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Growth, Yield and Quality of Black Wheat as Influenced by Integration of Organic Sources in Bundelkhand Region

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ABSTRACT

A field experiment was conduct during *rabi* season 2020-21 at Organic Research Farm Karguan ji, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, with aim to study the effect of different organic sources viz., farm yard manure (FYM), vermicompost (VC) and Poultry manure (PM) on various morpho-physiological traits, growth, yield, their attributes and quality of black wheat. The experiment was laid out in a Randomized Block Design with 11 treatments replicated thrice viz., T_0 (control 100:50:30 NPK kg/ha^{-1}), T_1 (50%+50% through FYM and VC kg/ha^{-1}), T_2 (50%+ 50% through FYM and PM kg/ha^{-1}), T_3 (50%+50% through VC and PM kg/ha^{-1}), T_4 (75%+ 25% through FYM and VC kg/ha^{-1}), T_5 (75%+ 25% through FYM and PM kg/ha^{-1}), T_6 (75%+ 25% through VC and PM kg/ha^{-1}), T_7 (25% + 75% through FYM and VC kg/ha^{-1}), T_8 (25% + 75% through FYM and PM kg/ha^{-1}), T_9 (25%+ 75% through VCand PM kg/ha^{-1}), T_{10} (33.33% + 33.33% + 33.33% through FYM, VC and PM respectively kg/ha^{-1}). The results revealed that different treatments influenced significantly the growth, yield and quality parameters of black wheat among the treatments T_9 (25%+ 75% through VC and PM) recorded significantly higher values of the growth parameters like plant height at 90 DAS (98.1cm), effective no. of tillers at 90 DAS (12.18), plant weight 90 DAS (149 g) grain yield (45.69q), straw yield (72.69q), biological yield (118.3q) and 1000 seed weight (45g) of black wheat crop.

Keywords Black wheat, Organic sources, Integration, Growth, Yield.

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INTRODUCTION

Wheat (*Triticum aestivum* L.), is also known as "Staff of life or king of cereals" and most important source of staple food crop worldwide. Wheat has its own outstanding importance in human food. Wheat is a major cereal crop cultivated in India and belongs to family Poaceae and the second most important food crop of the world which meets 20% of the total food, 19 % of calories and 10-12 % of protein requirements of the

global population. Wheat ranks first in area (218.22 mha) and production (765.53 mt) during 2018-19 at the global level and it is the staple food of nearly 35% of the world population (USDA 2019). After rice, wheat is the most important food grain crop grown in India, with an area of 31.45 mha and production of 107.59 MT with average wheat yield 3421 kg/ha during 2019-20 (DES.2019-20). Today, our country enjoys status of surplus in the wheat production against the shortage at the time of independence. But in spite of impressive achievement in the recent past, concerted efforts are still needed for achieving sustained growth in production to fulfill nutritional requirement of ever increasing population, maintaining buffer stock for food security and adequate supplies to wheat based food processing industries. The productivity of wheat depends upon the nutrient supplying capacity of the soil and fertilizers schedule there on.

Organic farming in many quarters is taken as a system of farming that prohibits the use of chemical fertilizers and pesticides all together. Application of organic manure such as vermicompost and farm yard as well as crop residue manure improves soil health by improving nutrient availability, water holding capacity (WHC), soil physical properties and microbial activity. As they improve soil fertility and physical properties such as soil structure, aeration, porosity, infiltration rate and water holding capacity and decrease soil crusting, organic matter in soil which ultimately improve physical condition of the soil for better performance of micro-organism and physical status of soil. Organic matter affects crop growth and yields either directly supplying nutrients or indirectly by modifying soil physical properties such as stability of aggregates, porosity and available water capacity that can improve the root environment and stimulate plant growth. Organic matter not only increases the water holding capacity of the soil but also proportion of water available for plant growth and improves physical properties of soil (Sial *et al.* 2007).

