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Effect of Foliar vs. Broadcast Application of Different Doses of Nitrogen on Wheat

Sohail Sabir, Jehan Bakht, Muhammad Shafi and Wajid Ali shah
Department of Agronomy, NWFP Agricultural University, Peshawar, Pakistan

Abstracrt: In order to study the effect of foliar versus broadcast application of various nitrogen levels on the yield and yield components of wheat, an experiment was conducted at Malakandher Research Farms, NWFP Agricultural University, Peshawar during 1999-2000. Statistical analysis of the data revealed that various doses of nitrogen and their methods of application had a significant effect on plant height, days to heading, days to maturity, number of grains spike^{-1}, productive tillers m^{-1}, spike length, 1000-grain weight, grain and biological yield. Plant height and days to heading were maximum when nitrogen was applied at the rate of 140 Kg ha^{-1}. When the effect of application method was taken into an account, it was observed that foliar application of nitrogen had a profound effect on plant height, days to heading, days to maturity, number of productive tillers m^{-1}, number of grains spike^{-1}, 1000-grain weight, grain yield and biological yield. Foliar application of nitrogen resulted in taller plants, heavier grain and maximum grain yield and biological yield.

Key words: Nitrogen levels, foliar, broadcast, wheat

Introduction

Population of the world in general and Pakistan in particular is increasing very fast. The primary challenge of this century is to meet the urgent need for food and fiber. Wheat plays an important role in Pakistan's economy but its grain yield per hectare is much less than that of the other countries of the world. Continuous cropping without the application of nutrient elements (plant food) not only decreases soil fertility but also causes sustainable decrease in crop yield. Supply of plant food especially nitrogen through fertilizer application is one of the best methods to increase the yield. Due to high importance of fertilizer and the initial role of nitrogen, the present study was conducted to compare soil versus foliar application of various levels of nitrogen in wheat.

Various factors are responsible for better crop harvest, among which use of nitrogenous fertilizers (Lathwal *et al.*, 1992). Campbell *et al.* (1977) reported that both root and shoot growth are reduced when nitrogen becomes limited. Need for balanced fertilizer in achieving true potential from varieties evolved for cultivation was emphasized by Raced and Salim (1992). Chandra *et al.* (1992) reported that Varieties, respond to their genetic makeup and physiological life process. Foliar application of nitrogen results in increased grain protein content and bread making quality of wheat when applied at or after anthesis (Gooding and Davies, 1992). Kettlewell and Juggins (1992) reported that leaf scorch from foliar nitrogen can be controlled by adjusting the number of spray applied. Mean grain yield of wheat increased with increasing nitrogen level. (Awasti and Bham, 1994). Rajput *et al.* (1995) concluded that foliar application in 3 split increased days to heading, maturity, grain and biological yield and gain highest return. Christianson and Lamoth (1995) reported that high rates of nitrogen applied early in growing season stimulated tillering but many of these did not produce spikes. Rimar *et al.* (1996) reported increase in yield when nitrogen was applied in liquid form.

Materials and Methods

An experiment was conducted to study the effect of foliar versus soil application of various doses of nitrogen on the yield and yield components of wheat at Malakandher Research Farms, NWFP Agricultural University, Peshawar during 1999-2000. The experiment was laid out in Randomized Complete Block (RCB) design with split plot arrangements, having four replications. The various levels of nitrogen (0, 100, 120, 140 Kg ha^{-1}) were applied either as soil or foliar application at three different growth stages (3 weeks after sowing, heading and grain formation stage). Wheat variety Bakhtawar- 92 was used in the experiment using standard agronomic practices. For foliar application volume of water was doubled than required for sole spray of water. Data was collected on Days to emergence, days to maturity, days to heading, number of productive tillers m^{-1}, number of non productive tillers m^{-1}, spike length (cm), plant height (cm), number of grains spike^{-1}, 1000-grain weight (g), grain yield (Kg ha^{-1}), biological yield (Kg ha^{-1}) and harvest index(%).

