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Yield, economics and quality improvement of wheat (*Triticum aestivum* L.) as affected by integrated nutrient management under late sown condition

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Abstract
A field experiments were conducted during *Rabi* season 2013-14 and 2014-15 at Students' Instructional Farm, C.S. Azad University of Agriculture & Technology, Kanpur (UP) with a view to find out the effect of vermicompost and FYM with chemical fertilizers on production, productivity and quality improvement of late sown wheat. The soil of experimental field was sandy loam in texture having organic carbon (0.34%), available nitrogen (170 kg/ha), P_2O_5 (12.6 kg/ha) and K_2O (155 kg/ha) with soil pH (7.7). Nine treatments were tested in Randomized Block Design with three replications. On the basis of experimental results it was found that highest grain yield (43.20 and 38.88 q/ha) was received in RDF + Vermicompost @ 5.0 t/ha followed by (41.90 and 37.71q/ha) in RDF + FYM @ 5.0 t/ha + Vermicompost @ 1.25 t/ha while highest net profit (Rs. 25044 and 18594/ha) and B:C ratio (1.47 and 1.33) was received in RDF + FYM @ 5.0 t/ha + vermicompost @ 1.25 t/ha in first and second year, respectively. The minimum grain yield (33.70 and 32.13 q/ha) was received in RDF 100% while minimum net profit (Rs. 14540 and 13353/ha) was recorded in RDF + FYM @ 5 t/ha during both the years, respectively. The minimum B:C ratio (1.27 and 1.19) was recorded in RDF + FYM 15 q/ha in first and second year of experimentation. Improvement the minimum protein content (10.97 and 11.03%) recorded under RDF (100%) doses treatment followed by RDF 125% (11.04 and 11.03%) were found significantly at par and maximum protein content (11.93 and 11.93%) was recorded under RDF + vermicompost @ 5 t/ha treatment in both the years, respectively. The maximum protein yield (5.15 and 4.64 q/ha) recorded under RDF + vermicompost @ 5 t/ha and minimum protein yield (3.70 and 3.54 q/ha) was recorded under control treatment the significant during both the year of experimentation, respectively.

Keywords: INM, late sown, FYM

Introduction
Wheat (*Triticum aestivum* L.) is one of the most important food grain crop in the world. In our country it is placed just after rice in term of production and consumption. It is the most important staple food of about two billion people (36% of the world population). World wide, wheat provides nearly 55% of the carbohydrates and 20% of the food calories consumed globally. It is consumed mostly in the form of chapati. Wheat straw is used for feeding the cattle. Wheat grain contain more protein (12%) than other cereals and has a relatively high content of niacin and thiamine. It is a basically concerned in providing the characteristics substance "gluten" which is very essential for bakers. The importance of micronutrients applications in increasing crop production has been recognized in India and it is becoming evident that without the use of the micronutrient is not possible to get the maximum benefits of NPK fertilizer and high yielding varieties of wheat. The growth and yield of a plant is determined by the availability of some specific mineral nutrient that are absolutely essential for completion of their life cycle. Excess or deficiency of certain elements from the crop can affect its yield, quality and subsequent post harvest life. Under specific circumstances wheat is sown in the month of December too. In late sown wheat, only short duration varieties should be sown because there is a comparatively less reduction in their yields compared to long duration varieties. Nitrogen is an important metabolic element for growth and development of plant. It is essential for synthesis of protein and other products. Nitrogen is directly concerned with physiological process occurring with plant. Nitrogen is required throughout the growing period of the crop. Phosphorus is second important major plant nutrient for crop production. It is necessary for such life process of plant as photosynthesis, development of plant cell as well as synthesis and breakdown of carbohydrates and transfer of energy with in plant. Potassium plays an important role in the maintenance of cellular organization.

It plays role in photosynthesis and translocation of food from leaves to seeds. FYM is an important component of sustainable agriculture. It contains 0.5% N, 0.25% P and 0.5% K. It improves the water holding capacity, texture soil and increase the water use efficiency. Vermicompost is a rich mixture of major and minor plant nutrients. It contains 3.0% N, 1.0% P and 1.5% Potash. Vermicompost is an excellent base for the establishment of beneficial free living and symbiotic microbes. The present experiment was undertaken to evaluate the yield, economics and quality improvement of wheat as affected by INM under late sown condition.

