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Evaluation of Wheat Varietal Performance under Different Nitrogen Sources

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Abstract

Nitrogen fertilization plays a very important role for crop productivity. New developed wheat varieties need proper fertilization for improved crop productivity. The present study was carried out to quantify, the effects of nitrogen derived from urea and FYM on the four newly developed wheat varieties *i.e.* Siran-2009, Ata Habib, Janbaz-2009 and Pirsabak-2008 for yield improvement, quality and soil fertility status. The N treatments were control, 100% of the recommended nitrogen from urea as well as FYM, and 50% from each source. The experiment was carried out at New Developmental Farm, Khyber Pakhtunkhwa Agricultural University Peshawar Pakistan, during Rabi 2011-12. Results of the data showed that Janbaz-2009 was more responsive to biological yield (11,011 $kg \cdot ha^{-1}$), grain yield (4339 $kg \cdot ha^{-1}$), and nitrogen use efficiency (14.8%), whereas Siran-2010 performed better for grain N contents (2.31%). Plots having both urea and FYM had improved biological yield (11,958 $kg \cdot ha^{-1}$), and grain yield (4901 $kg \cdot ha^{-1}$). Urea application had improved straw N contents (0.92%) in addition to Mix application of urea and FYM (0.93%). Mix application of both sources and sole FYM had higher grains N content (2.25%), whereas control plots in addition to mix application had improved nitrogen use efficiency (14.8%). Siran-2010 and Janbaz-2009 performed better in FYM and mix FYM and urea plots for most of the parameters. It was concluded from the experiment that Janbaz-2009 had improved yield and yield components, whereas Siran-2010 had improved the grain N content. Similarly, Mix application of FYM and urea had improved crop productivity, soil fertility and grains as well as straw N content. Thus wheat varieties Janbaz-2009 sown in mix FYM and urea is recommended for general cultivation in agro-climatic condition of Peshawar.

Keywords

Wheat (*Triticum avestium* L.), Yield, Urea, Farm Yard Manure

1. Introduction

Wheat (*Triticum aestivum*) is the most important food crop of the world, which occupied the largest crop area and has greater production than any other crop. In Pakistan, wheat is an important cereal crop and occupies about 65% of the total cropped area with an average yield of 2833 kg·ha^{-1} [1]. Lack of inputs management for wheat crop is one of the many reasons for its lower productivity. [2] to feed the ever-increasing human population. Achieving high yield of the potential wheat cultivars need quantification of adequate and balance nutrients. Nitrogen (N) is one of the primary nutrients, an integral part of the plant tissues and has both direct and indirect effects on the crop performance [3]. However, both excess and deficiency of N have adverse effects on the crop growth and development [4]. Higher N fertilization causes imbalance in N system, result in lower productivity and ultimately more N losses [5]. Losses of N depend on its source, and it is believed that urea and urea containing fertilizers have higher potential N losses than other nitrogen sources due to enzyme urease, which result in hydroxylation of urea in to ammonia (NH_3) and carbon dioxide. Soil incorporated organic residues believed to improve soil bulk density, total porosity, macro and micro pores, soil water retention and soil hydraulic conductivity compared with untreated soil [6]. Manures are natural sources of plant nutrients [7] derived from plants and animal sources and play a very significant role in increasing soil fertility [8] [9] obtained better results from the combined use of commercial and organic N fertilizer in arid and semi-arid areas. In general, the use of organic source of fertilizers enhances soil organic carbon more than application of the same amount of nutrients as inorganic fertilizers. Chemical fertilization seems to provide the adequate and on time nutrients for the wheat crop, but its high price, non-availability and low efficiency cause limitations to their application. Thus devising a sound strategy for improved fertilizers management having both commercial and organic sources of fertilization is need for sustaining crop productivity. Wheat is 30% - 80% lower than the potential yield of wheat crop [10], despite the use of adequate amount of chemical fertilizer and management. Wheat yield can be increased by the use of recently developed high yielding, disease resistant varieties and appropriate production technologies such as nutrients management. Production of newly wheat developed varieties through nitrogen management is a challenge for the agronomist, and need to be explored. Information on the integrated use of nitrogen is widely available, however interactive responses of newly developed wheat varieties to various nitrogen application is not available. Thus, keeping these constraints and factors in view the present study was laid out to screen out the optimum combination of urea N and FYM for the newly developed wheat varieties for improved N use efficiency and wheat productivity in agro-climatic conditions of Peshawar.