Days to emergence was recorded when more than 80 % plants emerged in each subplot. Days to heading data was collected from the date of sowing till when 80 % heads were emerged in each subplot and was then averaged. Days to maturity data was recorded from the date of sowing till when all the plants get matured in each subplot. To note number of productive tillers m^{-1} data were counted in an area of one square meter in each subplot, the number of productive tillers m^{-1}. Data on non productive tillers m^{-1} was recorded as described for productive tillers m^{-1}. To collect data on spike length, length of five spikes were randomly taken from each subplot and then their length was measured. To record data on grains spike^{-1}, five spikes randomly selected were taken from each subplot, threshed and then number of grains were counted and averaged. From each subplot, 1000-grains were randomly counted and were then averaged to record 1000-grain weight. Grain yield, biological yield and harvest index in each subplot was determined.

$$\text{Grain yield (kg ha}^{-1}) = \frac{\text{Grain yield (kg) subplot}^{-1}}{\text{Area sub plot}^{-1}} \times 10000$$

$$\text{Biological yield (kg ha}^{-1}) = \frac{\text{Biological yield (kg) subplot}^{-1}}{\text{Area sub plot}^{-1}} \times 10000$$

$$\text{Harvest index (H.I)} = \frac{\text{Grain yield}}{\text{Biological yield}^{-1}} \times 100$$

The data collected during the experiment was analyzed according to RCB design and upon obtaining significant differences Least Significant Differences (LSD) test was applied (Steel and Torrie, 1980).

Results and Discussion

Statistical analysis of the data revealed that days to emergence were non significantly affected by different levels of nitrogen and their modes of application (Table 1). However, maximum days to emergence were recorded when nitrogen was applied as broadcast. When different rates of nitrogen were applied as foliar spray, maximum days to emergence were taken by those plots which received nitrogen at the rate of 100 Kg ha^{-1}. While minimum days to emergence were recorded in plots treated with 120 or 140 Kg ha^{-1} (foliar). In case of broadcast application, days

Table 1: Days to emergence, plant height, days to heading and days to maturity as affected by different doses of nitrogen on wheat

Methods of application	Treatment (Kg N ha^{-1})	Days to emergence	Plant height (cm)	Days to heading	Days to maturity
Foliar	0	10.25	64.50a	126.75a	163.75a
	100	10.75	81.00b	128.25b	166.00b
	120	9.75	87.00c	130.25c	168.25c
	140	10.00	100.75d	132.50d	172.00d
Mean		10.18	83.31b	129.44bc	167.50bc
Broadcast	0	10.25	62.75a	125.75a	163.75a
	100	9.50	73.50e	127.00e	165.25b
	120	10.25	80.00b	128.50b	167.25bc
	140	10.75	91.75f	130.75c	169.50e
Mean		10.19	77.00g	128.00b	166.44b
	LSD (0.05)	N.S	2.439	0.5973	0.5041

Mean in the columns followed by different letters are significantly different at $P<0.05$

Table 2: Number of productive tillers^{-1}, number of non productive tillers^{-1}, spike length and grains spike^{-1} as affected by different doses of nitrogen on wheat

Methods of application	Treatment (Kg N ha^{-1})	Number of productive tillers^{-1}	Number of non productive tillers^{-1}	Spike length (cm)	Number of grains spike^{-1}
Foliar	0	253.50a	31.50a	8.25a	41.75a
	100	296.00a	11.25b	11.00b	49.25b
	120	349.50b	9.25b	10.75c	49.00b
	140	368.25b	5.75b	12.50d	46.50b
Mean		316.94b	14.44bc	10.62c	46.62ab
Broadcast	0	234.25ab	23.00d	7.00f	38.75ab
	100	297.00ab	11.75bc	10.00bc	46.50b
	120	325.75ab	10.25bc	10.25bc	46.00b
	140	360.50b	7.00bc	12.00d	48.25b
Mean		304.38b	13.00b	9.81bc	44.87b
	LSD(0.05)	24.50	4.178	0.8007	6.160

Mean in the columns followed by different letters are significantly different at $P<0.05$

Table 3: 1000-grain weight, grain yield, biological yield and harvest index as affected by different doses of nitrogen on wheat

Methods of application	Treatments (Kg N ha^{-1})	1000-grain weight (g)	Grain yield (Kg ha^{-1})	Biological yield (Kg ha^{-1})	Harvest index %
Foliar	0	30.77a	1735a	5548a.00	31.28
	100	40.79b	2758b	8777b	31.45
	120	44.70c	3018b	8663b	34.88
	140	45.96c	3150b	10237c	30.84
Mean		40.56b	2666.25bc	8306.25b	32.11
Broadcast	0	32.20a	1660ab	5272a	31.52
	100	42.04abc	2513bc	8373b	30.12
	120	41.01abc	2822bc	7785bc	36.13
	140	42.45abc	2979bc	9785d	30.63
Mean		39.42abc	2493.50bc	7794bc	32.10
	LSD(0.05)	3.078	399.6	421.2	N. S

