RoleAmeriolationof vermicompost and inorganic fertilizer on productivity of late-sown wheat Productivity

ABSTRACT

Globally wheat (*Triticum aestivum* L.) is a major cereal crop grown ~215 mha of the land and produce about 763.93 million tons.Wheat is the major staple food source for a large part of global populationworldwide. Due to the excessive use of inorganic fertilizer and unbalanced fertilization, the quality and productivity of soil, as well as the grains is arereducing because of unbalanced fertilization. So, there is a need to apply the abalanced fertilizer by mixingmix ofthe organic and as well as inorganic fertilizers to maintain the asustainable yield which thathelps to feed the ever-increasing population.The experiment was laid out in randomized block design (RBD) with 14 treatmentsreplicated thriceof three replicates. The treatmentsconsist ofwere as follows: T_1;: control, T_2;:Vermicompost (VC)@ (2.0 t./ha^{-1}), T_3;: VC@ (4.0 t./ha^{-1}),T_4;: VC@ (6.0 ton./ha^{-1}), T_5;:100% RDF (100%), T_6;: VC@ (2.0t.ha^{-1}ton/ha + 75%RDF), T_7;: VC@ (2.0t.ha^{-1}ton/ha +100%RDF), T_8;: VC@ (2.0t.ha^{-1}ton/ha + 125%RDF),T_9:;VC@ (4.0t.ha^{-1}ton/ha+75%RDF),T_{10}VC@ (4.0t.ha^{-1}ton/ha + 100%RDF), T_{11};: VC@ (4.0t.ha^{-1}ton/ha +125%RDF), T_{12};: VC@ (6.0 t.ha^{-1}ton/ha + 75%RDF), T_{13};: VC@ (6.0t.ha^{-1}ton/ha +100%RDF), and T_{14}: ;VC@ (6.0t.ha^{-1}ton/ha +125%RDF).The results revealed that the treatment T_{14} gave the significantly better growth parameters, andyield contributing characters with the highest grain and straw yield (4.38 t.ha^{-1}t/ha and 7.13 t/ha, respectively) compared to to rest of treatmentsothers. The minimum grain yield (2.74 t.ha^{-1}t/ha) and straw yield (4.80 t.ha^{-1}t/ha) was wererecorded under the treatment T1 (control).

Keywords: inorganic fertilizer, Vermicompost, inorganic fertilizer, Wheat, Yield

INTRODUCTION

Wheat is one of the most popular and staple foods in India among ~~both~~ vegetarians and non-vegetarians. It compares well with other cereals in nutritive value. It has a good nutrition profile with 12.1%~~percent~~protein, 1.8%~~percent~~ lipids, 1.8%~~percent~~ash, 2.0%r~~percent~~ educing sugar, 6.7%~~percent~~pentose, 59.2%~~percent~~starch, and~~with~~ a good source of minerals~~ of~~, vitamins, and nicotinic acid (Agam*et al.*, 2017). It is processed in different forms like flour, ~~suzi~~Suzi, and maida, and ~~being~~ iseaten by ~~number of~~ consumers in different ways such as porridge (Halwa), chapati, bread, and biscuits~~ etc~~. Besides that, wheat straw and wheat bran are ~~also~~ good sources of feed for animals (Yadav*et al.*, 2014). Wheat is mainly grown in the ~~Rabi~~ Fallseason (October-December to March-May) along with Barley, Lentils, Peas, Mustard, and Potatoes. The Production of Wheat during 2020-21 ~~is~~ was estimated at ~~record~~ 109.52 million tons. It is higher by 9.10 million tons than the average wheat production of 100.42 million tones (Anonymous, 2022).China is the top country ~~by~~ inwheat production with ~~in the world. As of 2020, wheat production in China was~~ 134,250 thousand tons~~that~~ whichaccounts for 20.66% of the world's wheat production in 2020~~.~~ , while~~The top 5 countries (others are~~ India, the Russian Federation, the United States of America, and Canada~~)~~ account for 63.46%~~ of it~~. The world's total wheat production was estimated at 649,759 thousand tons in 2020.India is the second largest producer and consumer of wheat in the world and therefore there is a need to increase the production of wheat ~~crop so that, it can be exported to other countries and thereby reducing the quality and quantity of wheat~~ and here focusing to boost the economy of ~~a~~ thenation by ~~combine~~ combiningthe application of organic and inorganic fertilizers.