2. Materials and Methods

Field experiment on "Effect of N sources on the production of wheat varieties" was conducted at New Developmental Research Farm of Khyber Pakhtunkhwa Agricultural University Peshawar during 2011-12. The following factors and their levels were studied in the experiment. (Table 1)

Factor A: Varieties (Main plot)

V1 Siran-2010

V2 Atta-habib

V3 Janbaz-2009

V4 Pirsabak-2008

Factor B: N sources (Sub plot)

The experiment was carried out in randomized complete block design in split plot arrangement with four replications. Newly developed wheat varieties were allotted to main plot and N sources to sub plots. The sub plot size was 5 × 3 m^2 having ten rows with row to row distance of 30 cm and row length of 5 m. FYM was soil incorporated 25 days before sowing, whereas urea N was applied in split half at sowing and other half after first irrigation. Recommended basal doses of P_2O_5 and K_2O at the rate of 60 kg·ha^{-1} each was applied at the time of sowing. All the agronomic and cultural practices including irrigation, weeding, hoeing etc. were practiced uniformly for all the treatment in each replication.

Data was recorded on the following parameters:

2.1. Biological Yield

Biological yield was recorded by harvesting the six central rows in each subplot and was sun dried. After drying it was weighed and was converted to kg·ha^{-1} using the formula:

$$\text{Biological yield}\left(\text{kg}\cdot\text{ha}^{-1}\right)=\frac{\text{Biological yield in six central rows}}{R-R\times\text{No. of rows}\times\text{row lenght}}\times 10{,}000$$

2.2. Grain Yield

Grain yield from six central rows was recorded for each subplot after threshing the grain from the dried samples harvested for biological yield. Sample data for grain yield was converted into kg·ha^{-1} using the following formula:

$$\text{Grain yield}\left(\text{kg}\cdot\text{ha}^{-1}\right)=\frac{\text{Grain yield in six central rows}}{R-R\times\text{No.of rows}\times\text{row lenght}}\times 10{,}000$$

Table 1. The integrated N treatments consisting of inorganic and organic nitrogen.

Treatment	% N derived from urea	% N derived from FYM	Pool N (kg·ha^{-1})
T0	0	0	0
T1	100	0	120
T2	0	100	120
T3	50	50	120

2.3. Harvest Index (%)

Harvest index was calculated using the following formula:

$$\text{Harvest index}\,(\%) = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

2.4. Soil Total Nitrogen

Soil total nitrogen for each treatment was determined following kjeldahl procedure [11] at the end of the experiment.

2.5. Plant Nitrogen Analysis

To determine grains and straw nitrogen contents, samples were randomly taken from the seed lots and straw of each subplot after harvesting and threshing. Both plant tissue and mature grains was dried in oven at 50˚C till constant weight, and then was grinded by KINEMICE tissue grinder using 0.2 mm sieve and was store in the laboratories for further analysis.

2.6. Nitrogen Contents

Kjeldahl method was used for the determination of N content both in straw and mature grains according to the procedure outlined by [12].

2.7. Nitrogen Use Efficiency

Nitrogen use efficiency is the wheat grain yield (Gw) per unit of N supply (Ns), and was calculated by formula (Gw/Ns). Nitrogen supply was calculated as N applied as fertilizer plus total nitrogen uptake in control plots [13].

