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N uptake and yield of wheat as influenced by integrated use of organic and mineral nitrogen

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Abstract

The effect of integrated use of mineral and organic N sources (farmyard manure, poultry manure, and Filter Cake) on yield and N uptake of wheat were assessed in biennial field experiment carried out on silty clay loam soil in Nuclear Institute for Food and Agriculture, Tarnab, Peshawar Pakistan during 2005-07. Combined dose of N provided from all sources was applied @120 kg ha^{-1}. There were 17 treatments with four replications; wheat variety (Fakhre-e-Sarhad) was sown in RCB design. Data on grain yield and straw yield were recorded in wheat. Samples of grain and straw were analyzed for total N to determine its uptake by the crop. Results indicated that in treatment where organic and mineral fertilizers were applied in the ratio of 25:75 from either organic source improved grain and straw yield. Maximum grain yield of (3248 kg ha^{-1}) and straw yield of (7154 kg ha^{-1}) were obtained from treatment where 25% N was applied from poultry manure and 75% from mineral fertilizer and maximum straw yield was found in treatment where 25% from filter cake and 75% from mineral N. Agronomic efficiency and nitrogen use efficiency were also found higher in the treatment where 25% N were applied from poultry manure and 75% from mineral fertilizer. It was concluded that combination of 25:75 organic and mineral N sources are the best combination to achieve sustainable yield.

Keywords: Fertilizer; uptake wheat yield; integrated use.

Introduction

In Pakistan wheat is grown an about 8 million hectares every year with an average yield of 2519 kg ha^{-1} (MINFAL, 2005-06). In North West Frontier Province irrigated wheat is grown on 308.2 thousand ha with an average yield of 2007 kg ha^{-1}. The average yield of North West Frontier Province is less than other three provinces of the country. The average yield is very low as compared to other developed countries of the world. Low yield of wheat in Pakistan may be attributed to many factors including imbalance fertilizer

application. The evidence is accumulating that growth in yields of different crops has started decreasing in the high potential agricultural areas of Pakistan (Gill 2000). The factors are mining of soil nutrients and declining of organic matter. Wheat is exhaustive crop and duple soil fertility. The alkaline and calcareous soils of Pakistan are extensively deficient in nitrogen, phosphorus, zinc and organic matter, hence application of fertilizer is considered imperative for increasing crop production (Memon, 1996). Mineral fertilizers play a significant role in boosting crop production on alkaline calcareous soils of Pakistan (Ahmad, 2000). Despite increased use of the fertilizers, per hectare yield has not been increased proportionally. (Ali, 2000). This has been attributed to the imbalanced use of mineral fertilizers and inappropriate method of their application that culminated in low efficiency. According to Zia et al. (2000), continuous use of chemical fertilizers even in balanced proportion will not be able to sustain crop productivity due to deterioration in soil fertility.

To overcome the problem of nutrient deficiency and to increase wheat yield, the farmers are applying chemical fertilizers. However, the chemical fertilizers are expensive and the small farmers cannot afford to use these fertilizers in suitable amount and balanced proportion, (Ahmad, 2000). Under such condition integrated use of chemical and organic fertilizer/manures can play an important role to sustain soil fertility and crop productivity (Tandon, 1998, Lampe, 2000). Application of organic manures or some organic wastes alone was found useful (Ibrahim et al., 1992, Alam and Shah, 2003), but integrated use of organic wastes and chemical fertilizer has proved more rewarding (Mian et al., 1989, Nasir and Qureshi, 1999, Khanam et al., 2001, Alam et al., 2003, 2005). Limited availability of additional land for crop production, along with declining yield of major food crops, have heightened concerns about agriculture's ability to feed the growing population expected to exceed 7.5 billion by the year 2020. Future strategies for increasing agricultural productivity will have to focus on using available nutrient resources more efficiently and sustainable use of available nutrient resources. Based on the assumptions it is estimated that about 1.5 million tons of nutrients are available from farmyard manure. Of this nitrogen accounts for 726 thousand tons, P_20_5 191 thousand tons and K_20 about 617 thousand tons (Bari, 2003). The droppings of poultry birds are rich in nutrients. The estimates show that properly collected poultry birds droppings will contribute about 101 thousand tons of nitrogen, 58 thousand tons of P_20_5 and 26 thousand tons of K_20 (Bari, 2003).

