

Original Research Article

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## Effect of Different Sources of Nutrient and NPK Levels on Growth, Yield Attributes and Productivity of Wheat (*Triticum aestivum*) in a Vertisol

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### ABSTRACT

A field experiment was conducted during Rabi 2018-19 and 2019-20 to test three sources of nutrients and five levels of NPK on wheat in a Vertisol. Application of inorganic (100%) and integrated source (50% inorganic + 50% organic) of nutrients significantly increased yield attributes and yield of wheat over organics (100%). However, the number of grains spike<sup>-1</sup>, grain and straw yield of wheat with inorganic were also found significantly superior to integrated source of nutrients. While the application of all the NPK level significantly increased the plant yield and yield attributes of wheat over control. However, the application of NPK levels @150 and 200% were found significant over 100% NPK level for yield and all yield attributes of wheat except number of tillers plant<sup>-1</sup> at 150% NPK but the difference between the two treatments was found non-significant. The application of 200% NPK with inorganics and integrated source of nutrients significantly increased the plant height and number of tillers plant<sup>-1</sup> over 100% NPK at the same source and level of NPK with organics. The application of 150 and 200% NPK were found significant over 100% NPK for grain and straw yield with inorganics and integrated sources of nutrients and length of spike and number of grains spike<sup>-1</sup> with inorganics. In general, the application of all the NPK level with inorganic and integrated source of nutrients were found significantly superior to the same levels of NPK with organics for yield and yield attributes of wheat.

#### Keywords

Inorganic source,  
Nutrient Levels,  
INM, Interaction,  
Yield, Correlation

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### Introduction

Wheat (*Triticum aestivum*) is one of the most important cereal crop of India followed by rice. In India wheat is grown in 30.41 mha with annual production of 92.29 MT and productivity of 3034 kg ha<sup>-1</sup> (Anonymous 2018). In Madhya Pradesh, is grown in an area of 5.91 mha with production of 17.69 MT and productivity of 2993 kg ha<sup>-1</sup>

(Anonymous 2015-16). The food grain requirement in India is gradually increasing every year and it may reach around 350 MT due to increasing population pressure expected to 1.8 billion up to 2050 (Khatkar *et al.*, 2016).

Presently, the productivity of wheat (3 t ha<sup>-1</sup>) is lower than its potential of other wheat growing countries like China and Mexico (5 t

ha<sup>-1</sup>). It might be due the recommended dose of NPK was considered optimum earlier actually become suboptimal as the soil testing laboratories are using the same soil fertility ratings since more than fifty years. Hence, the field crops exhibit substantial economic response on high fertility levels. (Singh, 2016) found that the productivity may further increase by increase in nutrient dose from 100% NPK to 150% NPK.

Nutrients additions on organic and biological form are designed to maintain good soil health and stability in production (Bishth *et al.*, 2018) but not to directly feed plants (Kirchmann and Ryan, 2004). As a result, crops in organic agriculture are often grown in nutrients deficient condition far below their production potential (Kirchmann *et al.*, 2008). Integrated nutrient management approach advocates combined use of organic source of nutrients and mineral fertilizers which helps in crop nutrient synchrony and reduction in nutrient loss through interactive and complementary effect between both types of inputs.

Thus management of good soil health and supply of available plant nutrients to the crop is necessary to raise the quality and productivity of crops. Hence, this investigation was undertaken to assess different nutrient management practices and NPK levels on growth and productivity of wheat in a Vertisol.

## **Materials and Methods**

### **Details of experimental site**

A field experiment was carried out in the Research Farm of the Department of Soil Science and Agricultural Chemistry at Jawaharlal Nehru Krishi Viswa Vidyalaya, Jabalpur (M.P.) during *rabi* season of 2018-19 and 2019-20. The soil was *Typic*

*Haplustert*, clayey in texture, having pH 7.54, EC 0.13 dSm<sup>-1</sup>, organic carbon 0.52%, available N 288 kg ha<sup>-1</sup>, available P 11.22 kg ha<sup>-1</sup>, available K 745 kg ha<sup>-1</sup>.

