Asian Journal of Plant Sciences

ISSN 1682-3974

science alert

ANSInet
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Asian Journal of Plant Sciences
Volume 1 Number 3: 213-215, 2002

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

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Abstract: In order to study the effect of foliar versus broadcast application of various nitrogen levels on the yield and yield components of barley, 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^{-2}, spike length, thousand grains weight, grain and biological yield. Plant height and days to heading was maximum when nitrogen was applied at the rate of 140 Kg ha^{-2}. When the effect of application method was taken into 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}, thousand grains weight, grains yield, biological yield and harvest index. Foliar application of nitrogen resulted in taller plants, heavier grain and maximum grain yield and biological yield.

Key words: Nitrogen levels, foliar, broadcast, barley

Introduction

Continuous cropping without the application of nutrient elements (plant food) not only decrease 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 barley. 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 barley 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

In order to study the effect of foliar versus soil application of various doses of nitrogen on the yield and yield components of barley, an experiment was conducted 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 (00, 100, 120, 140 Kg ha^{-1}) were applied either as soil or foliar application at three growth stages (3 weeks after sowing, heading and grain formation stage). Barley variety PRB-12 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 the following parameters during the course of the experiment:

Days to emergence, plant height (cm), days to heading, days to maturity, number of productive tillers m^{-2}, number of non productive tillers m^{-2}, spike length (cm), number of grains spike^{-1}, thousand grain weight (g), grain yield (Kg ha^{-1}), Biological yield (Kg ha^{-1}), harvest index and cost benefit ratio.

Days to emergence was recorded when 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 taken from the date of sowing till when all the plants get matured in each subplot. Number of productive tillers m^{-2} data was recorded in an area of one square meter in each subplot by counting the number of productive tillers m^{-2}. Data on non productive tillers m^{-2} was recorded as described for productive tillers m^{-2}. To collect data on spike length, length of five spikes were randomly taken from each subplot and then their length was measured and averaged. To record data on of 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 grains weight. Grain yield of each subplot was taken by threshing the crop and then converted into Kg ha^{-1}. Grain yield, biological yield and harvest index in each subplot was determined and then converted into Kg ha^{-1} according to the following formula.

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

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

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

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 was 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}.In case of broadcast application days, to emergence were maximum when N was applied either at lowest or highest rates (i.e. 0 or 140 Kg ha^{-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). Mean values of the data indicated that maximum (106.35 cm) plant height was attained when nitrogen was applied as foliar spray, while minimum (95.68 cm) plant height was attained 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 ha^{-1}). 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 data that maximum (133.50) days to heading were recorded when nitrogen was applied as broadcast while minimum (122.125) days to heading were noted when nitrogen was applied as foliar spray. Plots treated with 140 Kg ha^{-1} as foliar spray took maximum (125) days to heading. While minimum (118.75) 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). 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 when nitrogen was applied as broadcast. It can be inferred from different

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

Methods of application	Treatments(Kg N ha^{-1})	Days to emergence	Plant height	Days to heading	Days to maturity
Foliar	0	10.00	80.25a	120.00a	157.00a
	100	10.50	105.50b	120.75a	158.75b
	120	9.75	114.25d	122.75b	161.00c
	140	9.75	125.50c	125.00ac	163.75d
Mean		10.00	106.35b	122.12b	160.12e
Broadcast	0	10.50	80.75a	118.75a	156.75a
	100	10.25	91.50b	120.00b	158.00b
	120	10.00	100.00c	122.25c	159.75c
	140	10.50	110.50d	123.50d	161.75d
Mean		10.31	95.69e	133.5e	159.06e
	LSD (0.05)	N.S	2.439	0.5973	0.5041

Mean in the vertical columns followed by different letters are significantly different at P ≤ 0.05, using LSD test.

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 barley.

Methods of application	Treatments (Kg N ha^{-1})	Number of productive tillers	Number of non productive tillers	Spike length (cm)	Number of grains spike^{-1}
Foliar	0	270.25a	21.00a	6.75a	26.75a
	100	307.75b	10.25b	8.50b	33.25b
	120	336.25c	8.25b	9.75c	34.75b
	140	390.75d	5.00b	10.75d	40.00b
Mean		326.25bc	11.125b	8.939b	33.687a
Broadcast	0	242.00e	25.75c	6.00a	27.75a
	100	315.75b	13.75bc	7.75f	30.75ab
	120	313.75b	11.75b	8.50b	32.00ab
	140	356.75f	7.25b	9.50c	36.75b
Mean		307.062b	14.625bc	7.987b	31.812b
	LSD(0.05)	24.50	4.178	0.8007	6.160

Mean in the vertical columns followed by different letters are significantly different at P ≤ 0.05, using LSD test.

Table 3 Thousand grain weight , grain yield, biological yield and harvest index as affected by different doses of nitrogen on barley.

Methods of application	Treatments (Kg N ha^{-1})	Thousand grain weight (g)	Grain yield (Kg ha^{-1})	Biological yield (Kg ha^{-1})	Harvest index (%)
Foliar	0	29.69a	1815a	4819a	37.77a
	100	33.70b	1951a	8187b	23.84b
	120	37.07c	2152a	8142b	26.50b
	140	39.32c	2406a	10596c	22.75b
Mean		34.345ab	2081a	7936b	27.71b
Broadcast	0	31.15ab	1060b	4657a	22.75b
	100	32.36ab	1860a	7864a	23.66b
	120	31.69ab	2113a	7924a	28.68b
	140	35.65c	2318a	10047b	23.07b
Mean		32.712ab	1837. 57a	7623b	24.314b
	LSD(0.05)	3.078	399.6	421.2	7.789

Mean in the vertical columns followed by different letters are significantly different at P ≤ 0.05, using LSD test.