Mean in the columns followed by different letters are significantly different at $P<0.05$ NS non-significant

to emergence were maximum when N was applied either at lowest or highest rates (i.e., 0 or 140 Kg ha^{-1}). Days to maturity were significantly ($P\leq 0.05$) affected by nitrogen levels and their modes of application (Table 1). Mean value of the data showed that maximum days to maturity were taken when nitrogen was applied as foliar spray, while minimum days to maturity were observed in case of broadcast. It can be inferred from different levels of fertilizers applied either as foliar or broadcast that maximum (172.00) days to maturity were taken by those plots which received nitrogen at the rate of 140 Kg ha^{-1} (foliar). While control plots in broadcast or foliar application recorded minimum days to maturity. These results agree with those reported by Rajput *et al.* (1995). Analysis of the data indicated that days to heading were significantly ($P\leq 0.05$) affected by different nitrogen levels and their modes of application. It can be seen from the mean values of the data that maximum (129.44) days to heading were recorded when nitrogen was applied as foliar spray while minimum (128.00) days to heading were noted in case of broadcast application. Plots treated with 140 Kg ha^{-1} as foliar spray took maximum (132.50) days to heading. While minimum (125.25) days to heading were recorded in plots treated with 0 Kg ha^{-1}(broadcast). Nitrogen accelerates vegetative growth and due to greater vegetative growth, days to heading are delayed. Similar results are also reported by Rajput *et al.* (1995). Statistical analysis of the data showed that number of productive tillers m^{-1} were significantly ($P\leq 0.05$) affected by different nitrogen levels and their modes of application as presented in Table 2. Mean values of the data revealed that maximum (316.94) productive tillers m^{-1} were produced by those plots which were treated with nitrogen as foliar spray while minimum of 304.38 productive tillers m^{-1} were produced when nitrogen was applied as broadcast method. It is clear from the data that maximum of 368.25 productive tillers m^{-1} were produced by those plots which received nitrogen at the rate of 140 Kg ha^{-1} (foliar), while minimum (234.25) productive tillers m^{-1} were recorded in control plots (broadcast). Shah and Saeed (1989) reported that productive tillers m^{-1} increased significantly in response to increasing foliar application of nitrogen. Number of non productive tillers m^{-1} were significantly ($P\leq 0.05$) affected by different nitrogen levels and their modes of application (Table 2). Data showed that maximum (14.44) non productive tillers m^{-1}

were produced by those plots where nitrogen was applied as foliar spray, while minimum of 13.00 non productive tillers m^{-1} were produced when nitrogen was applied as broadcast. Similarly, control plots in case of foliar spray recorded maximum non productive tillers m^{-1} (31.50). While minimum non productive tillers m^{-1} were noted in those plots treated with 140 Kg ha^{-1} (foliar spray). Statistical analysis of the data also showed that spike length was significantly ($P \leq 0.05$) affected by various nitrogen levels and their modes of application. Mean values of the data revealed that lengthy spikes were produced by those plots when nitrogen was applied as foliar, while shorter spikes were recorded when nitrogen was applied as broadcast (Table 2). It can be inferred from the data that maximum (12.50 cm) spike length was produced when plots were treated with 140 Kg ha^{-1} (foliar), while control plots in case of broadcast noted minimum spike length. Fillipov and Mangora (1992) reported that in winter wheat, spike length was increased by foliar application of N.

Grains $spike^{-1}$ was significantly ($P \leq 0.05$) affected by various nitrogen levels and their methods of application (Table 2). Mean value of the data indicated that highest grains $spike^{-1}$ was produced by those plots where nitrogen was applied as foliar spray. While lowest (44.87) grains $spike^{-1}$ were observed when nitrogen was applied as broadcast. Plots treated with 100 Kg ha^{-1} recorded maximum grain $spike^{-1}$. While minimum (38.75) grains $spike^{-1}$ were produced by control plots (foliar). Sentlhas *et al.* (1987) reported that foliar application of N increased number of

