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Quality Parameters of Wheat (*Triticum aestivum*) as Affected by Use of *Azotobacter* spp and *Streptomyces badius*

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A B S T R A C T

A study was carried out at Student's Farm, School of Organic Farming, Punjab Agricultural University, Ludhiana and PAU Regional Research Station Bathinda, during *rabi* 2018-19. The experimental sites were normal soil pH and electrical conductivity, low in organic carbon and available N and medium in available P and K on both locations. The investigation consisted of 13 treatments each having different levels of nitrogen and phosphorus and two methods of biofertilizers application that were seed treatment and soil application. Results revealed that highest nutrients were found in treatments where 12.5 and 25 % less dose of chemical fertilizers with combination of biofertilizers were applied. Means biofertilizers have capacity to supply nutrients to plants even with less doses of chemical fertilizers. The results showed a higher uptake of Nitrogen, Phosphorus, Potassium and grain quality parameters like 1000-grain weight, grain appearance, grain hardiness were found in treatments where 12.5 and 25 % less chemical fertilizers were applied with biofertilizers.

Introduction

Wheat (*Triticum aestivum* L.) is an annual plant of poaceae family and one of the most important and strategic crops in the world contributing nearly about 30% of global cereal production with an area of 306 m ha and average productivity of 3.21 t ha^{-1} (FAO 2017). Wheat grain is the major food of people and supply roughly 70% calories and 80% protein of human diet. It contains 12 % protein which is higher than other cereals (Kumar *et al.,* 2011). It acts as a staple food especially for north and north western part of India and rank fourth in production after Russia, USA and China and produced 101.20 m t of wheat from an area of 29.55 m ha with an average yield of 34.24 q ha^{-1} in 2018-19.The major wheat producing states include Punjab, Haryana, Uttar Pradesh and Madhya Pradesh. Punjab is called the "Granary of India" and produces 20% of India's wheat. During 2018-19 it was grown on area of 3.52 m ha with production of 18.21 m t and productivity of 51.73q ha^{-1} (ICAR, Director Report 2019).

Biofertilizers are living cell containing microbes which improve the uptake and solubility of plant nutrients by increasing root surface area through colonization of plant rhizosphere and facilitates nutrient. These are

considered as precious constituent of sustainable agriculture in integrated plant nutrient management as well as holding enormous pledge in increasing the yield of crop plants (Narula *et al.,* 2005). Biofertilizers play a significant role in improving soil fertility by fixing atmospheric nitrogen both in association with plant roots and without it, solublise insoluble soil phosphates and produces plant growth substances in the soil. They are in fact being promoted to harvest the naturally available, biological system of nutrient mobilization. It has been perceived that the soil contain free living microscopic organisms which are able to fix nitrogen non-symbiotically.

The non symbiotic nitrogen fixer *Azotobactor* sp. has found to be beneficial for a wide range of crops due to its ability to fix atmospheric nitrogen, production of Indole Acetic Acid and fixation of atmospheric nitrogen, antibiotic production, siderophore production (Anjum *et al.,* 2007).

Likewise, soil bacteria which belonging to the *Streptomyces* group have potential to produce various substances like enzymes, enzyme inhibitors, plant growth promoters, alkaloids and vitamins. These bacteria support symbiosis, better growth and resistance to various biotic and abiotic stresses.

Materials and Methods

The experiment was conducted at Student's Farm, School of Organic Farming, Punjab Agricultural University, Ludhiana and PAU Regional Research Station Bathinda, during *rabi* 2018-19. Ludhiana is located in Trans-Gangatic agro-climatic zone and represents the Indo-Gangatic alluvial plains. It is located in 30° 56' N latitude and 75° 52' E longitude at an altitude of 247 m above the MSL. Ludhiana is characterized by sub-tropical semi-arid type of climate with hot summer and cold winters. However, Bathinda is located at 30° 12'N and 74° 56'E at 210 meters above mean sea level and placed in the southwestern region of Punjab. The climate of the place is mainly characterized by a very hot summer, a short rainy season and a bracing cold winter. At both locations the soil was normal in pH i.e. 8.4 and 7.8, low in organic carbon i.e. 0.25 and 0.22, low available N i.e. 140.35 and 135.26 kg ha^{-1} and medium in available P and K.