Materials and Methods

Field experiments were conducted during two consecutive *rabi* season of 2013-14 and 2014-15 at Students' Instructional Farm (SIF) of C.S. Azad University of Agriculture & Technology, Kanpur (UP), India. Treatments involve in the study viz. RDF 100% (80:40:30 NPK kg/ha), RDF 125%, RDF + FYM @ 5.0 t/ha, RDF + FYM @ 10.0 t/ha, RDF + FYM @ 15.0 t/ha, RDF + vermicompost @ 1.25 t/ha, RDF + vermicompost @ 2.50 t/ha, RDF + vermicompost @ 5.0 t/ha and RDF + FYM @ 5.0 t/ha + Vermicompost @ 1.25 t/ha. Laidout in Randomized Block Design (RBD) replicated three times. The variety K-9423 (Unnat Halna) of wheat was used and sowing on 04.01.2014 and 2015 in both years. The soil of experimental field was sandy loam with 49.90% sand, 24.20% silt, 26.70% clay and (0.34%) available nitrogen (170.0 kg/ha), medium in available in P_2O_5 (12.6 kg/ha) and available K_2O 155.0 Kg/ha. The meteorological observations recorded during the two seasons of study revealed that the maximum temperature averaged of 25.71 °C and 25.81 °C (2013-14 and 2014-15) and minimum temperature 11.52 °C and 13.67 °C (both years), averaged relative humidity at 72.0% and 75.44% (both years) and cumulative rainfall 157.60 mm and 200 mm (both years). During the year 2013-14 and 2014-15 a higher rainfall 67.20 mm and 95.0 mm in a day effected badly to crop condition and it reduces crop productivity. Crop responses to the treatments were measured in term of predetermined quantities indices the year-wise observation so recorded was subjected to statistical analysis.

Results and Discussion

Yields

The data regarding yield of wheat were summarised in Table the grain yield and straw yield of wheat were also positively affected by application of organic manures as soil amendments conditioners along with inorganic fertilizers. The grain yield (43.20 and 38.88 q/ha.) in 2013-14 and 2014-15, respectively, increased significantly when the crop responded up to RDF + Vermicompost @ 5.0 t/ha dose. The increase in grain yield is attributed to increase in weight of spike number of grains / spike, grains weight/ spike, grain yield/ plant and 1000 grains weight under the influence of Vermicompost along with inorganic manure as RDF application. Further the straw yield (66.74 and 60.16 q/ha.) in 2013-14 and 2014-15, respectively, which was also increased considerably due to application of RDF+Vermicompost @ 5.0 t/ha dose. The increase in straw yield is attributed to increase in vegetative characters viz; plant height, number of productive tillers, fresh and dry weight per plant continuously in present investigation. It is well known that the presence of essential plant nutrients would increase photo synthesis and favorable condition on provided by integrated application of organic and inorganic sources of nutrients. These all had played great roles in enhancing the biological, grain and straw yields, in the present experimentation. The similar results noted by Negi and Mahajan (2000) [1], Singh *et al.* (2003) [3], Pandey (2009) [2], Kumar and Singh (2010) [4] & Khan *et al.* (2013) [5].

Economics

The data concerned with economics of wheat were summarized in Table. It is envisaged with the table that cost of cultivation in rupees per hectare Economics of production is very important aspect to adjudge the efficiency of different production systems based on physical feasibility and its commercial viability, while calculating the economics viz; cost of cultivation, gross income, net income and B:C ratio were into consideration. The gross income was influenced significantly by the application of different organic and inorganic fertilizers treatments. The maximum gross income was recorded in treatment of RDF + Vermicompost @ 5.0 t/ha (Rs. 80502 and 76732/ha) in 2013-14 and 2014-15, respectively followed by treatment of RDF+ FYM @ 5.0 t/ha (Rs. 78142 and 75169/ha) in 2013-14 and 2014-15, respectively while the minimum gross income was recorded in treatment of RDF 100% (Rs. 63296 and 64229/ha) in 2013-14 and 2014-15, respectively was obtained. The increased gross income in RDF + Vermicompost @ 5.0 t/ha due to higher grain yield and straw yield produce than other treatment. Similar results were also reported by Girish Goyal *et al.* (2016) [8].