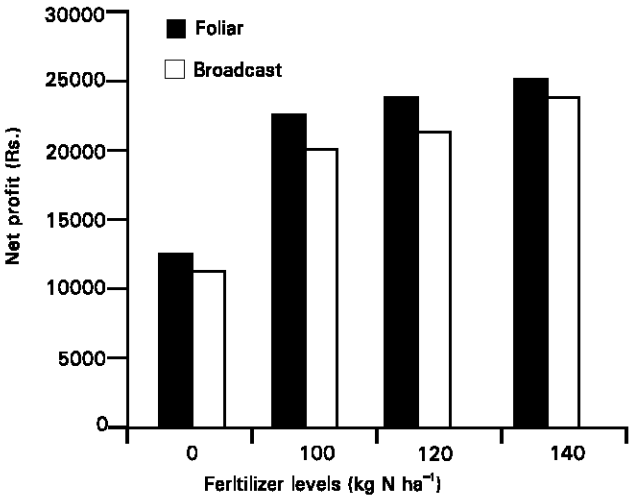

Fig.1: Net profit from different doses of Nitrogen and mode of application on wheat (kg ha^{-1})

grains $spike^{-1}$. Statistical analysis of the data also showed that plant height was significantly ($P \leq 0.05$) affected by various nitrogen levels and their modes of application (Table 1). Taller (83.31 cm) plants were attained, when nitrogen was applied as foliar spray, while shorter (77.00 cm) plants were recorded by broadcast application of N. In case of different fertilizer rates, taller plants were attained by those plots, which received nitrogen at the rate of 140 Kg ha^{-1} either as foliar or broadcast method. While shorter plants were attained by control plots (0 Kg N ha^{-1}). Statistical analysis of the data indicated that thousand grain weight was significantly ($P \leq 0.05$) affected by various nitrogen levels and their modes of application. Heavier (40.56 g) grains were recorded by those plots where nitrogen was applied as foliar spray (Table 3). In case of different fertilizer rates applied as foliar or broadcast, maximum (39.32 g) 1000-grain was recorded by plots treated with 140 Kg ha^{-1}, while minimum (29.69 g) 1000-grain weight was noted in control plots (foliar). Sentlhas *et al.* (1987) and Fillpov and Mangora (1992) reported that foliar application of N increased thousand grain weight. Analysis of the data indicated that different nitrogen levels and their methods of application had a significant ($P \leq 0.05$) effect on grain yield (Table 3). Mean value of the data revealed that maximum (2665.25 kg ha^{-1}) grain yield was produced by those plots where nitrogen was applied as foliar. While minimum (2493.50 Kg ha^{-1}) grain yield was produced where nitrogen was applied as broadcast. It can be seen from the data that maximum (3150.00 Kg ha^{-1}) grain yield was produced by plots treated with 140 Kg ha^{-1} (foliar), while minimum (1660.00 Kg ha^{-1}) grain yield was noted in control plots in case of broadcast. Shah and Saeed (1989) reported that grain yield of wheat increased significantly by foliar application of N. Fathi *et al.* (1990) and Szafranski (1995) reported that highest level of N applied in foliar form increased grain yield.

Statistical analysis of the data indicated that biological yield was significantly ($P \leq 0.05$) affected by various nitrogen levels and their modes of application (Table 3). Mean value of the data indicated that maximum (8306.00 Kg ha^{-1}) biological yield was recorded by those plots, where nitrogen was applied as foliar spray compared to broadcast method. In case of different fertilizer rates applied either foliar maximum (10237.00 Kg ha^{-1}) biological yield was produced by plots treated with 140 Kg ha^{-1} in case of foliar, while minimum (5272.00 Kg ha^{-1}) biological yield were produced by control plots in case of broadcast. Similar results are also reported by Shah and Saeed (1989) and Fathi *et al.* (1990). Analysis of the data indicated that harvest index was non significantly affected by different nitrogen levels and their methods of application (Table 3). Mean values of the data revealed that maximum (32.52 %) harvest index was produced by those plots where nitrogen was applied as foliar spray. While nitrogen applied as broadcast recorded minimum harvest index . It is clear from the data that maximum of 34.84 % harvest index was recorded by plots treated with 100 Kg ha^{-1} (foliar) while minimum (30.12 %) harvest index was recorded by plots treated with 100 Kg ha^{-1} (broadcast).

From the result presented in Fig. 1 it can be concluded that when N is applied at the rate of 140 Kg ha^{-1} as foliar spray had significant increased on all the yield components, thus resulted in an increased net income (26039 Rs.) when compared with other levels of nitrogen and broadcast method.

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