Pakistan sugar industry is producing about 1.2 million tons of filter cake every year, which is a rich source of organic matter, micro and macronutrients. If all these materials are recycled back to soil, it will provide essential plant nutrients for crop growth. Keeping in view these facts the study was designed to assess the effect of the application of organic materials i.e. farmyard manure, poultry manure and Filter cake along with mineral nitrogen on yield, yield components, nutrient uptake in wheat-maize cropping system under irrigated area of NWFP. This study was aimed to:

1. Study the integrated effect of different organic and mineral N fertilizer on the yield of wheat.
2. Study the effect of N sources on N uptake by wheat.
3. Find out best combination of mineral and organic N sources for maximum wheat production.

Material and methods

A field study was conducted on Research Farm of Nuclear Institute for Food and Agriculture (NIFA) for two years during Rabi 2005-06 and 2006-07 in North West Frontier Province of Pakistan. The soil of the experimental site belonged to Tarnab fine silty, mixed hyperthermic Udic Ustept. Nitrogen was applied at the rate of 120 kg ha^{-1} from organic and mineral N sources applied alone and in different combinations. The organic sources used were farmyard manure, poultry manure, and filter cake. The organic manure was applied all at sowing time and the mineral N (urea) was applied in three splits i.e. sowing, tillering and booting stages of the crop. The experiment was laid out according to Randomized Complete Block design (RCB) and was replicated four times; Plot size was 4 × 3.5 m. Phosphorus and K were applied at recommended rate in the form of single super phosphate and potassium sulphate as basal dose to the crop and adjusted on the basis phosphorus and potassium present in the organic sources. All other cultural practices, i.e. weeding, and hoeing, irrigation were adopted uniformly as and when required. Row to row distance was 30 cm and plant to plant 6 cm. being commonly grown by the farmers, wheat variety Fakhar-e-Sarhad was used as a test variety. The experimental details are given in (Table 3). Before sowing, a composite soil sample was collected from the field and was analyzed for physico-chemical properties (Table1) Soil texture was determined by hydrometer method as described by Moodi et al (1959). The pH and E.C in soil was determined by water suspension (1:2.5) with the help of pH and conductivity meters according to method outlined by Richard (1954). Organic matter was determined by the method given by Walkley and Black (Black 1965). In composite soil sample total nitrogen was determined by Kjeldhal digestion method and available P was determined by $NaHCO_3$ extraction method. In the organic manures total nitrogen was determined by Kjeldhal digestion method and total P and K were determined by method given in (A.O.A.C, 1979) (Table-2). Carbon content of organic manures was determined by method outlined by Nelson and Sommers (1996). At maturity the crop was harvested. Biological yield was recorded and straw and grain were separated with mini thresher.

Chemical analysis

The samples of straw and grains of wheat were ground to 40 mesh powder in the Wiley mill and Nitrogen was determined by Kjeldhal digestion method. Below equations also were used to determine N-uptake, N use efficiency and agronomic efficiency.

N-uptake

N concentration in treatment sample × Grain/ straw yield in plot.

N use efficiency

N use efficiency was derived by the following formula.

$$\frac{[\text{N-uptake (fertilized plot)}]- [\text{N-uptake (cont plot)}]}{\text{rate of N applied}} \times 100$$

Agronomic efficiency

was calculated by the following formula

$$\frac{[\text{Grain yield (fertilized)}] - [\text{grain yield (control)}]}{\text{rate of fertilizer applied}} \quad \text{kg per kg}$$

The data collected were statistically analyzed through method outlined by Ste el and Torrie (1980) using MSTAT software package.

