

Original Research Article

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Response of Wheat [*Triticum aestivum* (L.) emend. Fiori & Paol.] Cultivars to Integrated Nutrient Management

R.R. Choudhary^{1*}, A.L. Prajapat¹, S.L. Choudhary² and O.P. Meena¹

¹Rajasthan Agricultural Research Institute, (SKNAU) Jobner, Jaipur, Rajasthan, India

²Department of Agronomy, Sri Karan Narendra Agriculture University, Jobner, Rajasthan, India

*Corresponding author

ABSTRACT

The field experiment was conducted at research farm, Rajasthan Agricultural Research Institute, Durgapura, Jaipur for two consecutive years during *rabi* seasons 2014-15 and 2015-16 on loamy sand soil. The twenty four treatment combinations consisting of four varieties (PBW 502, Raj 4037, WH 1105 and HD 2967) and six integrated nutrient management practices (Farmer's practice, 100 % RDF, 100 % RDF + *Azotobacter* + PSB, 75 % RDF + *Azotobacter* + PSB, 75 % RDF + *Azotobacter* + PSB + ZnSO₄ and 50 % RDF + 25 % N through organic manure + *Azotobacter* + PSB + ZnSO₄) were tested in factorial randomized block design with three replications. Results showed that variety WH 1105 proved significantly superior over HD 2967 and PBW 502 varieties with respect to yield attributes (Effective tiller per metre row length, number of grains per spike, length of spike and test weight) and yield and closely followed by variety Raj 4037. Results further indicated that number of effective tillers, grains per spike, grain, straw and biological yields significantly increased with application of 100 % RDF + *Azotobacter* + PSB over farmer's practice but remained at par with 100 % RDF. Significantly higher net returns and B:C ratio was obtained with variety WH 1105 and application of 100 % RDF + *Azotobacter* + PSB independently.

Keywords

Wheat, INM, Varieties, Yield attributes, B:C ratio.

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Introduction

Wheat [*Triticum aestivum* (L.) emend. Fiori & Paol.] is the most important staple food crop of the world and emerged as the backbone of India's food security. It is grown all over the world for its wider adaptability and high nutritive value. It is an important winter cereal contributing about 38% of the total food grain production in India. Wheat straw is an important source of fodder for a large Indian animal population in India. Wheat and rice serve as life sustaining crops for our population and thus, considered to be the cornerstone of nation's food security

system. However, there is need to further increase the production to fulfill the requirement of exploding population, maintenance of adequate buffer stock and to meet out demand for processing industries.

The rice-wheat cropping system of Indian agriculture is the cornerstone of the nation's food security. This system contributes about 75 percent of the nation's total food grain production (Yadav *et al.*, 2005). It has tremendously helped the socio-economic development of the rural population in India.

The green revolution in India during the late 1960s has no doubt brought about self-sufficiency in food grain production.

But currently, there is a growing concern about the sustainability of the rice-wheat cropping system as the growth rates of rice and wheat yields have either become stagnant or declined in rice-wheat growing states like Punjab, Haryana, eastern Uttar Pradesh, Madhya Pradesh, Bihar, Himachal Pradesh, Jammu and Kashmir as well as southern and other states. The dwarf varieties of wheat have great potential but due to exhaustive nature they require more nutrients and have posed a great threat to long-term sustainability of crop production.

Materials and Methods

The field experiment was conducted at research farm, Rajasthan Agricultural Research Institute, Durgapura, Jaipur for two consecutive years during *rabi* seasons 2014-15 and 2015-16 on loamy sand soil. The twenty four treatment combinations consisting of four varieties (PBW 502, Raj 4037, WH 1105 and HD 2967) and six integrated nutrient management practices (Farmer's practice, 100 % RDF, 100 % RDF + *Azotobacter* + PSB, 75 % RDF + *Azotobacter* + PSB, 75 % RDF + *Azotobacter* + PSB + ZnSO₄ and 50 % RDF + 25 % N through organic manure + *Azotobacter* + PSB + ZnSO₄) were tested in Factorial Randomized Block Design (FRBD) with three replications.

The treatments were randomly allotted to different plots using random number table of Fisher and Yates (1963). The seed yield of each net plot (inclusive of tagged plants) was recorded in kg plot⁻¹ after cleaning the threshed produce was converted as q ha⁻¹. Straw yield was obtained by subtracting the seed yield (q ha⁻¹) from biological yield (q ha⁻¹).