Today, chemical fertilizers are used as the most economical tool to achieve maximum production per unit area and compensate for the shortage of resources, which leads to increased production costs along with the destruction of soil, water, and biological resources. Wheat is one of the most strategic crops ~~among cereals, which is~~ andis of great importance in the diet of human societies. Wheat plays an important role in providing essential minerals, carbohydrates, and protein, and if wheat production increases, many food deficiencies will be addressed (Akbarabadi*et al*., 2015). Most crops, including cultivated cereals, are deficient in micronutrients. Deficiency of these elements in the soil not only reduces the yield of the plant~~,~~but also reduces the absorption of these elements by humans and livestock ~~by reducing the concentration of these elements in the plant~~ and this leads to various diseases and endangers public health (Zirgoli and Kahrizi, 2015).

Therefore, the availability of nutrients in the soil determines the nutrient status of the plant. Deficiency or lack of sufficient micronutrients in the soil not only reduces crop productivity but also reduces the nutritional quality of agricultural products, thus leading to malnutrition in the human population and causing many hidden ~~but hidden human~~ health problems (Zuo and Zhang, 2011). When nutrients are present in the soil crops,plantswill grow well and produce significant amounts of ~~plant~~ biomass. Providing nutrients in the soil determines the status of these nutrients in the plant and the most important mission of agriculture ~~in~~ isthe production of healthy and nutritious food in human societies ~~in order~~ to achieve food security (Mohammadi*et al.*, 2015). The effects of chemical fertilizers have caused contamination in the soil, which is one of the threatening factors of production resources and is one of the most important agricultural concerns today. But bio-organic fertilizers will not cause soil pollution compared to mineral fertilizers (Savci, 2012; Awan*et al.*,2020; Sarker*et al.*, 2020).

Proper plant nutrition based on the use of organic fertilizers is one of the basic principles of achieving sustainable agriculture and plays an important role in improving the quality and quantity of agricultural products and the availability of nutrients. Chemical fertilizers, environmental protection, and enrichment of agricultural products are effective in food security and the health of human communities (Jat*et al.,* 2015). Soil remediation using organic fertilizers can be considered a useful way to improve the sustainability of agricultural systems. The use of organic fertilizers, soil organic matter, and nutrients increases the growth and activity of microorganisms and by maintainsing the structure of the soil, provides a good substrate for growth, and helps keep the plant healthy. Increasing biological activity improves nutrients from chemicals, organics, sources and decomposition of toxic substances, and nutrient exchange capacity (Chew *et al*., 2019).

Reducing the use of chemical fertilizers and replacing them with organic and integrated fertilizers has increased the yield, which is desirable and useful for achieving sustainable agriculture. The use of chemical fertilizers changes the concentration of soil salts and and on the other hand due to their acidic and alkaline properties causes changes in soil acidity which leads to the deposition or dissolution of trace elements by affecting their balance in the soil (Lansdown, 1995). Today, vermicompost is considered as a simple biotechnological process of compost and as an easy technology and annatureeco-friendly process, so that this process is used to obtain organic fertilizers from waste (Thakur *et al.*, 2021). With the increasing application of different levels of vermicompost in the soil, the concentration of zinc and copper in the soil increases (Thakur *et al.*, 2021). Nitrogen chemical fertilizer has a significant effect on wheat yield and quality (Liu *et al.*, 2021). Organic fertilizers can reduce phosphorus uptake and increase plant access to phosphorus (Adnan *et al.*, 2020).

The combined use of organic and inorganic fertilizers is an effective ways to maintains nutrient supply, provide the soil microbes withgives organic carbon to soil microbes, and mobilizes soil-bound nutrients on decomposition through the release of organic acids (Sharma *et al.*, 2013). Integration of inorganic fertilizers with organic manures and bio-fertilizers will not only help sustain the crop productivity but also will be effective in improvingimprove soil health and increase the nutrient-use efficiency (Verma*et al.*, 2006). Keeping this view in mind, an experiment was plannedWe aimed to know evaluate the effectiveness ofthe combined use of organic and inorganic fertilizers for improving the growth and yield attributes of wheat crop and their economics.

