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Bread wheat varieties as influenced by different nitrogen levels

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Abstract: Experiment was conducted to determine the effect of different nitrogen levels on four bread wheat varieties (*Triticum aestivum* L.) viz. Inqilab-91, Daman-98, Dera-98 and Punjab-96 at Gomal University, Dera Ismail Khan (NWFP), Pakistan during 2000~2001. The experiment was laid out in split plot design having four replications using a net plot size of 2 m×5 m. Nitrogen doses used were 0, 50, 100, 150 and 200 kg/ha. The results showed that different nitrogen levels had significant effects on plant height, total number of plants/m^2, number of grains/spike, number of spike/m^2, spike weight, biological yield, grain yield and grain protein content. Maximum plant height, total number of plants/m^2, number of spikes/m^2, spike weight, biological yield and grain protein content were observed at 200 kg N/ha. Among wheat varieties Daman-98 had maximum plant height, spike weight, grains/spike, 1000-grain weight, biological yield and grain yield. Inqilab-91 had heavier grains and the most grain protein content, while Dera-98 had the maximum plant population and spikes/m^2. Grain yield and biological yield were statistically similar at doses of 150 kg N/ha and 200 kg N/ha. However, dose of 200 kg N/ha, compared to dose of 150 Kg N/ha, significantly increased the protein content.

Key words: Wheat, Nitrogen, Grain yield, Protein
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INTRODUCTION

Dera Ismail Khan lies in Pakistan's arid zone (71.07° longitude, 31.57° latitude and 500 m above sea level). This zone is in the extreme south of (NWFP) Pakistan at the bank of the River Indus. Dera Ismail Khan is bounded by Sulaiman Range to the West, the Indus River on the East, Marwat and Bhittani Ranges on the North and Vehowa Nala (Punjab) on the South. Besides certain local variability the area is comprised of four basic divisions viz mountains, a series of steeply sloping alluvial fans, the "Daman" imperceptibly sloping piedmonths, and the "Kacha" the flood plains of the Indus River. The soils of the area are calcareous, deficient in organic matter, nitrogen, phosphorus and adequate to marginal in potassium. The climate is arid to semi-arid. It is hot and dry in summer with moderate spells of rain during monsoon season. The mean annual precipitation is 150~250 mm and relative humidity varies from 51% in June to 78% in October (Anonymous, 2002).

Wheat (*Triticum aestivum* L.) belongs to family Poaceae tribe Hordeae. It is the most important winter crop of Pakistan. Wheat is primarily used as a staple food providing more protein than any other cereal crop. It is consumed in many forms like bread, cakes, biscuits, bakery products, and many confectionery products. Its straw is used as animal feed and also for manufacturing paper. Nitrogen plays a vital role in all living tissues of the plant. No other element has such an effect on promoting vigorous plant growth. Abundant protein tends to increase the size of the leaves, and accordingly, to bring about an increase in carbohydrate synthesis. Nitrogen plays a vital role in increasing the yield of the crop. Application of proper amount of nitrogen is considered key to obtain bumper crop of wheat. High nitrogen supply favours the conversion of carbohydrates into proteins, which in turn promotes the formation of protoplasm (Arnon, 1972). Nitrogen comprises 7% of total dry matter of plants and is a constituent of many fundamental cell components such as nucleic acids, amino acids, enzymes, and photosynthetic pigments (Bungard *et al*., 1999). Ayoub *et al*.(1994) reported that spilt N application had little effect on yield, but decreased lodging and spike population, while grain weight increased. Nitrogen application at 120 kg/ha for wheat has been recommended by various research workers (Lathwal *et al*., 1992; Das *et al*., 1993). Geleto *et al*.(1995) reported that spike numbers and grain weight were increased with high level of nitrogen. Singh and Uttam (1992) recorded increased grain yield with increase in nitrogen level.

