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Nitrogen Management for Better Yield and Quality of Wheat

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Abstract

The investigation was conducted to study the effect of seed rates and stages of nitrogen application on wheat variety WH-711. Results revealed that splitting of recommended dose of nitrogen improved the grain quality by increasing the quality parameters viz. hectoliter weight,β–carotene content, wet, dry gluten content and total protein content. Higher protein content of 12.68% was obtained at highest value of seed rate (125 kg/ha) and split dose of nitrogen.

Key words : Protein, Sugar, Gluten, Seed rate, Split dose of nitrogen, Wheat.

Wheat is nature's unique gift to mankind as it produces excellent source of nutrition in terms of carbohydrates,minerals and proteins. Globally, wheat is being cultivated over an area of 227 million hectares with a production of 610 million tones. India occupies second place in the world with a total production of 74.8 million tones which is 12% of the world food production from 27.4 million hectares of land (1). The increase in domestic demand of baked and pasta products in the country and economic liberalization and global trade have offered opportunities for better utilization of wheat. Wheat quality needs uppermost attention to meet the trade requirements of the domestic and international markets. Quality of food grain is a complex phenomenon and may be influenced by several factors which may be genetic and/or environmental. Cultural practices considerably influence the grain quality. Nitrogen is the most important constituent of plant proteins and is required throughout the crop growth period from vegetative stage to subsequent harvesting. Application of nitrogen is known to mainly increase the gluten strength, protein content, sedimentation value, protein fractions, pelshenke value. Application of 270 kg N/ha in three equal slits at preplanting, tillering and boot stage increased the grain size, grain density, grain protein content and reduced the yellow berry incidence as compared to its application in single dose. Top dressing of nitrogen at the heading stage gave higher protein content than its basal application (2). Many researchers have found that late season top dressed nitrogen addition as dry fertilizer material was most effective in attaining higher grain protein concentration, yield and increased fertilizer recovery and efficiency (3–5). Therefore, availability of nitrogen to wheat during various phases of its growth and development is an important factor influencing the yield and quality of grain. Seed rate also plays a key role in the grain yield and quality of wheat. Although sufficient information is available on the effect of fertilizers on yield attributes but the information on the effect of time of nitrogen application and seed rate on biochemical parameters is meager. Keeping this aspect in mind, the present investigation was planned with the objectives to study the impact of time of nitrogen application and seed rate on protein, protein fractions and yield of wheat.

Methods

The experiment was conducted during the *rabi* season of 2005–06. WH-711 wheat variety was sown at three different seed rates i.e. 100, 112.5 and 125 kg/ha and nitrogen at 150 kg/ha was applied in split doses as per the following stages : T_0 — No nitrogen, T_1— $^1/_2$ dose at sowing + $^1/_2$ dose at CRI (first irrigation), T_2—1/3rd dose at sowing + 2/3rd dose at first node (40—45 days), T_3—1/4th dose at sowing + $^1/_2$ at first node + 1/4th dose at anthesis (85—90) and T_4—1/3rd dose at sowing + (2/3rd dose –6.9 kg N) at first node + 6.9 kg N as 3 % Urea spray at post anthesis (95—

Table 1. Effect of seed rate and stage of nitrogen application on hectoliter weight (kg/ha) and grain hardness (kg/seed) of wheat cultivar WH-711.