MATERIAL AND METHODS

Field experiments were conducted during the winter of 2018-19 at the student Student instructional Instructional farm Farm (SIF) of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.), India. The soil was sandy loam having organic carbon of up to 0.45 % with pH 7.3, available N 170 kg.ha^{-1}, available $P_{2}0_{5}$ 16 kg ha^{-1}, and available $K_{2}0$ 180 kg.ha^{-1} at the start of the experiment in 0 to 30 cm soil layer during 2018-19(Table 1).

Table 1: Chemical analysis of the soil of the experimental field

SN	Soil characteristics	Value	Method of determination
1	Organic carbon (%)	0.45	Walkley and Black rapid titration method (Walkey and Black, 1934).

2	Soil PH	7.3	Glass electrode pH meter (Piper, 1950)
3	E.C. (mmhos/cm at 25^0C	0.22	Electrical conductivity bridge method (Jackson, 1973)
4	Available nitrogen (kg/ha)	170	Alkaline potassium permanganate method (Subbiah and Asija (1956))
5	Available phosphorus (kg/ha)	16	Olsen's method (Olson, 1960)
6	Available potash potash(kg/ha	180	Flame photometric method (Hanway and Heidal (1952))

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The experiment consists of fourteen treatmentsviz.,as followsT_1; control, T_2;Vermicompost (VC) (2.0 t.ha^{-1}), T_3; VC (4.0 t.ha^{-1}), T_4; VC (6.0 ton.ha^{-1}), T_5; RDF (100%), T_6; VC (2.0 t.ha^{-1} + 75%RDF), T_7; VC (2.0 t.ha^{-1} +100%RDF), T_8; VC (2.0 t.ha^{-1} + 125%RDF),T_9;VC (4.0 t.ha^{-1} +75%RDF),T_{10} VC (4.0 t.ha^{-1} + 100%RDF), T_{11}; VC (4.0 t.ha^{-1} + 125%RDF), T_{12}; VC (6.0 t.ha^{-1} + 75%RDF), T_{13}; VC (6.0 t.ha^{-1} +100%RDF), and T_{14};VC (6.0 t.ha^{-1} +125%RDF)T_1:control, T_2: Vermicompost (VC) @ 2.0 t/ha, T_3:VC@ 4.0 t/ha,T_4: VC@ 6.0 ton/ha , T_5: 100% RDF, T_6: VC@ 2.0ton/ha + 75%RDF, T_7: VC@ 2.0ton/ha +100%RDF, T_8: VC@ 2.0ton/ha + 125%RDF ,T_9: VC@ 4.0ton/ha+75%RDF ,T_{10}:VC@ 4.0ton/ha + 100%RDF, T_{11}:VC @ 4.0ton/ha +125%RDF, T_{12}: VC@ 6.0 ton/ha + 75%RDF, T_{13}: VC@ 6.0ton/ha +100%RDF, T_{14}:VC@ 6.0ton/ha +125%RDF (Table 2). The results revealed that the treatment T_{14} gave the significantly better growth parameters and, yield contributing characters with the highest grain and straw yield (4.38 t.ha^{-1}t /ha and 7.1 t.ha^{-1}t/ha, respectively) compared to rest of treatmentsthe others. The minimum grain yield (2.7 t.ha^{-1}t/ha) and straw yield (4.8t.ha^{-1}t/ha) was were recorded under the treatment T1 (control).The experiment was laid out in randomized block design with three replications. Vermicompost was applied 15 days before sowing as per treatment. Wheat cultivar UnnatHalna (K-9423)

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was sown in rows 22.50 cm apart on 25 December,2018 and harvested on 22 April, 2019. Half of nitrogen and full dose of phosphorus and potash were applied at the time of sowing as per treatment combination. The remaining nitrogen as per treatment was top dressed after first irrigation. N, P and K were applied through urea, single super phosphate, and murate of potash respectively. The crop received three uniform irrigations at ~~(at~~ crown root initiation, flowering, and milking stages~~)~~. Organic carbon, pH, available N, P, K of soil and N, P, K contents in plants were estimated ~~by standard methods~~. Nutrient uptake was estimated by multiplying the dry-matter accumulation at maturity in grain and straw of wheat by their respective percentages. Total uptake was calculated by adding uptake of grain and straw. The yield parameters and yields were recorded and analyzed as per Gomez and Gomez (1984). The treatment comparisons were made using t-test at 5% level of significance. The economics was calculated on the basis of prevailing local market price of wheat grains and cost of inputs**.**

