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Effect of varieties and nutrient management practices on nutrient content, uptake and quality parameters of wheat (*Triticum aestivum*)

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Abstract
The field experiment was conducted at Durgapura, Jaipur (Rajasthan) for two consecutive years during winter (*rabi*) seasons 2014-15 and 2015-16 to study the effect of wheat varieties and nutrient management practices on nutrient content, uptake and quality parameters. Twenty four treatment combinations consisted of four varieties *viz.*, PBW 502, Raj 4037, WH 1105 and HD 2967, and six nutrient management practices *viz.*, farmers' practice, 100% RDF, 100% RDF + *Azotobacter* + PSB, 75% RDF + *Azotobacter* + PSB, 75% RDF + *Azotobacter* + PSB + $ZnSO_4$ and 50% RDF + 25% N through organic manure + *Azotobacter* + PSB + $ZnSO_4$ were tested in factorial RDB design. Hectolitre weight, sedimentation volume, and uptake of nitrogen, phosphorus and potassium by grain and straw were higher under variety WH 1105. Further, application of 100% RDF + *Azotobacter* + PSB gave significantly higher values of protein content, hectolitre weight, sedimentation volume, beta carotene, nutrient content and uptake of nitrogen, phosphorus and potassium by grain and straw.

Keywords: Wheat varieties, nutrient management, nutrient content, nutrient uptake, quality parameters

Introduction
India is the second largest producer of wheat after china, producing 103.59 million tonnes from 29.31 million hectares area with average productivity of 3.53 tonnes per hectare (FAOSTAT, 2019) [6]. A number of wheat varieties have been developed in recent past, which has helped in enhancing food grain production substantially. However, wheat varieties are inherently very low in nutrient content and to assess nutrient management practices for increasing their content in grain is a tough task particularly in soils inherently low in nutrients.
The use of chemical fertilizers is one of the ways to restore depleted nutrients. However, the higher cost of chemical fertilizers coupled with their low affordability by small farmers is the biggest obstacle for their use (Kemal and Abera, 2015) [12]. Additionally, the improper and imbalanced use of chemical fertilizers declined nutrient-use efficiency, making the consumption of chemical fertilizers uneconomical. Evaluation of cropping system largely depends on efficient utilization of nutrients by the crops. Performance of crops can be improved by increasing nutrient use efficiency through economically optimal nourishment of crops and minimizing the loss of nutrients from the field (Fixen *et al.* 2015) [7], and it is greatly affected by nutrient management practices. Earlier, to meet the food grains demand, intensive cropping was adopted, but currently the decreasing response to inputs has emerged as a major challenge for the sustainability of cropping systems (Kakraliya *et al.* 2017) [11]. It is estimated that about 30–50% of nitrogen and 45% of phosphorus applied through fertilizers are used by the crops (Ghosh *et al.* 2005) [8]. The efficiency of nutrients can be increased through the integrated use of organic manures and chemical fertilizers (Kumar *et al.* 2014) [14]. The basic concept underlying integrated nutrient management is maintenance of nutrient status of soil through judicious and efficient use of chemical fertilizers, organic manures, and biofertilizers (Kumar and Mukhopadhyay, 2017) [15]. The organic manures increase the efficiency of applied nutrients in wheat based systems (Singh *et al.* 2012) [18]. The use of organic manures has beneficial effects on soil health by improving the soil properties besides supplying nutrients and increasing the availability of nutrients and their uptake (Dhaliwal *et al.* 2019) [5]. Quality of wheat flour improved by integrated use of organic manures with inorganic fertilizers as organic manures led to increase in the amount of gluten in wheat grains thereby enhancing the protein content (Gopinath *et al*., 2008) [9].

Therefore, the present study was undertaken to assess the effect of nutrient management practices on grain quality, and nutrient content and uptake in wheat varieties.