The author is not aware of any reports of research on the effect of allelopathy of *Eucalyptus camaldulensis* on protein content of wheat under the climatic conditions of Dera Ismail Khan (NWFP) Pakistan. However, various research workers had shown the allelopathic effects on gain yield and yield components of wheat. Putname (1984) reported that *Eucalyptus* species released volatile compounds such as benzoic, cinnamic, and phenolic acids, which inhibit growth of crops and weeds growing near it. Bisal *et al*.(1992), Lisanework and Michelson (1993), Schuman *et al*.(1995) reported that *Eucalyptus camaldulensis* has harmful effects on germination, and seedling growth of wheat, barley, chickpea, mustard and many weeds.

In view of the above findings it was imperative to conduct experiment involving different wheat varieties with regard to their response to low and high nitrogen levels in order to obtain the potential grain yield of these varieties. Another objective was to ascertain the effect of nitrogen application on the protein contents of the tested varieties in the fields surrounded by *Euclyptus camaldulensis* trees since 1967 in Dera Ismail Khan (NWFP) Pakistan’s cilmate. It was very important to know whether the behaviour of nitrogen and/or the wheat grain protein content are adversely affected or not under the above mentioned conditions.

MATERIALS AND METHODS

A field experiment was conducted under the shade of *Euclyptus camaldulensis* trees to determine the effect of different nitrogen doses on four varieties of wheat viz. Daman-98, Punjab-96, Dera-98, and Inqilab-91 at the agronomic research area of the Faculty of Agriculture, Gomal University, Dera Ismail Khan (NWFP) Pakistan during 2000~2001. The design used was split plot with four replications. The sub-plot size was 2 m×5 m. Nitrogen was applied at the rate of 0 (control), 50, 100, 150 and 200 kg/ha. Half of the nitrogen was applied at the time of sowing, with the remaining half applied during the initial irrigation. A basal 55 kg/ha dose of phosphorus was applied to all treatment plots before sowing. The crop received five irrigations in all. The crop was irrigated first at the time of tillering and formation of adventitious roots followed by a second irrigation at anthesis stage, a third irrigation at milking stage, a fourth irrigation at the time of spike emergence and a last irrigation at dough stage. The amount of each irrigation was four acre inches, so twenty acre inches of water was applied throughout the growing period of wheat. Weedicide namely, “Quatro”, at the rate of 1.8 liter per hectare was sprayed before the tillering stage of wheat to control weeds. Urea and single super phosphate were used as source of nitrogen, and phosphorus, respectively. All other agronomic practices were kept uniform for all treatments.

Parameters observed during the course of study were:

1. Final plant height (cm) at maturity

Twenty tillers were selected at random from each plot at 3 places, their heights were measured in cm and means were taken.

2. Number of plants/m^2 and spikes/m^2

An area of 1 m^2 was selected at random at 3 places in each plot to count total number of plants and spikes, average was used in the statistical analysis.

3. Spike length (cm) and grains per spike (No.)

Ten spikes were randomly selected from each unit area in each plot. Each spike was measured with scale from the base to the apex to record the spike length in cm. To record the grains per spike, each spike was threshed separately and grains of each spike were counted and averaged.

4. 1000-grain weight (g)

Thousand grains were counted at random from each plot and their weights were taken with a spring balance.

5. Biological yield (t/ha) and grain yield (t/ha)

Whole plots were harvested and tied into bundles. Biological yield was recorded by weighing the bundles of each plot with spring balance.

The bundles were first sun-dried and then threshed by a thresher. The grain weight was recorded in kg and then subsequently converted into t/ha.

6. Grain protein content (%)

Grain protein contents were determined by Microkjeldahl method by taking sample of 500 seeds from each plot and grinding them. The digestion was done by Gunning and Hibherds H_2SO_4 method (Ahmad *et al*., 2001) and distillation was done by Microkjeldahl apparatus (Jackson, 1962) to determine seed nitrogen contents. Thereafter protein content was calculated by multiplying nitrogen contents in seed with a constant factor of 5.71 (Peter and Young, 1980).