Table 1. basic properties of the experimental soil

Texture	pH (1:25 suspension)	EC (1:25 suspension) (dS m^{-1})	$CaCO_3$ (%)	organic matter (%)	$NaHCO_3$ extra-P (mg kg^{-1})	N (%)
Silty clay loam	8.10	0.62	18	0.89	3.5	0.05

Table 2. Composition of organic materials.

Organic manures	%N	% P	% K	%O.C	C:N
farmyard manure	0.6	0.44	1	8.46	14.1
poultry manure	2.87	1.30	1.75	33.8	11.7
filter cake	0.50	0.35	1	5.6	11.2

Table 3. Treatments details.

T_1= control (no-nitrogen)	T_9= 50% FYM+ 50% mineral nitrogen
T_2= 120 kg N ha^{-1} from mineral source	T_{10}= 50% PM+ 50% mineral nitrogen
T_3= 120 kg N $ha^{-1}$from farmyard manure	T_{11}= 50% FC+ 50% mineral nitrogen
T_4= 120 kg N ha^{-1} from poultry manure	T_{12}= 75% FYM+ 25% mineral nitrogen
T_5= 120 kg N ha^{-1} from filter Cake	T_{13}= 75% PM+ 25% mineral nitrogen
T_6= 25% FYM+ 75% mineral nitrogen	T_{14}= 75% FC+ 25% mineral nitrogen
T_7= 25% PM+ 75% mineral nitrogen	T_{15}= 25% FYM+ 25% PM+ 50% mineral nitrogen
T_8= 25% FC+ 75% mineral nitrogen	T_{16}= 25% FYM+ 25% FC+ 50% mineral nitrogen
	T_{17}= 25% PM+ 25% FC+ 50% mineral nitrogen

Results and discussion

Wheat grain and straw yield

Data regarding grain yield of wheat as affected by the application of different organic, inorganic nitrogen applied alone and in different combinations are presented in table 4. Statistical analysis of the data showed that the effect of treatments on grain yield was significant ($P<0.05$). The average of two years showed that statistically similar grain yield were obtain in treatments received 25% N from all applied organic sources and 75% from mineral source. Individual year data showed that highest grain yield of (3375 kg ha^{-1}) during 2006-07 was obtained in treatment receiving N 25% from poultry manure and 75% from mineral fertilizer, similar results were obtained by Shaaban (2006) who reported that higher

grain yield were recorded with (80kg organic (chicken) N + 40 kg inorganic N). The data was statistically at par with other treatment that received 25% N applied from organic sources and 75% from mineral nitrogen. These results are in agreement with Ahamd et al. (1998), Sushila and Gajendra (2000), Idris et al. (2001), Singh and Agarwal (2001), Zeidan and Kramany (2001) and Iqbal et al (2002) who reported that application of farmyard manure (FYM) increased the growth, yield and water use efficiency of wheat under limited water supply.

Almost similar trend in response was observed during 2005-06 however during 2005-06, an overall comparatively lower yield was obtained. It has also been established that delay in planting of wheat after optimal sowing time i.e. 20th November results in reduction of potential yield by about 1-1.5 percent per day (Hobbs 1985, Ortiz-Monasterio et al. 1984, Randhawa et al. 1981). The lowest grain yield of 984.4 kg ha^{-1} was obtained under control.
Grain yield or economic yield is an important characteristic. It is the ultimate output of any crop under study and depends upon various factors such as soil status, environmental factors and plant genetic make up. The probable reason for these findings could be related the better utilization of excess nutrients in plots receiving combination of higher dose of nitrogen fertilizer, poultry manure and filter cake, which made plants more efficient in photosynthetic activity. Grains become a dominant sink at their maturity stage and the entire photo-assimilate deposited in the grains gave them weight and ultimately more grain yield.