2.8. Statistical Analysis

Data obtained for each parameter was subjected to analysis of variance technique appropriate for two factors randomize complete block design with split plot arrangements, to detect the significant differences among the treatments. Least significant difference (LSD) test [14] was carried out to separate the treatment means. Special planned mean comparisons was also made to achieve the specific goals of the research (**Table 2**).

3. Result and Discussion

3.1. Nitrogen Content in Grains

Nitrogen content in grains was significantly affected by wheat varieties. In planned mean comparisons control vs. rest and sole vs. mixed were found significant while urea vs. FYM was non-significant. Janbaz-2009 had lowest value (1.77%) as compared to the rest of varieties, while highest nitrogen content in grains (2.31%) was observed in Siran-2010. The higher nitrogen content in grain 2.25% was noted in those plots where treatment combination was urea with FYM mixed, but lowest value (1.86%) was recorded in control plots. The mean comparisons of nitrogen with varieties showed a positive effect. The highest

(2.25) nitrogen content in grain in plots where Urea with FYM and lowest was recorded in variety Janbaz 1.77% shown in Table 3. Among planned mean comparisons control plots showed less content of nitrogen in grains (1.86%) than treated plots (2.16%). As compared to rest. 50% of recommended nitrogen derived from (urea + FYM) having maximum Nitrogen content in grains (2.25%) as compare to sole treated plots (2.11%) These results are in close agreement with the finding of [3] [15]-[20].

Table 2. Soil physical and chemical properties at selected experimental site.

Soil Property	Soil layers (cm)	
	0 - 15	15 - 30
Sand (%)	43.6	45.2
Silt (%)	45.5	33.4
Clay (%)	13	9
pH	7.36	7.63
Organic matter (%)	1.06	1.32
NO_3-N (mg·kg^{-1})	7	5
Total nitrogen (%)	0.148	0.096
P (mg·kg^{-1})	1.98	1.19
K (mg·kg^{-1})	110	112
Sulfur (mg·kg^{-1})	3	3

Table 3. Nitrogen content (%) in grains of wheat varieties in response to sources of nitrogen.

Nitrogen Sources	Wheat varieties				Mean
	Siron-10	Ata Habib	Janbaz-09	Pirsabak-2008-08	
Control	1.82	1.89	1.92	1.82	1.86 c
Urea	2.09	2.30	1.76	2.21	2.09 b
FYM	2.84	2.06	1.77	1.89	2.14 ab
Urea + FYM	2.46	2.77	1.66	2.09	2.25 a
Mean	2.31 a	2.26 a	1.77 c	2.00 b	

	Planned mean comparisons	Mean	P value
Control	Control vs. rest	1.86	0.0000
Rest		2.16	
FYM	FYM vs. urea	2.14	0.4886
Urea		2.09	
Sole	Sole vs. mixed	2.11	0.0445
Mixed		2.25	

LSD value for N source at $p \le 0.05 = 0.15$; LSD value for wheat varieties at $p \le 0.05 = 0.20$ Interaction (V × N) = **.

3.2. Nitrogen Content in Straw

Nitrogen content in straw was significantly affected by different sources of nitrogen and interaction between varieties and these nitrogen sources, while response of variety were found non-significant. Planned mean comparisons *i.e.* control vs. rest, urea vs. FYM and sole vs. mixed were found significant (Table 4). Higher value for Nitrogen content in straw (0.93%) was examined in urea + FYM in plots statistically at par with those plots are fertilized with Urea fertilizer. Among planned mean comparisons in plots where the level of treatment was zero having less nitrogen content in straw (0.60%) as compared rest of the plots (0.86%). Plots having FYM has lower nitrogen content in straw (0.75%) than those plots where urea was applied alone (0.92%).Combination of (urea + FYM) gave maximum nitrogen content in straw (0.93) as compare to sole application of nitrogen sources (0.83%). Interactive response of wheat varieties with different nitrogen sources showed that Sirn-2010 wheat variety were more positively responsive in plots where both urea and FYM contributing 50% of N, whereas all other three varieties had higher straw nitrogen contents in plots having urea alone These results are supported by the findings of [21].