Data recorded were analyzed using ANOVA technique (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

Plant height (cm)

Table 1 data show that there were significant differences in plant height among the four wheat cultivars i.e. Daman-98, Punjab-96, Dera-98 and Inqilab-91. The amount of nitrogen also significantly affected plant height. Interaction was non-significant among the four cultivars and the five nitrogen doses. Plant height increased, with increasing nitrogen level from the control level to 200 kg/ha. Maximum plant height (82.2 cm) was recorded when nitrogen dose was 200 kg/ha, while minimum plant height (65.6 cm) was recorded in the control. The plant height for the four cultivars averaged over doses of nitrogen showed that Daman-98 had maximum plant height (87.4 cm) while Dera-98 had the minimum plant height (63.3 cm). The interaction between nitrogen and the cultivars was found to be non-significant. However, maximum plant height (92.8 cm) was recorded for Daman-98 when nitrogen dose was 150 kg/ha, while Dera-98 had minimum plant height (53.5 cm) with 0 kg/ha N was applied. These results are supported by the findings of Saleem (1987) and Khan *et al*.(2000) who reported that increasing the level of nitrogen increased the plant height.

Plant population per meter square

Table 2 data show that there were significant differences in plants per meter square of the four wheat cultivars. The amount of nitrogen also significantly affected the number of plants per meter square. Interaction among the four cultivars and the five nitrogen doses was non-significant. Number of plants per meter square increased from the control level of nitrogen to 200 kg/ha. Maximum number of plants per meter square (351.4) was recorded when dose was 200 kg/ha. While the minimum number of plants per meter square (189.8) was recorded in control. The tillers per meter square for the four cultivars averaged

Table 1 Plant height (cm) in wheat varieties as affected by different nitrogen levels

Nitrogen levels (kg/ha)	Daman-98	Punjab-96	Dera-98	Inqilab-91	Means
0	78.5*	64.9	53.5	65.7	65.6c
50	86.7	80.4	60.6	77.6	76.3b
100	91.0	85.9	68.7	82.6	82.0a
150	92.8	81.0	65.7	84.8	81.1a
200	87.8	85.9	67.8	87.2	82.2a
Means	87.4a	79.6b	63.3c	79.6b	

*Non-significant; *CV*.=8.15%; Means not sharing a letter in common differ significantly at 5% level of probability

Table 2 Plant population/m² of wheat varieties as affected by different nitrogen levels

Nitrogen levels (kg/ha)	Daman-98	Punjab-96	Dera-98	Inqilab-91	Means
0	158.3*	152.8	211.8	236.5	189.8c
50	219.5	234.3	306.0	323.3	270.8b
100	267.5	315.5	373.3	310.3	316.6ab
150	279.3	278.8	333.5	336.5	307.0ab
200	281.6	299.0	456.8	368.5	351.4a
Means	241.2 b	256.1b	336.3a	315.0ab	

*Non-significant; *CV*.=20.51%; Means not sharing a letter in common differ significantly at 5% level of probability

over doses of nitrogen showed that Dera-98 produced the maximum number of plants per meter square (336.3) followed by Inqilab-91 (315) and Punjab-96 (256.1). Daman-98 produced the lowest number of plants per meter square (241.2).

Interaction between the nitrogen and the cultivars was found to be non-significant. However, maximum number of plants per meter square (456.8) was produced by Dera-98 when the dose was 200 kg/ha, while Punjab-96 grown with 0 kg N/ha produced the lowest number of fertile tillers per meter square (152.8). Tiller production is considered as an inherent genotype features but Bhorghi (2000) reported that by increasing nitrogen at plant level, the biomass increase is associated with larger leaves that stay green longer, tall stems and a large number of tillers surviving to maturity.