Results and Discussion

Data (Table 1) revealed that wheat variety WH 1105 recorded higher number of effective tiller per metre row length, number of grains per spike, length of spike and test weight, which was found at par with variety Raj 4037 during both the years and in pooled analysis. Data (Table 1) further indicated that application of 100 % RDF + *Azotobacter* + PSB significantly increased the number of effective tiller per metre row length, number of grains per spike, length of spike and test weight during both the years and in pooled analysis over farmer's practice and was found at par with 100 % RDF. Data (Table 2) revealed that wheat varieties differed significantly in the grain yield during both the year of experimentation and on pooled basis. Variety WH 1105 proved significantly superior as compared to other varieties during both the years of experimentation and recorded highest grain yield (44.86 q ha⁻¹) on the basis of pooled data and increased the grain yield by 7.26 and 15.14 percent as compared to variety HD 2967 and PBW 502, respectively but remained at par with variety Raj 4037 (44.44 q ha⁻¹). Further, data showed that application of integrated nutrient management significantly increased grain yield of wheat as compared to farmer's practice during both the years of experimentation and in pooled data. Application of 100 % RDF + *Azotobacter* + PSB significantly increased the grain yield (45.22 q ha⁻¹) as compared to other treatments while, it proved at par with 100 % RDF. On the basis of pooled data, 100 % RDF + *Azotobacter* + PSB increased the grain yield by 17.12 per cent over farmer's practice, 5.11 per cent over 50 % RDF + 25 % N through organic manure + *Azotobacter* + PSB + ZnSO₄, 6.00 per cent over 75 % RDF + *Azotobacter* + PSB + ZnSO₄ and 11.21 per cent over 75 % RDF + *Azotobacter* + PSB. Straw and biological yields was found

superior over variety HD 2967 and PBW 502 and 100 % RDF + *Azotobacter* + PSB was recorded higher value of straw and biological yields.

The overall improvement in crop growth under the influence of optimum nutrition involving combination of all nutrients and increasing role of fertility levels could be ascribed to their potential role in modifying soil and plant environment conducive for better development of both physiological and biochemical components of the plant growth that increase efficiency of physiological processes of plant system. Amongst nutrients, nitrogen is considered to be a vitally important plant nutrient. It is necessary for chlorophyll synthesis and as a part of the chlorophyll molecule, which is the primary absorber of light energy needed for photosynthesis. Lack of N and chlorophyll means the crop will not utilize sunlight as an energy source to carry on essential function such as nutrient uptake. It is a component of vitamins and energy systems in plants. Nitrogen is an essential component of amino acids, which form plant proteins. Besides these, it is also a constituent of certain organic compounds of physiological importance (Brady and Well, 2002; Havlin *et al.*, 2006).

Further, phosphorous also improves the various metabolic and physiological processes thus known as “energy currency” which is subsequently used for vegetative and reproductive growth through phosphorylation. In addition to this vital metabolic role, P is an important structural component of nucleic acid, phytin, phospholipids and enzymes. An adequate supply of phosphorous early in the life cycle of plant is important in laying down the primordia for its reproductive part. It also increases the initiation of both first and second rootlets and their development. The extensive root system helps in exploiting the maximum nutrients and water from the soil

(Tondon, 1987). Whereas, K is not a structural part of any molecules inside the plant but it is necessary to many plant functions, including carbohydrate metabolism, enzyme activation, osmotic regulation and efficient use of water, N uptake and protein synthesis and translocation of assimilates. Besides these, it also has a role in decreasing certain plant diseases, improving quality and reducing the lodging of crop (Kumar *et al.*, 2010). Further, Zinc plays important role in synthesis of various enzymes, N metabolism and several oxidation-reduction reactions. Further, synergistic interactions between these nutrients particularly Zn with primary nutrients (NPK) on growth and development of plants were also noted (Raghav *et al.*, 2011; Singh *et al.*, 2011).

Since, wheat yield formation is a complex process and governed by interaction between source (photosynthesis and availability of assimilates) and sink component (storage organs). Thus, as a consequence of marked improvement in both these regulative process as evidenced from higher accumulation of biomass and nutrients as well as yield components under variety WH 1105 led to significant increase in grain yield. Further, the grain yield of wheat is dependent on two most important components namely grains per unit area and weight of grains (test weight). Thus, due to more number of grains by virtue of increased number of spikes and more test weight under WH 1105, increased the grain yield over HD 2967 and PBW 502, But at par with variety Raj 4037. Since, biological yield is a sum of grain and straw yield produced by the crop, the increased grain yield under WH 1105 might have resulted in higher biological yield in this variety. The marked variation in various yield components and yield between varieties was observed by Pandey *et al.*, (1999), Nainwal (2000), Sardana (2001) and Singh *et al.*, (2007).

Table.1 Effect of varieties and integrated nutrient management on yield attributes of wheat

