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Effect of Soil Test Crop Response Basis Integrated Nitrogen Management on Growth and Yield of Wheat (*Triticum aestivum* L.)

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A B S T R A C T

A field experiment was conducted during the *rabi* season of 2017 in wheat crop (var. HUW-234) at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Allahabad (U.P.). The experiment was laid out in a Randomized Block Design with 12 treatment combinations, consisting of three nitrogen levels (100,125 and 150 kg N/ha) on soil test basis (STB) compared to farmer practice (FP) and nitrogen management viz. 100% N through urea, 75% N through urea + 25% N through vermicompost with seed inoculation by *Azotobacter*. The experimental result reveals this saving of nitrogen by 16.5 to 31.7 kg/ha without any significant effect on growth and yield of wheat was noticed. The growth parameters viz. plant height, no. of tillers/running row meter, Crop-growth rate (CGR), and Yield attributes viz. No. of effective tillers/m^2, grains/spike and grain yield (4.57 t/ha) were significantly higher with 150 kg N/ha (Farmer Practice) when applied 100 % N through urea, where as plant dry weight, leaf area index (LAI) and straw yield (7.63 t/ha) were significantly higher with 150 kg N/ha (Farmer Practice) when applied 75% N through urea + 25% N through vermicompost + *Azotobacter* (Seed inoculation).

Introduction

Wheat (*Triticum aestivum* L.) is the most important staple food of about 36% of the world population and improvement in its productivity has played a key role in making the country self-sufficient in food grains. Worldwide this crop provides nearly 55% of the carbohydrates and 20% of the food calories. USDA, 2017 report shows that it is grown in all the continents of the world covering an area of 225.07 million hectares with production of 736.98 million tonnes. In India, total area under wheat is 31.72 million hectares with the production and productivity of 96.0 million tonnes and 3.13 tonnes hectares, respectively (Tiwari *et al.,* 2017).

Nitrogen is subjected to different kinds of losses like denitrification, volatilization and leaching which causes environmental threats. Nitrous oxide has contributed 310 times to the global warming potential of carbon dioxide, and its emissions are affected by poor nitrogen management in intensive crop production which is major source for it (Jat *et al.,* 2014). Therefore, the continuous availability of N to wheat during various phases of its growth and development is important factors which influence the grain quality and yield of wheat. The basic concept underlying the principles of integrated nutrient management (INM) is the maintenance and possibly improvement of soil fertility for sustaining crop productivity on long term basis. This may be achieved through combined use of all possible sources of nutrients and their scientific management for optimum growth, yield and quality of different crops and cropping systems (Patel *et al.,* 2017). Nambiar and Abrol (1989) and Gupta *et al.,* (2000) also reported that under continuous and high intensive farming, the nutrient supplying power of most of the soils has been found to be decline particularly when rice based cropping systems are followed. Due to decline in soil fertility, farmers have to use more and more fertilizer year after year to obtain optimum yield (Hobbs *et al.,* 1990). The excessive and imbalance use of inorganic fertilizer was reported to be the major constraint of declining productivity of rice–wheat cropping system (Hobbs, 1994). When these crops are grown under good management conditions, they remove large quantities of nutrients.

However, insufficient N availability to wheat plants results in low yields and significantly reduced profits compared to a properly fertilized crop. Efficient nutrient-management programmes supply plant nutrients in adequate quantities to sustain maximum crop productivity and profitability while minimizing environmental impacts of nutrient use (Jat *et al.,* 2013). Ensuring optimum nutrient availability through effective nutrient-management practices requires knowledge of the interactions between the soil, plant and environment. In this experiment use of some tools for in season nitrogen management like Site-specific nutrient management (SSNM) through soil-test crop response (STCR) in fulfilling the crop nutrient requirement with less environmental footprints (Jat *et al.,* 2014; Kumar *et al.,* 2014) was planned to see the effect of integrated nitrogen management on soil test basis on growth and yield of wheat.

Materials and Methods

A experiment was conducted during the *Rabi* season of 2017 in wheat crop at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Allahabad (U.P.). The experiment consisted of three nitrogen levels, viz. 100, 125 and 150 kg N/ha through nitrogen management by 100% N through urea and 75% N through urea + 25% N through vermicompost with seed inoculation by *Azotobacter*, laid out in a Randomized Block Design with twelve treatment combinations which replicated thrice. The soil of the experimental field was sandy loam in texture with pH 7.6, low in organic carbon 0.42%, available P 13.50 kg/ha and available K 257.04 kg/ha. Wheat 'HUW 234' variety was sown 23rd of November in 2017.

Nitrogen, Phosphorus and Potassium were applied through urea, single super phosphate and muriate of potash, respectively. Half of nitrogen as per treatment and full dose of phosphorus, potassium and remaining nitrogen as per treatment was top dressed after the soil test analysis..The crop received five uniform irrigations. All the growth and yield attributes were recorded using standard procedure and grain yield was calculated at 12% moisture content.