### **Experiment details**

This study use split plot design with thrice replication. The treatment comprised of 3 sources of nutrient i.e. inorganic (100%), organic (100%) and integrated nutrient (50% inorganic + 50% organic) management and five levels of NPK ie. control (0 NPK), 100% NPK (120-60-40 kg ha<sup>-1</sup>), 150% NPK (180-90-60 kg ha<sup>-1</sup>), 200% NPK (240-120-80 kg ha<sup>-1</sup>) and soil test value (STV) based NPK (149-176-33 kg ha<sup>-1</sup>). The inorganic source of nutrients was applied through Diammonium phosphate, urea, single super phosphate and muriate of potash.

The nutrients with organic sources were applied through farm yard manure, vermicompost, *Azotobacter* and phosphorous solubilizing bacteria. VST based nutrients with organic source was applied through wheat straw, *Azotobacter* and phosphorus solubilizing bacteria. Well decomposed farm yard manure (FYM), vermicompost (VC) and wheat straw were applied by mixing with the soil well before 30 days of sowing.

One third N of treatment and full dose of P and K were applied through fertilizer as basal application. The 1/3 N was applied at 21 days after sowing and remaining 1/3 N was applied at 65 days after sowing as per treatment during both the year. The wheat seed of variety GW-366 was sown at 22.5 cm row spacing @ 120 kg per ha on 13<sup>th</sup> December 2018 during first year and 19 December 2019 during second year. One hand weeding was done after 30 days of sowing during both the year. Four irrigations were applied during both the year.

## Research parameters

### Yield attributes

Five plants per plot were tagged during both the year to measure the plant height, no. of tillers plant<sup>-1</sup>, length of spikelet and number of grains spikelet<sup>-1</sup>. The crop was harvested on 13<sup>th</sup> April 2019 and 23 April 2020 during first and second year respectively. The grain and straw yield of wheat was recorded at the time of threshing during both the year.

### Data analysis

The data from observations using analysis of variance with a levels of  $\alpha = 0.$ , which aims to determine whether there is an interaction or a real influence of treatment. If there is a real effect, then proceed with the LSD test with a level of  $p = 0.05$  to determine the difference between treatments.

## Results and Discussion

The highest plant height, number of tillers plant<sup>-1</sup>, length of spikelet, number of grains spikelet<sup>-1</sup>, grain and straw yield were observed with the application of inorganic source (100%) of nutrients followed by integrated source (50% inorganic + 50% organic) source of nutrients and organic source (100%) of nutrients (Table 1 and 2).

The application of inorganic and integrated source of nutrients, significantly increased the plant height, number of tillers plant<sup>-1</sup>, length of spikelet, number of grains spikelet<sup>-1</sup>, grain and straw yield of wheat over organic source of nutrients except plant height with integrated source but the treatments were found at par for number of tillers plant<sup>-1</sup> and length of spikelet. However, the application of inorganic significantly increased the number of grains spikelet<sup>-1</sup>, grain and straw yield of wheat over integrated source of

nutrients. The increased growth and yield parameters with inorganic source of nutrients might be due to high solubility of inorganic fertilizer and supply of readily available inorganic form of nutrients in appropriate amount in soil solution resulting adequate supply of nutrients during periods of crop demand leading to better absorption of nutrients promotes higher growth and yield due to cell division and elongation, formation of nucleotides and co-enzymes, energy transfer resulted in increased meristematic activity and photosynthetic area and hence more production and accumulation of photosynthates which reflects higher growth and yield.

The lower value of growth and yield parameters with organics might be due to less amount of available nutrients (inorganic form) to plant as the slow rate of mineralization. Organic manures have a low efficiency due to lack of synchrony (asynchrony) may occur when a nutrient is released or added to soil during periods of restricted plant demand or when it is releases at a rate exceeding the uptake or slower than the plant's needs (Mayers *et al.*, 1994). While the higher values of growth and yield attributing characters with integrated sources (50% inorganic + 50% organic) than organic source might be due to higher supply of nutrients than organic source.