Number of spikes per meter square

Table 3 data show that the four wheat cultivars had no significant differences in total spikes per meter square. The amount of nitrogen significantly affected the total number of spikes per meter square. Interaction among the four cultivars and the five nitrogen doses was not significant. Total number of spikes per meter square increased from the control level of nitrogen to 200 kg/ha. The interaction of nitrogen amount with wheat cultivars showed that maximum number of spikes per meter square (315.4) was produced when dose was 200 kg/ha while the minimum number of spikes per meter square (154) was recorded in control. The total number of spikes per meter square for the four cultivars averaged over doses of nitrogen showed no significant differences. The interaction between nitrogen and cultivars was also found to be not significant regarding the total number of spikes per meter square. However, maximum number of spikes per meter square (422.5) was produced by Dera-98 when nitrogen dose was 200 kg/ha while Daman-98 produced with 0 kg N/ha lowest number of spikes per meter square (133). These results confirm the findings of Hussain *et al*.(1984), who observed that increasing nitrogen application increased the number of fertile tillers per unit area. Geleto *et al*.(1995) reported that grain yield is closely related to the number of spikes per unit area. Fertilized plots produced more spikes than the control. Such response can be attributed to the adequate nitrogen availability which might facilitate the tillering ability of the plants, resulting in a greater spike population. Ayoub *et al*.(1994) also reported that spike population increased with increase in nitrogen level.

Single spike weight (g)

Table 4 data show that there were no significant differences in spikes weight of the four wheat cultivars. The amount of nitrogen significantly affected

Table 3 Number of spikes/m^2 of wheat varieties as affected by different nitrogen levels

Nitrogen levels (kg/ha)	Daman-98	Punjab-96	Dera-98	Inqilab-91	Means
0	133.0*	135.8	158.3	189.0	154.0c
50	219.5	227.0	302.5	271.5	255.1b
100	257.3	266.0	344.8	277.5	286.4ab
150	266.5	261.0	282.3	277.3	271.8ab
200	260.3	261.0	422.5	318.0	315.4a
Means	227.3*	230.2	302.1	266.6	

*Non-significant; *CV*.=21.3%; Means not sharing a letter in common differ significantly at 5% level of probability

Table 4 Single spike weight (g) of wheat varieties as affected by different nitrogen levels

Nitrogen levels (kg/ha)	Daman-98	Punjab-96	Dera-98	Inqilab-91	Means
0	3.4*	2.7	2.6	2.6	2.8c
50	3.8	3.1	3.0	2.8	3.2b
100	4.2	3.1	3.1	2.9	3.3ab
150	4.2	2.9	2.6	3.1	3.2b
200	4.2	3.4	3.3	3.2	3.5a
Means	3.9a	3.0b	2.9b	2.9b	

*Non-significant; *CV*.=11.85%; Means not sharing a letter in common differ significantly at 5% level of probability

spike weight. Interaction among the four cultivars and the five nitrogen doses was non-significant. Spike weight increased as amount of nitrogen was increased from the control level to 200 kg/ha. Table 4 shows that maximum spike weight (3.5 g) was produced when the nitrogen dose was 200 kg/ha while the minimum spike weight (2.8 g) was recorded in the control. The spike weight of the four wheat cultivars averaged over doses of nitrogen showed that Daman-98 produced the heaviest spike (3.9 g) while Dera-98 produced the lowest spike weight (2.9 g). The nitrogen levels and wheat cultivars did not interact positively because all nitrogen doses were not significantly different from the spike weight in the control treatment, but these results are in conformity with Khan *et al*.(2000) regarding the effect of nitrogen on the varietal means of spike weight.

Number of grains per spike

Table 5 data show that there were no significant differences in number of grains per spike of the four wheat cultivars. Nitrogen at 0 to 200 kg/ha significantly affected the number of grains per spike. Interaction among the four cultivars and the five nitrogen doses was significant. Application of nitrogen resulted in more grain production per spike as compared to the control. But at higher doses, grain production per spike did not differ significantly from that of the non-fertilized plots. The number of grains per spike of the four wheat cultivars averaged over doses of nitrogen also showed no significant effect. Punjab-96 produced the maximum number of grains per spike (51.8) followed by Dera-98 (51.8) and Inqilab-91 (51.6) while Daman-98 produced the lowest number of grains per spike (50.0). Maximum number of grains per spike (59.1) was produced by Inqilab-91 when dose was 200 kg/ha while Inqilab-91 at 0 kg N/ha also produced the lowest number of grains per spike (43.0 g). These results coincide with the results of Ashraf (1986) who concluded that nitrogen increased the number of grains per spike. Meynard (1987) reported that the number of grains per spike is the best indicator of wheat response to nitrogen and that grains per spike is negatively affected by nitrogen deficiency.