The crop growth rate (CGR) was calculated using the standard procedure and formulae. The leaf-area index (LAI) was calculated by dividing leaf area with ground area available for each plant.

Results and Discussion

Effect on growth attributes and growth rates

Among N-management practices in wheat, application of 150 kg N/ha (Farmer Practice) 100% N through urea produced significantly higher growth attributing characters, i.e. plant height (72.99 cm),No. of tillers/running row meter (82.67) and CGR (2.775 g/m^2/day) at 40-60 DAS. The results of the present investigation are in close conformity with those of Singh *et al.*, (2007) and Singh *et al.*, (2013).

The dry-matter accumulation (23.10 g) and leaf area index (4.18) when found to be significantly higher with 150 kg N/ha (Farmer Practice) 75% N through urea + 25% N through vermicompost + *Azotobacter* (Seed inoculation). It may be attributed to higher availability of nutrients in vermicompost, increased availability of both the native and applied nutrients and better source and sink relationship that contributed to better dry-matter production of crops leading to the production of favourable yield components.

Kumawat *et al.,* (2006) and Khandwel *et al.*, (2006) have also reported better response of integrated nutrient management by crops. Integrated nitrogen management leads to higher leaf-area index (LAI), leading to higher photosynthetic rate and accumulation of more assimilates which in turn increased the sink size. Similar findings were reported to by Verma *et al.,* (2016).

Effect on yields and yield attributes

Effective number of tillers (320.00), number of grains/spike (58.00) significantly higher with 150 kg N/ha (Farmer Practice) 100% N through urea.

The results are in close agreement with the findings of Singh *et al.*, (2011) and Prajapat *et al.*, (2014). The length of spike (11.53 cm) was significantly higher with 125 kg N/ha (Farmer Practice) 100% through urea. Similar findings were also reported by Gupta *et al.*, (2007).

The grain yield (4.57 t/ha) and harvest index (44.31%) was also higher with 150 kg N/ha (Farmer Practice) 100% N through urea that may be due to cumulative effect of growth and yield-attributing characters owing to fertilization. Greater availability of metabolites (photosynthates) and nutrients to developing reproductive structures seems to have resulted in 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), Tripathi *et al.*, (2013) and Pandey *et al.*, (2006).

The straw yield (7.63 t/ha) was higher with 150 kg N/ha (Farmer Practice) 75% N through urea + 25% N through vermicompost + *Azotobacter* (Seed inoculation).The integrated use of organic and inorganic source of nutrients might have supplied readily available nutrients to crop which resulted in greater assimilation, production and partitioning of dry- matter to yield. Similar findings also reported were found by Verma *et al.,* (2016) and Singh *et al.*, (2016).

On the basis of above findings it can be concluded that for obtaining higher grain yield, number of effective tillers/m^2 and other growth and yield attributes were found to be the best treatment 150 kg N/ha (Farmer Practice) when applied 100% N through Urea with wheat variety HUW-234 (Malviya). These findings are based on 1 season; therefore, further trials may be required for considering it for recommendation.

Table.1 Effect of soil test crop response basis integrated nitrogen management on growth attributes in wheat

	Treatments	Growth attributes (80 DAS)				Growth Rate (40-60 DAS)
		Plant height (cm)	No. of tillers (Running row meter)	Plant Dry weight (g)	Leaf area index (LAI)	Crop Growth Rate ($g/m^2/day$)
T_1	[100 kg N/ha (STB)] 100% N through Urea	47.27	65.00	10.92	2.79	1.114
T_2	[100 kg N/ha (STB)] 75% N through Urea + 25% N through VC + *Azotobacter* (SI)	48.09	70.33	17.03	3.37	2.107
T_3	[125 kg N/ha (STB)] 100% N through Urea	49.95	68.00	14.10	3.50	1.483
T_4	[125 kg N/ha (STB)] 75% N through Urea + 25% N through VC + *Azotobacter* (SI)	51.17	72.67	16.83	3.74	1.913
T_5	[150 kg N/ha (STB)] 100% N through Urea	52.24	78.33	21.13	3.98	2.463
T_6	[150 kg N/ha (STB)] 75% N through Urea + 25% N through VC + *Azotobacter* (SI)	52.91	79.00	22.30	4.04	2.653
T_7	[100 kg N/ha (FP)] 100% N through Urea	49.34	67.33	12.88	3.15	1.329
T_8	[100 kg N/ha (FP)] 75% N through Urea + 25% N through VC + *Azotobacter* (SI)	50.07	69.00	12.84	3.27	1.172
T_9	[125 kg N/ha (FP)] 100% N through Urea	50.66	72.33	19.53	3.16	2.046
T_{10}	[125 kg N/ha (FP)] 75% N through Urea + 25% N through VC + *Azotobacter* (SI)	51.33	74.67	17.12	3.34	1.534
T_{11}	[150 kg N/ha (FP)] 100% N through Urea	54.21	82.67	23.10	4.14	2.775
T_{12}	[150 kg N/ha (FP)] 75% N through Urea + 25% N through VC + *Azotobacter* (SI)	53.62	81.67	22.24	4.18	2.535
	SEd (±)	0.72	2.14	2.69	0.37	0.342
	CD (P=0.05)	1.50	4.43	5.58	0.78	0.710

