Tamim Fazily *et al*, International Journal of Advances in Agricultural Science and Technology,
Vol.8 Issue.1, January-2021, pg. 106-118

ISSN: 2348-1358
Impact Factor: 6.057
NAAS Rating: 3.77

Effect of Integrated Nutrient Management on Growth, Yield Attributes and Yield of Wheat

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DOI: 10.47856/ijaast.2021.v08i1.014

Abstract

A field experiment was conducted during 2017-18 and 2018-19 at Agronomy Research Area, CCS HAU Hisar to study the effect of integrated nutrient management on growth, yield attributes and yields of wheat. The experiment was laid out in randomized block design with three replication and ten treatments *viz.* T_1.Control, T_2.100% RDN (recommended dose of nitrogen)+25% N through FYM, T_3.100% RDN+25% N through vermicompost, T_4.75% RDN+25% N through FYM, T_5.75% RDN+ 25% N through vermicompost, T_6.50% RDN+50% N through FYM, T_7. 50% RDN+50% N through vermicompost, T_8.25% RDN+75% N through FYM T_9.25% RDN+75% N through vermicompost and T_{10}. 100% RDN. The highest yield attributes and yield of wheat was produced with application of 100 percent recommended dose of nitrogen (RDN)+25 percent nitrogen through vermicompost during both the consecutive years, but it did not differ significantly with application of 100 percent recommended dose of nitrogen (RDN)+25 percent nitrogen through FYM and the treatment where 100 percent of recommended dose of nitrogen was applied. On the basis of two years pooled data, T_3 produced 94.96 percent higher number effective tillers, 34.14 percent taller spike length, 25.47 percent more test weight, 165.21 percent higher grain yield and 157.13 percent higher straw yield of wheat over control.

***Keywords*:** INM, yield attributes, yield, wheat

INTRODUCTION

Wheat (*Triticum aestivum* L.) one of the most important cereal crops of the world, which globally stand in second position both in terms of area and production next to rice. It is cultivated over an area of 222.2 million hectares with annul production of 737 million tons and average productivity of 3.32 tons ha^1 (Anonymous, 2017). Balanced use of nitrogen is a key point for higher land profitability and healthy environment. Nitrogen is one of the major essential nutrients applied to the crop for higher vegetative growth, productivity and quality (Iqbal *et al*., 2012). Nitrogen fertilizer is a major nutrient required for canopy growth of crops which this canopy photosynthesis ultimately decides the final yield of the crop. Due to extensive agriculture the Indian soils are deficient in

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ISSN: 2348-1358
Impact Factor: 6.057
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nutrients particularly in nitrogen and the, soil is degrading day by day with respect to soil fertility and productivity. This may be attributed to the minimum and extra removal of nutrient resources from the soil strata than they are replenished, so soil is becoming deficient in available nutrients. Since, agriculture becomes more intensive and chemical dependent, therefore soil toxicities and nutrient imbalance threaten sustainable production. So, we have to think about the cheap and easily available alternate source of nutrients, which not only supply the nutrients to the soil but also improve the physico-chemical properties of the soil. Thus, demand for fertilizers can be lowered by supplementing the nutrients through organic manures. In recent years due to unsuitable effect of chemical fertilizers on the soil, using of organic materials serves as a good and suitable source to supply soil food elements. In addition to supply nutrients, organic manures may improve the soil health, physico-chemical properties and biological conditions of the soil. Application of organic manures may improve availability of native nutrients in soil as well as the efficiency of applied fertilizers (Sawrup, 2010). Judicious use of FYM with chemical fertilizers improves soil physical, chemical and biological properties and improves the crop productivity (Sharma *et al*. 2007). To build ecologically sound and economically viable farming systems integrated nutrient management (INM) is a viable option for wheat production as it utilizes available organic and inorganic nutrients. Keeping this in view of above facts, an attempt was made to study the effect of integrated nutrient management on growth, yield attributes and yield of wheat.

