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

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Abstract
A field experiment was conducted during *rabi* season of 2013-14 at N. D. University of Agriculture & Technology, Kumarganj, Faizabad to study the effect of integrated nutrient management on the performance of Wheat (*Triticum aestivum* L.) variety HUW-234 which maturity period was 120-125 days. Treatments consist of 12 levels of fertility were evaluated in a randomized block design. Under the investigation, significantly highest number of tiller m^{-2}, leaf area index, length of spike (cm), grain $spike^{-1}$, grain yield and straw yield (kg ha^{-1})were found under incorporation of 125% recommended dose of fertilizer + 25% N through vermicompost (T_{12}), however, highest harvest index (%) was recorded under application of 100% RDF + 25% through FYM (T_7), while highest net return (Rs.ha^{-1})and benefit: cost ratio was observed under 100% RDF + 25% through vermicompost (T_9).

Keywords: INM, FYM, bio-compost, vermi-compost, growth, yield

Introduction

Wheat (*Triticum aestivum* L.) is an important staple food crop, which grown ancient time in the world and known as 'king of cereal' belongs to the family 'Poaceae'. Wheat is cultivated globally on an area of 222 million hectares adding 717 million tonnes of grains annually to the world food basket, with an average productivity of 3229 kg ha^{-1} (FAO, 2015-16). It is the most important *Rabi* cereal crop of India, cultivated on an area of 29.25 million hectares and 88.89 million tonnes of total production with an average 3039 kg ka^{-1}. In Uttar Pradesh, wheat is the cultivated in an area of 9.63 million hectare with an annual production of 30.16 million tones with average productivity of 3113 kg ha^{-1} (Anonymous, 2016) [1].

In an intensively crop growing area of India, a high annual productivity of crops result in removal of nutrients in substantial amounts that after exceed replenishment through chemical fertilizer and manures ultimately leading to poor soil health. Yields decline and increasing production factors have been reported. Growers have started to use of higher doses of fertilizers, to maintain productivity. Such emerging trends of indiscriminate use of fertilizer without use of organic sources of nutrients are also responsible to deterioration of soil health. Imbalance fertilizer use has resulted in multinutrient deficiencyin soils. Therefore, soils encounter a diversity of constraints because of soil quality and ultimately end up with poor functional capacity (Singh and Jat, 2016) [7]. The low recovery of applied plant nutrient by crop raises the question of the fate of the applied fertilizer i.e. not use by crop. This plant nutrient may be lost from the soil-plant system through run-off, fixation, leaching, denitrification and volatilization. Hence the use efficiency of fertilizer needs to be enhanced to maintain the productivity of crops. It can be achieved only if application rates consistently exceed decomposition rates. Apart from this, theconstraints in the fertilizer production, there escalating costs, and low fertilizer use efficiency also call for more attention to the integrated nutrient management system (Singh *et al.*, 2004 and Sharma *et al.*, 2004) [5, 4].

Nutrient schedule along with balanced fertilization using organic manures as considered as promising agro-technique to maintain yield, increase fertilizer use efficiency and to restore soil fertility. The strength of the combined use system also lies in its ability to meet the short-term as well as long-term nutrient requirements of crops through the fast releasing fertilizer nutrient pool and the slow releasing organic nutrient pool respectively. The integrated nutrient supply including the use of chemical fertilizers, organic manures like FYM along with bio-fertilizers helps not only in bridging the existing gap between the nutrient removal and addition but also in ensuring balanced nutrient proportion as well as boost the productivity of wheat. Organic matter is the substrate for a large number of soil living beneficial organisms which are essential to keep the plant healthy (Kumar *et al.*, 2015) [3]. Keeping these aspects in mind, the present study was conducted to evaluate the effect of integrated use of inorganic and organic sources of nutrient on productivity and economics of wheat.