The experiment was laid out in Randomized Complete Block Design (RCBD) with 13 treatments, viz. T_1:Control, T_2:RDF, T_3:RDF + *Azotobacter* sp. + *Streptomyces badius* (Seed Treatment), T_4: 87.5% N +100% P + *Azotobacter* sp. + *Streptomyces badius* (Seed Treatment), T_5:75% N + 100% P + *Azotobacter* sp. + *Streptomyces badius* (Seed Treatment), T_6:100% N + 87.5% P + *Azotobacter* sp. + *Streptomyces badius* (Seed Treatment), T_7:100% N + 75% P + *Azotobacter* sp. + *Streptomyces badius* (Seed Treatment),T_8: 87.5% N + 87.5% P + *Azotobacter* sp. + *Streptomyces badius* (Seed Treatment), T_9:75% N + 75% P + *Azotobacter* sp. + *Streptomyces badius* (Seed Treatment), T_{10}: RDF + *Azotobacter* sp. + *Streptomyces badius* (Soil Application) T_{11}:87.5%N + 100%P + *Azotobacter* sp. + *Streptomyces badius* (Soil Application), T_{12}: 100%N +87.5% P + *Azotobacter* sp. + *Streptomyces badius* (Soil Application), T_{13} 87.5%N + 87.5% P+ *Azotobacter* sp. + *Streptomyces badius* (Soil Application) and replicated three times. Sowing of wheat variety unnat PBW 343 was done on November 20 and 22, 2018 at Ludhiana and Bathinda, respectively, with *Kera* method using seed rate of 100 kg/ha. All crop management practices were performed as per recommendation of Punjab Agricultural University Ludhiana. Half the dose of nitrogen and full dose of phosphorus and potassium was applied at the time of sowing by broadcasting method. Remaining half

nitrogen was applied by top dressing after first irrigation.

Growth parameters of crop like plant height, dry matter accumulation, leaf area index (LAI), number of tillers and yield contributing characters like effective tillers, ear length, number of grains ear^{-1} were recorded periodically during the crop growth cycle. To study the effect of biofertilizers on growth and productivity of wheat crop data was analyzed under CPCS1 software. Correlation matrix, scatter plot diagrams and regression equations were determined for both the Locations in SPSS stat software.

Results and Discussion

Nutrient content in grain

Nitrogen is vital component of wheat grain. The percentage of protein depends upon the nitrogen content of the grains. From the data, it could be inferred that all the treatment combination had non significant effect on N percentage in grains (Table 1).

However, numerically higher (1.87 and 1.83 %) N concentration was noticed in the treatment having 87.5% N + 87.5% P +*Azotobacter* sp. + *Streptomyces badius* (ST) followed by (1.81 and 1.79 %) 75 % N+ 75 % P+ *Azotobacter* sp. + *Streptomyces badius* (ST) at Bathinda and Ludhiana respectively.

P and K were also non significantly affected by different combinations of treatments. At Bathinda, higher P (0.27%) was noted in 100% N + 75% P + *Azotobacter* sp. + *Streptomyces badius* (ST) and at Ludhiana (0.29%) in 87.5%N + 87.5% P +*Azotobacter* sp. + *Streptomyces badius* (ST). K percentage was highest (0.47 and 0.48%) observed in 87.5%N + 87.5% P + *Azotobacter* sp. + *Streptomyces badius* (ST) on both locations.

Nutrient uptake by grains

Uptake of N by grain was significantly affected with different levels of fertilizers and biofertilizers. Statistically higher (101.73 and 98.91 kg ha^{-1}) nitrogen uptake was noticed in treatments having 12.5% less dose of chemical fertilizers with biofertilizers which were statistically at par with all other treatments except control plot, having no application of fertilizer or chemical fertilizers.