MATERIALS AND METHODS

A field experiment was conducted at Agronomy Research Farm of CCS Haryana Agricultural University, Hisar ; Hisar located in Indo-Gangetic Plains of North-West India with latitude of $29^0$10' North and longitude of $75^0$46' East at 215.2 meters above mean sea level during *Rabi* seasons of 2017-18 and 2018-19 to study the effect of integrated nutrient management on yield attributes and yield of wheat. The experiment was laid out in randomized block design with three replications consisting of ten treatments combinations i.e. T_1- Control; T_2- 100% recommended dose of nitrogen (RDN) + 25% N through FYM; T_3- 100% RDN + 25% N through vermicompost; T_4- 75% RDN + 25% N through FYM; T_5- 75% RDN + 25% N through vermicompost; T_6- 50% RDN + 50% N through FYM, T_7- 50% RDN + 50% N through vermicompost; T_8- 25% RDN + 75% N through FYM; T_9- 25% RDN + 75% N through vermicompost and T_{10}-100% RDN through chemical fertilizer. The fertilizers were used as recommended package of practice in all treatments except control and an additional 25 percent N through FYM and vermicompost were used in T_2 and T_3 respectively. The vermicompost and FYM were applied two weeks before sowing as per treatments. The initial status of soil fertility

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ISSN: 2348-1358
Impact Factor: 6.057
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was 172:17:270 kg NPK ha^{-1} with 0.44 percent organic carbon. Full dose of phosphorus and half of nitrogen, as per treatments, were applied at the time of sowing and remaining half of the nitrogen was top-dressed. Data on plant height, dry matter accumulation and leaf area index were recorded, number of effective tillers, spike length, number of grains/spike, 1000 grain weight, grain yield and straw yield were recorded by using standard procedure for wheat crop.

RESULTS AND DISCUSSION

1. Growth parameters

1.1 Plant height

The significantly taller plant height of wheat was measured with application of 100% RDN+25% N through vermicompost (T_3) being at par with application of 100% RDN+25% N through FYM (T_2) and application of 100% RDN (T_{10}) at all taken observation stages of the crop and at harvest during both the growing seasons. On the basis of two years pooled data T_3 produced 89.37 percent taller plant height of wheat over control at harvest of wheat. The significantly higher plant height of wheat in T_3 might be due to rapid mineralization of chemical fertilizer which might have supplied the nitrogen in early stages of the crop and presence of relatively readily available nutrient, growth promoting substances and other beneficial micro-organisms in vermicompost, which are involved in nitrogen fixation, glucose decomposition and other beneficial activities for nutrient availability in later stages of the wheat crop. These findings are in line with Hadis *et al.* (2018) and Kumar *et al.* (2017) who concluded that, vermicompost is the source of different essential plant nutrients and hormones with low amount, and its application with inorganic fertilizer increases the growth attributes and yield of wheat.

1.2 Dry matter accumulation

During both the years, the significantly higher dry matter (g/ meter row length) at harvest of wheat was produced with T_3, being at par with T_2 and T_{10} at all the observations taken during growth stages of the crop and at harvest. It was observed that application of 100% RDN+25% N through vermicompost produced 354 percent and 341.24 percent higher dry matter at harvest of wheat over control treatment during both the consecutive years. This increase in dry matter of wheat is attributed due to higher plant and leaf area index which were produced due sufficient and adequate supply of nutrient and further these increased growth characters contributed to higher dry matter production. Such types of results have been reported by Patel *et al.* (2018), Mohan *et al.* (2018), and Singh *et al.* (2017), who stated that, better availability of nutrient particularly nitrogen to wheat crop translocates

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maximum photosynthesis from source to sink which accumulates to individual plant parts and results to higher dry matter production of wheat crop.

The control treatment accumulated minimum dry weight at harvest of wheat during both the growing seasons. These findings are in close confirmation with Patel *et al.* (2018), Mohan *et al.* (2018), and Singh *et al*. (2017), stated that, adequate amount of nutrient supply especially nitrogen translocates more photosynthesis from source to sink and increase the dry matter accumulation of wheat crop.

1.3 Leaf area index

Among all the treatments, application of 100% RDN+25% N through vermicompost/FYM produced the significantly higher LAI at crop anthesis, being at statistically at par with application of 100% RDN during both the years of the experimentations. It was found that the leaf area index of wheat was 62.91 percent and 53.93 percent higher with application of 100% RDN+25% N through vermicompost over control treatment during both the consecutive years, respectively. This increase might be attributed due to better integration of chemical fertilizer which organic manures, which may have supplied the nutrient at active growth stages of the crop through both the sources and resulted to higher LAI. These results are in conformity with Patel *et al.* (2018), who stated that, supply of adequate amount of nutrient particularly nitrogen at active growth stages of the crop leads to leaf area development and increases LAI.