3.3. Nitrogen Use Efficiency (%)

Table 5 results are demonstrated that Nitrogen use efficiency (NUE) was significantly affected by wheat varieties and nitrogen sources while interaction between wheat varieties and nitrogen sources were non-significant. Planned mean

Table 4. Nitrogen content in straw (%) of wheat varieties in response to sources of nitrogen.

Nitrogen Sources	Wheat varieties				Mean
	Siron-10	Ata Habib	Janbaz-09	Pirsabak-2008-08	
Control	0.53	0.72	0.54	0.62	0.60 c
Urea	0.80	0.93	0.97	0.96	0.92 a
FYM	0.73	0.73	0.75	0.78	0.75 b
Urea + FYM	1.07	0.92	0.79	0.93	0.93 a
Mean	0.78	0.83	0.76	0.82	

	Planned mean comparisons	Mean	P value
Control	Control vs. rest	0.60	0.0000
Rest		0.86	
FYM	FYM vs. urea	0.75	0.0005
Urea		0.92	
Sole	Sole vs. mixed	0.83	0.0158
Mixed		0.93	

LSD value for N source at $p \leq 0.05 = 0.09$; LSD value for wheat varieties at $p \leq 0.05$ = NS; Interaction (V × N) = NS; Means followed by same letter (s) within the same category are statistically non significant using LSD test at $P \leq 0.05$.

Table 5. Nitrogen use efficiency (%) of wheat varieties in response to sources of nitrogen.

Nitrogen Sources	Wheat varieties				Mean
	Siron-10	Ata Habib	Janbaz-09	Pirsabak-2008-08	
Control	15.3	14.7	14.7	14.6	14.8 a
Urea	13.5	13.3	14.3	12.9	13.5 b
FYM	13.0	12.6	13.6	12.5	12.9 b
Urea + FYM	13.9	14.8	16.7	15.3	15.2 a
Mean	13.9 b	13.9 b	14.8 a	13.8 b	

	Planned mean comparisons	Mean	P value
Control	Control vs. rest	14.8	0.0016
Rest		13.9	
FYM	FYM vs. urea	12.9	0.0921
Urea		13.5	
Sole	Sole vs. mixed	13.2	0.0000
Mixed		15.2	

LSD value for N source at $p \leq 0.05 = 0.7036$; LSD value for wheat varieties at $p \leq 0.05 = 0.7374$; Interaction (V × N) = NS; Means followed by same letter(s) within the same category are statistically non-significant using LSD test at $P \leq 0.05$.

comparisons control vs. rest and sole vs. mixed were significant while Urea vs. FYM was not significant (Table 4) for NUE. Nitrogen use efficiency was higher for Janbaz-2009 (14.8%) compared to all other wheat verities where no statistical differences were observed for NUE. Combined application of urea and FYM, contributing 50% of the recommended N had higher NUE (15.2%) than sole application of urea (13.5%) and/or FYM (12.9%). However NUE in control were not statistically different than plots having both urea and FYM. The interaction between verity and sources of nitrogen was positive. The highest nitrogen use efficiency was observed in wheat cultivar Janbaz (14.8) at par with Siron-10 (13.9). Planned mean comparison showed that in sole plots 13.2% had lower NUE than mixed (FYM vs Urea) plots (15.2%). Our results are in line with the finding of [20] [22].

3.4. Biological Yield (kg·ha^{-1})

Biological yield were significantly affected by varieties, nitrogen sources and interaction between varieties and nitrogen sources. Planned mean comparisons *i.e.* control vs. rest, urea vs. FYM and sole vs. mixed were observed significant (Table 6) for biological yield. In Janbaz-2009 had higher biological yield (11,011 kg·ha^{-1}) than all other wheat varieties; however minimum biological yield (9932 kg·ha^{-1}) was observed in Siran-2010. Higher biological yield (11,958 kg·ha^{-1}) was recorded in urea + FYM plots, while lower biological yield (8176 kg·ha^{-1}) was recorded in control plots. Among planned mean comparisons control plots having minimum biological yield (8176 kg·ha^{-1}) as compared the treated plots.

