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Effect of nitrogen application on grain yield and incidence of grain mottling of durum wheat (*Triticum durum*)

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ABSTRACT

A 2-year field investigation was conducted on sandy-loam soils of Gurdaspur, to study the influence of nitrogen application on yield and grain mottling incidence on varieties of durum (*Triticum durum* Desf.) wheat. Significant increase in grain and straw yields and reduction in grain mottling were observed with application of nitrogen up to 120 and 160 kg/ha, respectively, though increasing trend of grain yield continued up to 160 kg N/ha in both the years. Differences among different varieties for growth, yield attributes (except 1,000-grain weight), grain and straw yields were also significant. Varieties 'PDW 245' and 'PDW 251' gave the highest grain yield with 160 kg N/ha which was on a par with that of 'PBW 34' and 'WH 912' at the same level of nitrogen. The lowest grain mottling incidence was also recorded in 'PDW 251' when it received 160 kg N/ha. Grain mottling incidence in 'PDW 233' and 'Raj 6513' was also low at 160 kg N/ha.

Key words : Durum wheat, Grain mottling, Nitrogen, Varieties, Yellow berry, Yield

Durum wheat is especially used for preparing instant foods such as noodles, semolina, pasta, vermicelli, spaghetti, *upman,* porridge etc. Due to fast changing food habits, its demand in India is also increasing. Increasing global demand, value-addition potential, better price in the international market and resistance to diseases (karnal bunt, rusts, loose smut) are some of the important factors which make durum wheat as an export commodity.

High incidence of grain mottling (also known as yellow berry, starchiness, non ,vitreousness, mealy endosperm) in durum wheat, which is a physiological disorder caused by excessive starch accumulation, is known to be have an adverse effect on the quality of its end-products (Raath *et al.,* 1995). In the recent past, several varieties of durum wheat have been developed which may have differential response to nitrogen fertilization and may also differ in reaction to grain mottling. Since very meagre information is available on these aspects, this study was undertaken to investigate the effect of N on the grain yield and mottling incidence of recently released varieties of durum wheat.

MATERIALS AND METHODS

The field investigation was conducted on loamy sand (Alfisols-Hablustalfs) soils, low in organic carbon (0.34%), medium in available phosphorus (21.2 kg P_2O_5/ha) and available potassium (140 kg K_2O/ha) at Regional Research Station, Gurdaspur (32°02' N, 75°22' E and 260 m above mean sea-level), during winter season of 1996–97 and 1997–98. A total of 27 treatments, replicated 3 times, were arranged in split-plot design with 3 levels of nitrogen in the main plots and 9 varieties in the subplots (Table 1). The crop was sown in lines 23 cm apart on 19 November in both years and harvested on 13 May in 1997 and 5 May in 1998. Gross and net plot sizes were kept as 12.88 m^2 (8.0 m × 1.61 m) and 8.05 m^2 (7.0 m × 1.15 m) respectively. Half the dose of nitrogen as per the treatments along with 60 kg P_2O_5/ha through urea and diammonium-phosphate, respectively, were drilled at the time of sowing, and the remaining nitrogen as per the treatments was applied after the first irrigation. All the other recommended practices were followed. To record the incidence of mottled grains, sample of 500 grains was taken at random from the bulk produce of the whole plot. The number of mottled grains were counted and expressed in per cent.

Statistical analysis for growth, yield and quality parameters was done (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Nitrogen

Application of 120 kg N/ha significantly increased the grain yield of wheat over 80 kg N/ha, though the increasing trend continued up to 160 kg N/ha (Table 2). Nitrogen at 120 kg/ha increased the mean grain yield by 32.5% over 80 kg N/ha. Similar trend was observed for straw yield. The results confirm the findings of Kumar (1997). Higher dose of nitrogen significantly increased the duration of the crop, resulting in significantly better growth and improvement in spikes/m and grains/spike (Table 1) and consequently increased the grain and straw yields compared to lower levels (Table 2). However, the effect of N on 1,000-grain weight was not significant. Kataria and Bassi (1997) also reported delayed maturity in wheat with increasing levels of nitrogen. Since N is an integral constituent of enzymes, nucleotides and chlorophyll, its increased supply results in taller plants and better development of yield attributes and increased yield owing to increased availability of photosynthates, higher assimilation rate and metabolic activity.