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Table 1: Plant height (cm) of wheat as influenced by integrated nutrient management

Treatments	2017-18					2018-19				
	Days after sowing					Days after sowing				
	30	60	90	120	at harvest	30	60	90	120	at harvest
T_1. Control	13.36	20.74	41.89	49.57	52.93	12.93	21.19	42.07	49.68	53.52
T_2. 100% RDN+ 25% N through FYM	22.30	45.59	81.25	91.35	98.17	24.03	46.38	82.79	92.38	101.18
T_3.100%RDN+ 25% N through vermicompost	22.52	46.07	82.50	92.21	99.33	24.37	47.14	84.12	93.55	102.27
T_4. 75% RDN+ 25% N through FYM	20.32	42.57	76.37	85.79	93.03	21.68	43.28	77.69	86.85	94.72
T_5. 75% RDN+ 25% N through vermicompost	20.65	43.25	77.07	87.13	93.88	21.85	43.58	78.65	88.24	95.68
T_6. 50% RDN+ 50% N through FYM	19.65	39.75	72.13	82.65	89.46	20.75	40.19	73.29	83.76	90.12
T_7. 50% RDN+ 50% N through vermicompost	19.88	40.85	74.18	83.61	90.64	21.28	41.16	75.64	85.07	93.22
T_8. 25% RDN+ 75% N through FYM	18.09	37.21	69.49	78.54	84.23	18.67	37.64	70.45	79.36	85.85
T_9. 25% RDN+ 75% N through vermicompost	18.25	38.52	71.35	80.99	86.75	19.17	38.95	72.47	81.92	89.41
T_{10}. 100% RDN	22.26	45.48	80.54	90.43	97.39	23.88	46.06	81.57	91.44	100.33
SEm±	**0.44**	**0.72**	**0.80**	**0.96**	**1.04**	**0.64**	**0.76**	**0.93**	**0.98**	**1.12**
CD at 5%	**1.30**	**2.15**	**2.41**	**2.89**	**3.12**	**1.91**	**2.28**	**2.79**	**2.95**	**3.36**

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Table 2: Effect of integrated nutrient management on dry matter accumulation (g m^{-1}) row length of wheat

Treatments	2017-18					2018-19				
	Days after sowing					Days after sowing				
	30	60	90	120	at harvest	30	60	90	120	at harvest
T_1. Control	5.41	17.45	35.64	46.61	51.93	5.82	19.21	38.47	50.03	55.21
T_2. 100% RDN+ 25% N through FYM	10.58	63.21	167.78	217.58	232.55	11.22	66.78	174.96	223.41	238.17
T_3.100%RDN+ 25% N through vermicompost	10.98	64.06	170.44	219.25	235.77	11.46	68.22	178.32	227.78	243.61
T_4. 75% RDN+ 25% N through FYM	9.28	54.13	157.17	202.25	215.07	10.03	59.19	160.77	207.56	218.17
T_5. 75% RDN+ 25% N through vermicompost	9.49	55.72	159.48	205.34	219.22	10.27	61.08	163.95	210.43	223.25
T_6. 50% RDN+ 50% N through FYM	8.51	48.07	150.78	192.51	203.70	9.02	53.18	151.39	195.32	206.02
T_7. 50% RDN+ 50% N through vermicompost	8.66	50.55	152.16	196.01	207.73	9.21	55.35	155.05	200.11	211.89
T_8. 25% RDN+ 75% N through FYM	7.50	41.85	141.84	182.39	192.04	8.08	46.31	143.29	185.14	192.15
T_9. 25% RDN+ 75% N through vermicompost	7.78	44.54	144.18	185.12	196.20	8.24	49.42	146.83	189.07	197.11
T_{10}. 100% RDN	10.44	62.01	165.78	214.86	229.70	11.09	65.73	171.77	220.14	235.12
SEm±	**0.20**	**1.07**	**1.99**	**2.80**	**3.31**	**0.24**	**1.13**	**2.39**	**3.02**	**3.36**
CD at 5%	**0.59**	**3.19**	**5.96**	**8.39**	**9.91**	**0.73**	**3.39**	**7.16**	**9.05**	**10.07**

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Table 3: Leaf area of wheat as affected by integrated nutrient management