Materials and Methods

The field experiment was carried out during the winter season of 2013-14 at N. D. University of Agriculture & Technology, Kumarganj, Faizabad. Geographically experimental site is situated at 26^0 47' N latitude and 82^0 12 'E longitude at an elevation of about 113 meters above mean sea level in Indo-gangetic regions of eastern Uttar Pradesh. The experimental site was fairly uniform in topography and well drained. It has sub-tropical type of climate with hot summer and cold winter. The total rainfall in the study area during the crop growing season (5th November to 1st April) was recorded 155.4 mm. besides the crop was irrigated four times, coinciding with the critical stages of the plant growth. The average weekly maximum and minimum temperatures during the crop growing period ranged from 35.8 ^{0}C to 15.5 ^{0}C and 15.7^{0}C to 5.9^{0}C respectively. The relative humidity ranged between 49.8% to 87.9%, wind speed between 1.7 to 4.4 km hr^{-1} average evaporation was 1.2 to 6.4 mm day^{-1} and bright sunshine between 0.4 to 8.1 hr day^{-1}. The soil was silt loam in texture with 7.9 pH and available nitrogen (180.4 kg ha^{-1}), phosphorus (18.4 kg ha^{-1}) and potassium (290.0 kg ha^{-1}). The experiment consisted of 12 treatments viz. T_1 (75% RDF), T_2 (100% RDF), T_3 (125% RDF), T_4 (75% RDF + 25% through FYM), T_5 (75% RDF + 25% through bio-compost), T_6 (75% RDF+25% through vermicompost), T_7 (100% RDF+ 25% through FYM),T_8 (100%+ 25% through bio-compost), T_9 (100% RDF+25% through vermicompost), T_{10} (125% RDF+25% through FYM), T_{11} (125% RDF+ 25% through bio-compost) and T_{12} (125% RDF+25% through vermicompost). The recommended dose of nitrogen, phosphorus and potassium @ 150 kg, 60 kg and 40 kg ha^{-1}, respectively. Neem coated urea (46 %), DAP (18 % N, 46 % P_2O_5), MOP (60 % K_2O), FYM (0.5 % N, 0.25 % P_2O_5, 0.5 K_2O), Vermicompost (3.0 % N, 1.0 % P_2O_5, 1.5 % K_2O) and Bio-compost (1.8 % N, 1.5 % P_2O_5, 2.0 % K_2O) were used as the source of nitrogen, phosphorus and potassium. The organic manures singly and in combinations were applied uniformly as per treatment and incorporated into the soil three week before sowing. Full dose of phosphorus and potassium and half dose of nitrogen were given just before sowing and remaining half dose as top dress at 30 days after sowing through urea full dose in the treatment having RDF. The irrigation was given at 21 days interval. All other operations were performed as per recommendation for the crop. There was row to row spacing 20cm. and plant to plant spacing 5cm. The data on various growth stages, seed yield and quality attributes were recorded indifferent treatments.

Result and Discussion

Growth attributes: Number of tillers and leaf area index under different treatments have been presented in Table 1. The number of tillers and leaf area index at all growth stages was significantly influenced by different treatments except at 30 DAS. Application of 125% RDF+25% through vermicompost (T_{12}) produced highest number of tillers and leaf area index and it were at par with to application of 100% RDF(T_2), 125% RDF (T_3), 100% RDF+25% through FYM (T_7), 100%+25% through bio-compost (T_8), 100% RDF+25% through vermicompost (T_9), 125% RDF+25% through FYM (T_{10}) and125% RDF+ 25% through bio-compost (T_{11}). The greater availability of nutrients in soil due to increasing application might have enhanced multiplication and elongation of cells leading to increased number of tillers and leaf area index. 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 Sharma and Jain, 2014 under wheat-based cropping system and Bhagwati *et al.*, 1992 [2] also reported to responses of nitrogen on wheat.

Yield attributes and yield: The yield contributing characters *viz.* length of spike, number of grain $spike^{-1}$ were associated highly with 125% RDF+25% through vermicompost (T_{12}) and it were at par with the all other treatments except 75% RDF (T_1) and 75% RDF + 25% through FYM (T_4). 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 [6] in wheat genotypes. Table 2. This showed the sink capacity of a plant depend mainly on vegetative growth that is affected positively by application of nitrogen fertilizers and supply of photosynthesis for the formation of yield components. These finding are in closely conformity with (Zahoor, 2014) [8].

Application of 125% RDF+25% through vermicompost (T_{12}) was recorded significantly highest grain and straw yield and it were at par with the 100% RDF+25% through FYM (T_7), 100%+25% through bio-compost (T_8), 100% RDF+25% through vermicompost (T_9), 125% RDF+25% through FYM (T_{10}) and 125% RDF+ 25% through bio-compost (T_{11}). The harvest index was slightly improving with increasing the rate of RDF but not reached to level of at par, it were recorded highest under application of100%RDF+25% through FYM (T_7)followed by 125% RDF+25% through FYM (T_{10}).

Nitrogen uptake by the crop at harvest (kg ha^{-1})

nitrogen uptake various treatments have been presented in Table 3 The significantly higher nitrogen uptake by grain at harvest was recorded with T_9 (100% RDF + 25% Vermicompost) which was at par with T8 (100% RDF +25% Biocompost), T_{10} (125% RDF + 25% FYM), T_{11}(125% RDF + 25% Biocompost), T_{12} (125% RDF + 25% Vermicompost) and significantly superior over all other treatments, while in case of nitrogen uptake by straw, recorded highest with T_{12} (125% RDF + 25% Vermicompost) which was at par with T_8 (100% RDF +25% Biocompost), T_9 (100% RDF+25% Vermicompost), T_{10} (125% RDF + 25% FYM), T_{11}(125% RDF + 25% Biocompost) and significantly superior over rest of the treatments.