Stage of nitrogen application	Hectoliter weight (kg/ha) Seed rates (kg/ha) 100	112.5	125	Mean	Grain hardness (kg/seed) Seed rates (kg/ha) 100	112.5	125	Mean
T_0 : Control (No nitrogen)	77.21	75.70	76.77	76.56	8.46	10.00	10.43	9.63
T_1 : $^1/_2$ at sowing + $^1/_2$ at CRI	77.85	77.66	77.93	77.81	10.50	11.10	11.60	11.06
T_2 : 1/3 at sowing + 2/3 at 1st node	77.41	77.33	78.20	77.65	11.16	10.76	11.83	11.25
T_3 : $^1/_4$ at sowing + $^1/_2$ at 1st node +$^1/_4$ at anthesis	77.40	79.35	78.82	78.52	11.33	10.33	12.96	11.54
T_4 : 1/3at sowing + (2/3 –7 kg) N at 1st node + 3% urea spray at post anthesis	77.68	77.28	77.14	77.36	10.66	10.00	14.33	11.33
Mean	77.51	77.46	77.77		10.42	10.44	12.23	
LSD 0.05	Seed rate		NS		Seed rate		NS	
	Nitrogen		1.059		Nitrogen		0.957	
	Seed rate × Nitrogen		NS		Seed rate × Nitrogen		2.225	

100 days). Treatment without nitrogen (control) was included for comparison. Hectoliter weight was determined by using the hectoliter weight instrument and values were expressed as kg per hectoliter. Grain hardness was measured by pressing ten average sized well fitted grains in the grain hardness tester (Manufactured by Kiya seisakusho Ltd., Japan). The force was applied to crush the grains by turning the knob. The force (kg) displayed on dial at the time of crushing the grain was recorded. Wet gluten, dry gluten and β-carotene were estimated by the method of AOAC (6). Crude protein was estimated by micro-Kjeldahl's method of AOAC (6).

Results and Discussion

The data pertaining to hectoliter weight and grain hardness as influenced by seed rate and stage of nitrogen application are presented in Table 1. Hectoliter weight varied from 75.70 to 79.35 kg/ha but no significant results were obtained with increase in seed rate. Among stage of nitrogen application treatments, N-application in 3 splits ($^1/_4$ at sowing + $^1/_2$ at first node + $^1/_4$ at anthesis) recorded highest mean hectoliter weight of 78.52 kg/ha, which differed significantly from T_4 which was at par with $T_1$and T_2. The interactive effect of seed rate × stage of nitrogen application was not statistically significant.

Maximum value of grain hardness was observed at 125 kg/ha seed rate i. e. 12.23 kg/grain and is significantly higher than grain hardness observed at 100 (10.42) and 112.5 (10.42) kg/ha seed rate which were at par. The highest and lowest mean value of grain hardness were observed at T_4 and T_0 time of nitrogen application treatments; the per cent increase being 14.84, 16.82 and 19.83 at T_1,T_2 and T_3 treatment respectively. The interaction between seed rate and stage of N-application on grain hardness of wheat was found to be significant. The results obtained in the present study are in conformity of the results reported by previous workers (7—9).

Highest and lowest wet gluten content (Table 2) in wheat was recorded in T_4 (35.08g/100g flour) and T_0 (25.38 g/ 100g flour) respectively. The differences among T_1, T_2 and T_3 were however, not significant. Like wet gluten, dry gluten content in flour was not influenced significantly by different seed rate treatments, highest and lowest dry gluten content was observed in T_4(11.48 g/100 g flour) and T_0 (8.43 g/100 g flour) respectively. The interaction between seed rate and stage of nitrogen application on dry gluten content was also found to be non-significant.

A high degree of positive correlation existed between nitrogen application and wet and dry gluten content. Anureet (4) reported that the application of nitrogen at 125 kg/ha increases the percentage of wet gluten content by 8—9%, which further increased by foliar spray to about 10%.

Table 2. Effect of seed rate and stage of nitrogen application on wet gluten (g/100 g flour) and dry gluten (g/100 g flour) of wheat cultivar WH-711.