Treatments	LAI at anthesis	
	2017-18	2018-19
T_1. Control	3.02	3.05
T_2. 100% RDN+ 25% N through FYM	4.81	4.89
T_3.100%RDN+ 25% N through vermicompost	4.92	5.02
T_4. 75% RDN+ 25% N through FYM	4.46	4.53
T_5. 75% RDN+ 25% N through vermicompost	4.52	4.61
T_6. 50% RDN+ 50% N through FYM	4.16	4.22
T_7. 50% RDN+ 50% N through vermicompost	4.24	4.33
T_8. 25% RDN+ 75% N through FYM	3.95	4.01
T_9. 25% RDN+ 75% N through vermicompost	4.02	4.07
T_{10}. 100% RDN	4.78	4.83
SEm±	**0.06**	**0.08**
CD at 5%	**0.18**	**0.23**

2. Yield parameters

2.1 Number of effective tillers, spike length, number of grain per spike and test weight

The significantly highest number of effective tillers per meter row length and test weight of wheat was recorded with T_3 being statistically at par with T_2 and T_{10} during both the consecutive years. However the spike length and number of grain per spike was more with T_3 but it was statistically at par with T_2, T_4, T_5, T_6, T_7 and T_{10}. On the basis of two years pooled data, application of 100% RDN+25 N through vermicompost produced 94.96 percent higher number effective tillers, 34.14 percent taller spike length and 25.47 percent more test weight over control. The significantly higher yield attribute of wheat with T_3 is due to adequate quantities and balanced proportions of plant nutrients throughout the growth stages of the crop, which further increased the yield attributing characters and yield of wheat. These results are in conformity with Patel *et al.* (2018), who concluded that, sufficient availability of nitrogen has stimulatory

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ISSN: 2348-1358
Impact Factor: 6.057
NAAS Rating: 3.77

impact on tillering of wheat through synthesis of cytokines and rapid conversion of synthesized carbohydrates, which results to rapid multiplication and increase the size and number of growing cell thus results more number of effective tillers. Devi *et al.* (2011) during both the years of their experiment found that application of 100% RDF+1 t vermicompost ha^{-1} produced significantly higher but at par numbers of effective tillers with application of 100% RDF. Hadis *et al.* (2018), stated that, vermicompost contains essential plant nutrient with low mount of hormones and its integration with chemical fertilizers increase the growth and yield characters of wheat crop. Patel *et al.* (2018), concluded that, the increase in test weigh of wheat with RDF was the consequence of adequate amount of nutrient supply which increased the photosynthetic activities and translocated more photosnthates in reproductive stages of the crop, thereby promoted growth and increased the test weight of wheat. Singh *et al.* (2016) stated that application of nitrogen at latter stages of plant growth is necessary for the development of grain. The non-availability of nitrogen at this stage reflects a decrease in grain weight.

2.2 Grain, straw yield

The grain yield of wheat significantly increased with application of 100% RDN+25% N through vermicompost/FYM, being at par with application of 100% RDN during both the years. Application of 100% RDN+25% N through vermicompost produced 164.82 percent and 165.60 percent higher grain and 157.08 percent and 157.18 percent straw yield of wheat over control treatment during both the consecutive years of the experimentations, respectively. The increase in grain and straw yield of yield of wheat with application of 100% RDN+25% N through vermicompost was due to significantly higher plant height, dry matter accumulation, leaf area index, number of effective tillers, test weight etc. which all these growth and yield attributing characters contributed to final yield of the wheat crop. These findings are in line with Mohan *et al.* (2018) who concluded that, the significantly higher and grain and straw yield of wheat by application of 100% RDF+25% N through vermicompost/FYM followed by application of 100% RDF were due to due adequate quantities and balanced proportions of plant nutrients throughout the growth stages of the crop, which further increased the yield attributing characters and yield of wheat. Maurya *et al.* (2019) recorded the significantly recorded higher grain and straw yield of wheat with application of 125% RDF+25% N

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ISSN: 2348-1358
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NAAS Rating: 3.77

through vermicompost/ FYM followed by application of 100% RDF+25% through vermicompost/FYM and application of 100% RDF. They concluded that, greater availability photosynthates and nutrients to developing reproductive structures of the crop increased all the yield attributing characters, which ultimately improved the final yield of wheat. It also indicated that the sink capacity of a plant depends mainly on vegetative growth that is positively affected by application of nitrogen fertilizers and supply of photosynthesis for the formation of yield components. The grain and straw yield of wheat significantly decreased with replacement of each 25% RDN through chemical fertilizer with 25% N through organic manures, this might be due to direct and rapid supply nutrients through chemical fertilizer for crop growth and slow mineralization and release of nutrients through organic manures throughout growing period of the crop, that would have increased the availability of nutrients in soil in later stage and brought improvement to soil properties.