Data on straw yield of wheat as affected by the application of various organic and inorganic nitrogen sources applied alone and in various combinations are presented in Table 5. From the data it is revealed that effect of different treatments on straw yield was significant ($P<0.05$). Maximum straw yield of 7154 kg ha^{-1} was obtained in the treatment where 25% N was applied from filter cake and 75% from mineral source followed by the treatment where only mineral nitrogen was applied. Individual year data showed that highest straw yield of 7513 kg ha^{-1} was obtained in treatment where 25% N was applied from Filter cake and 75% from mineral source followed by treatment where all nitrogen was applied from mineral source during 2006-07. Idris et al. (2001), Idris and Wisal (2001) Alam and Azam (2002) and Hussain and Ibrahim (1987) reported increase in dry matter yield with the integration of organic manure with mineral fertilizer. The mean year data showed that highest straw yield of 5485 kgha^{-1} was obtained during 2006-07 where the crop was well on time. During the previous decrease in straw yield was associated with delay in sowing. The results are in agreement with Khan (2003) who reported loss in wheat straw and grain due to delay sowing.

Nitrogen uptake in wheat grain and straw kg/ha

Data on wheat grain N uptake as influenced by different organic and mineral N sources applied alone and in combination are presented in Table 6. Analysis of the data revealed that different treatments had significant affect on N uptake. Maximum uptake of 65.39 kg ha^{-1} were found in treatment where N was applied 25% from poultry manure and 75% from mineral source followed by the treatment where 25% N was applied from FYM and 75% from mineral source. Organic and mineral fertilizer applied at the ratio 25:75 has almost equal N-uptake where only mineral nitrogen was applied at the rate of 120 kg ha^{-1}. Year wise data showed that highest N uptake in grain were found during 2006-07 in treatment where 25%N

was applied from poultry manure and 75% from mineral source followed by the treatment where 25% N was applied from FYM and 75% from mineral source. The lowest nitrogen concentration was found in control treatment. Years mean are also significant and maximum grain N uptake of 51.44 kg ha^{-1} was found during 2006-07. This is due to the more favorable condition for the crop to have high yield and N-uptake. The organic and mineral fertilizer applied at the ratio 25:75 had equal N-uptake where only mineral nitrogen was applied at the rate of 120 kg ha^{-1}. Theses results are in accordance with the Iqbal et al (2002) Shah and M. Ishaq (2006) Idris et al (2001) who reported that combination of organic and inorganic N resulted in greater N-uptake from than those obtained when each was applied singly.

Data on N uptake (kg ha^{-1}) by wheat straw as influenced by different organic and mineral nitrogen sources applied alone and in combination are presented in Table 7. Analysis of the data showed that different treatments had significant affect on N uptake. Maximum N uptake (27.93 kg ha^{-1}) was found in treatment where 25% N was applied from filter cake and 75% N was applied from mineral source. It was closely followed by the treatment where 25% N was applied from organic manures and 75% from mineral fertilizer. Almost similar N-uptake was found in treatments where mineral fertilizer was applied alone. The results are in agreement with shah and Ishaq (2006), Bandyopadhyay and Sarkar (1999) who reported high N-uptake under treatment where mineral N and organic N ratio was 75:25 and 50:50 N respectively. Year wise N-uptake data was also significant and maximum N uptake of 34.05 kg ha^{-1} was found in treatment where 25%N was applied from filter cake and 75% from mineral source in 2005-06. This was closely followed by the treatment where 25% N was applied from poultry manure and 75% from mineral fertilizer. The lowest nitrogen uptake was found in control treatment. Years mean were also significant and maximum straw N uptake (24.61 kg ha^{-1}) was found during 2005-06 due to high straw yield and high N concentration.

Agronomic efficiency

Agronomic efficiency as affected by various mineral N and organic N and their combination is presented in table 4. Significant differences were observed in the trial under study and maximum agronomic efficiency of (17.58 $kgkg^{-1}$) was observed in the treatment to which 25%PM and 75% mineral Nitrogen was applied followed be the treatment where 25%FC and 75% mineral nitrogen was applied. The high agronomic efficiency might be due to the reason that organic manures change in soil quality after manure addition are linked to the effects of OM content on soil structure and biological activity (Bronick and Lal 2005; Tisdall and Oades 1982). Soil quality and good soil management are vital components of sustainable crop production because soil supports the fundamental physical, chemical, and biological processes that must take place in order to support plant growth and ultimately yield.