Thousand grain weight (g)

Thousand grain weight is an important yield parameter. Table 6 data show that there were no significant differences in the 1000-grain weight of the four wheat cultivars. The nitrogen levels significantly affected 1000-grain weight. Interaction among the four cultivars and the five nitrogen doses was also found not significant. Nitrogen at high rate produced heavier grains. The thousand grain weight of four wheat cultivars averaged over doses of nitrogen showed no significant differences. These results showed that the 1000 g weight of the four wheat cul-

Table 5 Number of grain/spike of wheat varieties as affected by different nitrogen levels

Nitrogen levels (kg/ha)	Daman-98	Punjab-96	Dera-98	Inqilab-91	Means
0	47.3cd	46.7cd	47.0cd	43.0d	46.0c
50	48.5cd	48.7bcd	48.9bcd	49.7abcd	48.9bc
100	50.7abcd	53.0abc	51.2abcd	53.0abc	51.9ab
150	52.3abcd	58.1ab	55.4bc	53.0abc	54.7a
200	53.4abc	52.8abc	56.2ab	59.1a	55.4a
Means	50.0*	51.8	51.7	51.6	

*Non-significant; *CV*.=10.86%; Means not sharing a letter in common differ significantly at 5% level of probability

Table 6 1000-grain weight (g) of wheat varieties as affected by different nitrogen levels

Nitrogen levels (kg/ha)	Daman-98	Punjab-96	Dera-98	Inqilab-91	Means
0	40.5*	42.5	39.0	42.0	41.0c
50	45.3	46.3	45.8	46.3	45.9ab
100	45.4	45.0	46.2	46.0	45.6ab
150	46.3	46.5	45.9	49.0	46.9a
200	47.2	46.3	46.4	47.0	46.7a
Means	44.9*	45.3	44.7	46.1	

*Non-significant; *CV*.=7.83%; Means not sharing a letter in common differ significantly at 5% level of probability

tivars were Inqilab-91>Punjab-96, Daman-98>Dera-98. It is obvious from these results that an increase in the nitrogen dose resulted in an increase in the grain weight. These results agree with the findings of Chaudhary and Mehmood (1998) who reported that 1000-grain weight of wheat was significantly affected by different nitrogen levels.

Biological yield (t/ha)

The total dry matter produced by a plant as the result of photosynthesis and nutrients uptake, minus that lost by respiration is called biological yield (Shah, 1994). Table 7 shows the biological yield of wheat varieties as affected by nitrogen levels. There were no significant differences in biological yield (t/ha) of the four wheat cultivars. Interaction among the four cultivars and the five nitrogen doses was significant. The biological yield increased as amount of nitrogen applied was increased from the control level to 200 kg/ha. Maximum biological yield (9.6 t/ha) was recorded at 200 kg/ha, which was not significantly different from the recommended dose of nitrogen (100 kg/ha). The biological yield of the four cultivars averaged over doses of nitrogen showed no significant differences. Daman-98 produced the maximum biological yield, which could be attributed to the plant height characteristics, followed by Inqilab-91 (8.3 t/ha) and Punjab-96 (7.0 t/ha). Dera-98 produced the lowest biological yield (6.8 t/ha). The nitrogen levels and the cultivars interacted significantly. These results agree with those obtained by Hayee *et al.*(1989), who concluded that by increasing level of nitrogen increased biological yield. These results confirmed the results of Khan *et al.*(2000) who obtained maximum biological yield in plots treated with 285 kg nitrogen per hectare.