The beneficial effect of integrated nutrient management on nutrient availability through enhanced microbial action, conversion from unavailable form to available form and also due to improve physical and biological condition resulted increased yield as reported by Sharma and Dixit (1987). These results are in agreement with Begum (2004) Malghani *et al.*, (2010), Vedpathak and Chavan (2016), Wailare and Kesarwani (2017) and Bonu (2018).

**Table.1** Effect of different sources of nutrient and levels of NPK on plant height, number of tillers plant<sup>-1</sup> and length of spikelet of wheat (Pooled data of 2018-19 and 2019-20)

Levels of NPK (kg ha <sup>-1</sup> )	Plant height (cm)				Number of tillers plant <sup>-1</sup>				Length of spikelet (cm)			
	Sources of nutrient				Sources of nutrient				Sources of nutrient			
	Inorganic	Organic	INM	Mean	Inorganic	Organic	INM	Mean	Inorganic	Organic	INM	Mean
<b>0 NPK</b>	75.64	77.43	74.06	<b>75.71</b>	5.33	6.00	6.17	<b>5.83</b>	3.50	3.42	3.44	<b>3.45</b>
<b>100% NPK (120-60-40)</b>	85.34	84.83	85.45	<b>85.21</b>	9.83	7.33	9.50	<b>8.89</b>	5.75	5.04	5.96	<b>5.58</b>
<b>150% NPK (180-90-60)</b>	87.29	87.31	88.00	<b>87.53</b>	11.33	7.67	11.00	<b>10.00</b>	6.80	6.17	6.33	<b>6.43</b>
<b>200% NPK (240-120-80)</b>	91.63	82.67	89.47	<b>87.92</b>	13.17	8.17	11.83	<b>11.06</b>	6.74	6.56	6.47	<b>6.59</b>
<b>STV based NPK (149-176-33)</b>	88.29	74.25	85.00	<b>82.51</b>	10.83	6.83	9.00	<b>8.89</b>	6.58	3.44	5.58	<b>5.20</b>
<b>Mean</b>	<b>85.64</b>	<b>81.30</b>	<b>84.39</b>	<b>83.78</b>	<b>10.10</b>	<b>7.20</b>	<b>9.50</b>	<b>8.93</b>	<b>5.87</b>	<b>4.92</b>	<b>5.56</b>	<b>5.45</b>
<b>SEm± for comparison of two sources of nutrient</b>	<b>0.689</b>				<b>0.283</b>				<b>0.084</b>			
<b>CD (P=0.05)</b>	<b>4.186</b>				<b>1.719</b>				<b>0.513</b>			
<b>SEm± for comparison of two NPK levels</b>	<b>0.684</b>				<b>0.342</b>				<b>0.111</b>			
<b>CD (P=0.05)</b>	<b>2.227</b>				<b>1.113</b>				<b>0.362</b>			
<b>Interaction (M×S)</b>												
<b>SEm± for comparison of two NPK levels at the same source of nutrients</b>	<b>1.184</b>				<b>0.592</b>				<b>0.193</b>			
<b>CD (P=0.05)</b>	<b>3.366</b>				<b>1.682</b>				<b>0.548</b>			
<b>SEm± for comparison of two sources of nutrient at same or different levels of NPK)</b>	<b>1.737</b>				<b>0.775</b>				<b>0.241</b>			
<b>CD (P=0.05)</b>	<b>4.938</b>				<b>2.202</b>				<b>0.686</b>			

**Table.2** Effect of different sources of nutrient and levels of NPK on number of grain per spike, grain and straw yield of wheat (Pooled data of 2018-19 and 2019-20)

