	0.63	1.82	0.50	0.51	0.27
C.D	1.06	1.38	3.98	1.10		

Economic Feasibility

To examine the economic feasibility and viability of different treatments under investigation, economics of wheat production in terms of gross return (Rs per ha), net return (Rs per ha) and B: C ratio was calculated for different treatments and the outcome is presented in Table 3.

Table 3: Gross return, net return and benefit: cost ratio of Wheat as affected by different combinations of Integrated Nutrient Management.

Treatment	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	Benefit cost ratio
T_1	79687.50	28601.50	0.55
T_2	84150.00	34744.50	0.70
T_3	84575.00	34949.50	0.70
T_4	86912.50	37837.00	0.77
T_5	87975.00	37744.25	0.75
T_6	92437.50	42082.50	0.83
T_7	91396.25	41316.25	0.80

It is obvious from the above Table that the Treatment T_6 i.e. 75% R D F + 25% of Vermicompost was registered with the highest gross return (Rs. 92437.50), net return (Rs. 42082.50) and benefit cost ratio (0.83) per ha., this might be due to higher yield in the treatment compared to other treatments

Conclusion

Based on the experimental findings, it may be concluded that 75 of% R D F + 25% Vermicompost has been proved to be an ideal to exploit the maximum yield.

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