Grain yield (t/ha)

Table 8 data on grain yield show that there were significant differences in grain yield of the four wheat cultivars. The amount of nitrogen also significantly affected grain yield. Interaction among the four cultivars and the five nitrogen doses was found to be significant. Grain yield increased as amount of nitrogen was increased from the control level to 200 kg/ha. The nitrogen levels interacted positively with wheat cultivars.

The highest grain yield of any crop is the result of all positive relationships of the yield components. Fertilizer (especially nitrogen) application enhances the grain yield of wheat varieties.

The different wheat varieties belong to the same *Triticum aestivum* L. species. But the soil nitrogen level was very low (0.02%), the experimental site located in the arid region of the country where organic matter level is low (0.5%) (Table 9).

The results presented in Table 8 reveal that low to high nitrogen application significantly increased

Table 7 Biological yield (t/ha) of wheat varieties as affected by different nitrogen levels

Nitrogen levels (kg/ha)	Daman-98	Punjab-96	Dera-98	Inqilab-91	Means
0	3.8d	2.9d	2.2d	3.6d	3.1c
50	9.3abc	7.4bcd	7.1bcd	8.4bc	8.0b
100	9.8ab	7.9bcd	8.1bc	9.3ab	8.8ab
150	10.0a	7.8bcd	7.6bcd	9.9ab	8.8ab
200	9.8ab	9.3abc	8.9ab	10.5a	9.6a
Means	8.5*	7.0	6.8	8.3	

*Non-significant; *CV.*=22.11%; Means not sharing a letter in common differ significantly at 5% level of probability

Table 8 Grain yield (t/ha) of wheat varieties as affected by different nitrogen levels

Nitrogen levels (kg/ha)	Daman-98	Punjab-96	Dera-98	Inqilab-91	Means
0	1.6d	1.4d	1.6d	1.5d	1.5c
50	4.8abc	4.1bcd	3.9cd	4.4cd	4.3ab
100	4.8abc	4.1bcd	4.4bcd	4.4bcd	4.4ab
150	5.6a	4.3bcd	4.5bcd	5.7a	5.0a
200	5.4ab	4.7bcd	4.5bcd	5.6ab	5.0a
Means	4.4a	3.7b	3.8b	4.3a	

CV.=25.33%; Means not sharing a letter in common differ significantly at 5% level of probability

Table 9 Soil analysis report

No.	Contents	Date	
		Nov. 2000	May 2001
1	pH	8.5	8.5
2	Ecx 10^6 1:5	1200	1300
3	Ca^{2+}+Ma^{2+} (meq*/L)	6.1	6.9
4	CO_3 (meq/L)	Nil	Nil
5	HCO_3 (meq/L)	1.4	0.9
6	Cl (meq/L)	2.3	3.8
7	P ($\times10^{-6}$)	7	7
8	Organic matter (%)	0.5	0.7
9	N (%)	0.02	0.03
10	Lime (% age)	20.3	16.8
11	Gypsum requried (t/ha)	Nil	Nil

Location: Agronomic research area, Faculty of Agriculture D.I. Khan (NWFP) Pakistan; *meq: Milli equivalent

the grain yield over that of the control. Wheat grain yield resulting from application of 50 to 200 kg/ha nitrogen differing insignificantly from each other could be attributed to the low soil organic matter content. Wheat grain yield resulting from nitrogen application at 200 kg/ha did not differ significantly from the yield resulting from application of recommended dose of nitrogen for the area. It was obvious that the low dose was not significantly different from 100, 150 and 200 kg N/ha. This non-significant difference indicates the positive effect of nitrogen supply on wheat. This difference of 0.74 t/ha between the lowest and the highest N dose seems to provide high benefit from a high dose of nitrogen application under the experimental conditions. The application of nitrogen at 200 kg/ha resulted in boosting the grain yield of wheat (*Triticum aestivum* L.). The response of varieties to application of nitrogen at different rates was found to be significant. First, the difference of grain yield can be attributed to variations in the grain yield potential of tested varieties. Second, their different response to differently applied nitrogen. The variety means averaged over the nitrogen levels shows that Daman-98 and Inqilab-91 are varieties superior to Punjab-96 and Dera-98. Both superior and inferior varieties differ significantly from each other but there were non-significant differences within the group. Punjab-96 did not differ significantly from Dera-98 but these two varieties had a lower grain yield than Daman-98 and Inqilab-91, and so, were inferior varieties. The interaction between two factors (N levels×varieties) was statistically significant. The interaction results indicated that except for Inqilab-91, the remaining three varieties showed similar interaction with application of 50 to 200 kg N/ha. The low dose (50 kg N/ha) was significantly different from the high dose of N but it did not differ significantly from the recommended dose of fertilizer (100 kg N/ha).