Black wheat was produced at the National Agrofood Biotechnology Institute (NABI) Mohali; Punjab in 2017 by the Scientist "Monika Garge". This wheat is named as "'NABI MG" and is available in black, blue and purple color and much more nutritious than common wheat. The "NABI MG" name came from "NABI" means the name of institute and "MG" means the name of scientist (https://hindi.krishijagaran.com). The black color in black wheat is due to the pigment named "Anthocyanin" which provides health benefits as in fruit like blueberry. The concentration of this pigment determines the color of other natural edibles much more than regular wheat have contain 10-13ppm (Parts-Per-Million) concentration of anthocyanin. On the other hand, black wheat grain is reported to have around 135 ppm of anthocyanin. Improvement in nutritional quality of staple crops can have easy and wider outreach to address national challenges. Recently, based on seven year research, colored wheat lines (black, blue, purple) developed and adapted to Indian climatic conditions with acceptable yield potential. The color in these lines is due to high anthocyanin content. These lines also showed high micronutrients like iron and zinc. The high fat diet induced mouse model studies have indicated preventive effect of these lines for obesity, insulin resistance and hyper cholesterol (Garge *et al*. 2017). No scientific information on nutrient management of black wheat in bundelkhand is available. The present attempt was therefore made to study the growth, yield and quality of black wheat as influenced by organic sources.

MATERIALS AND METHODS

To study the comparative performance of different combinations of organic resources nutrients on growth, yield, their parameters and quality of black wheat. Experiment was conducted at Organic Research Farm, Karguaji, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh during the *rabi* season (2020-21). Jhansi located in south of Uttar Pradesh. The farm is situated at latitude 25^0 27'31" N. Longitude $78^0$34'47" E. and altitude of 284 m. The experiment involving 11 treatments was laid out in Randomized Block Design (RBD) with 3 replications. The plot size was 3m×3.4m (10.2 m^2). To get semi fine seedbed for sowing, soil was first deep ploughed with a soil turning plough followed by two cross ploughing and planking after each ploughing. Layout of the experimental field was carefully done as per technical program of the experiment. All organic sources were applied based on nitrogen content.

FYM was applied at the time of land preparation and vermicompost and poultry manure was applied in a moist soil in a row 2 to 3 cm below from the seeds at the time of sowing. Wheat seeds at the rate of 90 kg ha^{-1} were sown 22.5 x 5 cm apart as on 07.11.2020 in lines. Pre-sowing irrigation was given to ensure proper germination and five irrigations offered at CRI, tillering, late jointing, Ear/Spike emergence and milking stage. Interculture operations and weed management were done as and when required. The crop was harvested on 04.04.2021 at complete maturity as judged by visual observation. One border row from both the sides and one plant from both sides in lines were harvested first. Thereafter, crop of each net plot was harvested separately and brought threshing floor after proper tagging. The produce of net plot weighed individually and recorded before threshing. Threshing was done by mechanically and seed weight was recorded for net plot after winnowing the produce. To obtain straw yield, the seed weight was subtracted from total biomass recorded from each plot. Data was recorded at 30, 60 and 90 DAS on growth and yield while quality parameters of grains using standard methods. The growth attributes viz., Plant height (cm), number of leaves per plant (nos), fresh and dry weight of shoot (g), fresh and dry weight of root (g), number of tillers/hill (nos), length of spike (cm), number of spike/hill (nos) recorded during growth period. The yield attributes, 1000 grain weight (g), number of grain/spike (nos), grain yield, straw yield, biomass yield (q/ha) were recorded at harvest or after harvesting. Protein content was analyzed using Kjeldhal Method as described by Dr Rakesh Singh while Zinc and Iron content were analyzed using Atomic Absorption Spectrophotometer (AAS).

Soil samples from each treatment were analyzed for soil nutrient analysis. Organic carbon was estimated using Walkley and Black's Method while available nitrogen was estimated using Alkaline Potassium Permanganate Method (Subbiah and Asija 1956) and available phosphorus was estimated by Olsen's Method and available potassium was estimated by Flame Photometer. Date regarding soil analysis was displayed in Table 1. The recorded data was statistically analyzed by using ICAR-STAT GOA and the CD at 5% level of probability.

Table 1. Initial soil properties of experimental site.

Sl. No.	Particular	Values	Analytical method applied
1.	Texture	Sandy loam	
	Sand (%)	42.0	
	Silt (%)	38.0	
	Clay (%)	20.0	
2.	pH 1:2.5	7.9	Potentiometric
3.	Organic carbon (%)	0.50 – 0.52	Walkley and Black's rapid titration method
4.	Available nitrogen (kg ha^{-1})	175	Alkaline KMnO4 method
5	Available phosphorus (kg ha^{-1})	4.50	Olsen's method
6.	Available potassium (kg ha^{-1})	249	Flame photometric method

RESULTS AND DISCUSSION

Growth and growth attributes

The growth attributes were significantly influenced by integration of organic sources (Table 2). The plant height was not affected significantly in early stages of plant growth. However at 90 DAS it was significantly influenced due to different treatment combinations. The application of 25% VC and 75% PM (T_9) per hectare recorded significantly higher plant height (98.1 cm) followed by treatment (T_8) involved 25% FYM and 75% PM (94.4 cm) while minimum plant height was recorded from control plot (T_0) respectively. The plant height attributes to the integration effect of poultry manure with vermicompost. The increase in plant height due to the nutritive effect of organic sources is in conformity with those of Abro and Mahar (2007), Haq *et al.* (2007) and Haque *et al.* (2015) in rice crop.

