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ECONOMICS OF INTEGRATED NUTRIENT MANAGEMENT ON WHEAT (*TRITICUM AESTIVUM* L.) CULTIVATION

Siddharth[1]*, Gaurav Aggarwal[2] and Rakesh Kumar[2]

[1]Department of Agronomy, Maharishi Markandeshwar University, Ambala, Haryana, India

[2]Quantum University, Roorkee, Uttarakhand, India

*Corresponding author E-mail: agrisiddharth99@gmail.com

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ABSTRACT

Wheat is rabi crop and is a staple food followed by rice in India, the present study was evaluated on effect of various doses of N, P and K along with combination of organic manures viz., compost and vermicompost on wheat (*Triticum aestivum* Linn.) at Quantum University, Roorkee, Uttarakhand in the rabi season during 2023-24. This investigation was carried with seven treatments *viz.*, T1 100 percent RDF of N, P and K, T2 (75% RDF and 25% Compost), T3 (50% RDF and 50% compost), T4 (25% RDF and 75% compost), T5 (100% compost), T6 (100% vermicompost) and T7 (control). The treatments were replicated thrice. The result revealed that among all the treatments T3 showed the best result with high initial plant population (56.33 per m2 area) 20 DAS followed by T1 with 52.00 plants/ square meter. Whereas number of tillers per plant was recorded highest in the treatment T3 only with 5.22. The effect of vermicompost and compost was also observed satisfactory and was sarcastically at par with treatment T2. Plant height was found highest in treatment T3 with 52.89 cm followed by T2 (50. 56 cm). Yield parameters such as number of spike, wheat spike length, number of grains/ spike and test weight were recorded and found maximum in treatment T3, dry matter accumulation (g/m2) and biological yield was also highest in treatment T3 with 12.07 t/ h. Grain yield per ton per hectare was recorded maximum in treatment T3 (50% RDF + 50% compost) with 5.67 tonn/hac. Cost benefit ratio was (1:3.04) calculated and obtained highest in treatment T3 followed by T1 (1: 2.57).

***Key words*:** Wheat, organic manures, N.P.K, yield, growth, economics

Introduction

Wheat (*Triticum aestivum* L.) is widely recognized as a fundamental crop in global agriculture due to its high adaptability and contribution to human and animal diet. It is the primary food and forage crop in India and many other nations (Youssef *et al*., 2013). It is a tall annual plant that ranges in height from two to four feet and is hexaploid, belonging to the poaceae family with chromosome number 42 (2n=42). It evolved from wild grasses. It is regarded as the most significant winter crop (rabi) since both urban and rural cultures use its grains for food, and its straw is a vital source of animal feed (Youssef *et al*., 2013). According to the second advance estimates for the agricultural year 2022–23, wheat production in India is projected to reach 112.18 million tonnes, marking an increase of 4.44 million tonnes compared to the output recorded in 2021–22."The wheat production per state-wise is also increased in wheat sowing area in the current year i.e. 2022-23 over the last five years 2017-18 to 2021-22, (pib.gov.in). The requirement of wheat is increasing every year as a result of population pressure. its yield per hectare is low. Low down yield can be caused by a variety of factors and high input cost due to unprofessional farmers with lack of knowledge of sustainable farming system and integrated nutrient management. Farmers have to Increasing yield per unit area is necessary to close the yield gap. The collective application of appropriate fertilizer types is crucial to closing the yield gap between actual and prospective yield since the right fertilizer combination can boost yield by 50% (Zia *et al*., 1991).

Integrated Nutrient Management (INM) refers to

the strategic and balanced application of both organic and inorganic fertilizers with the objective of preserving soil fertility, reducing cultivation costs, sustaining crop productivity, and mitigating environmental harm (Tandon *et al.*, 1992). This approach focuses on applying and conserving nutrients effectively, using modern technologies to improve how plants absorb nutrients, and encouraging the sharing of knowledge between researchers and farmers (Palm *et al.*, 2001). The combined application of organic and inorganic nutrient sources contributes to achieving sustainable crop yields and improving soil health, thereby enhancing overall agricultural productivity (Kumara *et al.*, 2013).

