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Integrated Nitrogen Management through Different Sources on Growth and Yield of Wheat (*Triticum aestivum* L.)

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A field experiment on study of nitrogen management through different sources on growth and yield of wheat *(Triticum aestivum* L.) was conducted during *rabi* season of 2016-17 at Agronomy Farm, B. A. College of agriculture, Anand Agricultural University, Anand on loamy sand soil. Nitrogen management on wheat var. GW 496 with ten treatments comprising of 100 % RDN, 75 % RDN along with 25 % N through FYM or vermicompost or 2% urea sprays at 30 and/or 40 and/or 50 DAS and 50 % RDN along with 50 % N through FYM or vermicompost or 2% urea sprays at 30 and/or 40 and/or 50 DAS into randomized block Design with four replications. Application of 75 % RDN + 2 % urea spray at 30, 40 and 50 DAS was found superior for growth and yield attributes *viz*; plant height at 60 DAS, number of spikelet spike^{-1}, length of spike, number of grains spike^{-1}, dry matter accumulation, test weight (48.78 g) and grain yield (6662 kg ha^{-1}). However, treatment with 75% RDN + 25% N through VC recorded significantly higher plant height at harvest, number of total tillers, effective tillers and straw yield of wheat The highest net realization (Rs. 84643 ha^{-1}) and BCR (3.95) were secured under treatment 75% RDN + 2% Urea spray at 30, 40 and 50 DAS.

Keywords: RDN (Recommended dose of nitrogen), Foliar spray, Farm Yard Manure (FYM), Vermicompost (VC), Wheat.

Wheat (*Triticum aestivum* L.) is the most strategic cereal crop in the world as well as in India and it is estimated that more than 35 per cent of the world population depends on wheat. Wheat is the second important staple food crop in India after rice. India, being the 2nd largest producer of wheat all over the world, next to china, produced around 12 per cent of world wheat production, covering an area of 29.04 million hectares with total production of 87.39 million tonnes with productivity of 3009 kg ha^{-1}. While, in Gujarat it is grown over an area of 1.35 million hectares with an annual production of 3.65 million tonnes with the productivity of 2730 kg ha^{-1} (Anon., 2015), which is lower compared to national productivity. The existing low yield level suggests the scope and need for increasing the productivity of wheat.

Fertilizer has been and will continue to be the key input for achieving the estimated food grain production goals of the country. The importance of nitrogen and phosphorus application to wheat crop has been recognized since long and is the backbone of any fertilizer management programme. Adequate nitrogen fertilization is a prerequisite to produce high yields of wheat and to improve the grain quality. Wheat is sensitive to nitrogen deficiency and very responsive to nitrogen fertilization. Adequate supply of nitrogen improves the yield

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components and ultimately increases the grain yield. However, the prolonged and injudicious use of fertilizers leads to human and soil health hazard along with environment pollution. In such situation organic sources of nitrogen improve the availability of mineral nutrients in the soil for plants (Ghafoor et al., 2015). For sustainable and high productivity of crops over prolong period, maintenance of soil organic matter at a satisfactory level is necessary. The FYM and vermicompost are the sources of primary, secondary and micro nutrients for plant and are constant sources of energy for hetrotrophic micro-organisms, which helps in increasing the availability of nutrients, quality and quantity of the crop produce.

Traditionally, nitrogen is applied through urea in the soil, which becomes inadequate for the farmer at sowing time. In such situation the foliar application of plant nutrient is effective and economical. Furthermore it has been observed that fertilizer efficiency particularly urea application through soil is not as effective as if it is applied to plants through foliage along with soil application, because only 20 to 50% of the soil applied nitrogen is recovered by annual crops. Even several researchers have shown that foliar nitrogen application has higher recovery rather than soil application (Bajwa, 1992). Khan et al., (2009) also reported that nitrogen is also taken up directly through wheat leaves when applied as a solution. Recently foliar fertilization is widely used practice to correct nutritional deficiencies in plants and has potential advantages over soil application and it may increase the efficacy of fertilizer use. Similarly, in terms of yield it is more efficient than soil fertilization for both macro and micronutrients in different soil types. (Ali et al., 2008, Alam et al., 2010).

MATERIALS AND METHODS

A field experiment was conducted during *rabi* season of 2016-17 at Agronomy Farm, B. A. College of agriculture, Anand Agricultural University, Anand to sstudy nitrogen management through different sources on growth and yield of wheat *(Triticum aestivum* L.) on loamy sand soil, having 0.38 % Organic Carbon by Walkley and Black method (Jackson, 1973), 231.50 kg ha^{-1} available N by Alkaline KMnO4 method (Subbiah and Asija, 1956) , 39.56 kg ha^{-1} available P_2O_5 by Spectrophotometric method (Olsen *et al*., 1954) and 310.40 kg ha^{-1} available K_20 by Flame Photometric method (Jackson, 1973) with 8.02 pH by Potentiometric method (Jackson, 1973).

