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Yield and Yield Components of Wheat Under Inorganic Nitrogen Levels and Their Application Method

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ABSTRACT

A field experiment was conducted to assess the suitable nitrogen (N) levels and placements for the yield and yield traits of wheat. Three N levels (80, 120 and 150 kg ha^{-1}) were incorporated through broadcast, banding, pop-up and foliar. The results showed that banding of 120 kg N ha^{-1} significantly produced lengthy spikes, more grain number per spike, better seed index and maximum grain yield per hectare followed by broadcast, foliar and pop-up N placements. It is concluded that banding of 120 kg N ha^{-1} was better way to apply N fertilizers that resulted in greater wheat yield and yield components.

Key Words: Application methods; Wheat; Nitrogen; Yield

INTRODUCTION

In Pakistan wheat is grown on an area of 8.46 million hectares having the average yield of 2.5 metric tons per hectare (GOP, 2002), which is very low as compared to other wheat producing countries like India, USA and China. There are many factors responsible for decrease in yield; among which fertilizer management is considered as major one. Nitrogen (N) is often the most limiting of all the plant nutrients and wheat is very sensitive as well as responsive to N fertilizers. Nitrogen is an important constituent of proteins; building substances from which the living material or protoplasm of every cell is made. In addition, N is also found in chlorophyll, the green coloring matter of leaves, which enables the plant to capture energy from sunlight in photosynthesis. Excessive N causes lush succulent growth, resulting sometimes in crop lodging, delayed maturity and greater susceptibility to diseases (McKenzie *et al.*, 2002). It has been also reported that the methods of N application have significant effect on the efficiency of nitrogen fertilizer in increasing yield. In Alberta, barley yields increased when N fertilizer was banded (Malhi & Nyborg, 1990), and net returns were also greater to the producer (Handford *et al.*, 1993). Banded fertilizer stimulates plant growth early in the growing season with increased plant N and P content. As drought conditions developed during the season, there were no grain yield differences due to N fertilizer application and N rates; however, straw yield was highest with banding (Jacobsen *et al.*, 1993). Carefoot, *et al.* (1990) reported that difference in grain and N derived from fertilizer were related to immobilization of broadcast ammonium nitrate. This depends on the degree of contact between the fertilizer, crop residue and soil moisture levels. Lower recovery of fertilizer N has been attributed to immobilization of N with surface application of fertilizer (Fredriukson *et al.*, 1982). Previous research has suggests that because of possibilities of increased immobilization of broadcast N, banding fertilizer N below the surface residue layer may be necessary (Malhi, *et al.*, 1988). Efficient use in fertilizer N requires that the contact between fertilizer and crop residue be minimized by placing N below surface (Rice & Symth, 1984). In view of the economic importance of wheat crop and its nutrient management, this study was conducted to assess the appropriate N levels and and their application for achieving satisfactory grain yield.

MATERIALS AND METHODS

The study to assess the appropriate nitrogen levels and placements on yield, and yield attributes of wheat variety Kiran-95 was laid-out at Student Experimental Farm, Sindh Agriculture University, Tandojam, Pakistan. Three nitrogen levels (80, 120 and 150 kg ha^{-1}) were tested through N application by broadcast, banding, pop-up and foliar in randomized complete block design (split plot arrangement) randomizing the nitrogen levels in main plots and N application methods in sub plots. All the cultural practices for area maintenance were adopted uniformly.

Nitrogen Placement Methodologies

Broadcast application. This is general practices used by farmers. In this method, N fertilizer from the available urea source was incorporated on the surface of the soil in three split applications i.e., during land preparation, tillering and booting stage.

Band application. In this method N fertilizer from the urea was applied in narrow strips (single row strip) 5 cm apart and deep from plant in three split applications i.e., during seed drilling, tillering and booting stage.

Pop-up application. In this method N fertilizer was applied in three equal splits. The first split was placed directly with the seed same as seed placed during drilling. However, other

two splits were incorporated during tillering and booting stages as broadcast on moist surface.

Foliar application. Foliar feeding refers to spraying nutrient solution on the foliage. In this method granular urea was dissolved with water and solution was split applied i.e., during 20 days of sowing, 30 days, tillering and booting stages. Data were analyzed using the procedures of Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The statistical analysis of variances for spike length, number of grains per spike, seed index and grain yield per hectare were significantly different under N levels and placements; their interactions were non-significant (Table Ia).