Material and method

A field experiment was carried out at the Quantum university Roorkee Uttarakhand in the year 2023-24 during rabi season. Seven treatments are examined in the study. Treatments *viz.*,T1 (100% RDF of NPK), T2 (75% RDF + 25% compost) T3 (50% RDF + 50% compost) T4 (25% RDF +75% compost) T5 (100% compost) T6 (100% vermicompost) and T7 (control) were tested in randomized block design having three replications. The wheat variety PBW 292 was sown by line sowing on November 19, 2023, at a seed rate of 100 kg/ha-1. Half the recommended dosage of NPK and 100 percent compost and vermicompost were applied at 15 days after sowing (DAS) The remaining dose of NPK was top-dressed at two phases in equal proportions at 40 DAS and 65 DAS. The source of N, P and K were urea, single superphosphate and murate of potash, respectively. The observations of various treatments were recorded on plant growth as plant height, number of tillers, at recorded 30, 60 and 90 DAS. The crop was irrigated at the appropriate times based on the soil's appearance and the crop's stages of tillering, late jointing, flowering, and milking, respectively. Weed control were carried out manually. Disease and insect pests were not found on wheat plants and field during the investigation period. The crop was harvested at maturity, as determined by visual examination. When leaves and stems turned yellow and then dried. Which was harvested using by sickle and threshing was done by threshing machine. The cost of cultivation includes as *viz.*, cost of seed, cost of fertilizers, cost of compost and vermicompost, labour cost etc. The yield of produce was weighted (kg) and gross return was calculated by cost of cultivation minus market price and then cost benefit ratio was also calculated.

Cost benefit ratio was calculated by given formula:

$$\text{B:C} = \frac{\text{Net Profit (Rs.)}}{\text{Cost of Cultivation}}$$

Results and Discussion

The investigation on "Evaluation of various doses of N, P, K and combination with organic manure on yield and growth of wheat (*Triticum aestivum* L.) in western Uttarakhand" contains result obtained during research and supported by various scientists worked done in the same areas.

Growth parameters

Initial plant population

During investigation initial plant population was recorded 20 DAS where it has been observed that maximum plant population per square meter was 56.33 plants/ m2 in treatment T3@ (50% RDF + 50% compost) whereas the effect of treatments was seen almost same in treatments T4 and T6 with 50.00 plants/ m^2 while the treatment T2 was somehow better than the formers with 51.66 plants/ m^2. It has been also observed that check showed a smaller number of plant population (42.00 plants/ m^2). Hence it can be observed that effect of treatment T3 with equal ratio of organic and inorganic fertilizers were better than rest of the treatments.

Plant height (cm)

After 30 day after sowing (DAS) treatment T3 **(**50% RDF + 50% compost**)** with maximum plant height with 30.00 cm followed by T2 **(**75% RDF of NPK + 25% compost (29.00 cm). The treatment T1 **(**100% RDF of NPK**)** has better effect than the organic fertilizer *viz.*, T5 and T6 with 28.00, 27.67 cm, respectively. While lowest plant height was observed in control with 24.00 cm. The impact of various doses of fertilizers have been seen with increased plant height at 60 DAS and it was found maximum in treatment T3 with 46.67 cm followed by T2 (42.00 cm). Plant height in treatment T2 and T1 was recorded 79.00 and 78.00 cm respectively. At 90 DAS, maximum height in plant was observed in treatment T1 with 82.00. Whereas treatments T2 and T1 had almost similar effect on plant height with 79.00 and 78.00 cm, plant height. The overall mean on plant height clears that the treatments T3 (50% RDF + 50% compost) was superior with 52.89 cm was superior to the treatment T2 with 50.56 cm, while effect of RDF of fertilizers T1 (49.33 cm) was found better than treatments T4 (48.44 cm) whereas compost and vermicompost alone with 47.78 and 46.89, respectively. Among all the treatments least effective was in control with 41.56 cm of plant height. That similar results was showed significantly increase the plant height (7.26, 38.54, 86.40 and 88.60 cm) studied done by Chopra *et al.*, (2016).

Number of tillers (per plant)

The effect of various treatments on number of tillers

Table 1: Effect of N, P and K and organic manures on growth parameters of wheat (*T. aestivum* L.).

