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Impact of Organic and Inorganic Sources of Nitrogen on Growth Phenology, Yield and Quality of Wheat (*Triticum aestivum* L.)

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Abstract

A field experiment was conducted at Agronomy Research Farm of CCS Haryana Agricultural University, Hisar during *Rabi* season of 2017-18 and 2018-19 to study the impact of integrated nutrient management on growth phenology, yield and quality 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 . Treatment T_3 (100% RDN + 25% N through vermicompost) has taken significantly higher number of days to 50% heading (94.67 and 96.33), 50% anthesis (102.33 and 104.33) and to maturity (150.00 and 150.33) during both the consecutive years, respectively. Similarly T3 had significantly higher grain yield (5654 and 5798 kg/ha), hectoliter weight (82.50 and 83.35 kg/hl), grain appearance score (7.81 and 7.93 scale/10) and protein content (11.94 and 12.31%) of wheat during both the consecutive years, respectively.

Keywords: "Nutrient sources, growth phenoly, yield, quality, wheat".

1. Introduction

Wheat (*Triticum aestivum* L.) is one of the main and second most important food crops of the world in terms of area, production and nutrition. Wheat contributes 20 per cent of the total food, 19 per cent of calories and 20 per cent of protein requirements of the global population. Besides being a major source of dietary fibre in human nutrition since decades. India is the second largest producer of wheat next to china, which produces about 99.7 million tons of wheat from an area of 29.6 million hectare with an average productivity of 3371 kg ha^{-1} (Anonymous, 2018). The states which produce considerable amount of wheat are Haryana, Uttar Pradesh, Punjab, Rajasthan, Gujarat, Madhya Pradesh, Bihar and Maharashtra. Haryana, produces 11.31 million tons of wheat from 2.57 million hectares area with an average productivity of 4410 kg ha^{-1} (AICRP on Wheat and Barley, Director's Report 2017-18). The green revolution has increased the crops yield to a great extent due to the use of chemical fertilizers but the continuous use of synthetic fertilizer and chemicals led to soil erosion, ecological hazards and depletion of water table and other sources of energy (Bisen *et al.* 2011). Due to continuous use of synthetic fertilizer the soil productivity has gone down, and now time has come to

supplement these chemical fertilizers with organics to sustain the fertility and productivity of the soils Behera *et al*. (2007). Besides of environmental degradation by chemical fertilizers, the smaller farmers cannot tolerate to pay the higher cost of chemical fertilizer due their lower purchasing power. Therefore under these situations the integrated nutrient management is the best option to ensure the grain security, and maintain the soil fertility and wheat productivity. Singh *et al.* (2018) observed that treatments received 50% RDF + 50% N as FYM ha^{-1} has taken maximum number of days (98.7 days) to 50% anthesis and maturity (136.5 days) in rice, which was at par with 100% RDF and all other plots. The control plots have taken minimum number of days to 50% anthesis (90.8 days) and maturity (126.2 days). Khan *et al*. (2016) observed the longest duration (116 days) to spike initiation of wheat with integrated application of organic and inorganic fertilizers as compared to application of organic or inorganic and inorganic fertilizer alone. Mondal *et al.* (2015) observed that application of 100% RDF + 25% RDN organic manure has taken more number of days flowering and maturity of rice. Kakraliya *et al*. (2017) reported that application of FYM, VC and Azotobacter with NPK fertilizer in different combination produced significantly higher grain protein as compared to control. Rahman *et al.* (2011) observed, higher grain protein in wheat increased with increasing rate of nitrogen fertilizer. Similar results were achieved through several studies in wheat (Halverson *et al.*, 2004; Subedi *et al.*, 2007 and Garrido-Lestache *et al*., 2004). Whereas the recommended dose of nitrogen through organic sources alone significantly produced lowest grain protein over rest of the treatments. However the source of fertilizer had no significant effect on hectoliter weight and grain score of wheat. Rathwa *et al.* (2018) revealed that maximum grain and straw yield of wheat was obtained with application of 75% RDN + 25% N through vermicompost ha^{-1}. Yadav *et al.* (2018) found that application of 125% RDF produced higher but at par spike length, number of grain per spike, test weight and grain yield with 100% RDF during both the experimental years. Singh *et al*. (2017) found that higher grain and straw yield of wheat were obtained with application of 75% RDN + 25% N through vermicompost ha^{-1}. Similar observation was recorded by Jan and Noor (2007) and Reza *et al.* (2015) in wheat and by Nanjappa *et al*. (2001) in maize. Patel *et al.* (2017) obtained higher grain and straw yield of wheat with application of 75% RDF + 10 t FYM ha^{-1} as compared to combination of lower rate of inorganic fertilizers with higher doses of organic manures. Thus integration of organic and inorganic sources of nutrient enhances the growth phenology and quality of wheat as well as improves the soil fertility.