At Bathinda, highest P uptake (14.35 kg ha^{-1}) was observed in 100% N+75% P + *Azotobacter* sp. + *Streptomyces badius* (ST) and at Ludhiana highest (16.26 kg ha^{-1}) was recorded in 87.5 % N + 87.5 % P + *Azotobacter* sp. + *Streptomyces badius* (ST).

Highest K uptake (25.67 and 26.01 kg ha^{-1}) was observed in 87.5 % N + 87.5 % P + *Azotobacter* sp. + *Streptomyces badius* (ST) at Bathinda and Ludhiana, respectively.

Similarly, Kader *et al.*, (2002) obtained higher uptake of N, P and K in grains where biofertilizers were applied. Singh *et al* (2008) also found higher N and P uptake by grains with application of biofertilizers with RDF (Table 2).

Nutrient content in straw

Straw is an important source for animal feed. It contains moderate amount of N and K but little amount of P. Percentage of N, P and K in straw was non significantly affected by biofertilizers.

Higher N (0.55 and 0.52%) was found in 87.5% N 87.5 P+ *Azotobacter* sp. + *Streptomyces badius* (ST) followed by (0.54 and 0.52) 75% N + 75% P+ *Azotobacter* sp. + *Streptomyces badius* (ST) and (0.54 and 0.50%) 100% N + 75% P + *Azotobacter* sp. + *Streptomyces badius* (ST) at Bathinda and Ludhiana consequently (Table 3).

Table.1 Effect of *Azotobacter* sp. and *Streptomyces badius* on nutrient content in grain

Treatments	Nutrient content in grains (%)					
	Nitrogen		Phosphorus		Potassium	
	Bathinda	Ludhiana	Bathinda	Ludhiana	Bathinda	Ludhiana
T_1: Control	1.52	1.61	0.21	0.22	0.34	0.36
T_2: RDF	1.65	1.67	0.23	0.24	0.38	0.38
T_3: RDF+Bio (ST)	1.71	1.72	0.23	0.24	0.38	0.39
T_4: 87.5%N+100%P+Bio (ST)	1.76	1.77	0.25	0.23	0.42	0.41
T_5: 75%N+100%P+Bio (ST)	1.77	1.78	0.24	0.24	0.42	0.40
T_6: 100%N+87.5%P+Bio (ST)	1.73	1.75	0.26	0.25	0.41	0.42
T_7: 100%N+75%P+Bio (ST)	1.69	1.72	0.27	0.26	0.42	0.44
T_8: 87.5%N+87.5%P+Bio (ST)	1.87	1.83	0.25	0.29	0.47	0.48
T_9: 75%N+75%P+Bio (ST)	1.81	1.79	0.25	0.24	0.42	0.42
T_{10}: RDF+Bio (SA)	1.76	1.70	0.24	0.24	0.37	0.46
T_{11}: 87.5%N+100%P +Bio (SA)	1.62	1.71	0.24	0.22	0.35	0.39
T_{12}: 100%N+87.5%P +Bio (SA)	1.77	1.76	0.25	0.25	0.39	0.40
T_{13}: 87.5%N+87.5%P+Bio (SA)	1.66	1.74	0.25	0.26	0.40	0.30
CD (p=0.05)	NS	NS	NS	NS	NS	NS

RDF – Recommended dose fertilizers, ST- Seed treatment, SA-Soil application

Table.2 Effect of *Azotobacter* sp. and *Streptomyces badius* on nutrient uptake by grain