The net income as presented for going chapter showed that higher net income of (Rs. 24904 and 17657/ha) in 2013-14 and 2014-15, respectively were computed at RDF + Vermicompost @ 5.0 t/ha over other treatment under organic and inorganic sources. The highest net income was obtained due to higher grain and straw yield and reduced cost of cultivation than other treatment, while the minimum net profit was recorded in treatment of RDF 100% (Rs. 17898 and 15154/ha) in 2013-14 and 2014-15, respectively where, cost of cultivation were increased. The observation of B:C ratio are being presented in foregoing chapter, it is the proportion of cost to the benefit. B:C ratio was markedly influenced by nutrient application. The maximum B:C ratio was recorded in treatment of RDF + FYM@5.0 t/ha + Vermicompost @ 1.25 t/ha of 1.47 in 2013-14 and RDF (125%) 1.36 in 2014-15 respectively while, the minimum was recorded in treatment of RDF + FYM @ 15.0 t/ha (1.27 and 1.19) in 2013-14 and 2014-15, respectively.

Quality parameters

The protein yield (q/ha) in grain (5.15 and 4.64 q/ha.) in 2013-14 and 2014-15, respectively, increased significantly and protein contents (%) in grain (11.93 and 11.93 %) in 2013-14 and 2014-15, respectively, also increase due to use of inorganic fertilizers along with organic manures (RDF + Vermicompost @ 5.0 t/ha) in present investigation. It may be due to important role of essential plant elements and soil amendments conditioner in cell division and cell content Ashok *et al.* (2009), Singh, R.V. and Singh and Kumar (2010) [6, 4].

Studies about the integrated nutrient management on yield, economics & quality of wheat

Table 1: Effect of nutrient management on production productivity and quality improvement during 2013-14 and 2014-15.

Treatments	Grain yield (q/ha)		Straw yield (q/ha)		Gross Income		Net Income		B:C Ratio		Protein per cent in grain		Protein yield (q/ha)	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
RDF (100%)	33.70	32.13	53.72	50.4	63296	64229	17898	15154	1.39	1.31	10.97	11.03	3.70	3.54
RDF (125%)	35.00	33.30	60.44	56.46	67132	68046	20623	18030	1.44	1.36	11.04	11.03	3.86	3.67
RDF + FYM@ 5.0 t/ha	34.00	33.12	58.46	52.64	65138	67428	14540	13353	1.29	1.25	11.79	11.78	4.00	3.90
RDF + FYM@ 10.0 t/ha	40.00	37.04	64.29	57.80	75287	73956	19689	14881	1.35	1.25	11.86	11.85	4.74	4.39
RDF + FYM@ 15.0 t/ha	41.00	38.25	65.87	58.83	77161	76054	16563	11979	1.27	1.19	11.90	11.90	4.88	4.55
RDF + Verm @ 1.25 t/ha	34.88	32.30	57.30	51.58	66022	65518	17924	13943	1.37	1.27	11.78	11.78	4.11	3.80
RDF + Verm @ 2.50 t/ha	37.90	35.01	60.68	54.67	68699	70253	18371	16178	1.36	1.30	11.82	11.83	4.48	4.14
RDF + Verm @ 5.0 t/ha	43.20	38.88	66.74	60.16	80502	76732	24904	17657	1.45	1.30	11.93	11.93	5.15	4.64
RDF + FYM @ 5.0 t/ha + Verm. @ 1.25 t/ha	41.90	37.71	64.94	58.53	78142	75169	25044	18594	1.47	1.33	11.87	11.86	4.97	4.47
SE (d)	1.661	1.097	2.152	2.111	1762.76	1664.83	468.69	169.18	-	-	0.12	0.126	0.15	0.14
C.D. at 5%	3.523	2.325	4.562	4.476	3737.34	3529.70	933.69	994.74	-	-	0.26	.250	0.32	0.31

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