Treatments	Growth parameters								
	IPP	Plant height (cm)				Number of tillers/ plants			
	20 DAS	30DAS	60DAS	90DAS	Mean	30DAS	60DAS	90DAS	Mean
T_1 (100% RDF of NPK)	52.66 (7.32)	28.00 (5.38)	42.00 (6.55)	78.00 (8.88)	49.33 (6.94)	3.00 (2.00)	5.00 (2.44)	6.00 (2.64)	4.67 (2.36)
T_2 (75 % RDF of NPK+ 25 % compost)	51.66 (7.25)	29.00 (5.47)	43.67 (6.68)	79.00 (8.94)	50.56 (7.03)	3.33 (2.07)	4.67 (2.37)	5.67 (2.58)	4.56 (2.34)
T_3 (50% RDF+ 50% compost)	56.33 (7.57)	30.00 (5.56)	46.67 (6.90)	82.00 (9.11)	52.89 (7.19)	3.67 (2.15)	5.33 (2.51)	6.67 (2.76)	5.22 (2.48)
T_4 (25% RDF 75% compost)	50.00 (7.14)	27.33 (5.32)	41.33 (6.50)	76.67 (8.81)	48.44 (6.88)	3.00 (2.00)	4.67 (2.37)	5.33 (2.51)	4.33 (2.29)
T_5 (100% compost)	49.00 (7.07)	27.67 (5.35)	39.00 (6.32)	74.00 (8.66)	46.89 (6.77)	3.33 (2.07)	4.33 (2.30)	5.33 (2.51)	4.33 (2.30)
T_6 (100% vermicompost)	50.00 (7.14)	27.67 (5.35)	40.67 (6.40)	75.00 (8,71)	47.78 (6.84)	3.33 (2.07)	4.67 (2.37)	5.67 (2.58)	4.56 (2.34)
T_7 (Control)	42.00 (6.55)	24.00 (4.99)	32.33 (5.77)	68.33 (8.32)	41.56 (6.36)	2.67 (1.91)	3.67 (2.15)	5.00 (2.44)	3.78 (2.17)
CD (5%)	1.49	1.59	1.40	1.14	2.74	0.63NS	1.18 NS	0.83*	0.41**
CV (%)	1.67	3.23	1.94	1.54	3.19	11.16	14.43	8.31	5.24
SEM (±)	0.48	0.51	0.45	0.50	0.89	0.20	0.38	0.27	0.13

IPP: Initial plant population; DAS- Day After Sowing, Data presented in parentheses are $\sqrt{x}+ 0.5$(square root transformed); ** Data in indicate significant at P = 0.05%;

was recorded 30DAS and found that treatment T3 (3.67 tiller/plant) showed good result while there was no significant difference among rest of the treatments, only control had 2.67 tillers/ plant. At 60 DAS, numbers of tillers were found 5.33 tillers/ plant highest in T3 followed by T1 (5.00 tillers/ plant) whereas treatments T2, T4 and T6 showed similar effect with 4.67 tillers/plant. Control has a smaller number of tillers with 3.67 tillers/ plant. Effect of treatments at 90 DAS illustrate that significantly superior result was obtained in treatment T1 with 5.22 tillers/plant while number of tillers were non significantly and statistically at par with each other in the rest of the treatments excluding control with 3.78 tillers/ plant. The overall mean indicates that T3 has 5.22 tillers and was better than rest of the treatments, while in treatments T5 and T4 recorded equal number of tillers with 4.33 tillers/ plant a smaller number of tillers were obtained in control (3.78 tillers/ plant). Similar findings have been reported in previous studies, where the application of sewage sludge led to significant improvement in the growth parameters of wheat (Jamil *et al*., 2006). A notable increase in the plant height of spring wheat following the application of farmyard manure (FYM) was also observed by Sharma *et al*., (2005). Furthermore, El-Ghamry *et al*., (2009) reported that the plant height of maize under integrated application of FYM with half the recommended dose of NPK fertilizers was statistically comparable to that achieved with the full recommended dose of NPK.

Number of spikes

The effect of yield parameters such as number of spike recorded that among all the treatments T3 (361.67) had maximum number of spike /m^2 followed by T1 (319 spikes/ m^2). While number of spikes recorded in treatments T2 (306.00 spikes/m^2) and T4 with 300.33 spikes/m^2 than were higher than the treatments T5 (289.67 spikes/ m^2) and T6 (290.33 spikes/m^2) in control T7 (240 spikes/m^2) number of spikes was recorded.

Length of spike (cm)

The result on yield parameters as spike length was obtained maximum 14.67 cm in treatment T1 and found significantly superior than rest of the treatments. The RDF in treatment recorded T1 (13.67cm) and in treatment T6 and T2 with 13.33 cm were statistically at par and recorded better results than treatment T5 (100% compost) with 12.00 cm and in control lowest spike length was recorded (10.67 cm) and during research. The result was supported by work done by Maurya (2019) significantly highest number of tillers per m^2, leaf area index, length of spike (cm), grain per spike[1], grain yield and straw yield (kg ha^{-1}) were found under incorporation of 125% recommended dose of fertilizer + 25% N through vermicompost (T12).

Number of grains per spike

Number of grains in a spike was found significantly maximum in treatment T1 with 74.67 grains/ spike

Table 2: Effect of N, P and K and organic manures on yield parameters of wheat (*T. aestivum* L.).