Ten treatments comprising of 100 % RDN (T_1), 75 % RDN + 25 % N through FYM (T_2), 75 % RDN + 25 % N through VC (T_3), 50 % RDN + 50 % N through FYM (T_4), 50 % RDN + 50 % N through VC (T_5), 50 % RDN + 25 % N through FYM + 25 % N through VC (T_6), 75 % RDN + 2 % urea spray at 30 DAS (T_7), 75 % RDN + 2 % urea spray at 30 and 40 DAS (T_8), 75 % RDN + 2 % urea spray at 30, 40 and 50 DAS (T_9), 50 % RDN + 2 % urea spray at 30, 40 and 50 DAS (T_{10}) were taken on wheat variety "GW 496" into randomized block Design with four replications. Nitrogen was applied through Urea with FYM and Vermicompost as per treatments. P_2O_5 and K_2O each @ 60 kg ha^{-1} were applied as basal dose. 50 % N ha^{-1} was applied as basal and remaining 50 % N ha^{-1} was applied at 30 DAS as per treatment.. Nitrogen was added on equivalent basis of N content in FYM and vermicompost added in different plots; which were 0.5 % and 1.5 %, respectively.

The harvest index for each treatment was worked out by using the following formula given by Donald and Hamblin (1976):

$$\text{Harvest index (\%)} = \frac{\text{Economic yield (kg ha-1)}}{\text{Biological yield (kg ha-1)}} \times 100$$

The Benefit: Cost ratio (BCR) for each treatment as well as for treatment combinations was also calculated on the basis of formula given below:

$$\text{B.C.R} = \frac{\text{Total realization (Rs. ha}^{-1}\text{)}}{\text{Total cost of cultivation (Rs. ha-1)}}$$

RESULTS AND DISCUSSION

Effect on growth parameters

A close proximity to the growth data furnished in table-1 revealed that initially at 30 DAS, plant height remained unaffected due to different treatments, but at later growth stages, treatment T_9 (75% RDN + 2% Urea spray at 30, 40 and 50 DAS), being at par with T_1, T_3, T_2, T_4 and T_5 had significantly higher plant height (78.33 cm) at 60 DAS. However, at harvest, treatment T_3 (75% RDN + 25% N through VC) recorded significantly

Table 1. Growth parameters as influenced by nitrogen management practices through different sources in wheat

	Treatment	Plant Height (cm)			Total tillers (per meter row length)	Effective tillers (per meter row length)
		30 DAS	60 DAS	At harvest		
T_1	100 % RDN (RDN : 120 kg N ha^{-1})	39.35	75.75	100.65	145.16	138.41
T_2	75% RDN + 25% N through FYM	39.20	74.55	102.50	144.30	141.20
T_3	75% RDN + 25% N through VC	42.70	75.65	109.50	157.35	151.53
T_4	50% RDN + 50% N through FYM	38.45	73.15	103.00	140.88	133.78
T_5	50% RDN + 50% N through VC	36.35	72.50	91.55	126.98	120.43
T_6	50% RDN + 25% N through FYM + 25% N through VC	36.50	67.53	94.00	118.20	108.33
T_7	75% RDN + 2% Urea spray at 30 DAS	36.75	65.90	96.20	127.70	117.38
T_8	75% RDN + 2% Urea spray at 30 and 40 DAS	37.15	69.60	100.00	133.60	127.25
T_9	75% RDN + 2% Urea spray at 30, 40 and 50 DAS	40.95	78.33	105.05	152.91	146.75
T_{10}	50% RDN + 2% Urea spray at 30, 40 and 50 DAS	36.85	72.45	95.35	135.60	129.13
	S.Em ±	1.72	2.27	3.68	6.91	6.09
	C. D. at 5%	NS	6.60	10.68	20.05	17.67
	C. V. %	8.93	6.27	7.38	9.13	9.27

Table 2. Yield attributes as influenced by nitrogen management practices through different sources in wheat