Materials and Methods

The field experiment was conducted at research farm, Rajasthan Agricultural Research Institute, Durgapura, SKNAU, Jobner, Rajasthan, for two consecutive years during winter (*rabi)* seasons 2014-15 and 2015-16. The twenty four treatment combinations consisting of four varieties *viz.* PBW 502 (V_1), Raj 4037 (V_2), WH 1105 (V_3) and HD 2967 (V_4), and six nutrient management practices *viz.* farmers' practice (N_1), 100% RDF (N_2), 100% RDF + *Azotobacter* + PSB (N_3), 75% RDF + *Azotobacter* + PSB (N_4), 75% RDF + *Azotobacter* + PSB + $ZnSO_4$ (N_5) and 50% RDF + 25% N through organic manure + *Azotobacter* + PSB + $ZnSO_4$ (N_6) were tested in factorial randomized block design (FRBD) with three replications. The soil of the experimental site was loamy sand with bulk density of 1.55 g/cm and field capacity of 9.7% (w/w). It had 0.25% organic carbon, 140.5 kg $KMnO_4$ oxidizable N/ha, 27.6 kg 0.5 N $NaHCO_3$ extractable P_2O_5/ha, 186.5 kg 1.0 N NH_4OAC-exchangeable K_2O/ha, 0.58 mg DTPA-extractable available Zn/kg soil, 8.2 pH and 0.14 dS/m electrical conductivity at the start of the experiment. The recommended doses of fertilizers, i.e. 150:60:40 N, P_2O_5 and K_2O kg/ha was applied to wheat as per the treatments and 80:40: N and P_2O_5 kg/ha applied as farmers' practice. Full dose of phosphorus and potassium was applied at the time of sowing and one third dose of nitrogen was drilled in furrow while sowing and remaining dose of nitrogen split twice (in two equal parts) at the time of second and third irrigation. Soil application of zinc was done at 5 kg Zn/ha through $ZnSO_4.7H_2O$. Wheat varieties were sown on 19th and 23rd November during first and second year, respectively, by using 100 kg/ha seed rate with row to row spacing of 20 cm. Grain protein content was calculated by multiplying the nitrogen content (%) in the grain by the factor 6.25. The weight expressed as kg/hectolitre is known as per hectolitre weight. For sedimentation value 5 g flour was added to 50 ml water and shaken rapidly for 15 sec, and then 50 ml sodium dodecyl sulphate was added. Sediment volume was measured to the nearest ml. Beta carotene was estimated using 10 g wheat flour sample from each experimental unit and dispersed in 50 ml water saturated n-butanol to get homogeneous suspension. It was shaken gently and allowed to stand overnight under dark. The optical density of the clear filtrate was measured at 440 nm as absorbance, using the spectrophotometer. Evaluation of the contents was based on a beta carotene calibration curve. N, P, and K content was determined by using Nessler's reagent colorimetric method (Lindner 1994), Vanadomolybdophosphoric yellow colour method (Richards 1968), and Flame photometric method (Richards 1968), respectively.

Results and Discussion

Quality parameters

Wheat varieties had significant effect on quality parameters except protein content, *viz.*, hectolitre weight, sedimentation volume and beta carotene content (Table 1). The maximum grain protein content was recorded in variety WH 1105 (10.8%) and minimum in variety PBW 502 (10.4%). The high protein content in WH 1105 might be due to its high nitrogen content and equally higher nitrogen accumulation or uptake in grains. Alam (2012) [2] also reported protein content in wheat grain significantly influenced in different varieties.

Table 1: Effect of varieties and nutrient management on quality of wheat grain and protein yield

Treatments	Protein content (%)	Hectolitre Weight (kg/hl)	Sedimentation Volume (CC)	Beta Carotene (ppm)
Varieties				
V_1	10.43	77.25	40.13	3.11
V_2	10.70	77.59	42.78	2.81
V_3	10.76	78.25	43.22	2.75
V_4	10.56	77.46	41.59	3.28
S.Em±	0.12	0.17	0.26	0.07
CD (P=0.05)	NS	0.51	0.79	0.20
Nutrient management				
N_1	9.93	76.45	40.21	2.35
N_2	10.84	78.56	43.69	3.27
N_3	10.87	78.85	44.08	3.38
N_4	10.58	77.10	41.45	2.61
N_5	10.69	77.69	42.36	2.92
N_6	10.76	77.81	42.72	3.01
S.Em±	0.15	0.19	0.29	0.08
CD (P=0.05)	0.42	0.56	0.83	0.22

V_1: PBW 502; V_2: Raj 4037; V_3: WH 1105; V_4: HD 2967; N_1: farmers' practice; N_2: 100% RDF; N_3: 100% RDF + *Azotobacter* + PSB; N_4: 75% RDF + *Azotobacter* + PSB; N_5: 75% RDF + *Azotobacter* + PSB + $ZnSO_4$; N_6: 50% RDF + 25% N through organic manure + *Azotobacter* + PSB + $ZnSO_4$.

Significantly higher values of hectolitre weight and sedimentation volume were recorded with variety WH 1105 as compared to other varieties. While, minimum values of hectolitre weight and sedimentation volume were observed in variety PBW 502. It might be due to the fact that different genotypes had different diastatic power which is an indicator of enzymatic activity in wheat flour. Further, variety HD 2967 recorded significantly higher beta carotene content than other wheat varieties. Results of the present investigation are in close agreement with Kumar *et al.* (2018) [13].

Moreover, wheat quality parameters were influenced by nutrient management practices (Table 1). Application of 100% RDF + *Azotobacter* + PSB recorded significantly higher grain protein content. This might be due to increased availability of nitrogen to plants and as the nitrogen is the major component of amino acids, it leads to protein synthesis.

Akram *et al.* (2017) [1] also reported that nitrogen increased the grain protein content in wheat. Similarly, higher hectolitre weight was obtained with 100% RDF + *Azotobacter* + PSB. The hectolitre weight reflects the conditions during the grain filling period of the crop and higher availability of nutrients ultimately enhanced the value of hectolitre weight. Sardana *et al.* (2005) [17] reported that increased hectolitre weight was obtained with increasing nitrogen levels. Moreover, maximum values of sedimentation volume and beta carotene were also obtained with application of 100% RDF + *Azotobacter* + PSB. This might be attributed to the fact that biofertilizer application in association with higher nitrogen dose leads to increased amino acid synthesis which enhanced protein content and grain hardness, which further contributed to increase in sedimentation value. Further, higher value of nitrogen application with biofertilizer enhanced the absorption of nutrients by wheat grain which improved the value of beta carotene in wheat grain. Mattas *et al.* (2011) [16] reported that beta carotene in durum wheat increased significantly with raising levels of nitrogen.