***STB- Soil test basis; FP- Farmer Practice; VC-Vermicompost; SI- Seed inoculation**

Table.2 Effect of soil test crop response basis integrated nitrogen management on yield attributes in wheat

	Treatments	Yield attributes			
		Number of effective tillers/ m^2	Length of spike (cm)	No. of grains/ spike	Test weight (g)
T_1	[100 kg N/ha (STB)] 100% N through Urea	250.67	8.90	46.67	39.61
T_2	[100 kg N/ha (STB)] 75% N through Urea + 25% N through VC + *Azotobacter* (SI)	264.00	10.00	51.33	39.89
T_3	[125 kg N/ha (STB)] 100% N through Urea	265.33	9.73	50.00	39.44
T_4	[125 kg N/ha(STB)] 75% N through Urea + 25% N through VC + *Azotobacter* (SI)	284.00	10.50	50.33	40.46
T_5	[150 kg N/ha(STB)] 100% N through Urea	302.67	10.70	54.67	42.35
T_6	[150 kg N/ha(STB)] 75% N through Urea + 25% N through VC + *Azotobacter* (SI)	306.67	11.23	57.33	41.78
T_7	[100 kg N/ha (FP)] 100% N through Urea	261.33	9.57	50.00	39.47
T_8	[100 kg N/ha (FP)] 75% N through Urea + 25% N through VC + *Azotobacter* (SI)	269.33	9.70	51.33	39.46
T_9	[125 kg N/ha (FP)] 100% N through Urea	280.00	11.53	54.67	40.40
T_{10}	[125 kg N/ha (FP)] 75% N through Urea + 25% N through VC + *Azotobacter* (SI)	285.33	10.33	55.00	40.63
T_{11}	[150 kg N/ha (FP)] 100% N through Urea	320.00	11.50	58.00	41.61
T_{12}	[150 kg N/ha (FP)] 75% N through Urea + 25% N through VC + *Azotobacter* (SI)	318.67	11.43	57.67	42.12
	SEd (±)	6.61	0.53	2.01	0.75
	CD (P=0.05)	13.71	1.10	4.16	1.55

Table.3 Effect of soil test crop response basis integrated nitrogen management on yield and harvest index in wheat

	Treatments	Yield and Harvest Index		
		Grain yield (t/ha)	**Straw yield (t/ha)**	**Harvest Index (%)**
T_1	[100 kg N/ha (STB)] 100% N through Urea	2.70	5.03	35.16
T_2	[100 kg N/ha (STB)] 75% N through Urea + 25% N through VC + *Azotobacter* (SI)	3.18	5.77	35.58
T_3	[125 kg N/ha (STB)] 100% N through Urea	2.97	6.15	32.53
T_4	[125 kg N/ha(STB)] 75% N through Urea + 25% N through VC + *Azotobacter* (SI)	3.97	7.02	36.11
T_5	[150 kg N/ha(STB)] 100% N through Urea	4.23	7.55	35.98
T_6	[150 kg N/ha(STB)] 75% N through Urea + 25% N through VC + *Azotobacter* (SI)	4.27	7.57	36.08
T_7	[100 kg N/ha (FP)] 100% N through Urea	3.43	5.10	40.21
T_8	[100 kg N/ha (FP)] 75% N through Urea + 25% N through VC + *Azotobacter* (SI)	4.20	5.73	42.61
T_9	[125 kg N/ha (FP)] 100% N through Urea	3.82	6.55	36.93
T_{10}	[125 kg N/ha (FP)] 75% N through Urea + 25% N through VC + *Azotobacter* (SI)	4.27	6.50	39.62
T_{11}	[150 kg N/ha (FP)] 100% N through Urea	4.57	5.75	44.31
T_{12}	[150 kg N/ha (FP)] 75% N through Urea + 25% N through VC + *Azotobacter* (SI)	4.50	7.63	37.03
	SEd (±)	0.30	0.62	1.99
	CD (P=0.05)	0.62	1.28	4.12

*STB- Soil test basis; FP- Farmer Practice; VC- Vermicompost; SI- Seed inoculation

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