Treatments	Yield parameters								
	NS	SL	NG	TW	DMA	GY	SY	BY	HI
T1 (100% RDF of NPK)	319.00 (17.88)	13.67 (3.82)	70.33 (8.44)	38.33 (6.27)	468.44 (20.09)	4.00 (2.23)	5.36 (2.52)	9.36 (-)	42.75
T2 (75% RDF of NPK + 25% compost)	306.00 (17.52)	13.33 (3.78)	71.33 (8.50)	40.00 (6.40)	457.78 (19.87)	3.67 (2.15)	4.86 (2.42)	8.52 (-)	43.02
T3 (50% RDF + 50% compost	361.67 (19.04)	14.67 (3.95)	74.67 (8.69)	42.67 (6.60)	501.89 (20.79)	5.67 (2.51)	6.40 (2.72)	12.07 (-)	45.45
T4 (25% + RDF 75% compost)	300.33 (17.35)	13.00 (3.73)	68.00 (8.30)	36.33 (6.10)	442.78 (19.55)	4.00 (2.23)	4.46 (2.33)	8.46 (-)	47.28
T5 (100% compost)	289.67 (17.04)	13.33 (3.78)	66.33 (8.20)	35.67 (6.05)	428.11 (19.23)	3.33 (2.07)	4.31 (2.30)	7.64 (-)	43.61
T6 (100% vermicompost)	290.33 (17.06)	12.00 (3.60)	69.00 (8.36)	36.67 (6.13)	428.89 (19.23)	3.66 (2.15)	4.33 (2.30)	7.99 (-)	45.87
T7 (Control)	240.00 (15.52)	10.67 (3.41)	55.00 (7.48)	28.67 (5.44)	314.00 (16.66)	0.60 (1.00)	3.00 (2.01)	3.60 (-)	40.00
CD (5%)	2.12**	1.32**	1.66**	1.18**	84.71*	0.92**	0.12**	-	-
CV (%)	0.14	5.75	1.38	1.80	10.95	13.80	1.53	-	-
SEM (±)	0.72	0.43	0.54	0.38	27.71	0.29	0.41	-	-

NS: Number of spike (m^2); **SL:** Spike length (cm); **NG:** Number of grains/ spikes; **TW:** Test weight (1000 seed weight in g); **DMA:** Dry matter accumulation (g/m^2); **GY:** Grain Yield (t/ha); **SY:** Straw yield (t/h); **BY:** Biological yield t/ha; **HI:** Harvest index (%)
Data presented in parentheses are $\sqrt{x+0.5}$(square root transformed); ** Data in indicate significant at P = 0.05%;

followed by T2 (71.33 grains/ spike) and T1 (70.33 grains/ spike). The effect of treatments on number of grains/ spikes was found better in treatments T6 (69.00 grains/ spike) and T4 (68.00 grains/ spike) then the treatment T5 (66.33 grains/ spike). Less number of grains was obtained in control with 55.00 grains/ spike. The similar result was showed by Chopra *et al.,* (2016) in research where umber of grains per ear was recorded 42.95.

Test weight (g)

Similarly, the result of yield parameters was noted that treatment T3 was superior to rest of the treatment with 42.67 g followed by T2 (40.00 g). Treatments T1 revealed better result with 38.33 g test weight than others treatments T4 (36.33 g) and T6 (36.67 g) where T4 and T6 were statistically after with each other. Treatment with 100 percent compost gave comparatively lower test weight than others (excluding control with 28.67 g) proved least effective. The obtained result was supported with the work of by Shah *et al.,* (2016) where test weight 1000 seed was 41.91gm.

Grain yield (t ha^{-1})

We revealed that grain yield (t/h) was significantly highest in treatment in T3 (5.67 t/ h) followed by T1 and T4 having similar yield with 4.00 t/h. Here, it has been observed that treatment with organic manure also have better impact on yield with 3.67 and 3.33 t/h in T6 and T5 and were statistically at par, while the result in combination of NPK with compost had almost same impact on yield 3.67 (T2). Whereas control recorded less yield (2.25 t/ h). Similarly, the result obtained by Main *et al.,* (2019) revealed that estimated grain yield of wheat was 4135 kg/ha (4.135 Kg/ha) at late sown condition.

Straw yield (t ha^{-1})

Straw yield after harvesting was noted highest in the treatment T3 with 6.40 t/h followed by T1 (5.36 t/h). Result in case of treatments T2, T4, T5 and T6 found significantly at par with 4.48, 4.46, 4.31 and 4.33 t/ h, while less straw yield was obtained in control with 2.25 t/ h. The similar results on straw yield were observed by Devi *et al.,* (2011) in our respective research.