Table 2: Treatment Combination

Symbol	**Treatments**
T_1	Control
T_2	VC~~@~~ at a rate of 2.0 t.ha^{-1} ~~ton/ha~~
T_3	VC~~@~~ at arate of 4.0 t.ha^{-1} ~~ton/ha~~
T_4	VC~~@~~ at a rate of 6.0 t.ha^{-1} ~~ton/ha~~
T_5	100% RDF
T_6	VC~~@~~ at a rate of 2.0 t.ha^{-1} ~~ton/hac.~~+75% RDF
T_7	VC~~@~~ at a rate of 2.0 t.ha^{-1} ~~ton/hac.~~+100% RDF

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T_8	VC~~@~~ at a rate of 2.0 t.ha^{-1}~~ton/hac.~~+125% RDF
T_9	VC~~@~~at a rate of 4.0 t.ha^{-1}~~ton/hac.~~+75% RDF
T_{10}	VC~~@~~ at a rate of 4.0 t.ha^{-1}~~ton/hac.~~+100% RDF
T_{11}	VC~~@~~ at a rate of 4.0 t.ha^{-1}~~ton/hac.~~+125% RDF
T_{12}	VC~~@~~ at a rate of 6.0 t.ha^{-1}~~ton/hac.~~+75% RDF
T_{13}	VC~~@~~ at a rate of 6.0 t.ha^{-1}~~ton/hac.~~+75% RDF
T_{14}	VC~~@~~ at a rate of 6.0 t.ha^{-1}~~ton/hac.~~+75% RDF

RESULTS AND DISCUSSION

Effect on growth parameters

Plant height (cm)

The results ~~of the analysis of variance of data~~ in (Table 3 and Fig. 1) showed that ~~the effect of~~different manures and fertilizers had a significant ($P < 0.05$) effect on the plant height~~ of the plant had a significant effect on the level of 1% probability~~. ~~Thus, the studied treatments caused a relative increase in plant height compared to the control.~~ The maximum and minimum heights~~of the plants~~were recorded at 30, 60, and 90 DAS and maturity stages for the treatment T_{14} and T_1~~ with values of 14.93, 79.30, 81.69 and 83.09 cm and 9,35, 49.64,~~

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52.24 and 54.14 cm, respectively. The effect of chemical fertilizers on plant growth is was due to the increased availability of nutrients, especially nitrogen, and phosphorus. Nitrogen increases the growth of aerial organs, phosphorus increases the energy transfer for the growth of plant vegetative organs,, and in general, it improves photosynthesis and thus plants growth. The increase of these traits by chemical fertilizers can be considered by increasing the length of intermediates attributed to the availability of due to providing water and nutrients required by the plant. Chemical fertilizers increase plant height (Jamir *et al.*, 2017). The reason for increase ining plant height is probably a consequence of affected by the increased number of spikes per unit area and the control treatment by reducing the number of spikes per unit area, and for light and nutrient availability, compared to other fertilizer treatments has a high level of competition between plants. This increases the plant height in the plant (Geravandi*et al.*, 2011). The use of chemicals and manures separately had the highest and lowest plant height. Nitrogen increase leads to an increase in plant height and has a significant ($P < 0.05$) effect on plant aerial height. Consumption of organic fertilizers along with chemical fertilizers increased the length of the spike compared to the control. Increasing the height of the plant is contributed to higher fertile fertility and has more flowers, which increases the number of seeds per spike (Sepahvand*et al.*, 2021).

Dry matter accumulation (g.plant^{-1})

The observed data of dry matter accumulation are shown results in (Table 3 and Fig. 2)). revealed The a significant ($P < 0.05$) mass increase in dry matter from 30 to 90 DAS due to faster growth and a further increase in dry matter until maturity is was very slow because of the diminishing growth rate of crop. The resultsshows showed that there was a significant (P <