Table 6. Biological yield of wheat varieties in response to sources of nitrogen.

Nitrogen Sources	Wheat varieties				Mean
	Siron-10	Ata Habib	Janbaz-09	Pirsabak-2008-08	
Control	7132	9153	8025	8394	8176 c
Urea	10,718	11,218	12,086	11,130	11,288 b
FYM	10,583	10,395	11,295	11,053	10,831 b
Urea + FYM	11,296	11,993	12,638	11,908	11,958 a
Mean	9932 c	10,689 ab	11,011 a	10,621 b	

	Planned mean comparisons	Mean	P value
Control	Control vs. rest	8176	0.00
Rest		11,359	
FYM	FYM vs. urea	10,831	0.05
Urea		11,288	
Sole	Sole vs. mixed	11,060	0.00
Mixed		11,958	

LSD value for N source at $p \leq 0.05 = 461.3$; LSD value for wheat varieties at $p \leq 0.05 = 371.1$; Interaction ($V \times N$) = *

Biological yield (11,288 kg·ha^{-1}) was higher in urea applied plots as compared to FYM incorporated plots. Mixed (urea + FYM) plots gave greater biological yield (11,958 kg·ha^{-1}) than sole application. These results are confirm with finding [18] [20].

3.5. Grain Yield (kg·ha^{-1})

Mediation of data indicated that varieties and nitrogen sources had significantly affected grain yield, whereas interactive response was non-significant. Planned mean comparisons *i.e.* control vs. rest and sole vs. mixed had significantly affected grain yield (**Table 7**), whereas urea vs. FYM were non-significant. Results showed that Janbaz-2009 produced greater grain yield (4339 kg·ha^{-1}), than all other wheat varieties, whereas lower grain yield (4019 kg·ha^{-1}) was recorded for was observed in Siran-2010. Combined application of urea and FYM contributing 50% of the recommended N each, had 63% higher grain yield over control plots. However there were no differences in grain yield when solely urea and/or FYM had used as source of N. Among the planned mean comparisons control plots had lower grain yield (3004 kg·ha^{-1}) as compared to treated plots. Combined application of urea + FYM had produced higher grain yield (4901 kg·ha^{-1}) than sole application of N sources (3378 kg·ha^{-1}). Grain yield of a crop is the function of yielding components, and was observed higher in plots where both FYM and urea were applied in combination than control. This higher yield in the fertilized plots over the control could be associated with more nutrients availability in fertilized plots. These results are in close agreement with the finding of [3] [23] [24] [25] [26] [27].

Table 7. Grain yield of wheat varieties in response to sources of nitrogen.

Nitrogen Sources	Wheat varieties				Mean
	Siron-10	Ata Habib	Janbaz-09	Pirsabak-2008-08	
Control	3108	2984	2971	2953	3004 c
Urea	4346	4294	4616	4169	4356 b
FYM	4183	4066	4373	4027	4162 b
Urea + FYM	4492	4787	5396	4928	4901 a
Mean	4032 b	4033 b	4339 a	4019 b	

	Planned mean comparisons	Mean	P value
Control	Control vs. rest	3004 b	0.0000
Rest		4473 a	
FYM	FYM vs. urea	4162	0.0612
Urea		4356	
Sole	Sole vs. mixed	4259 b	0.0000
Mixed		4901 a	

LSD value for N source at $p \leq 0.05 = 203$; LSD value for wheat varieties at $p \leq 0.05 = 226$; Interaction (V × N) = NS; Means followed by same letter (s) within the same category are statistically non significant using LSD test at $P \leq 0.05$.