Stage of nitrogen application	Wet gluten Seed rates (kg/ha) 100	112.5	125	Mean	Dry gluten Seed rates (kg/ha) 100	112.5	125	Mean
T_0 : Control (No nitrogen)	8.46	8.30	8.53	8.43	25.50	25.20	25.46	25.38
T_1 : $^1/_2$ at sowing + $^1/_2$ at CRI	10.16	10.23	10.30	10.23	31.43	30.96	29.63	30.67
T_2 : 1/3 at sowing + 2/3 at 1st node	10.00	10.83	9.93	10.25	30.33	33.26	30.83	31.47
T_3 : $^1/_4$ at sowing + $^1/_2$ at 1st node + $^1/_4$ at anthesis	9.77	10.26	9.96	10.00	30.06	30.80	30.13	30.33
T_4 : 1/3 at sowing +(2/3 –7 kg) N at 1st node + 3% Urea spray at post anthesis	11.10	11.70	11.66	11.48	34.73	35.30	35.23	35.08
Mean	9.90	10.26	10.08		30.41	31.10	30.26	
LSD 0.05	Seed rate		NS		Seed rate		NS	
	Nitrogen		0.507		Nitrogen		1.858	
	Seed rate × Nitrogen		NS		Seed rate × Nitrogen		NS	

Grain yield was significantly higher at 125 kg/ha and 112.5 kg/ha as compared to 100 kg/ha seed rate (Table 3). Splitting of recommended dose of nitrogen at T_4 increased the grain yield by 4.1% (43.5 q/ha) than the grain yield obtained (41.7 q/ha) at T_1. Increase was due to higher number of plants and more number of tillers per meter row length. The similar response of decrease in yield with decreasing seed rates have been reported by various workers (4,5,7). Protein content as affected by seed rate and stage of nitrogen application is shown in Table 3. Among seed rates, 112.5 kg seed rate/ha recorded significantly higher protein content in WH-711 as compared to 100 (1.34 g/100 flour) and 125 kg/ha (11.35 g/100 g flour) seed rates which were at par. Under all seed rates, T_4 treatment (12.68 g/100 g flour) showed higher value of protein content as compared to T_3. In WH-711, mean values of protein content were 10.23, 11.55 and 12.68 g/100 g flour under T_0, T_2 and T_4 stage of nitrogen application treatments respectively. The grain yield increased with increase in split doses of nitrogen and seed rate. The interactive effect of seed rate

Table 3. Effect of seed rate and stage of nitrogen application on total protein content (g/100 g flour) and grain yield (q/ha) of wheat cultivar WH-711.

Stage of nitrogen application	Total protein content (g/10 g flour) Seed rates (kg/ha) 100	112.5	125	Mean	Grain yield (q/ha) Seed rates (kg/ha) 100	112.5	125	Mean
T_0 : Control (No nitrogen)	10.13	10.30	10.26	10.23	20.4	22.4	21.9	21.5
T_1 : $^1/_2$ at sowing + $^1/_2$ at CRI	11.43	11.43	11.16	11.34	40.4	41.0	43.6	41.7
T_2 : 1/3 at sowing + 2/3 at 1st node	11.23	11.53	11.13	11.30	38.1	42.9	43.1	41.4
T_3 : $^1/_4$ at sowing + $^1/_2$ at 1st node + $^1/_4$ at anthesis	11.33	11.90	11.43	11.55	40.3	41.4	43.8	41.8
T_4 : 1/3 at sowing + (2/3 –7 kg) N at 1st node + 3% Urea spray at post anthesis	12.56	12.73	12.76	12.68	40.2	43.7	46.6	43.5
Mean	11.34	11.58	11.35		35.9	38.3	39.8	
LSD 0.05	Seed rate		NS		Seed rate		1.9	
	Nitrogen		0.506		Nitrogen		3.7	
	Seed rate × Nitrogen		NS		Seed rate × Nitrogen		NS	

and stage of nitrogen application on total protein content was not statistically sound. In the present investigation, the content of protein increased significantly with increasing dose of nitrogen application, though the seed rate did not produce any significant difference. This is supported by the study conducted by various workers (10–14).

Based on these results, it can be concluded that although grain yield and protein content have a negative correlation, but this belief is not true in nutritional studies as the higher grain yield and better grain quality in terms of protein content and hectoliter weight can be increased side by side through proper management and timely application of nitrogen. When the nitrogen is applied in splits crop do not suffer at any stage of development due to nitrogen deficiency rather increased supply at the time of higher demand give better results.

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