0.05) difference between the treatments at 30, 60, and 90 DAS and harvest stages. At 30 DAS, ~~the~~ treatment T_{13} ~~was~~ recorded the highest dry matter accumulation, ~~(2.80g)~~ while thelowest dry matter ~~accumulation~~was recorded in treatment T_1~~(1.67g)~~. Dry matter accumulation at 60 DAS revealed the ~~recorded~~ highest in T_{14} ~~(7.72g) compared to rest of the treatment~~. At 90 DAS, ~~the~~ treatment T_{14}~~observed~~ showedthe highest dry matter accumulation~~(18.30g)~~ which is on par with treatments T_{11},T_{12},and T_{13}, and the lowest dry weight was recorded ~~under the treatments~~in T_1~~(13.15)~~. At the harvest stage, treatment T_{14}~~recorded~~ showedthe highest dry matter accumulation per plant ~~(23.43g) compared to rest of the treatments~~.The increase in dry matter accumulation was due to the balanced application of nutrients ~~which~~ thatwere supplied through ~~both the sources (~~organic and inorganic~~).~~ sources. Plants~~uptake~~ utilizeadequate amounts of soil nutrients ~~from the soil and~~ whichincreases ~~its~~ theirphotosynthetic areas and ~~finally~~ led to more dry matter accumulation. Similar findings were observed by (Kakraliya*et al.*, 2017).

Table 3: Effects of vermicompost and inorganic fertilizer on growth parameters of late sown

Treatment	Plant height (cm)				Dry matter accumulation (g/plant)			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T1: Control	9.35	49.64	52.24	54.14	1.67	5.55	13.15	16.85
T2: VC ~~@~~ (2.0ton.~~/~~ha^{-1})	11.30	60.00	61.81	63.07	1.84	6.12	14.51	18.59
T3: VC (~~@~~ 4.0ton.ha^{-1}~~ton/ha~~)	11.40	60.56	62.35	63.63	1.84	6.13	14.54	18.63
T4: VC (~~@~~ 6.0ton.ha^{-1}~~ton/ha~~)	11.72	62.23	64.05	65.33	1.88	6.24	14.80	18.57
T5: 100% RDF	12.04	63.95	65.79	67.11	1.90	6.34	15.04	19.27

T6: VC @ 2.0ton.ha^{-1}ton/ha+75%RDF	12.69	67.44	69.38	70.80	1.90	6.55	15.61	20.00
T7: VC@2.0ton.ha^{-1}ton/ha+100%RDF	13.03	69.26	71.18	72.65	2.06	6.87	16.28	20.86
T8: VC @2.0ton.ha^{-1}ton/ha+125%RDF	13.27	70.52	72.45	73.60	2.11	7.03	16.67	21.36
T9: VC @ 4.0ton/haton.ha^{-1}+75%RDF	13.38	71.06	72.70	73.90	2.15	7.15	16.96 33	21.74
T10: VC @4.0ton.ha^{-1}ton/ha+100%RDF	13.53	71.86	73.66	75.12	2.17	7.21	17.08	21.88
T11: VC @4.0ton.ha^{-1}ton/ha+125%RDF	13.89	73.79	75.88	77.36	2.20	7.31	17.32	22.19
T12: VC@ 6.0ton.ha^{-1}ton/ha+75%RDF	14.40	76.50	78.63	80.30	2.22	7.40	17.51	22.43
T13:VC @6.0ton.ha^{-1}ton/ha+100%RDF	14.62	77.67	79.97	81.50	2.80	7.57	17.95	23.00
T14: VC@6.0ton.ha^{-1}ton/ha+125%RDF	14.93	79.30	81.69	83.09	2.32	7.72	18.30	23.43
SEm (±)	0.57	1.68	1.64	1.56	0.04	0.37	0.47	0.67
CD at 5%	1.17	3.46	3.38	3.21	0.09	0.76	0.97	1.39

Figure 1: Effects of vermicompost and inorganic fertilizer on growth parameters of ~~late~~ late-sown wheat

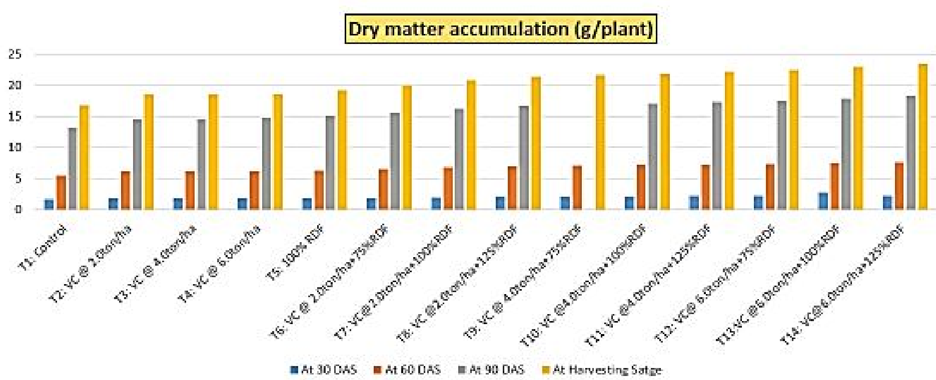

Figure 2: Effects of vermicompost and inorganic fertilizer on growth parameters of ~~late~~ late-sown wheat

