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GRAIN DEVELOPMENT IN WHEAT AS AFFECTED BY DIFFERENT N LEVELS UNDER WARM DRY CONDITIONS

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A field experiment was conducted to study the influence of different doses of nitrogen fertilizer on grain filling, grain yield and yield components of two wheat (Triticum aestivum L.) varieties under warm dry conditions. Data on grain filling rate (GFR) and grain filling duration (GFD) were obtained from successive samples collected after anthesis. With increasing nitrogen application there was almost a linear increase in grain yield and various yield components of both the varieties. Grain filling rate (GFR) was positively influenced by N application and medium level (120 kg N ha^{-1}) gave the maximum GFR. Grain development in the lower part of the spike responded more to N application. Grain filling duration, however, remained unchanged at all levels of N used. Cultivars differed significantly in GFR, leaf area and various yield components. Results suggest that it should be possible to simultaneously improve GFR and grain weight without lengthening the GFD.

INTRODUCTION

Grain yield in wheat is the result of the number of effective tillers, the number of grains per spike and the grain weight. The grain number and weight in spike are determined after anthesis and are strongly influenced by environmental factors (Sinha and Aggarwal, 1980) and availability of photosynthates (Sayed and Gandorah, 1984). Assimilation and partitioning of photosynthates in relation to grain growth are, therefore, of vital importance.

Nitrogen plays a crucial role in the process of grain filling (Green, 1984). Application of nitrogen increases the leaf area index, and may result in increased dry matter production by intercepting more sunlight than a crop without nitrogen fertilizer (Pearman et al., 1978). Nitrogen also increases the number of grains per plant and per unit area (Black, 1982). The objective of this study was to evaluate the influence of nitrogen on the grain development in two wheat varieties under warm dry conditions.

MATERIALS AND METHODS

A field experiment consisting of two wheat varieties (Lu-26S and Pak-81) and three N levels (60,120,180 kg ha^{-1}) was layed out according to spilt plot design with four replications. The varieties were placed in main plots and N levels in sub-plots. Each sub-plot consisted of eight 5 m rows which were 0.25 m spaced. The soil of the experimental area was sandy loam in texture. Nitrogen was applied as urea and basal dose of 30 kg P ha^{-1} in the form of DAP was also applied at sowing. After germination the distance between plants was maintained at 3.0-3.5 cm. Thirty days after germination a sufficient number of main tillers was tagged at random in each sub-plot for subsequent observations.

The samples were collected from four guard rows in each sub-plot for measuring grain filling, the remaining four rows being used for estimation of grain yield and other observations at harvest. Each sample consisting of five main tiller spike from each sub-plot, was taken twice a week. Central 6 spikelets were chopped from each spike and dried at 70°C to constant weight. Grain weight of each sample was taken. The grain filling rate was calculated using formula W2-W1/t2-t1, where W2 and W1 are the grain weights at time t1 and t2 (Sayed and Gandorah, 1984). Grain filling duration was determined as the number of days from anthesis to the day of physiological maturity (maximum grian weight). Two estimates of GFR were obtained for each cultivar. First GFR for the time of rapid fill was estimated over a period of 21 days for LU-26S and 18 days for Pak-81. Second, on the assumption that grain weight is zero at anthesis (t1=0), an average grain filling rate was estimated as W2/t2 where

W2 is maximum grain weight and t2 grain filling duration (GFD).

Five flag leaves were taken just before anthesis from each sub-plot and mean flag leaf area was measured on Leaf Area Meter (LI-Cor,Inc.USA). At harvest, 10 tagged spikes were collected from each sub-plot. After threshing the grains were removed from basal, middle and apical spikelets. The 3rd, 9th and 17th in LU-26S and 3rd, 11th and 20th spiklet in Pak-81, respectively, were used for this purpose. Number and weight of grains from each position were measured and average grain weight was computed. The data were subjected to analysis of variance technique (Steel and Torrie, 1980) and Duncan's Multiple Range Test was applied at 5% probability to compare the treatment means.

RESULTS AND DISCUSSION

Increasing nitrogen level progressively increased the total and fertile tillers per unit area of both the varieties (Table 1). Number of grain per spike of the two varieties significantly increased with 120 kg N ha^{-1}, but application of the higher N leevel (180 kg ha^{-1}) did not increase the grain number further. Grain yield of both the varieties was enhanced with application of higher dose of N, particularly 120 kg N ha^{-1}. The harvest index of LU-26S was not affected by N application while that of Pak-81 was greatly improved by higher N levels indicating greater response of this cultivar to fertilizer application. The grain weight increased at low to medium levels of N (60 to 120 kg ha^{-1}), but further increase in nitrogen level resulted in lighter grain in both the varieties. The N-induced increase in the grain weight was very much dependent upon its position within the ear.