Levels of NPK (kg ha <sup>-1</sup> )	Number of grain per spike				Grain yield (t ha <sup>-1</sup> )				Straw yield (t ha <sup>-1</sup> )			
	Sources of nutrient				Sources of nutrient				Sources of nutrient			
	Inorganic	Organic	INM	Mean	Inorganic	Organic	INM	Mean	Inorganic	Organic	INM	Mean
<b>0 NPK</b>	13.49	12.00	11.92	<b>12.47</b>	1.42	1.36	1.74	<b>1.50</b>	1.98	1.75	2.06	<b>1.93</b>
<b>100% NPK (120-60-40)</b>	28.22	17.50	24.78	<b>23.50</b>	3.47	1.46	2.66	<b>2.53</b>	5.96	2.25	3.99	<b>4.06</b>
<b>150% NPK (180-90-60)</b>	31.89	19.58	27.85	<b>26.44</b>	4.27	1.86	3.51	<b>3.21</b>	7.23	3.12	5.44	<b>5.26</b>
<b>200% NPK (240-120-80)</b>	34.68	21.57	26.62	<b>27.62</b>	4.53	2.08	3.84	<b>3.48</b>	7.72	2.67	6.40	<b>5.60</b>
<b>STV based NPK (149-176-33)</b>	31.03	11.67	23.67	<b>22.12</b>	3.50	1.43	3.13	<b>2.69</b>	7.40	1.93	3.07	<b>4.14</b>
<b>Mean</b>	<b>27.86</b>	<b>16.46</b>	<b>22.97</b>	<b>22.43</b>	<b>3.44</b>	<b>1.64</b>	<b>2.98</b>	<b>2.68</b>	<b>6.06</b>	<b>2.34</b>	<b>4.19</b>	<b>4.20</b>
<b>SEm± for comparison of two sources of nutrient</b>	<b>0.675</b>				<b>0.061</b>				<b>0.129</b>			
<b>CD (P=0.05)</b>	<b>4.102</b>				<b>0.370</b>				<b>0.782</b>			
<b>SEm± for comparison of two NPK levels</b>	<b>0.546</b>				<b>0.102</b>				<b>0.166</b>			
<b>CD (P=0.05)</b>	<b>1.777</b>				<b>0.331</b>				<b>0.539</b>			
<b>Interaction (M×S)</b>												
<b>SEm± for comparison of two NPK levels at the same source of nutrients</b>	<b>0.945</b>				<b>0.176</b>				<b>0.287</b>			
<b>CD (P=0.05)</b>	<b>2.686</b>				<b>0.501</b>				<b>0.815</b>			
<b>SEm± for comparison of two sources of nutrient at same or different levels of NPK)</b>	<b>1.592</b>				<b>0.199</b>				<b>0.363</b>			
<b>CD (P=0.05)</b>	<b>4.526</b>				<b>0.566</b>				<b>1.032</b>			

**Table.3** Correlation between yield and yield attributes of wheat

Characters	Grain yield	Straw yield
Plant height	0.831	0.882*
Number of tillers plant <sup>-1</sup>	0.973**	0.950**
Number of grain spikelet <sup>-1</sup>	0.971**	0.980**
Length of spikelet	0.886**	0.879**

\*\* . Correlation is significant at the 0.01 level

\* . Correlation is significant at the 0.05 level

The application of 100, 150 and 200% NPK and STV based NPK levels significantly increased plant height, number of tiller plant<sup>-1</sup>, length of spikelet, number of grains spikelet<sup>-1</sup>, grain and straw yield of wheat over control. However, the application of 150 and 200% NPK levels were found significantly superior to 100% NPK or STV based NPK level for plant height, number of tillers plant<sup>-1</sup>, length of spikelet, number of grains spikelet<sup>-1</sup>, grain and straw yield of wheat except number of tillers plant<sup>-1</sup> @ 150% NPK but the difference between the two treatment was found nonsignificant. The significantly higher values of growth and yield attributes with increasing levels of NPK over control might be due to increasing availability of NPK with increased level of NPK.

The higher values of growth and yield attributes with 150 and 200% NPK than 100% NPK might be due to higher requirement of NPK of high yielding varieties of wheat which significantly responded to 150 and 200% NPK and 100% NPK level became suboptimal. These results are in collaborated with Malghani *et al.*, (2010).