Effect on yield attributes

Integrated use of fertilizers with vermicompost increased the dry matter accumulation, number of effective tillers, grains/spike,~~-1~~ and the test weight (Fig. 3). The enhanced early vegetative growth in terms of higher leaf area, dry matter accumulation, and vigorous root system resulted in more spikes which consequently increased the number of spike bearing tillers significantly. It might be due to the stimulated vegetative growth of wheat on account of an adequate and prolonged supply of essential nutrients.~~Similarly, t~~The number of effective tillers, grain/spike, and test weight produced by the application ~~Vermicompost @6.0ton/ha+125%RDF~~of T_{14}were found to be significantly (P < 0.05) higher than the other treatments and the lowest from the control. These results are in line with ~~the findings~~ Dey, S.R*et al.* (1999) who reported a significant increase in the number of plants per meter row by combined application of manure and fertilizers.

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Grain yield (ton.ha^{-1}~~t/ha~~)

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~~Addition~~ The addition of vermicompostwith different fertilizer levels produced significantly (p < 0.05) higher grain and biological yields than the application of fertilizers alone maximum grain yield and biological yield were obtained with the application of ~~125% RDF+ vermicompost @ 6.0t ha^{-1}~~T_{14}. The lowest grain yield ~~(2.74 t ha^{-1})~~ and biological yield ~~(4.81 t ha^{-1})~~ were recorded from the control (Table 4). The increase in grain and biological yield might be due to adequate quantities and balanced proportions of plant nutrients supplied ~~to the crop~~ as per need during the growth period resulting in a favorableincrease in yield attributing characters which ultimately led towards an increase in economic yield. Improved physico-chemical properties of the soil through the application of organic manure might be the other possible reason for higher productivity. Rao *et al.*, (1996) ~~also~~ reported that the combination of organic and inorganic N sources resulted in comparable rice yield to the application of only inorganic nitrogen~~ alone~~. Patil*et al.* (2000) ~~also~~ reported that the

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combination of organic manure and fertilizer significantly improved the grain and biological yield of wheat.

All vermicompost and fertilizer rates produced significantly ($P < 0.05$) higher grain yield~~(4.38 t/ha)~~ of wheat than the control~~ (2.74 t/ha)~~. But the highest values ~~of this parameter~~ were obtained with T_{14} followed by T_{13} and T_{12}~~ in that order~~. This is in agreement with ~~findings of~~ Yousefi and Sadeghi (2014) who reported that application of vermicompost to soil significantly increases the yield of wheat. Grain yield is a result of ~~various~~ numerousfactors such as dry matter, effective tillers, and the number of filled grains. The higher the grain yield, the ~~was due to~~ higher the dry matter accumulation and ~~a~~ thegreater number of filled grains per spike. This was due to the efficient utilization of nutrients ~~results more~~givingvegetative growth and efficient partitioning of photosynthates.

Arancon and Edwards, (2005)~~Besides, different studies have also~~ demonstrated the beneficial effect of the application of vermicompost at different rates on the yields of other crops such as tomatoes~~ (Arancon and Edwards, 2005). As vermicopost is a source of different essential plant nutrients, its application in soil with low nutrient content especially in NPK will definitely increase the growth, yield and yield components of crops including wheat~~. However, in addition to being a source~~s~~ of different nutrients, vermicompost is ~~also~~ supposed to contain ~~growth~~ growth-promoting hormones (Edwards *et al.*, 2004) which might facilitate higher nutrient uptake by plants and this could be an additional factor for the positive effect of vermicompost on crops.

The positive effects of vermicompost and NPK fertilizers application on wheat ~~seen~~ in ~~this~~ the current study~~experiment~~ suggested that the ~~study~~ soils are low in ~~its~~ nutrient contents, particularly of nitrogen potash. The result of initial soil~~sanalyses~~ analysis data also proves (Table 1) this claim.