	Treatment	Number of Spikelet spike^{-1}	Spike Length (cm)	Number of grains Spike^{-1}	Dry matter accumulation (g plant^{-1}) at 45 DAS	Dry matter accumulation (g plant^{-1}) at 45 DAS	Test weight (g)	Harvest index (%)
T_1	100 % RDN (RDN : 120 kg N ha^{-1})	52.65	9.95	51.23	10.03	10.03	44.88	40.75
T_2	75% RDN + 25% N through FYM	49.70	9.80	48.55	9.10	9.10	44.07	43.25
T_3	75% RDN + 25% N through VC	54.13	9.93	52.28	10.43	10.43	46.32	41.50
T_4	50% RDN + 50% N through FYM	51.25	10.00	46.20	9.48	9.48	39.73	38.75
T_5	50% RDN + 50% N through VC	49.10	8.48	43.15	7.78	7.78	42.18	43.25
T_6	50% RDN + 25% N through FYM + 25% N through VC	43.60	9.63	46.85	8.93	8.93	36.75	41.25
T_7	75% RDN + 2% Urea spray at 30 DAS	41.25	8.88	46.70	8.18	8.18	38.41	41.00
T_8	75% RDN + 2% Urea spray at 30 and 40 DAS	46.93	9.90	46.75	9.20	9.20	42.22	44.25
T_9	75% RDN + 2% Urea spray at 30, 40 and 50 DAS	55.70	10.53	53.48	10.58	10.58	48.78	42.75
T_{10}	50% RDN + 2% Urea spray at 30, 40 and 50 DAS	50.80	9.05	46.05	8.35	8.35	43.18	43.75
	S.Em ±	1.73	0.41	1.74	0.37	0.37	1.91	1.77
	C. D. at 5%	5.03	1.19	5.04	1.07	1.07	5.54	NS
	C. V. %	7.00	8.53	7.22	8.0	8.0	8.95	8.42

Table 3. Yield and economics as influenced by nitrogen management practices through different sources in wheat

Treatment	Yield (kg ha^{-1})		Income (Rs. ha^{-1})			Cost incurred (Rs. ha^{-1})				
	Grain	Straw	Grain	Straw	Total	Common cost	Treatment cost	Total Cost of cultivation	Net realization (Rs. ha^{-1})	BCR
T1	6056	8819	90840	13229	104069	26318	1539	27857	76212	3.74
T2	6088	8032	91320	12048	103368	26318	7332	33650	69718	3.07
T3	6381	8971	95715	13457	109172	26318	13332	39650	69522	2.75
T4	5528	8796	82920	13194	96114	26318	13126	39444	56670	2.44
T5	5844	7944	87660	11916	99576	26318	25126	51444	48132	1.94
T6	5142	7458	77130	11187	88317	26318	19126	45444	42873	1.94
T7	5358	7731	80370	11597	91967	26318	1569	27887	64080	3.30
T8	5856	7380	87840	11070	98910	26318	1984	28302	70608	3.49
T9	6662	8953	99930	13430	113360	26318	2399	28717	84643	3.95
T10	5972	7759	89580	11639	101219	26318	2015	28333	72886	3.57

Selling Price of wheat : Grain : Rs. 15 kg^{-1}; Straw : Rs. 1.50 kg^{-1}

higher plant height (109.50 cm), though it was found at par with T_9, T_4, T_2 and T_1.

An improvement in plant height could be attributed to the fact that nitrogen being an integral part of chlorophyll, a primary absorber of light energy needed for photosynthesis, is directly absorbed through stomata of plant leaves owing to foliar sprays with urea from time to time, which might be responsible for increase in stem length at boot stage due to increase cell division and multiplication. The favourable effect of organic sources viz; FYM or vermicompost on growth might be attributed to presence of relatively readily available plant nutrients, growth enhancing substances and number of beneficial organisms like nitrogen fixing, cellulose decomposing and other beneficial microbes as well as antibiotics, vitamins and hormones etc. Similar trend was observed by Dhillon et al., (1987), Patel et al., (1991) and Kumar et al., (2015).

Effect on yield and yield attributes

The data pertaining to yield attributes viz; are furnished in table-2. It was explicit from the results that treatment T_3 (75% RDN + 25% N through VC) recorded significantly higher number of total tillers (157.35) and effective tillers (151.53), however, treatments T_9, T_1, T_2 and T_4 and T_9, T_2 and T_1 remained at par with T_3 for total and effective tillers, respectively.