Treatments	Nutrient uptake by grains (kg ha^{-1})					
	Nitrogen		Phosphorus		Potassium	
	Bathinda	Ludhiana	Bathinda	Ludhiana	Bathinda	Ludhiana
T_1: Control	52.72	56.71	7.36	7.68	11.78	12.78
T_2: RDF	79.46	81.64	11.04	11.84	18.27	18.56
T_3: RDF+Bio (ST)	86.76	86.25	12.04	12.34	19.43	19.52
T_4: 87.5%N+100%P+Bio (ST)	90.48	93.39	13.24	12.31	21.99	21.93
T_5: 75%N+100%P+Bio (ST)	90.98	89.8	12.184	12.54	21.62	20.14
T_6: 100%N+87.5%P+Bio (ST)	92.26	94.49	13.86	13.4	21.85	22.52
T_7: 100%N+75%P+Bio (ST)	90.67	93.63	14.35	14.1	22.69	23.98
T_8: 87.5%N+87.5%P+Bio (ST)	101.73	98.91	13.9	16.26	25.67	26.01
T_9: 75%N+75%P+Bio (ST)	97.45	96.71	13.57	13.12	22.93	22.91
T_{10}: RDF+Bio (SA)	86.03	83.3	11.74	11.83	18.51	22.34
T_{11}: 87.5%N+100%P +Bio (SA)	80.24	83.92	11.94	10.85	17.38	19.12
T_{12}: 100%N+87.5%P +Bio (SA)	87.91	86.22	12.26	12.75	19.32	19.67
T_{13}: 87.5%N+87.5%P+Bio (SA)	82.6	86.58	12.85	12.98	20.08	19.62
CD (p=0.05)	22.35	20.14	3.28	NS	5.39	4.94

RDF – Recommended dose fertilizers, ST- Seed treatment, SA-Soil application

Table.3 Effect of *Azotobacter* sp. and *Streptomyces badius* on nutrient content in straw

Treatments	Nutrient content in straw (%)					
	Nitrogen		Phosphorus		Potassium	
	Bathinda	Ludhiana	Bathinda	Ludhiana	Bathinda	Ludhiana
T_1: Control	0.44	0.45	0.11	0.12	0.99	0.96
T_2: RDF	0.46	0.46	0.14	0.13	1.01	0.99
T_3: RDF+Bio (ST)	0.51	0.47	0.13	0.14	1.04	1.03
T_4: 87.5%N+100%P+Bio (ST)	0.53	0.48	0.13	0.13	1.04	1.04
T_5: 75%N+100%P+Bio (ST)	0.51	0.49	0.13	0.13	1.07	0.97
T_6: 100%N+87.5%P+Bio (ST)	0.53	0.50	0.16	0.15	1.05	1.03
T_7: 100%N+75%P+Bio (ST)	0.54	0.50	0.15	0.15	1.04	1.03
T_8: 87.5%N+87.5%P+Bio (ST)	0.55	0.52	0.15	0.15	1.10	1.11
T_9: 75%N+75%P+Bio (ST)	0.54	0.52	0.17	0.14	1.08	1.06
T_{10}: RDF+Bio (SA)	0.47	0.45	0.13	0.14	1.04	1.03
T_{11}: 87.5%N+100%P +Bio (SA)	0.48	0.46	0.13	0.14	1.04	1.06
T_{12}: 100%N+87.5%P +Bio (SA)	0.48	0.48	0.12	0.14	1.05	0.99
T_{13}: 87.5%N+87.5%P+Bio (SA)	0.49	0.49	0.12	0.13	1.06	1.00
CD (p=0.05)	NS	NS	NS	NS	NS	NS

RDF – Recommended dose fertilizers, ST- Seed treatment, SA-Soil application

Table.4 Effect of *Azotobacter* sp. and *Streptomyces badius* on nutrient uptake by straw