Table 4: Effects of vermicompost and inorganic fertilizer on yield attribute

Treatment	Effective tiller (m^{-2})	No of grains/ear	Test weight(g)	Grain yield (tons/ha)	Straw yield (tons/ha)	Harvest index (%)
T1: Control ~~T1: Control~~	268.70	36.65	36.0	2.74	4.81	36.35
T2: VC (2.0ton.ha^{-1})~~T2: VC @ 2.0ton/ha~~	297.17	40.53	36.35	3.34	5.6	37.15
T3: VC (4.0ton.ha^{-1})~~T3: VC @ 4.0ton/ha~~	299.65	40.87	37.48	3.34	5.63	37.23
T4: VC (6.0ton.ha^{-1})~~T4: VC @ 6.0ton/ha~~	303.21	41.33	37.21	3.43	5.77	37.33
T5: 100% RDF ~~T5: 100% RDF~~	308.04	42.02	37.26	3.53	5.94	37.41
T6: VC 2.0ton.ha^{-1}+75%RDF ~~T6: VC @ 2.0ton/ha+75%RDF~~	319.68	43.60	37.38	3.72	6.21	37.48
T7: VC2.0ton.ha^{-1}+100%RDF ~~T7: VC@2.0ton/ha+100%RDF~~	333.41	45.46	37.56	3.82	6.35	37.56
T8: VC 2.0ton.ha^{-1}+125%RDF ~~T8: VC @2.0ton/ha+125%RDF~~	341.16	46.52	37.71	3.89	6.45	37.65
T9: VC 4.0ton.ha^{-1}+75%RDF ~~T9:~~	347.59	47.39	37.86	3.95	6.47	37.75

~~VC @ 4.0ton/ha+75%RDF~~						
T10: VC 4.0ton.ha^{-1}+100%RDF ~~T10: VC @4.0ton/ha+100%RDF~~	349.96	47.72	37.98	3.96	6.52	37.81
T11: VC 4.0ton.ha^{-1}+125%RDF ~~T11: VC @4.0ton/ha+125%RDF~~	354.84	48.41	37.68	4.75	6.68	37.87
T12: VC6.0ton.ha^{-1}+75%RDF ~~T12: VC@ 6.0ton/ha+75%RDF~~	358.77	48.93	37.75	4.22	6.91	37.93
T13:VC 6.0ton.ha^{-1}+100%RDF ~~T13:VC @6.0ton/ha+100%RDF~~	367.74	50.15	38.18	4.29	7.00	37.98
T14: VC6.0ton.ha^{-1}+125%RDF ~~T14: VC@6.0ton/ha+125%RDF~~	374.71	51.10	38.32	4.38	7.13	38.05
SEm (±)	5.68	0.75	0.28	1.67	2.54	0.23
CD at 5%	11.68	1.54	0.58	3.45	6.05	0.48

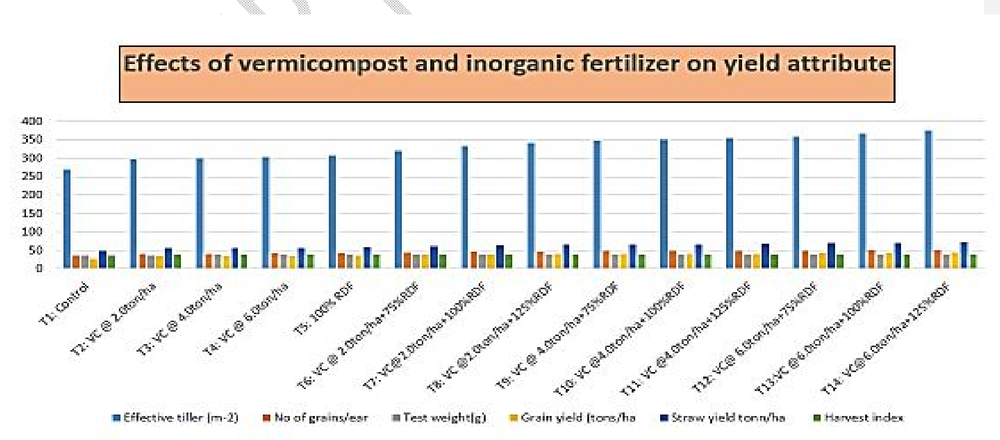

Figure 3: Effects of vermicompost and inorganic fertilizer on yield attribute

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Economics

Net ~~return~~ Return and Benefit: ~~Cost~~ The cost ratio increased with the supplementation of the recommended dose of fertilizer. Highest net return (Rs.77450.ha^{-1}) and B: C ratio (2.50) ~~was~~ wereobtained with the application of ~~125% RDF +vermicompost @ 6.0tha^{-1}~~ T_{14}(Table 5 and Fig. 4). Suthar(2006) reported that integrated application of NPK fertilizers ~~along~~ with vermicompost in field crops not only influences growth and production of the plant but ~~at the same time~~ also reduces the production budget.