Nitrogen application significantly decreased the incidence of grain mottling (yellow berry) (Table 2). On an average, grain mollting decreased from 69.5 to 42.1 to 19.4% with the increase in dose of N from 80 to 120 to 160 kg/ha. Incidence of yellow berry is highly correlated with grain protein content. Irregular synthesis of protein and high starch accumulation are reported to be the cause of high yellowberry incidence in grains. With the increase in nitrogen doses, prevalence of yellowberry decreases (Sharma *et al.*, 1983; Kumar, 1997). Since nitrogen is an integral constituent of grains, its supply increases the amount of protein formed in grains and

Table 1. Effect of nitrogen and varieties on the growth and yield attributes of durum wheat

Treatment	Days to heading			Days to maturity			Plant height (cm)			Spikes/m			Grains/spike			1,000-grain weight (g)		
	Y_1	Y_2	Mean	Y_1	Y_2	Mean	Y_1	Y_2	Mean	Y_1	Y_2	Mean	Y_1	Y_2	Mean	Y_1	Y_2	Mean
Nitrogen (kg/ha)																		
80	112.0	100.7	106.3	149.3	147.3	148.3	79.1	69.8	74.4	44.3	38.3	41.3	40.6	38.4	39.5	43.1	45.0	44.0
120	112.1	100.4	106.3	153.8	148.3	151.1	81.5	73.9	77.7	54.7	46.6	50.6	43.5	40.2	41.9	42.1	46.5	44.3
160	112.1	100.1	106.1	155.7	151.1	153.4	81.3	75.6	78.5	55.6	49.1	52.4	45.4	41.2	43.3	43.0	45.7	44.4
CD (P =0.05)	NS	NS	NS	0.79	1.39	0.63	NS	2.52	0.94	NS	4.24	4.75	2.5	NS	1.29	NS	NS	NS
Variety																		
'PBW 34'	110.7	99.5	105.1	151.9	148.3	150.1	79.1	71.4	75.2	51.1	40.6	45.9	44.6	40.2	42.4	43.2	47.3	45.2
'PDW 233'	112.1	103.1	107.6	153.0	151.3	152.3	82.0	77.3	79.7	53.4	45.1	49.2	41.2	40.4	40.8	38.0	43.1	40.6
'PDW 245'	111.9	98.9	105.4	154.7	149.8	152.2	82.4	75.9	79.1	50.9	48.0	49.4	43.1	37.9	40.5	42.1	45.9	44.0
'PDW 251'	111.3	98.3	104.8	151.2	147.8	149.5	82.1	69.8	76.0	52.2	44.7	48.5	42.9	38.4	40.7	50.6	46.3	48.4
'WH 912'	115.9	103.0	109.4	155.7	148.1	151.9	83.3	74.8	79.1	53.5	49.8	51.7	38.7	36.6	37.6	42.9	49.5	46.2
'WH 913'	111.6	100.1	105.9	153.0	149.1	151.1	77.9	70.3	74.1	46.3	43.6	44.9	44.6	44.6	44.6	43.3	46.3	44.8
'Raj 6513'	112.0	99.7	105.8	152.5	148.0	150.3	80.3	72.6	76.5	54.7	44.5	49.6	43.1	40.3	41.7	38.6	39.9	39.3
'Raj 6516'	112.1	101.6	106.9	152.3	149.4	150.8	79.7	72.9	76.3	54.8	43.5	49.2	46.5	41.3	43.9	41.6	42.2	41.9
'UPD 52'	111.1	99.5	105.3	153.0	148.4	150.7	79.2	72.8	76.0	46.9	41.9	44.4	44.0	39.5	41.7	45.1	51.2	48.2
CD (P=0.05)	0.68	1.28	0.75	1.15	1.30	0.98	2.20	2.10	1.31	3.90	4.16	2.30	NS	NS	3.84	2.43	1.98	1.67

Y_1, 1996–97; Y_2, 1997–98

consequently grain-mottling incidence decreases.

Varieties

Grain and straw yields of varieties significantly differed (Table 2). In 1996–97, 'PDW 251' gave significantly higher grain yield than all the varieties, whereas in 1997–98 the higher grain yield was registered with 'PDW 245' which was on a par with 'PDW 251' but significantly superior to rest of the varieties. On an average, grain yields of 'PDW 251' and 'PDW 245' were at par with each other but significantly higher than all the other varieties. The lowest grain yield was found in 'Raj 6513' during 1996–97 and in 'PDW 233' during 1997–98. However, the highest straw yield was obtained with 'Raj 6516' and 'WH 912' and the minimum with 'WH 913, and 'PWD 251' during 1996–97 and 1997–98 respectively. Differences in yield among the varieties were due to significant differences among the varieties for maturity duration, plant height, spikes/m and 1,000-grain weight (Table 1). Varieties also significantly differed for days taken for heading and maturity. 'WH 912' took maximum number of days for days taken to heading. Number of days required for maturity were maximum in 'WH 912' in 1996–97 and in 'PDW 233' in 1997–98.