The interaction between sources of nutrients and levels of nutrients were found significant for all the growth, yield parameters, grain and straw yield of wheat. The application of 200% NPK through inorganic or integrated source of nutrients significantly increased the plant height and number of tillers plant<sup>-1</sup> over 100% NPK or STV based NPK except plant height at STV based NPK level with inorganic.

However, the plant height and tillers plant<sup>-1</sup> @ 200% NPK with inorganic but these were found at par with integrated sources of nutrients. While the plant height @ 150% NPK with organics was found significantly superior to 200% NPK and STV based NPK. The plant height at 200% NPK and STV based NPK level with inorganic or integrated source were found significant over the same level of NPK with organics.

The application of 150, 200% NPK and STV based NPK levels with inorganic significantly increased the length of spikelet, number of grains spikelet<sup>-1</sup>, grain and straw yield of wheat over 100% NPK except grain yield @ STV based NPK. However, the application of 200% NPK with inorganic source also significantly increased the number of grains spikelet<sup>-1</sup> over 150% NPK or STV based NPK.

While the application of 150 and 200% NPK levels with organics were found significant for length of spikelet over 100% NPK or STV based NPK level but the difference two treatments was found non significant. The number of grains spikelet<sup>-1</sup> at the 150% NPK with integrated source was found significantly superior to 100% NPK or STV based NPK but it was found at par with 200% NPK.

The application of 100, 150, 200% NPK and STV based NPK with inorganic and integrated source were found significantly superior to organics at the same level of NPK for number of tillers plant<sup>-1</sup>, number of grains

spikelet<sup>-1</sup>, grain and straw yield except number of tillers plant<sup>-1</sup> @100% NPK with integrated source. However, the application of 200% NPK and STV based NPK level with inorganic were found significantly superior to the same level of NPK with integrated source of nutrients for number of grains spikelet<sup>-1</sup>. While the application of 100% NPK and STV based NPK levels with inorganic and integrated source were found significantly superior to the same level of NPK through organics for length of spikelet.

The STV based NPK level with inorganic was found significantly superior to 100% NPK for straw yield but it was found at par with integrated source. However, the application of 100, 150 and 200% NPK and STV based NPK levels with inorganic were also found significantly superior to the same level of NPK with integrated source of nutrients for grain and straw yield. STV based NPK level with inorganic was also found significantly superior to the same level of NPK through integrated source of nutrient for straw yield.

The significantly higher grain and straw yield of wheat with inorganics and integrated source of nutrient might be due to significantly higher growth and yield parameters of wheat with inorganic and integrated sources of nutrients than organics due to supply of higher available NPK nutrients. The plant height was found positively and significantly correlated with grain (0.831) and straw (0.882) yield. The number of tillers plant<sup>-1</sup> was found positively and significantly correlated with grain (0.973) and straw (0.950) yield.

The length of spikelet was found positively and significantly correlated with grain (0.886) and straw (0.879) yield. The number of grains spikelet<sup>-1</sup> was found positively and significantly correlated with grain (0.971) and straw (0.980) yield. Similar findings were

also reported by Liu *et al.*, (2003), Rajeshwari (2007) Kovacevic *et al.*, (2012), Sree (2014) and Rakshit *et al.*, (2015).

In conclusion the application of inorganics was found significantly superior to organics and integrated sources of nutrients for number of grains per spikelet, grain and straw yield of wheat but it was found at par with integrated sources of nutrients for plant height, number of tillers per plant and length of spikelet.

The application of 150 and 200% NPK were found significantly superior to 100% NPK for plant height, number of tillers per plant, length of spikelet, number of grains per spikelet, grain and straw yield (except number of tillers per plant @ 150% NPK) but the difference between the two treatment was found nonsignificant.

However, the grain and straw yield of wheat with inorganics @ 100, 150 and 200% NPK were found significantly superior to the same level of organics and integrated source of nutrients. While the application of inorganics and integrated sources of nutrients were found significantly superior to organics at the same levels of NPK for number of tillers per plant, number of grains per spikelet, grain and straw yield of wheat.

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