Treatments	Effective tillers (m ⁻¹ row length)			Length of spike (cm)			Number of grains spike ⁻¹			Test weight (g)		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Varieties												
PBW 502	59.10	61.55	60.33	9.71	9.88	9.80	37.74	38.44	38.09	35.20	35.62	35.41
Raj 4037	67.51	68.39	67.95	10.75	11.39	11.07	40.88	42.93	41.91	37.45	37.49	37.47
WH 1105	68.23	68.52	68.38	10.92	11.49	11.21	40.96	43.00	41.98	37.59	37.65	37.62
HD 2967	63.19	65.05	64.12	10.19	10.65	10.42	39.22	40.71	39.97	37.08	37.12	37.10
SEm±	0.91	0.95	0.66	0.14	0.20	0.12	0.48	0.53	0.36	0.56	0.50	0.38
CD (P=0.05)	2.60	2.71	1.85	0.39	0.57	0.34	1.38	1.51	1.01	1.59	1.43	1.06
Integrated nutrient management												
Farmer's practice	57.88	58.41	58.14	9.24	9.11	9.18	36.45	36.62	36.54	34.40	34.33	34.36
100 % RDF	68.90	70.13	69.52	11.05	11.94	11.50	41.78	44.22	43.00	37.71	37.72	37.71
100 % RDF + <i>Azotobacter</i> + PSB	69.17	70.46	69.81	11.18	11.99	11.58	41.85	44.31	43.08	37.87	37.75	37.81
75 % RDF + <i>Azotobacter</i> + PSB	61.04	62.82	61.93	9.88	10.08	9.98	38.17	39.19	38.68	36.39	37.13	36.76
75 % RDF + <i>Azotobacter</i> + PSB + ZnSO ₄	64.88	66.67	65.78	10.46	10.94	10.70	39.87	41.54	40.71	37.14	37.41	37.27
50 % RDF + 25 % N through organic manure + <i>Azotobacter</i> + PSB + ZnSO ₄	65.17	66.77	65.97	10.55	11.05	10.80	40.08	41.73	40.91	37.47	37.49	37.48
SEm±	1.12	1.16	0.81	0.17	0.24	0.15	0.59	0.65	0.44	0.68	0.62	0.46
CD (P=0.05)	3.18	3.32	2.27	0.48	0.69	0.42	1.69	1.85	1.24	1.95	1.75	1.29

Table.2 Effect of varieties and integrated nutrient management on yield of wheat

Treatments	Grain yield (q ha ⁻¹)			Straw yield (q ha ⁻¹)			Biological yield (q ha ⁻¹)		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Varieties									
PBW 502	38.16	39.76	38.96	55.11	57.44	56.28	93.27	97.20	95.24
Raj 4037	43.55	45.33	44.44	64.15	67.48	65.82	107.70	112.81	110.26
WH 1105	43.91	45.81	44.86	64.88	67.93	66.41	108.79	113.74	111.27
HD 2967	41.05	42.59	41.82	59.34	63.11	61.23	100.39	105.70	103.05
SEm±	0.51	0.57	0.38	0.98	1.06	0.72	1.29	1.57	1.02
CD (P=0.05)	1.44	1.61	1.07	2.80	3.03	2.03	3.66	4.48	2.86
Integrated nutrient management									
Farmer's practice	37.91	39.30	38.61	53.98	56.43	55.20	91.88	95.73	93.81
100 % RDF	44.02	45.89	44.95	65.17	68.57	66.87	109.19	114.45	111.82
100 % RDF + <i>Azotobacter</i> + PSB	44.31	46.13	45.22	65.45	68.71	67.08	109.76	114.85	112.31
75 % RDF + <i>Azotobacter</i> + PSB	39.84	41.47	40.66	57.67	60.67	59.17	97.51	102.14	99.83
75 % RDF + <i>Azotobacter</i> + PSB + ZnSO ₄	41.72	43.60	42.66	61.35	64.71	63.03	103.08	108.30	105.69
50 % RDF + 25 % N through organic manure + <i>Azotobacter</i> + PSB + ZnSO ₄	42.19	43.84	43.02	61.60	64.85	63.23	103.80	108.70	106.25
SEm±	0.62	0.69	0.47	1.20	1.30	0.89	1.58	1.93	1.25
CD (P=0.05)	1.77	1.97	1.31	3.42	3.71	2.49	4.48	5.49	3.50

Table.3 Effect of varieties and integrated nutrient management on net returns and B:C ratio

Treatments	Net returns (Rs ha ⁻¹)			B:C ratio		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Varieties						
PBW 502	64868	68986	66927	1.96	2.09	2.03
Raj 4037	79455	84479	81967	2.40	2.56	2.48
WH 1105	80505	85565	83035	2.44	2.59	2.51
HD 2967	72319	77199	74759	2.19	2.34	2.26
SEm±	987	1183	770	0.04	0.05	0.03
CD (P=0.05)	2809	3368	2163	0.12	0.15	0.09
Integrated nutrient management						
Farmer's practice	66575	70419	68497	2.20	2.33	2.25
100 % RDF	80690	85898	83294	2.43	2.58	2.50
100 % RDF + <i>Azotobacter</i> + PSB	81115	86167	83641	2.42	2.57	2.50
75 % RDF + <i>Azotobacter</i> + PSB	70230	74799	72514	2.19	2.33	2.26
75 % RDF + <i>Azotobacter</i> + PSB + ZnSO ₄	74390	79584	76987	2.23	2.39	2.31
50 % RDF + 25 % N through organic manure + <i>Azotobacter</i> + PSB + ZnSO ₄	72721	77477	75099	2.02	2.15	2.09
SEm±	1208	1449	943	0.05	0.06	0.04
CD (P=0.05)	3440	4125	2650	0.15	0.18	0.11

In conclusion, based on the results of two years experimentation, it may be concluded that wheat variety WH-1105 out yielded and fetched significantly highest net returns and B: C ratio hence got the first preference which was closely followed by Raj-4037 (Table 3). Application of 100 % RDF + *Azotobacter* + PSB was found to be the most suitable integrated nutrient management practice. However, 100 % RDF also proved equally effective.

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