rates of fertilizers applied either as foliar or broadcast that maximum (163.75) days to maturity were recorded by those plots which received nitrogen at the rate of 140 Kg ha^{-1} (foliar). While control plots in broadcast application recorded minimum days to maturity. These results are also reported by Rajput *et al.* (1995). Statistical analysis of the data showed that number of productive tillers m^{-2} were significantly (P≤ 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 (326.25) productive tillers m^{-2} were produced by those plots which were treated with nitrogen as foliar while minimum of 307.062 productive tillers m^{-2} were produced when nitrogen was applied as broadcast method. It is clear from the data that maximum of 390.75 productive tillers m^{-2} were produced by those plots which received nitrogen at the rate of 140 Kg ha^{-1} (foliar) while minimum (242.00) productive tillers m^{-2} were recorded in control plots (broadcast). Shah and Saeed (1989) reported that productive tillers m^{-2} increased significantly in response to increasing foliar application of nitrogen. Analysis of the data shown in Table 2 revealed that number of non productive tillers m^{-2} were significantly (P ≤ 0.05) affected by different nitrogen levels and their modes of application. Data indicated in Table 2 showed that maximum (14.625) non productive tillers m^{-2} were produced by those plots when nitrogen was applied as broadcast while minimum of 11.125 non productive tillers m^{-2} were produced when nitrogen was applied as foliar spray. Similarly, control plots in case of broadcast method recorded maximum non productive tillers m^{-2} (25.75). While minimum non productive tillers m^{-2} were noted in those plots treated with 140 Kg ha^{-1}(broadcast). Statistical analysis of the data also showed that spike length was significantly (P ≤ 0.05) affected by various nitrogen levels and their modes of application. Mean values of the data presented in Table 2 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. It can be inferred from the data that maximum (10.75 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 Mangova (1992) reported that in winter wheat, spike length was increased by foliar application of N. Grains spike^{-1} were significantly (P ≤ 0.05) affected by various nitrogen levels and their methods of application (Table 2). Mean value of the data indicated that highest number of grains spike^{-1} were produced by those plots where nitrogen was applied as foliar spray. While lowest of 31.812 grains spike^{-1} were observed when nitrogen was applied as broadcast. Plots treated with 140 Kg ha^{-1}(foliar) recorded maximum grains spike^{-1}. While minimum (27.75) grains spike^{-1} were produced by control plots in case of broadcast. Sentelhas *et al.* (1987) reported that foliar

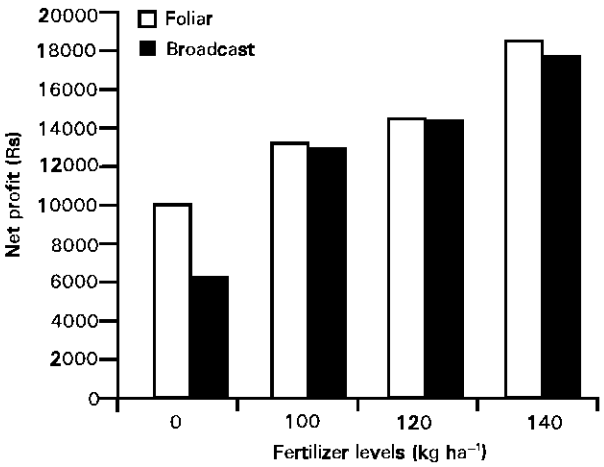

Fig. 1: Net profit from different doses of Nitrogen and different modes of application on barley (ha^{-1})

application of N increased the number of grains $spike^{-1}$. 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. Mean value of the data presented in Table 3 revealed that heavier (34.34 g) grains were recorded by those plots, where nitrogen was applied as foliar spray. In case of different fertilizer rates applied as foliar or broadcast, maximum (39.32 g) thousand grain weight was recorded by plots treated with 140 Kg ha^{-1}, while minimum (29.69) thousand grain weight was noted in control plots (foliar). Sentelhas *et al*. (1987) and Fillipov and Mangova (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 (2081.00 Kg ha^{-1}) grain yield was produced by those plots when nitrogen was applied as foliar. While minimum (1837.75 Kg ha^{-1} grain yield was produced where nitrogen was applied as broadcast. It can be seen from the data that maximum (2406.00 Kg ha^{-1}) grain yield was produced by plots treated with 140 Kg ha^{-1} (foliar) while minimum (1060.00 Kg ha^{-1}) grain yield was noted in control plots in case of broadcast. Shah and Saeed (1989) reported that grain yield of barley increased significantly by foliar application of Nitrogen. Fathi *et al*. (1990) and Szafranski (1995) reported that highest level of N applied in foliar form increased the 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 as presented in Table 3. Mean value of the data indicated that maximum (7936.00 Kg ha^{-1}) biological yield was recorded by those plots where nitrogen was applied as foliar spray compared with broadcast method. In case of different fertilizer rates applied either foliar or broadcast, maximum (10596.00 Kg ha^{-1}) biological yield was produced by plots treated with 140 Kg ha^{-1}in case of foliar, while minimum (4657.00 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 significantly ($P \leq 0.05$) affected by different nitrogen levels and their methods of application (Table 3). Mean values of the data revealed that maximum (27.715%) 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 37.77 % harvest index was recorded by control plots (foliar) while minimum (22.75 %) harvest index was recorded by control plots in case of broadcast or 140 Kg N ha^{-1}(foliar). Data regarding cost benefit ratio is presented in Fig. 1. It is clear from Fig. 1 that when N is applied at the rate of 140 Kg ha^{-1} as foliar spray had a significant effect on all the yield components which resulted in maximum net profit. It can be also inferred from Fig. 1 that net profit was minimum for broadcast application

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