3.6. Harvest Index (%)

Harvest index were significantly affected by nitrogen sources, whereas wheat varieties and interaction response were non-significant. Among planned mean comparisons control vs. rest and sole vs. mixed were significant, whereas urea vs. FYM were not significant shown in Table 8. The higher harvest index (40.9%) was noted in urea + FYM incorporated plots whereas lower harvest index (37.2%) was recorded in plots where no application was applied. In planned mean comparisons control plots had lower harvest index (37.2%) than plots (39.3%) where application was applied. Combined application of (urea + FYM) had resulted in greater harvest index (40.9%) as compare to sole application of N sources (38.5%). Harvest index was higher in fertilized plots over the control. Crop fertilization had significantly affected both grain yield and biological yield in non-proportional way, and thus quantified for the variation in the significant harvest index. Our results agree the finding of [28], who were of the opinion that crop fertilization had significant effects on the harvest index. No significant variations among the varieties were observed for harvest index.

3.7. Nitrogen Content in Soil

Nitrogen content in soil was significantly affected by nitrogen sources and interaction between varieties and nitrogen sources while varieties were found non-significant. Planned mean comparisons showed that control vs. rest, urea vs. FYM, and sole vs. mixed were found significant. The results in Table 9 described that nitrogen content in soil was higher (0.08%) in plots having both urea and

Table 8. Harvest index of wheat varieties in response to sources of nitrogen.

Nitrogen Sources	Wheat varieties				Mean
	Siron-10	Ata Habib	Janbaz-09	Pirsabak-2008-08	
Control	43.9	32.8	37.0	35.2	37.2 b
Urea	40.5	38.3	38.3	37.5	38.7 b
FYM	39.5	39.1	38.7	36.4	38.4 b
Urea + FYM	39.7	40.0	42.7	41.4	40.9 a
Mean	40.9	37.5	39.2	37.6	

	Planned mean comparisons	Mean	P value
Control	Control vs. rest	37.2	0.0095
Rest		39.3	
FYM	FYM vs. urea	38.4	0.8058
Urea		38.7	
Sole	Sole vs. mixed	38.5	0.0057
Mixed		40.9	

LSD value for N source at $p \le 0.05 = 1.909$; LSD value for wheat varieties at $p \le 0.05$ = NS; Interaction (V × N) = NS.

Table 9. Nitrogen content in soil (%) after wheat varieties harvest in response to sources of nitrogen.

Nitrogen Sources	Wheat varieties				Mean
	Siron-10	Ata Habib	Janbaz-09	Pirsabak-2008-08	
Control	0.05	0.04	0.05	0.04	0.05 d
Urea	0.05	0.06	0.07	0.05	0.06 c
FYM	0.07	0.06	0.05	0.09	0.07 b
Urea + FYM	0.08	0.08	0.08	0.08	0.08 a
Mean	0.06	0.06	0.06	0.07	

	Planned mean comparisons	Mean	P value
Control	Control vs. rest	0.05	0.0000
Rest		0.07	
FYM	FYM vs. urea	0.07	0.0441
Urea		0.06	
Sole	Sole vs. mixed	0.06	0.0004
Mixed		0.08	

LSD value for N source at $p \le 0.05 = 0.0071$; LSD value for wheat varieties at $p \le 0.05$ = NS; Interaction (V × N) = **; Means followed by same letter (s) within the same category are statistically non-significant using LSD test at $P \le 0.05$.

FYM compared to the lower nitrogen content in soil (0.05%) been observed in control plots. In planned mean comparisons control plots having low nitrogen content in soil (0.05%) as compared to rest of the plots (0.07%). Comparing sole sources of N, FYM has higher nitrogen content in soil (0.07%) than urea applied plots (0.06%). Combined application of urea and FYM had resulted in greater N content in soil (0.08%) than using the sole sources of N (0.06%). Interactive response of varieties and nitrogen sources showed that Sirn-2010, Janbaz-2009 and Ata Habib had higher soil total N content in plots where both FYM and urea was applied, whereas Pirsabak-2008 were more responsive in FYM applied plots. These findings were in close conformity with result of [15] [16].

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