Treatments	Nutrient uptake by straw (kg ha^{-1})					
	Nitrogen		Phosphorus		Potassium	
	Bathinda	Ludhiana	Bathinda	Ludhiana	Bathinda	Ludhiana
T_1: Control	19.58	18.57	5.54	4.62	44.08	39.71
T_2: RDF	24.23	23.11	6.80	7.16	53.39	49.65
T_3: RDF+Bio (ST)	29.99	25.28	8.45	7.35	61.35	54.11
T_4: 87.5%N+100%P+Bio (ST)	32.41	26.45	8.24	7.16	62.82	57.23
T_5: 75%N+100%P+Bio (ST)	30.61	26.45	7.70	7.21	63.40	52.39
T_6: 100%N+87.5%P+Bio (ST)	32.53	27.98	9.06	8.93	63.83	57.81
T_7: 100%N+75%P+Bio (ST)	34.07	29.11	9.40	8.56	65.16	59.28
T_8: 87.5%N+87.5%P+Bio (ST)	35.36	31.73	10.03	9.40	70.65	67.38
T_9: 75%N+75%P+Bio (ST)	34.32	30.85	9.36	10.26	67.97	63.56
T_{10}: RDF+Bio (SA)	26.61	23.51	8.08	6.99	59.03	53.00
T_{11}: 87.5%N+100%P +Bio (SA)	27.91	24.20	7.97	6.77	59.15	55.52
T_{12}: 100%N+87.5%P +Bio (SA)	27.62	25.11	8.11	6.45	60.00	52.26
T_{13}: 87.5%N+87.5%P+Bio (SA)	28.70	26.10	7.77	6.40	61.73	53.60
CD (p=0.05)	6.91	6.34	1.74	2.27	8.29	12.38

RDF – Recommended dose fertilizers, ST- Seed treatment, SA-Soil application

Table.5 Effect of *Azotobacter* sp. and *Streptomyces badius* on quality parameters of wheat

Treatments	Protein content %		Grain appearance score		Grain hardiness	
	Bathinda	Ludhiana	Bathinda	Ludhiana	Bathinda	Ludhiana
T_1: Control	8.82	9.30	5.00	5.10	10.14	10.75
T_2: RDF	9.53	9.67	5.00	5.00	9.90	10.55
T_3: RDF+Bio (ST)	9.90	9.96	5.10	4.93	11.12	10.27
T_4: 87.5%N+100%P+Bio (ST)	10.19	10.26	5.06	5.00	9.14	9.64
T_5: 75%N+100%P+Bio (ST)	10.24	10.28	5.00	4.93	10.60	10.89
T_6: 100%N+87.5%P+Bio (ST)	10.01	10.11	4.93	5.06	9.47	9.44
T_7: 100%N+75%P+Bio (ST)	9.76	9.96	5.00	4.86	10.82	11.69
T_8: 87.5%N+87.5%P+Bio (ST)	10.80	10.57	5.20	5.10	10.64	10.59
T_9: 75%N+75%P+Bio (ST)	10.46	10.34	5.33	5.20	10.98	10.86
T_{10}: RDF+Bio (SA)	10.19	9.86	5.30	5.10	10.90	11.71
T_{11}: 87.5%N+100%P +Bio (SA)	9.40	9.92	5.06	5.06	10.23	10.72
T_{12}: 100%N+87.5%P +Bio (SA)	10.24	10.17	4.80	5.10	10.26	11.76
T_{13}: 87.5%N+87.5%P+Bio (SA)	9.61	10.05	5.13	4.93	11.00	11.52
CD (p=0.05)	NS	NS	NS	NS	NS	NS

RDF – Recommended dose fertilizers, ST- Seed treatment, SA-Soil application

Phosphorus percentage was higher (0.15 and 0.15%) in 87.5% N 87.5 P+ *Azotobacter* sp. + *Streptomyces badius* (ST) on both locations. Percentage of K was highest (1.10 and 1.11%) in 87.5% N + 87.5% P+ *Azotobacter* sp. + *Streptomyces badius* (ST).

Nutrient uptake by straw

Data pertaining to N uptake by straw at harvest was presented in Table 4. N uptake by the plants was significantly affected by different combinations biofertilizers and chemical fertilizers.