The grain development in lower part of spike was more sensitive to N than at the middle and apical position (Table 2). The grain weight of the basal spikelet increased significantly when N was increased from 60 to 120 kg N ha^{-1}. This increase may be a result of hastened initiation of florets by N (Whingwiri and Stern, 1982) and increased grain

Table 1. *Yield and yield components of two wheat-varieties as affected by different N levels (kg ha⁻¹)*

Parameters	LU-26S			Pak-81		
	N60	N120	N180	N60	N120	N180
Total tillers(m^{-2})	226 c*	256 b	269 a	214 c	326 b	356 c
Fettile tillers(m^{-2})	220 c	252 b	266 a	206 c	321 b	353 a
Grains per spike	44 b	50 a	50 a	66 b	70 a	71 a
Grain weight (mg)	40.0b	50.2a	42.7c	36.2a	39.5 a	33.7 b
Grain yield (q ha^{-1})	26.5c	34.3b	35.6a	26.4b	37.2a	37.4 a
Harvest index	38.4a	38.8a	38.2a	29.8c	37.0a	32.9 b

* The means(under a variety) followed by the same letters do not differ significantly at 5% level.

filling rate (Eichenauer _et al._, 1986). However, the final grain weight depends upon the rate and duration of grain filling. The grain weight increased slowly following anthesis. This was followed by a linear trend of dry matter production until the late stages of grain development. Similar growth patterns for the grain filling period of wheat has been reported by others (Gebeyehou _et al._, 1982; Sayed and Ghandorah, 1984).

Nitrogen, particularly 120 kg ha^{-1}, significantly increased the dry matter production during this period. This increase may be attributed to the increased light

Table 2. *Grain weight (mg) in upper, middle and lower parts of the spike of two wheat varieties at different N levels (kg ha^{-1})*

	LU-26S			Pak-81		
Spike position	N60	N120	N180	N60	N120	N180
Upper	39.4a*	41.3a	42.7a	28.0a	28.6a	30.3a
Middle	45.8a	51.3a	48.5a	38.5a	41.2a	39.9a
Lower	43.0b	48.0a	44.4b	32.4b	37.6a	30.2c

* The means (under a variety) followed by the same letters do not differ significantly at 5% level.

intercepting area, resulting in more production and assimilation of photosynthates (Pearman et al., 1978) and hence increase in grain filling rate (Table 3) resulting in heavier grain weight (Table 1). When the cultivars were supplied with high nitrogen level (180 kg ha^{-1}), GFR and final grain weight decreased which may be attributed to (i) the decreased overall photosynthetic rate due to increased respiration rate of the lower leaves in denser crop which reduces the assimilation of the photosynthates towards grain formation (Pearman et al., 1979) and (ii) the excessive vegetative growth which depletes soil moisture reserves resulting in poor filling of the grains (Donald and Hamblin, 1976). The maximum rate of grain filling was acheived by the cultivar LU-26S (44.9 mg day^{-1}) at medium nitrogen level which was significantly higher than that of Pak-81 (37.4 mg day^{-1}) at the same N level.

Grain gilling duration (GFD) of both cultivars remained unaffected at all nitrogen levels (Talbe 3). Possible reason may be higher temperature during spring which shortens the growing season, as a result plants mature abruptly. LU 26S had slightly longer GFD (36 days) than Pak-81 (32 days) but

Table 3. *Flag leaf area (FLA) and grain filling rate(GFR) and duration (GFD) of two wheat varieties at different N levels (kg ha^{-1})*

	LU-26S			Pak-81		
Parameters	NO60	N120	N180	N60	N120	N180
FLA(cm^2)	7.6 c*	8.2 b	8.8 a	9.6 c	10.6 b	11.0 a
GFR(mg day^{-1})						
(a) Average	29.4 c	32.7 a	30.4 b	26.5 b	28 a	25.9 b
(b) Rapid	39.8 c	44.9 a	43.2 b	34.9 b	37.4 a	34.2 c
GFD (days)	36	36	36	32	32	32

* The means(under a variety) followed by the same letters do not differ significantly at 5% level.

both were statistically at par. As a result of higher grain filling rate and longer duration LU-26S had significantly heavier grains than Pak-81. Most of the previous studies (Gebeyebou et al., 1982; Housley et al., 1982) revealed that duration of grain filling is more important in contributing to higher grain yield than is the rate of grain filling. Many of these studies were conducted under long-season non-stress environments. But under our warm dry conditions. it is not possible to increase GFD. This is supported by the findings of Nass and Reiser (1975) who concluded that in short season areas wheat genotypes with high grain filling rates could produce higher yields.

Inspite of different grain filling rates, both cultivars acheived statistically same grain yield ha^{-1}. The cultivars differed in such a way that LU 26S acheived the same yield with small number of large grains while Pak-81 lid so with large number of small grain. It is concluded that under warm dry conditions, wheat improvement programmes should place amphesis not only on increasing GFR by optimum use of nitrogen fertilizer but also on increasing the number of grains (both per plant and per unit area) simultaneously.

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