Comparing the individual sources, the organic manures can not compete with mineral fertilizer as the nutrients are easily available to the crops from the mineral source than the organic source. Organic and mineral nitrogen in the ratio of 50:50 and 75:25 produced lower agronomic efficiency as compared to mineral fertilizer applied alone. The possible reason might be due to the fact that mineral fertilizer ratio become equal or lesser than organic manure ratio applied in treatment; it slows the process of availability of the nutrient to the crop. The

ratio of 25:25: and 50 organic and mineral fertilizers also resulted in lesser agronomic efficiency than the treatments where only mineral fertilizer was applied.

Nitrogen use efficiency

Nitrogen use efficiency is the recovery of the applied fertilizer by the harvested crop. Nitrogen use efficiency as affected by various organic and mineral fertilizers and their combination are presented in Fig.2. Significant differences were observed in N-use efficiency and maximum NUE of (40.15%) was observed in the treatment where 25%PM and 75% mineral Nitrogen was applied followed be the treatment where 25%FYM and 75% mineral nitrogen was used.

Comparing the individual sources, the organic manures can not compete with mineral fertilizer as the nutrient is easily available to the crops from the mineral source than the organic source. The ratio of 50:50 and 75:25 organic and mineral nitrogen ratio also seem to be incompatible with the mineral fertilizer applied alone. This might be due to the reason that when the mineral fertilizer ratio becomes equal or lesser than organic manure ratio applied in treatment, it slows down the process of availability of the nutrient to the crop. The ratio of 25:25: and 50 organic and mineral fertilizers also produced lesser NUE than the treatments where only mineral fertilizer was applied. These results are in agreement with Idris et al. (2001) Bandyopadhyay and Sarkar (1999) and Yaduvashi (2003) who reported that conjunctive application of urea and FYM resulted in the increased fertilizer nitrogen recovery relative to other treatment both by rice (30.6%) and wheat (2.2%).

Table 4. Effect of integrated use organic and inorganic Nitrogen on wheat grain yield Kgha^{-1}

Treatment	Grain yield kg ha^{-1}			Agronomic efficiency (Kg/kg)
	Years			
	2005-06	2006-07	Mean	
control (no-nitrogen)	1293 i	984.4 i	1138 G	-
120 kg N ha^{-1} from M N	3075 a-d	3343 a	3209 A	17.25
120 kg N ha^{-1} from FYM	2825 b-e	1893 h	2359C-E	10.17
120 kg N ha^{-1} from PM	2560 ef	2046 gh	2303 DE	9.71
120 kg N ha^{-1} from FC	1903 h	1753 h	1828 F	5.70
25% FYM+ 75% M N	3058 a-d	3322 a	3190 A	17.1
25% PM+ 75% MN	3120 ab	3375 a	3248 A	17.58
25% FC+ 75% MN	3060 a-d	3362 a	3211 A	17.27
50% FYM+ 50% MN	2748 b-e	3040 a-d	2894 B	14.63
50% PM+ 50% MN	2625 c-f	3050 a-d	2837 B	14.15
50% FC+ 50% MN	2200 fgh	3101 a-c	2651 BC	12.61
75% FYM+ 25% MN	2388 efg	2611 d-f	2499 CD	11.34
75% PM+ 25% MN	1963 gh	2195 f-h	2079 EF	7.84
75% FC+ 25% MN	1843 h	2515 ef	2179 DE	8.67
25% FYM+ 25% PM+ 50% MN	2510 ef	3127 ab	2819 B	14
25% FYM+ 25% FC+ 50% MN	2183 fgh	2787 b-e	2485 CD	11.22
25% PM+ 25% FC+ 50% MN	1750 h	3206 ab	2478 CD	11.16
Mean	2418 b	2689 a		

Mean in same column followed by different letters are significantly different at 5% level of probability using DMR test.
LSD value at 5% for year = 220.7; LSD value at 5% for treatment = 286.1;
LSD value at 5% for interaction = 404.6

Table 5. Effect of integrated use organic and inorganic Nitrogen on wheat Strawn yield Kg ha^{-1}