It can be summarized from these results that all four varieties performed well and showed positive response to the high dose of nitrogen under the climatic conditions of Dera Ismail Khan (NWFP) Pakistan. Nitrogen can be applied at high rate of 200 kg N/ha to any wheat variety without having adverse effect on the recommended yield. These results agree with the findings of Gandapur and Bhatti (1983), Rustam and Yasin (1991), and Bakhsh *et al.*(1999), who reported that by increasing the level of nitrogen, the grain yield was also increased.

Grain protein content (%)

The data regarding the grain protein content in Table 10 data on grain protein content show that there were significant differences in the quality of four wheat varieties tested under the climatic conditions of D.I. Khan (NWFP) Pakistan. The amount of nitrogen also significantly affected the quality of grain protein. Interaction among the four cultivars and five nitrogen doses was found to be significant. Evidently protein content increased as amount of nitrogen was increased from the control level to 200 kg/ha. Maximum grain protein content (14.5%) was noted at the

Table 10 Grain proteins content (%) of wheat varieties as affected by different nitrogen levels

Nitrogen levels (kg/ha)	Daman-98	Punjab-96	Dera-98	Inqilab-91	Means
0	8.7i	8.7i	8.5i	8.6i	8.6e
50	10.8h	11.2h	11.4ef	12.5ef	11.5d
100	11.8fg	12.5ef	12.9de	12.7c	12.5c
150	13.0e	13.2cde	13.9abc	13.5b	13.4
200	13.7bcd	14.1ab	14.5a	14.2a	14.5a
Means	11.6d	11.9c	12.2b	12.3	

CV.=4.09%; Means not sharing a letter in common differ significantly at 5% level of probability highest dose of 200 kg/ha in variety Dera-98. The minimum grain protein content (8.5%) was recorded in the control for variety Dera-98.

The grain protein content of the four wheat cultivars averaged over doses of nitrogen showed that grains of Inqilab-91 contained maximum grain protein content (12.3%) followed by Dera-98 (12.2%) and Punjab-96 (11.9%). Daman-98 produced the lowest grain protein content. These results agree with the findings of Chaudhary and Mehmood (1998) who reported that grain protein content was significantly affected by levels of nitrogen. Guaer *et al*.(1992) concluded that application of N fertilizer increased grain protein content compared with the control in all cultivars. Positive responses to increasing nitrogen have been associated with increase in grain protein content. Inqilab-91 proved to be the best in protein content which might be due to its better genetic response to the applied nitrogen. This was confirmed by Banziger *et al*.(1992), who reported that genotypic variability in grain protein content may be affected not only by physiological traits but also by N supply in the soil. Our finding that protein content varied among the tested varieties confirms the findings of Zhu *et al*.(1991), who reported variation of protein content in seven wheat varieties.

It can be concluded from these results that Inqilab-91 is richer in protein, compared to Daman-98, Punjab-96 and Dera-98 wheat varieties. The results showed that high quality grains of wheat i.e., rich in protein and high grain yield can be obtained only by application of nitrogen at high rates especially in fields surrounded by *Eucalyptus camaldulensis* as its allelopathy had no ill effect on the protein content of wheat.

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