As compared to control plot statistically higher uptake of N (35.36 and 31.71 kg ha^{-1}) was observed in 87.5% N + 87.5% P+ *Azotobacter* sp. + *Streptomyces badius* (ST) followed by (34.32 and 30.85 kg ha^{-1}) 75% N + 75% P+ *Azotobacter* sp. + *Streptomyces badius* (ST) at Bathinda and Ludhiana location, respectively.

Phosphorus uptake was also significantly affected with biofertilizers. At bathinda, as compared to Control and RDF statistically higher uptake of P (10.03 kg ha^{-1}) was observed in 87.5% N + 87.5% P + *Azotobacter* sp. + *Streptomyces badius* (ST) and 10.26 kg ha^{-1} in 75% N + 75% P+ *Azotobacter* sp. + *Streptomyces badius* (ST) at Ludhiana

Statistically higher potassium (70.65 and 67.38) uptake was observed in 87.5% N 87.5 P+ *Azotobacter* sp. + *Streptomyces badius* (ST) followed by (67.97 and 63.56 kg ha^{-1}) 75% N + 75% P+ *Azotobacter* sp. + *Streptomyces badius* (ST) and (65.16 and 59.28 kg ha^{-1}) 100% N + 75% P + *Azotobacter* sp. + *Streptomyces badius* on both locations.. Wani *et al.*, (2012) also found higher uptake of N and P by straw where biofertilizers were applied.

Quality analysis

Protein content is an important parameter in quality analysis. Generally, wheat contain higher protein content than other cereals. Different doses of chemical fertilizers and biofertilizers non significantly affect the protein content in wheat. But numerically higher protein content (10.80 and 10.57%) was observed in treatment having 87.5% N + 87.5% P with *Azotobacter* sp. and *Streptomyces badius* (ST) followed by (10.46 and 10.34%) 75% N + 75% P+ *Azotobacter* sp. + *Streptomyces badius* (ST). The grain appearance score (GAS), which includes size, lustre, shape and colour of the grains, Grain with good luster, medium size and oval shape etc. are favoured by the end consumer. Properly filled, uniformly shaped, bold, glossy and amber grains have higher GAS. The GAS was given on a scale of 0-10. The data on GAS have been given in Table 5. Nutrient level and biofertilizers have non significant effect on the GAS. In treatment where 25% less application of fertilizers was applied then the RDF, recorded maximum GAS (5.33 and 5.20) at both the locations.

Grain hardness is the superiority character which is used to facilitate wheat classification in soft, hard and *durum* classes. It is also an important character from milling and end use point of view. The grain hardness is estimation of bonding of starch and protein molecules. The data on grain hardness have been presented in the Table 5. Nutrient levels and biofertilizers non significantly affected the grain hardness. At Bathinda, the highest value of grain hardiness was found in RDF + *Azotobacter* sp. + *Streptomyces badius* (ST) and at Ludhiana, it was in 100% N + 87.5% P + *Azotobacter* sp. + *Streptomyces badius* (SA). Similarly, Behera and Rautaray 2010 also obtained non significant effect of biofertilizers on grain quality parameters.

From the research it can be concluded that biofertilizers non-significantly affected the quality parameters in wheat but Quality parameters include grain hardiness, appearance score and protein content**.** Numerically higher Protein content (10.80 and 10.57%) can observed in 87.5% N + 87.5% P with *Azotobacter* sp. and *Streptomyces badius* (ST). Highest value of grain appearance can be obtained in 75% N + 75% P +*Azotobacter* sp. + *Streptomyces badius* (ST), where 25% less dose of chemical fertilizers with biofertilizers was used.

In laboratory, nutrient percentage in grain and straw were analyzed. The N, P and K percentage were found to be non significant. But overall numerically higher N, P and K percentage were found in treatments where 12.5 and 25% less doses of chemical fertilizers with biofertilizer as seed treatment were applied. Uptake of N by grain was significantly affected with different levels of fertilizers and biofertilizers. Statistically higher (101.73 and 98.91 kg ha^{-1}) nitrogen uptake can obtained in treatments having 12.5% less dose of chemical fertilizers with biofertilizers.

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