Numbers of tillers per hill at 60 and 90 DAS were significantly affected due to organic manures. Application of 25% VC and 75% PM (T_9) per hectare found significantly superior and produced highest number of tillers/hill (10.9 and 11.1) respectively. The less number of tillers/hill (8.7) noted in inorganic treatment at 60 DAS while after 90 DAS lowest number of tillers (10.2) with 50% FYM and 50% VC (T_1). These finding are in support of previous findings by Ibrahim *et al.* (2008), Jaga and Upadhay (2013) and Kakraliya *et al.* (2017).

Table 2. Growth attributes of black wheat as affected by nutrient application through organic sources.

Treatments	Plant height (cm)	Leaves/plant (Nos.)	Plant weight/hill (g)		Root weight/hill (g)		Tillers/ hill (Nos.)
			Fresh	Dry	Fresh	Dry	
T_0- Control (100,50,30 kg NPK/ha)	87.5	63.3	122.44	38.83	4.77	1.83	10.62
T_1 -50% though FYM+50% through VC	90.6	60.7	132.88	31.00	3.55	1.02	10.29
T_2- 50%t hrough FYM+50% through PM	88.4	62.2	105.55	32.62	3.44	1.40	10.82
T_3- 50% through VC+50% through PM	86.5	61.5	107.00	34.23	5.66	1.55	10.98
T_4- 75% through FYM+75% through VC	88.6	61.0	107.43	32.09	5.66	1.75	10.82
T_5- 75% through FYM+25% through PM	86.6	58.7	131.77	36.54	4.33	1.33	10.28
T_6- 75 % through VC+25% through PM	91.7	60.2	108.88	30.02	4.44	1.34	10.44
T_7- 25% through FYM+75% through VC	92.9	59.7	117.88	32.43	4.44	1.88	10.40
T_8- 25% through FYM+75% through PM	94.4	62.3	122.77	30.70	5.33	1.59	10.74
T_9- 25% through VC+75 % through PM	98.1	65.2	149.22	46.53	6.25	1.91	12.18
T_{10}-33.3% through FYM+33 % through VC+ +33.3% through PM	89.7	61.9	129.51	31.00	6.10	1.37	09.94
CD at 5%	6.8	2.1	8.57	4.95	0.49	0.15	0.87

Maximum number of leaves (24.3, 52.9 and 65.2) were recorded when 25% VC and 75% PM (T_9) were applied but minimum number of leaves (15.5) recorded from FYM+VC+PM (T_{10}) and (49.6 and 58.5) 75% FYM and 25% PM (T_5) after 30, 60 and 90 DAS respectively. It might be due the optimum growth and development of the plant owing to the optimum availability of macro and micro nutrient and solar radiation that led to the proper translocation and assimilation of food to the plants.

The plant height taken at 30, 60 and 90 DAS was significantly influenced due to different combinations of organic manures at 90 days after sowing. Maximum plant height (98.1 cm) observed with application 25% VC and 75% PM (T_9) while minimum plant height (86.5 cm) was recorded from 50% VC and 50% PM (T_3). Same results were obtained by Jat *et al.* (2013), Mumtaz *et al*. (2015) and Kumar *et al.* (2016).

The fresh plant weight increased continuously up to maturity. Among the different treatments 25% VC and 75% PM (T_9) achieved highest fresh plant weight (4.25, 31.83 and 149.22 g) at 30, 60 and 90 DAS respectively. Combination of 75% FYM and 25% VC (T_4) recorded lowest fresh plant weight (2.51 and 17.26 g) at 30 and 60 DAS and 50% FYM and 50% PM (T_2) (105.55 g) at 90 DAS respectively. When significantly highest dry plant weight (0.73, 6.79 and 46.53 g) was observed at 30, 60 and 90 DAS, 25% VC and 75% PM (T_9) and lowest dry plant weight (0.40, 3.55 and 30.02 g) was recorded from the treatment 50% FYM and 50% VC (T_1). This might be due to availability of nutrients from organic sources and favorable conditions created in uptake of plant nutrients by the crop (Chavda and Rajawat 2015).