Table 1: Growth attribute of wheat influenced by integrated nutrient management

Treatments	Tiller m^{-2}				Leaf area index		
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS
T_1- 75%RDF	77.94	344.25	408.00	378.25	1.28	3.78	3.87
T_2- 100%RDF	90.89	409.05	484.80	449.45	1.30	4.49	4.60

T_3- 125%RDF	95.31	425.25	504.00	467.25	1.33	4.67	4.78
T_4- 75%RDF+25%FYM	83.55	364.50	432.00	400.50	1.35	4.01	4.10
T_5- 75%RDF+25%Bio-compost	85.76	372.60	441.60	409.40	1.36	4.09	4.19
T_6- 75%RDF+25%Vermicompost	86.95	376.65	446.40	413.85	1.41	4.14	4.23
T_7- 100%RDF+25%FYM	96.64	417.15	494.40	458.35	1.33	4.58	4.69
T_8- 100%RDF+25%Bio-compost	97.83	421.20	499.20	462.80	1.43	4.63	4.73
T_9- 100%RDF+25%Vermicompost	98.37	425.25	504.00	467.25	1.41	4.67	4.78
T_{10}- 125%RDF+25%FYM	105.06	429.30	508.80	471.70	1.46	4.72	4.82
T_{11}- 125%RDF+25%Bio-compost	110.72	433.35	513.60	476.15	1.42	4.76	4.87
T_{12}- 125%RDF+25%Vermicompost	112.67	441.45	523.20	485.05	1.48	4.85	4.96
SEm±	1.42	19.18	23.43	21.20	0.065	0.20	0.19
C.D.at 5%	NS	56.25	68.71	62.16	NS	0.59	0.56

Table 2: Yield attributes, yield and economics of wheat influenced by integrated nutrient management

Treatments	Yield attribute		Yield q ha^{-1}		H I (%)	Economics			
	Length of spike (cm)	Grain per spike	Grain yield	Straw yield		Cost of cultivation ($Rs.ha^{-1}$)	Gross return ($Rs.ha^{-1}$)	Net return ($Rs.ha^{-1}$)	B:C ratio
T_1- 75%RDF	8.60	42.70	24.10	36.85	39.54	28390	55212	26822	0.94
T_2- 100%RDF	9.80	48.50	27.55	43.95	38.53	29938	64120	34182	1.14
T_3- 125%RDF	9.90	50.40	29.20	45.55	39.06	31495	67339	35897	1.13
T_4- 75%RDF+25%FYM	8.90	43.20	25.75	38.95	39.80	38140	58760	20620	0.54
T_5- 75%RDF+25%Bio-compost	9.10	44.20	26.40	39.80	39.88	37765	60170	22405	0.59
T_6- 75%RDF+25%Vermicompost	9.20	44.60	26.75	40.15	39.99	35890	60870	24980	0.69
T_7- 100%RDF+25%FYM	10.00	49.20	34.45	47.65	47.70	39688	76160	36472	0.92
T_8- 100%RDF+25%Bio-compost	10.10	49.70	35.85	48.01	42.75	39313	78388	39075	0.99
T_9- 100%RDF+25%Vermicompost	10.15	49.90	36.45	49.99	42.17	37438	80347	42909	1.16
T_{10}- 125%RDF+25%FYM	10.20	50.90	34.80	48.23	42.91	41245	76986	35742	0.87
T_{11}- 125%RDF+25%Bio-compost	10.25	51.10	36.10	48.45	42.70	40870	78992	38122	0.93
T_{12}- 125%RDF+25%Vermicompost	10.30	51.60	36.80	50.38	42.21	38995	81069	42074	1.08
SEm±	0.44	2.29	0.82	0.97	1.25	-	-	-	-
C.D.at 5%	1.28	6.70	2.39	2.83	NS	-	-	-	-

Note: Recommended dose of N:P:K- 150:60:40 kg ha^{-1} respectively

Table 3: Effect of different treatments on nitrogen uptake at harvest by the wheat crop

S. No.	Treatment	Nitrogen uptake (Kg ha^{-1})	
		Grain	Straw
T_1	75%RDF	39.77	15.85
T_2	100%RDF	49.59	20.66
T_3	125%RDF	54.02	22.32
T_4	75%RDF+25%FYM	45.06	17.92
T_5	75%RDF+25%Bio-compost	46.46	18.31
T_6	75%RDF+25%Vermicompost	47.35	18.87
T_7	100%RDF+25%FYM	61.68	22.87
T_8	100%RDF+25%Bio-compost	65.24	23.04
T_9	100%RDF+25%Vermicompost	66.33	23.99
T_{10}	125%RDF+25%FYM	65.08	23.63
T_{11}	125%RDF+25%Bio-compost	65.08	23.74
T_{12}	125%RDF+25%Vermicompost	65.10	25.19
SEm±		1.43	1.09
C.D.at 5%		4.19	3.19

Economics

Economics of various treatments have been presented in Table 2. Application of 125% RDF+25% through vermicompost (T_{12}) gave highest gross return followed by 100% RDF+25% through vermicompost (T_9), while highest net return and benefit: cost ratio was realized in application of 100% RDF+25% through vermicompost (T_9) followed by 125% RDF+25% through vermicompost (T_{12}) and 100%RDF (T_2) respectively, but the differences could not turn significant.

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