Biological yield (t ha^{-1})

Biological yield was calculated by adding economical yield to straw yield and here it has been obtained that T3 was superior in biological yield with 12.07 t/ h followed by T1 (9.36 t/ h) however treatments T2 and T4 revealed similar result with 8.52 and 8.46 t/h, respectively, whereas treatment with 100 percent organic fertilizers also had no significant differences in result and recorded 7.99 and 7.64 t/h biological yield in T6 and T5, respectively. The result was supported with investigation was done by Shah *et al.,* (2016) who found estimated of biological yield of 10172 kg ha^{-1}.

Harvest index (%)

In case of harvest index, no significant differences

Table 3: Details of particulars used in experiment and their cost for wheat crop (*T. aestivum* L.).

Input	Quantity	Rate (Rs./kg)	Cost (Rs.)
Wheat Seed	630 g	Rs. 55	Rs. 34.65
Urea	45.38 g	Rs. 52	Rs. 2.36
SSP	53.45 g	Rs. 27	Rs. 1.44
MOP	26.63 g	Rs. 60	Rs. 1.60
Compost	1500 g	Rs. 10	Rs. 15.00
Vermicompost	1000 g	Rs. 22	Rs. 22.00
Field Preparation	—	—	Nil
Labour & Pesticide	—	—	Nil
Total Cost	—	—	Rs. 77.05

have been observed amongst the treatments, treatment T4 had better result with 47.28% followed by T3 45.45%. Treatment T3 50% RDF with 50% organic manure was showed good results against of others treatment.

Economics

Gross returns (Rs./ha), net returns (Rs./ha) and benefit cost ratio

Economic evaluation of integrated nutrient management treatments under wheat (*Triticum aestivum* L.) cultivation revealed that the combination of organic and inorganic fertilizers enhances both productivity and profitability. In a 21 m² plot, the integration of 50% recommended dose of NPK with 50% compost and vermicompost inputs yielded 7.8 kg of grain. At a market price of Rs. 30 per kg, the gross return was Rs. 234.00 with a total cultivation cost of Rs. 77.05. The resulting net profit was Rs. 156.95, achieving a high benefit-cost ratio of 1:3.04. These results emphasize that integrated nutrient management not only improves crop yield but also ensures cost-effective and sustainable wheat production. Promoting such practices among farmers can significantly reduce dependence on synthetic inputs, while maintaining profitability and soil health. This study reveal that improve yield and profitability in wheat when integrating farmyard manure and chemical fertilizers, supporting the economic benefits observed in INM systems. Chopra *et al.,* (2016). That similar results were showed blending vermicompost with inorganic fertilizers significantly boosted wheat productivity and provided better economic returns compared to conventional practices. Studied done by shah *et al.,* (2016).

Yield and Return Summary (for 21 m² area)

Total Grain Yield: 7.8 kg

Market Price: Rs. 30/kg

Market Value = 7.8 kg × Rs. 30 = Rs. 234.00

Net Profit = 234.00 – 77.05 = Rs. 156.95

Benefit-Cost Ratio (B:C) = Rs. 234.00 / Rs. 77.05 = 1:3.04

Conclusion

The present investigation clearly demonstrated that the integrated application of organic and inorganic fertilizers offers superior agronomic and economic benefits in wheat cultivation. Among the various treatments, T3, which included 50% Recommended Dose of Fertilizers (RDF) of N, P, and K in combination with 50% compost, exhibited the most favorable outcomes in terms of plant growth, yield, and economic returns. This synergy between organic and inorganic inputs likely enhanced soil microbial activity, nutrient availability, and plant uptake efficiency, thereby improving overall crop performance. The importance of phosphorus and potassium was evident, not only for vegetative and reproductive development but also for imparting resistance to pests and diseases. Remarkably, no incidence of pest or disease was observed across treatments, which can be attributed to the combined effect of balanced nutrient supply and the inherent resistance of the selected wheat variety. From an economic perspective, the use of integrated nutrient management strategies reduced dependency on costly chemical fertilizers while maintaining or even enhancing yield. Compost and vermicompost played a pivotal role in improving soil health and fertility, contributing to sustainable production with reduced external input costs. The integrated approach also proved to be environmentally sustainable, causing no adverse effects on non-target organisms, beneficial soil microbes, or the agro-ecosystem at large. Therefore, it is concluded that INM practices, especially the T3 treatment, not only ensure higher productivity but also offer a cost-effective and eco-friendly alternative to sole reliance on chemical fertilizers. Promoting such practices among farmers can lead to better economic returns, improved soil health, and long-term sustainability in wheat production systems.

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