3. Harvest index

The harvest index of wheat was not influenced significantly by any treatment during both years of the experimentations.

Table 4: Yield attributes of wheat as influenced by various integrated nutrient management

Treatments	No. of Effective tillers/ meter row length		Spike length (cm)		Number of grains per spike		Test weight (g)	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
T_1. Control	52.67	53.33	8.41	8.49	34.66	36.19	34.39	34.47
T_2. 100% RDN+ 25% N through FYM	99.67	101.67	11.12	11.38	42.73	45.43	39.38	39.84
T_3.100%RDN+ 25% N through vermicompost	101.33	104.33	11.18	11.49	43.06	45.86	39.66	40.11
T_4. 75% RDN+ 25% N through FYM	92.67	94.00	10.98	11.21	41.89	44.53	38.07	38.33
T_5. 75% RDN+ 25% N through vermicompost	94.33	95.67	11.05	11.27	42.26	44.66	38.20	38.53
T_6. 50% RDN+ 50% N through FYM	86.67	88.00	10.84	11.12	40.76	43.46	36.68	36.85
T_7. 50% RDN+ 50% N through vermicompost	88.33	90.00	10.88	11.16	40.59	43.83	37.15	37.33

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T_8. 25% RDN+ 75% N through FYM	78.33	79.33	10.66	10.97	40.23	42.73	35.40	35.68
T_9. 25% RDN+ 75% N through vermicompost	81.67	83.00	10.72	11.02	40.09	42.96	35.71	35.92
T_{10}. 100% RDN	99.00	100.67	11.07	11.31	42.63	45.13	39.33	39.65
SEm±	**1.44**	**1.25**	**0.13**	**0.14**	**0.85**	**0.83**	**0.23**	**0.29**
CD at 5%	**4.33**	**3.74**	**0.39**	**0.41**	**2.56**	**2.50**	**0.68**	**0.88**

Table 5: Grain and straw yield of wheat as affected by various integrated nutrient management

Treatments	Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})		Biological yield (kg ha^{-1})		Harvest index (%)	
	2017-18	**2018-19**	**2017-18**	**2018-19**	**2017-18**	**2018-19**	**2017-18**	**2018-19**
T_1. Control	2135	2183	2896	2931	5031	5114	42.50	42.74
T_2. 100% RDN+ 25% N through FYM	5548	5676	7327	7415	12875	13091	43.14	43.35
T_3.100%RDN+ 25% N through vermicompost	5654	5798	7445	7538	13099	13336	43.17	43.44
T_4. 75% RDN+ 25% N through FYM	5102	5200	6808	6841	11910	12041	42.86	43.18
T_5. 75% RDN+ 25% N through vermicompost	5232	5345	6922	6974	12154	12319	43.08	43.37
T_6. 50% RDN+ 50% N through FYM	4690	4799	6320	6357	11010	11156	42.64	43.01
T_7. 50% RDN+ 50% N through vermicompost	4850	4968	6510	6535	11360	11503	42.73	43.27
T_8. 25% RDN+ 75% N through FYM	4275	4371	5803	5829	10078	10200	42.43	42.87
T_9. 25% RDN+ 75% N through vermicompost	4419	4518	6030	6053	10449	10571	42.38	42.78
T_{10}. 100% RDN	5485	5587	7203	7288	12688	12875	43.24	43.41
SEm±	**72**	**73**	**84**	**93**	**141**	**145**	**0.34**	**0.38**
CD at 5%	**216**	**220**	**251**	**279**	**424**	**435**	**NS**	**NS**

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ISSN: 2348-1358
Impact Factor: 6.057
NAAS Rating: 3.77

CONCLUSION

To sustain the soil health and to obtain significantly higher wheat yield over control, application of 100 percent recommended dose of nitrogen+25 percent addition of nitrogen through vermicompost/FYM may be recommended to wheat growers.

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ISSN: 2348-1358
Impact Factor: 6.057
NAAS Rating: 3.77

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List of Publications

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ISSN: 2348-1358
Impact Factor: 6.057
NAAS Rating: 3.77

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