Significant differences among the varieties were observed for grain-mottling incidence (Table 2). It was 37.4–74.7% during 1996–97 and 22.9–45.3% during 1997–98 among the different varieties. On mean basis, the lowest incidence of yellow

Table 2. Effect of nitrogen and varieties of durum wheat on its grain and straw yields and incidence of yellow berry

Treatment	Grain yield (q/ha)			Straw yield (q/ha)			Yellow-berry incidence (%)		
	Y_1	Y_2	Mean	Y_1	Y_2	Mean	Y_1	Y_2	Mean
Nitrogen (kg/ha)									
80	23.5	22.7	23.1	39.7	46.1	42.9	84.6	54.4	69.5
120	32.3	28.9	30.6	52.4	61.4	56.9	51.5	32.8	42.1
160	33.3	30.2	31.8	52.0	67.9	60.0	19.5	19.3	19.4
CD (P=0.05)	1.28	3.24	1.57	6.0	8.0	3.94	13.7	10.8	6.0
Variety									
'PBW 34'	30.6	27.7	29.2	46.9	55.8	51.3	50.5	42.1	46.3
'PDW 233'	27.7	25.5	26.6	49.5	58.9	54.2	41.0	23.3	32.2
'PDW 245'	30.9	30.6	30.7	45.5	60.1	52.8	60.9	35.6	48.2
'PDW 251'	32.4	28.7	30.6	45.2	55.2	50.2	37.4	22.9	30.2
'WH 912'	30.1	27.9	29.0	47.7	64.1	56.4	58.7	28.9	43.8
'WH 913'	28.0	25.6	26.8	42.3	58.1	50.2	45.2	45.3	45.3
'Raj 6513'	26.6	26.1	26.4	55.0	59.9	57.5	45.7	49.3	47.5
'Raj 6516'	30.8	26.7	28.7	56.1	58.4	57.2	74.7	31.7	53.2
'UPD 52'	30.1	26.8	28.5	44.1	55.6	49.9	52.7	40.6	46.7
CD (P=0.05)	1.93	2.01	1.47	3.60	4.82	2.74	11.6	16.3	8.3

Y_1, 1996–97; Y_2, 1997–98

berry was registered in 'PDW 251' and the highest in 'Raj 6516'. Rao and Bhardwaj (1982) also observed differences in yellow-berry content among the different varieties of durum wheat. This may be bacause of differential behaviour of varieties under particular agro-climatic condition.

Interaction effects

Interaction effect of nitrogen levels and varieties on grain yield and grain mottling (mean data) was significant. Irrespective of the variety, grain yield increased up to 160 kg N/ha except in 'PDW 233' and 'WH 913' where the yield could increase up to 120 kg N/ha (Table 3). Application of 120 kg N/ha significantly increased the yield of all varieties over 80 kg N/ha. Similarly, further increase in yield with application of 160 kg over 120 kg N/ha was also significant in 'PBW 34', 'PDW 245' and 'PDW 251'. Varieties 'PDW 245' and 'PDW 251' gave the maximum grain yield with application of 160 kg N/ha and were at par with 'PBW 34' and 'WH 912', whereas the lowest yield was recorded in 'Raj 6513' when supplied with 80 kg N/ha.

Similar to grain yield, successive increment in N up to the highest level significantly reduced the incidence of grain mottling in different varieties (Table 4). At 160 kg N/ha, the lowest grain mottling was recorded in 'PDW 251', followed by 'PDW 233'. Even at this level of N, grain-mottling incidence was high in 'Raj 6516', being significantly higher than all other varieties at the same level of N. At 120 kg N/ha, the lowest incidence of grain mottling was observed in 'PDW 233', which was at par with that of 'PDW 251'. Rest of the

Table 3. Mean grain yield (q/ha) of different varieties of durum wheat as influenced by nitrogen

N (kg/ha)	Variety								
	'PBW 34'	'PDW 233'	'PDW 245'	'PDW 251'	'WH 912'	'WH 913'	'Raj 6513'	'Raj 6516'	'UPD 52'
80	22.7	23.7	24.8	24.3	22.2	22.5	21.8	24.2	21.9
120	29.9	29.7	32.3	32.3	31.9	30.9	26.4	30.8	31.4
160	34.8	26.4	35.1	35.1	33.0	27.1	31.1	31.2	31.9
CD (P=0.05)					2.54				

Table 4. Incidence (%) of grain mottling in different varieties of durum wheat as influenced by application of nitrogen (mean data of 2 years)

N (kg/ha)	Variety								
	'PBW 34'	'PDW 233'	'PDW 245'	'PDW 251'	'WH 912'	'WH 913'	'Raj 6513'	'Raj 6516'	'UPD 52'
80	69.0	58.4	75.8	46.6	61.9	77.9	85.9	65.8	84.4
120	52.0	24.6	43.7	31.5	47.4	40.4	41.7	58.9	39.4
160	17.8	13.4	24.4	12.5	22.1	17.4	14.8	35.0	16.1
CD (P = 0.05)					14.4				

varieties recorded significantly higher incidence of grain mottling than 'PDW 233' and 'PDW 251' at 120 kg N/ha. Although grain-mottling incidence in 'PDW 233' and 'Raj 6513' was low, these varieties also gave lower yields than the other varieties.

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