The results of study revealed that N banding significantly produced maximum spike length (9.07 cm), more grains per spike (Table Ib), greater seed index (41.26 g) and highest grain yield (4.49 metric tonne ha^{-1}) followed by N broadcast method. However, minimum values of these parameters were shown by plots where N pop-up practice was adopted.

Among the N levels, 120 kgN ha^{-1} efficiently recorded lengthy spikes (8.35 cm), more grains per spike (42.03), maximum seed index (41.17 g) and highest grain yield (Table Ic,d). However, the values of these characters were at the second and third places in 150 and 80 kg N ha^{-1}.

The interaction between N application methods and nitrogen levels revealed the non-significant differences. However, the values of yield and yield components were higher in the plots where band application of 120 kg N ha^{-1} was applied. The results are supported with the finding of Malik and Kroll (1994), who observed that spike length of wheat crop was greater under N application through band method. Furthermore, Rusan and Pan (1988) reported that spike length increased with increased level of N and P fertilizer and nitrogen application method.

Pramod and Rattan (2002) suggested that the application of urea alone or in various combinations in case of band application or sown seed below soil increased the number of grains per spike. The results are further supported by the similar findings of Haderlein *et al.* (2001).

Khan *et al.* (1985) reported that the performance of different varieties under placement of nitrogen as band application increased the 1000 grain weight. These data are in agreement with the findings of EL-Badry (1995) who noted that the application of N placement with copper fertilizer increased the 1000 grain weight and grain yield.

Malhi and Nyborg (1990) observed that the methods of N application have great effect on the efficiency of its use by the crop in increasing yield. The results are further supported by the findings of Tila *et al.* (1987) reported that highest grain yield was recorded by combined application of N and P with band application method.

Table 1.Yield and yield components of wheat under different nitrogen levels and application methods

a) Spike length (cm)

N application methods	80 kg N ha^{-1}	120 kg N ha^{-1}	150 kg N ha^{-1}	N application methods
Broadcast	7.20	8.33	7.53	7.69 ab
Banding	8.60	9.73	8.86	9.07 a
Pop-up	6.26	7.20	6.67	6.71 b
Foliar spray	6.80	8.13	7.26	7.40 b
N-level mean	7.23 b	8.35 a	7.58 b	-
	N levels	***N application methods***		***NxP***
SE	0.156	0.436		0.375
LSD(5%)	0.612	1.510		-
LSD(1%)	1.016	2.287		-

b) Number of grains per spike

N application methods	80 kg N ha^{-1}	120 kg N ha^{-1}	150 kg N ha^{-1}	N application methods
Broadcast	32.46	46.20	35.96	38.21 ab
Banding	37.43	49.80	45.43	44.22 a
Pop-up	24.76	33.36	25.80	27.98 c
Foliar spray	26.43	38.76	29.16	31.45 bc
N-level mean	30.27 b	42.03 a	34.09 b	
	N levels	***N application methods***		***NxP***
SE	1.340	2.349		4.00
LSD(5%)	5.260	8.130		-
LSD(1%)	8.733	12.32		-

c) Seed index [1000 grain weight (g)]

N application methods	80 kg N ha^{-1}	120 kg N ha^{-1}	150 kg N ha^{-1}	N application methods
Broadcast	28.07	44.46	32.16	35.03 ab
Banding	33.03	49.80	40.96	41.26 a
Pop-up	24.96	33.40	25.73	28.03 b
Foliar spray	27.16	38.90	29.43	31.83 b
N-level mean	28.31 b	41.17 a	32.07 b	-
	N levels	***N application methods***		***NxP***
SE	1.486	2.524		3.851
LSD(5%)	5.834	8.735		-
LSD(1%)	9.674	13.23		-

d) Grain yield (mt ha^{-1})

N application methods	80 kg N ha^{-1}	120 kg N ha^{-1}	150 kg N ha^{-1}	N application methods
Broadcast	3.42	4.85	3.61	3.96ab
Banding	3.74	5.40	4.32	4.49a
Pop-up	2.49	3.31	2.57	2.79c
Foliar spray	3.00	4.30	3.24	3.51b
N-level mean	3.16b	4.46a	3.44b	-
	N levels	***N application methods***		***NxP***
SE	0.32	0.24		0.44
LSD(5%)	0.52	0.82		-
LSD(1%)	0.86	1.24		-

Values with same letter are non-significant at 5% probability level.

In conclusion, banding proved to be a better method to apply N fertilizers and is therefore recommended for fetching greater wheat yield.

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