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Table 5. Effect of ~~treatments~~ Treatments on ~~economics~~ Economics

S.N	Treatment	cost of cultivation (Rs/h)	Gross income (Rs/h)	Net income (Rs/h)	B.C ratio (Rs/h)
1	Control ~~Control~~	42485	83100	40615	1.96
2	VC (2.0ton.ha^{-1})~~Vc @ 2.0ton/ha~~	45610	99106	53496	2.17
3	VC (4.0ton.ha^{-1})~~Vc @ 4.0ton/ha~~	45780	99893	54113	2.18
4	VC (6.0ton.ha^{-1})~~Vc @ 6.0ton/ha~~	46545	102509	55964	2.20
5	100% RDF ~~100% RDF~~	46995	105401	58406	2.24

6	VC 2.0ton.ha^{-1}+75%RDF Vc @ 2.0ton/ha+75%RDF	47213	110778	63508	2.34
7	VC2.0ton.ha^{-1}+100%RDF Vc @ 2.0ton/ha+100%RDF	48025	103614	65589	2.37
8	VC 2.0ton.ha^{-1}+125%RDF Vc @ 2.0ton/ha+125%RDF	48530	115528	66998	2.38
9	VC 4.0ton.ha^{-1}+75%RDF Vc @ 4.0ton/ha+75%RDF	48650	116230	67580	2.39
10	VC 4.0ton.ha^{-1}+100%RDF Vc @ 4.0ton/ha+100%RDF	48772	117420	68598	2.41
11	VC 4.0ton.ha^{-1}+125%RDF Vc @ 4.0ton/ha+125%RDF	49566	120445	70879	2.43
12	VC6.0ton.ha^{-1}+75%RDF Vc @ 6.0ton/ha+75%RDF	50912	124735	73823	2.45
13	VC 6.0ton.ha^{-1}+100%RDF Vc @ 6.0ton/ha+100%RDF	51028	126550	75522	2.48
14	VC6.0ton.ha^{-1}+125%RDF VC@6.0 ton/hac+125%RDF	51633	129083	77450	2.50
	SE (d) ±	445.309	872.551	1091.60	0.06
	C.D at 5%		1794.33	1794.33	0.13

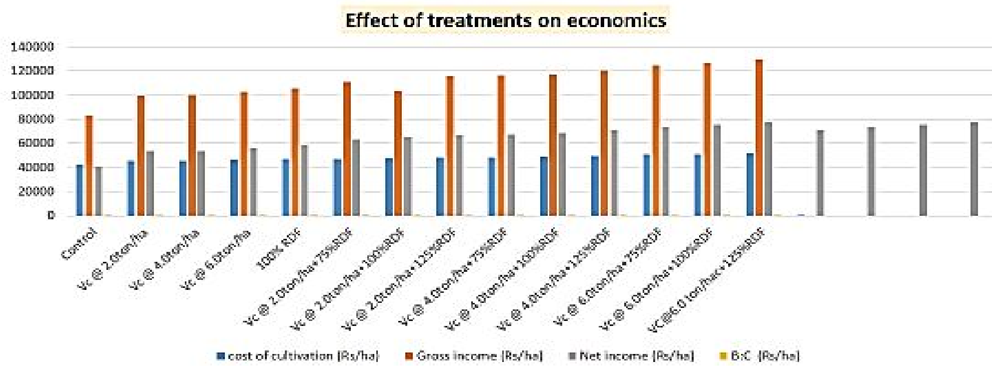

Figure 4: **Effect of treatments on economics**

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Comment [es1]: MUST BE UPDATED as 25.7% (9 out of 35) of the listed references were published in the past five years. The percentage has to increase to 30-40%. The old reference indicates less interest in the study field

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