Significantly highest root length was obtained from 25% VC and 75% PM (T_9) application at 60 and 90 DAS (11.4 and 13.6 cm). Similar observation was recorded earlier by Sims and Wolf (1994).

Yield & Yield Attributes

Application of 25% nutrients VC and 75% through PM (T_9) recorded significantly higher spike length (10.7 cm), number of spike hill^{-1} (12.4), number of grain per spike (38.4), grain yield (45.69 q/ha), straw yield (72.95 q/ha), biological yield (118.64 q/ha) and weight of 1000 grains (Test weight) while harvest index (42.23 %) was found significantly higher (Table 3) from the application of 75% nutrients through FYM and 25% through VC (T_4).

Higher length of spike, number of spike hill^{-1} and maximum number of grains per spike might be due addition of organic manures which improves plant air-water relationship, and physical condition of soil and fertility. Similar finding were also reported by Kashyap *et al*. (2017), Ibrahim *et al*. (2008), Patel *et al.* (2017), Singh *et al.* (2007). The significantly higher grain, straw and biomass yield this could be due to higher availability of nutrients and modifying soil nutrient and water status during critical growth

Table 3. Yield and yield attributes of black wheat as affected by organic nutrient management.

Treatments	Spike length (cm)	Grains/spike (Nos.)	Spike/ hill (Nos.)	1000 grain weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Biomass yield (q/ha)
T_0- Control (100,50,30 kg NPK/ha)	08.6	34.2	10.6	41.00	40.86	62.49	97.43
T_1 -50% though FYM+50% through VC	07.9	28.6	09.8	39.66	30.98	67.35	93.73
T_2- 50% through FYM+50% through PM	08.1	28.7	10.9	40.33	30.31	58.53	88.05
T_3- 50% through VC+50% through PM	08.8	23.7	10.8	39.33	26.64	53.80	80.38
T_4- 75% through FYM+75% through VC	09.1	37.7	10.6	41.33	36.28	60.31	84.94
T_5- 75% through FYM+25% through PM	08.8	35.2	10.4	40.00	33.15	60.39	87.47
T_6- 75 % through VC+25% through PM	08.2	27.8	10.6	39.33	26.25	48.21	76.82
T_7- 25% through FYM+75% through VC	09.1	31.2	10.4	41.33	32.90	61.39	90.22
T_8- 25% through FYM+75% through PM	08.5	28.7	10.5	40.00	32.51	67.54	89.66
T_9- 25% through VC+75 % through PM	10.7	38.4	12.4	45.33	45.69	72.95	111.15
T_{10}-33.3% through FYM+33 % through VC+ + 33.3% through PM	09.1	35.1	10.2	41.66	39.82	62.54	106.09
CD at 5%	0.8	4.1	1.2	2.83	3.68	5.88	6.43

Table 4. Effect of nutrient management through organic sources on quality of black wheat.

Treatments	Quality aspects		
	Protein (%)	Fe (mg/100g)	Zn (mg/100g)
T_0 - Control (100,50,30 kg NPK/ha)	11.56	3.5	1.8
T_1 -50% though FYM+50% through VC	12.42	3.47	2.30
T_2- 50%through FYM+50% through PM	12.21	3.21	2.38
T_3- 50%through VC+50% through PM	12.29	3.18	2.10
T_4- 75%through FYM+25% through VC	12.84	3.61	2.36
T_5- 75%through FYM+25% through PM	12.61	3.28	2.10
T_6- 75 %through VC+25% through PM	12.46	3.39	2.18
T_7- 25%through FYM+75% through VC	12.36	3.66	2.43
T_8- 25%through FYM+75% through PM	12.21	3.36	2.28
T_9- 25%through VC+75 % through PM	12.41	3.48	2.31
T_{10}-33.3% through FYM+33% through VC+ + 33.3% through PM	12.38	3.54	2.41

stages of crop by adding of organic manures resulted increase in the yield and yield attributes of crop, this is in agreement with the earlier findings of Usadadiya and Patel (2013), Rahman *et al*. (2014), Madik *et al.* (2015) and Mohan *et al.* (2018).

As far as quality is concerned there was no significant effect on protein, iron and zinc content in black wheat grains due to application of different combinations of organic manures. However zinc content in control plot (T_0) was found minimum as compare other organic combinations (Table 4).

The growth, yield attributes and yield of black wheat was significantly affected by the different combinations of organic manures and their integrations as 25% through VC and 75% through PM (T_9) as compared to treatments.

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