2. Material and Methods

A field experiment was conducted at Agronomy Research Farm of CCS Haryana Agricultural University, Hisar during *Rabi* season of 2017-18 and 2018-19 to study the impact of organic and inorganic sources of nitrogen on growth phenology, yield and quality of wheat (*Triticum aestivum* L.). 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 (RDN). The initial status of soil fertility was 172:17:270 kg NPK ha^{-1} with 0.44 percent organic carbon. The variety Wh1105 used for sowing at rate of 120 kg/ha. Both the organic manures were analyzed for available nitrogen and were calculated on the basis of RDN (150 kg/ha) and applied as percent RDN two weeks prior sowing. The nitrogen through chemical fertilizer was used half as basal after sowing and remaining half as top dressed after first irrigation. The phenological days were counted from days of sowing and the protein content of wheat was calculated by multiplying the nutrient content of wheat by 6.25.

3. Results and Discussion

3.1. Growth phenology

Growth phenology of a crop is the study of periodic plant life cycle, which shows the length of survival of a crop in an environment. It is important because the time of phonological events can affect the crop growth and final yield. Application of 100% RDN + 25% N through vermicompost has taken significantly more number of days to 50% heading (94.67 and 96.33) and 50% anthesis (102.33 and 104.33) of wheat being at par with application of 100% RDN + 25% N through FYM and application of 100% RDN. Similarly application of 100% RDN + 25% N through vermicompost had taken 24.29 percent and 25.70 more number of days to 50% heading and 24.29 percent and 25.70 more number of days to 50% anthesis over control treatment during both the consecutive years, respectively. The longer number of days taken to 50% heading and anthesis of wheat is associated might be due to continuous supply of nitrogen throughout the crop growth period. This result is in line with the findings of Kumar *et al.* (2012) who reported that, sufficient availability of nutrient particularly nitrogen, prolonged the days to heading and flowering of wheat and induced the crop to complete its full life cycle, explore its full yield potential and produce higher yield. Singh *et al.* (2018) stated that, integrated application of higher doses of nitrogen through chemical fertilizer over increase in nitrogen doses through organic sources increased the number of days taken to 50% anthesis in rice. They concluded that better availability of nutrients in balanced proportion through integrated nutrient management, increased the length of vegetative phase of the rice crop and delayed flowering as compared to sub-optimal supply of nutrient to crop. Redda and Abay (2015) also reported similar result in wheat. Similarly the number of days taken to maturity of wheat was significantly delayed by integrated application of 100% RDN + 25% N through vermicompost/FYM followed by application 100% RDN during both the years. It was observed that, treatments received 100% RDN + 25% N through vermicompost increased days to maturity of wheat of by 13.35 percent and 15.00 percent over control treatment during both the consecutive years respectively. This increase might be due higher availability of nitrogen in adequate proportion which delayed the senescence of leaves and succulence of plants and made the plant to stay green. This result is confirmation with findings of Shrestha (2007) in maize. Mondal *et al.* (2015) observed that application of 100% RDF + 25% RDN through organic manure has taken more number of days flowering and maturity of rice. Kumar *et al.* (2018) recorded maximum number of days taken to maturity of maize under application of 100% RDF + 25 t FYM ha^{-1}, whereas the lower days to maturity was observed by application of 50% RDF + 15 tons FYM ha^{-1}. The number of days taken to maturity of wheat was significantly delayed with replacement of each 25% RDN through organic manures with RDN through chemical fertilizer. This might be due to slower decomposition and release of nitrogen through organic sources of the nutrient as compared to chemical fertilizers which hydrolysis quickly and is readily available to crop. These findings are in the close with conformity of Redda and Abay (2015) who justified that, higher and instantly supply of nitrogenous fertilizers increases the number of days to maturity of wheat through keeping the greenery of the crop by interception of more solar radiation. The significantly minimum number of days taken to maturity of wheat during both the years of experiment was observed control treatment.

Table 8: Phenological characters of wheat as affected by integrated nutrient management

Treatments	Days take to 50 % heading		Days taken to 50 % anthesis		Days taken to maturity	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
T_1. Control	78.33	79.67	82.33	83.00	132.33	133.33
T_2. 100% RDN + 25% N through FYM	94.33	95.67	101.67	103.67	149.33	152.67
T_3.100%RDN + 25% N through vermicompost	94.67	96.33	102.33	104.33	150.00	153.33

T_4. 75% RDN + 25% N through FYM	92.33	93.33	98.67	100.00	144.67	147.67
T_5. 75% RDN + 25% N through vermicompost	92.67	94.00	99.33	101.00	145.33	148.33
T_6. 50% RDN + 50% N through FYM	90.00	91.00	95.33	96.67	142.33	144.33
T_7. 50% RDN + 50% N through vermicompost	90.67	91.67	95.67	97.33	143.33	145.33
T_8. 25% RDN + 75% N through FYM	87.67	89.00	92.33	94.00	140.33	141.67
T_9. 25% RDN + 75% N through vermicompost	88.33	89.67	93.33	95.00	141.00	142.33
T_{10}. 100% RDN	94.00	95.33	101.33	103.33	149.00	152.33
SEm ±	**0.35**	**0.38**	**0.37**	**0.40**	**0.38**	**0.44**
CD at 5%	**1.04**	**1.15**	**1.12**	**1.19**	**1.14**	**1.32**

3.2. Yield studies

Application of 100% RDN + 25% N through vermicompost produced 5656 and 5798 kg/ha grain yield of wheat which were 164.82 percent and 165.60 percent higher grain wheat over control treatment during both the consecutive years. 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 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 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 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. Yadav *et al.* (2018) stated that the significantly higher grain yield of wheat with application of 125 % RDF and application of 100 % RDF over rest of integrated nutrient management treatments were due to direct and quick supply of plant nutrients to crop. Tulsa and Mir (2006) also concluded that the higher grain and straw yield of wheat with 120 kg N + FYM 10 t ha^{-1} over 100 kg N + FYM 10 t ha^{-1} was due to adequate supply of nutrients particularly nitrogen, which increased the photosynthetic activities of wheat crop and increased the growth characters and grain yield of wheat.