Treatment T_9 (75% RDN + 2% Urea spray at 30, 40 and 50 DAS) had significantly higher number of spikelet spike^{-1} (55.70), which was statistically at par with T_3, T_1 T_4 and T_{10}. Length of spike was also significantly influenced by the same treatment (T_9) having higher length of spike (10.53 cm) which was found identical with treatments T_4, T_1 , T_3 , T_8, T_2 and T_6 .Similarly, treatment T_9 (75% RDN + 2% Urea spray at 30, 40 and 50 DAS), being at par with treatment T_3, T_1 and T_2, recorded significantly higher number of grains spike^{-1} (53.48). Dry matter accumulation (g plant-^{1}) at 45 DAS, was significantly influenced by different treatment. Treatment T_9 (75% RDN + 2% Urea spray at 30, 40 and 50 DAS) produced significantly higher dry matter accumulation per plant (10.58 g) , which was found identical with treatments T_3 and T_1. In case of test weight (g) again treatment T_9 (75% RDN + 2% Urea spray at 30, 40 and 50 DAS) recorded significantly higher test weight (48.78 g), which was found statistically at par with treatments T_3, T_1 and T_2 (44.07 g).

Grain yield (kg ha^{-1}) was significantly influenced by different treatments. Treatment T_9 (75% RDN + 2% Urea spray at 30, 40 and 50 DAS) produced significantly higher grain yield (6662 kg ha^{-1}) which was found statistically at par with treatments T_3, T_2 , T_1, T_5, T_{10} and T_8. The minimum grain yield (5142 kg ha^{-1}) was recorded

under T_6 (50% RDN + 25% N through FYM + 25% N through VC). An increase in wheat grain yield under the treatment T_9 was 10.60 and 23.56% higher to T_1 (100% RDN) and the lowest producing treatment T_6 (Table-3).

However, for straw yield of wheat (Table-3), treatment T_3 (75% RDN + 25% N through VC), being at par with treatments, T_9, T_4 , T_1 and T_2 yielded significantly higher straw yield (8971 kg ha-1). Nitrogen management did not show significant influence on harvest index.

Since, yield of the crop is a function of several yield components, which are dependent on complementary interaction between vegetative and reproductive growth of the crop. It was noticed that a magnitude of variation in the grain yield was proportional to the variation in the yield attributing parameters like number of effective tillers, number of spike plant^{-1}, number of spikelet spike^{-1}, spike length, dry matter accumulation and test weight. Further, an increase in the grain yield with vermicompost or FYM application along with 75 % RDN might be due to the fact that added vermicompost or FYM served as store house of several macro and micro-nutrients which are released during the process of mineralization. This might be due to the fact that urea is mineralized within 7-8 days of application (Islam and Parsons, 1978), whereas vermicompost and FYM initiated their mineralization from 15 days of their application and lasted up to 30 days (Joy and Kamath, 2017).

Among the treatments, conjunctive use of soil application along with foliar spray of 2% urea at 30, 40 and 50 DAS recorded higher grain yield probably because of optimum supply of nutrients at right time of crop requirement and wheat responds well to fertilizer application as a result of its well-developed root system, crop absorbed required nutrients from soil for effective dry matter production and translocation of photosynthates from leaves to the sink for better development of grains. (Alston et *al*,1979).

The other difference in grain yield due to nitrogen levels was related to the difference in size of photosynthetic surface and to the relative efficiency of total sink activity, which in turn influenced the direction of movement of substrates. Parvez *et al*., (2009) advocated that, urea foliar spray has advantage to increase wheat grain yield over 25 per cent in soil moisture deficient areas. Similarly, foliar application of urea to wheat at tillering increased grain yield and grain protein content under soil moisture limiting conditions in the marginal area.

Economics

Economics of wheat as influenced by different nitrogen management treatments (Table-2) revealed that the highest net realization (Rs. 84643 ha^{-1}) and BCR (3.95) were secured under treatment T_9 (75% RDN + 2% Urea spray at 30, 40 and 50 DAS), however, it was followed by T_1 (100% RDN) Rs. 76212 ha^{-1} with net realization and 3.74 BCR, Treatments T_{10} (50% RDN + 2% Urea spray at 30, 40 and 50 DAS) , T_8 (75% RDN + 2% Urea spray at 30 and 40 DAS), T_2 (75% RDN + 25 % N through FYM) and T_3 (75% RDN + 25 % N through VC) remained the next lower with net realization of Rs. 72886 ha^{-1}, Rs. 70643 ha^{-1}, Rs. 69718 ha^{-1} and Rs. 69522 ha^{-1}, respectively. The corresponding BCR were 3.57, 3.49, 3.07 and 2.75, respectively.

CONCLUSION

It could be concluded from the present investigation that higher grain yield, net realization and benefit cost ratio (BCR) of wheat could be achieved with 75% RDN (90 kg N ha^{-1} + 2% Urea spray at 30, 40 and 50 DAS) to curtail 16.2 kg N ha^{-1}. It is comparable with 75% RDN (90 kg N ha^{-1}) + 25 % N (30 kg N ha^{-1}) through vermicompost / FYM to curtail 25 % chemical load.

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