Nutrient content and uptake

Different wheat varieties failed to cause significant variation for nitrogen, phosphorus and potassium content in wheat grain and straw (Table 2).

Table 2: Effect of varieties and nutrient management on nitrogen, phosphorus, and potassium content in grain and straw of wheat

Treatments	N content (%)		P content (%)		K content (%)	
	Grain	straw	Grain	straw	Grain	straw
Varieties						
V_1	1.669	0.596	0.395	0.078	0.412	1.365
V_2	1.713	0.624	0.414	0.080	0.423	1.383
V_3	1.721	0.629	0.418	0.080	0.427	1.393
V_4	1.690	0.614	0.406	0.079	0.419	1.377
S.Em±	0.016	0.007	0.006	0.001	0.008	0.015
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Nutrient management						
N_1	1.589	0.566	0.367	0.073	0.372	1.288
N_2	1.734	0.638	0.425	0.082	0.435	1.411
N_3	1.739	0.643	0.426	0.082	0.437	1.417
N_4	1.694	0.603	0.400	0.078	0.421	1.372
N_5	1.711	0.617	0.412	0.079	0.427	1.390
N_6	1.722	0.625	0.416	0.080	0.429	1.397
S.Em±	0.019	0.009	0.008	0.001	0.009	0.019
CD (P=0.05)	0.054	0.024	0.022	0.003	0.027	0.053

V_1: PBW 502; V_2: Raj 4037; V_3: WH 1105; V_4: HD 2967; N_1: farmers' practice; N_2: 100% RDF; N_3: 100% RDF + *Azotobacter* + PSB; N_4: 75% RDF + *Azotobacter* + PSB; N_5: 75% RDF + *Azotobacter* + PSB + $ZnSO_4$; N_6: 50% RDF + 25% N through organic manure + *Azotobacter* + PSB + ZnSO4.

However, significantly higher uptake of nitrogen, phosphorus, potassium was recorded by variety WH 1105 as compared to other varieties (Table 3). This might be attributed to the genetic potential of nutrient content and uptake. The uptake of nutrients by the crop depends upon the dry matter production and nutrient content in plant parts. Thus, improvement in both of these ultimately led to higher uptake of nitrogen, phosphorus, potassium.

Further, application of 100% RDF + *Azotobacter* + PSB recorded significantly higher nitrogen, phosphorus and potassium content in grain and straw as compared to other nutrient management practices (Table 2). Similarly, higher uptake of nitrogen, phosphorus and potassium by grain and straw was under application of 100% RDF + *Azotobacter* + PSB (Table 3). Goyal (2002) [10] reported that recommended dose of fertilizer with biofertilizers enhanced efficiency of nutrients, thus maintained synergistic interaction. The uptake of nutrients usually follows the yield pattern. The amount of nutrients taken up per unit amount of biomass production determine the yields, as the essential nutrients are involved in the metabolism of the plants (Choudhary *et al.*, 2006; Chesti *et al.*, 2013) [4, 3].

Table 3: Effect of varieties and nutrient management on nitrogen, phosphorus, and potassium uptake by grain and straw.

Treatments	N uptake (kg/ha)		P uptake (kg/ha)		K uptake(kg/ha)	
	Grain	straw	Grain	straw	Grain	straw
Varieties						
V1	65.1	33.6	15.41	4.37	16.0	76.9
V2	76.2	41.1	18.42	5.28	18.8	91.2
V3	77.3	41.9	18.78	5.33	19.1	92.7
V4	70.7	37.6	17.00	4.85	17.5	84.4
S.Em±	0.75	0.54	0.23	0.07	0.21	1.22
CD (P=0.05)	2.11	1.53	0.64	0.20	0.60	3.42
Nutrient management						
N1	61.3	31.3	14.20	4.05	14.3	71.1
N2	78.0	42.7	19.11	5.48	19.5	94.4
N3	78.6	43.2	19.31	5.53	19.7	95.1
N4	68.9	35.7	16.29	4.64	17.1	81.2

N5	73.0	38.9	17.61	5.01	18.2	87.6
N6	74.1	39.6	17.91	5.05	18.4	88.3
S.Em±	0.92	0.67	0.28	0.09	0.26	1.49
CD (P=0.05)	2.58	1.87	0.79	0.24	0.73	4.19

Conclusion
Wheat variety WH-1105 with application of 100% RDF + *Azotobacter* + PSB found superior in term of quality parameters, and nutrient content as compared to other varieties under various nutrient management options.

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Conflict of Interest
The authors declare no conflict of interest.

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