Table 2: Effect of integrated nutrient management on yield and quality of wheat

Treatments	Grain yield (kg ha^{-1})		Hectoliter weight (kg/hl)		Grain appearance score (10 scale)		Protein content (%)	
	2017-18	**2018-19**	**2017-18**	**2018-19**	**2017-18**	**2018-19**	**2017-18**	**2018-19**
T_1. Control	2135	2183	77.13	77.22	6.53	6.55	10.31	10.37
T_2. 100% RDN + 25% N through FYM	5548	5676	82.33	82.95	7.76	7.86	11.81	12.12
T_3.100%RDN + 25% N through vermicompost	5654	5798	82.50	83.35	7.81	7.93	11.94	12.31
T_4. 75% RDN + 25% N through FYM	5102	5200	81.02	81.37	7.22	7.35	11.31	11.56
T_5. 75% RDN + 25% N through vermicompost	5232	5345	81.13	81.78	7.34	7.43	11.38	11.69
T_6. 50% RDN + 50% N through FYM	4690	4799	80.06	80.52	7.02	7.05	11.19	11.44

T_7. 50% RDN + 50% N through vermicompost	4850	4968	80.15	80.71	7.07	7.12	11.25	11.50
T_8. 25% RDN + 75% N through FYM	4275	4371	79.05	79.48	6.85	6.90	10.88	10.97
T_9. 25% RDN + 75% N through vermicompost	4419	4518	79.22	79.61	6.95	7.00	10.94	11.13
T_{10}. 100% RDN	5485	5587	82.12	82.69	7.75	7.81	11.69	11.94
SEm ±	**72**	**73**	**0.27**	**0.29**	**0.079**	**0.091**	**0.15**	**0.17**
CD at 5%	**216**	**220**	**0.82**	**0.87**	**0.24**	**0.27**	**0.46**	**0.52**

3.3. Quality characters

Among all the treatment, the significantly higher hectoliter weight of wheat (82.50 and 83.35 kg/hl), grain appearance score (7.81 and 7.93 scale/10) and protein content of wheat (11.94 and 12.31%) was recorded with application of 100% RDN + 25% N through vermicompost being at par with application of 100% RDN + 25% N through FYM and application of 100% RDN during both the years. Similarly application of 100% RDN + 25% N through vermicompost indicated 6.96 percent and 7.94 percent higher hectoliter weight of wheat over control treatment. The increase in hectoliter weight of wheat is associated with higher test weight of wheat which indicates the grain-soundness. These results are in the close with the conformity of Babli *et al.* (2017) in pearlmillet and wheat cropping systems. The higher grain appearance score was attributed due to better size, shape, color and luster of the grain. The increase in grain protein content might be due to better availability of nitrogen, which increased the nitrogen content in grain and enhanced the grain protein content of wheat. These results corroborate the findings of Kakraliya *et al.* (2017) and Hlisnikovsky and Kunzova (2014), who concluded that, the higher grain protein content in wheat with RDF + vermicompost or FYM was associated with good ability of organic manures, which provided adequate amount of nutrients particularly nitrogen throughout the crop growing period.

4. Conclusion

Application of 100% RDN + 25% N through vermicompost/FYM prolonged phenological growth, yield and grain protein content of wheat during both the consecutive years.

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List of Publications

1. Fazily Tamim, Thakral S.K and Dhaka A.K. Effects of integrated nutrient management on yield attributes and yield of wheat (*Triticum aestivum* L.) under irrigated condition" published in Golden Jubilee International Conference. Organized by Directorate of Research CCS Haryana Agricultural University on Nov-6-2019.
2. Fazily Tamim, Hunshal C.S., Chimmad V.P, Hebbar Manjunath and Potdar M.P. Response of late sown wheat (*Triticum aestivum* L.) to organics" published in International Symposium: A need for sustainable Agriculture. Organized by Directorate of Research CCS Haryana Agricultural University on Feb-2-2019.
3. Fazily Tamim,. Thakral S.K., Dhaka A.K and Sharma M.K. (2020). Evaluation of yield and economics of wheat under integrated nutrient management. *International Journal of Research and Development in Technology*. 13(1): 49-53.
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6. Fazily Tamim (2020). Impact of integrated nutrient management on wheat productivity and sustainable soil fertility: A review. *EPRA International Journal of Multidisciplinary Research*. *6* (1): 236-241.
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