Straw yield kg ha^{-1}			
Treatment	Years		Mean
	2005-06	06-07	
control (no-nitrogen)	2832 n	2819 n	2825 I
120 kg N ha^{-1} from M N	5828 d-g	7407 ab	6617 AB
120 kg N ha^{-1} from FYM	5548 e-h	4196 j-l	4872 EFG
120 kg N ha^{-1} from PM	5075 g-j	3782 k-n	4429 FGH
120 kg N ha^{-1} from FC	4125 j-m	3655 k-n	3890 H
25% FYM+ 75% M N	6158 c-f	6607 a-d	6382 BC
25% PM+ 75% MN	6283 c-e	6857 a-c	6570 AB
25% FC+ 75% MN	6795 a-d	7513 a	7154 A
50% FYM+ 50% MN	5250 f-i	5781 d-g	5516 DE
50% PM+ 50% MN	5075 g-j	6504 b-e	5789 CD
50% FC+ 50% MN	4845 g-j	6165 c-f	5505 DE
75% FYM+ 25% MN	4988 g-j	4996 g-j	4992 EF
75% PM+ 25% MN	4145 j-m	4448 i-k	4296 GH
75% FC+ 25% MN	3263 l-n	4432 i-k	3847 H
25% FYM+ 25% PM+ 50% MN	5035 g-j	6587 a-d	5811 CD
25% FYM+ 25% FC+ 50% MN	4550 h-k	5277 f-i	4913 EFG
25% PM+ 25% FC+ 50% MN	3185 mn	6223 c-f	4704 FG
Mean	4881 b	5485 a	

Mean in same column followed by different letters are significantly different at 5% level of probability using DMR test.
value at 5% for year = 455.4
LSD value at 5% for treatment = 610.1
LSD value at 5% for interaction = 862.9

Table 6. Effect of integrated use organic and inorganic Nitrogen on N-uptake in wheat Grain kgha^{-1}

Treatment	Grain N-uptake kg ha^{-1}			N use efficiency
	Years		Mean	
	05-06	06-07		
control (no-nitrogen)	20.23 n	14.18n	17.20I	-
120 kg N ha^{-1} from MN	59.03 c-e	66.22a-c	62.63A	37.85
120 kg N ha^{-1} from FYM	49.78 g-i	34.30lm	42.04E-G	20.70
120 kg N ha^{-1} from PM	44.22 h-k	37.72k-m	40.97E-G	19.81
120 kg N ha^{-1} from FC	34.13 lm	32.10m	33.11H	13.26
25% FYM+ 75% MN	60.63 bcd	68.65a	64.64A	39.53
25% PM+ 75% MN	58.63 c-f	72.15a	65.39A	40.16
25% FC+ 75% MN	59.58 c-e	68.25ab	63.91A	38.93
50% FYM+ 50% MN	50.42 f-i	55.33d-g	52.88 B	29.73
50% PM+ 50% MN	51.42 e-h	58.05c-g	54.74 B	31.28
50% FC+ 50% MN	41.85 i-l	59.95c-e	50.90 BC	28.08
75% FYM+ 25% MN	42.53 i-k	47.10h-j	44.81D-F	23
75% PM+ 25% MN	34.38 lm	39.20j-m	36.79GH	16.32
75% FC+ 25% MN	33.10 m	45.92h-k	39.51FG	18.59
25% FYM+ 25% PM+ 50% MN	46.28 h-j	59.05c-e	52.66 B	29.55
25% FYM+ 25% FC+ 50% MN	43.15 h-k	55.70d-g	49.42B-D	26.85
25% PM+ 25% FC+ 50% MN	32.10 m	60.67b-d	46.39C-E	24.33
Mean	44.79 b	51.44a		

Mean in same column followed by different letters are significantly different at 5% level of probability using DMR test.
LSD value at 5% for year = 4.043; LSD value at 5% for treatment = 5.177
LSD value at 5% for interaction = 7.321

Table 7. Effect of integrated use organic and inorganic Nitrogen on N-uptake Straw Kgha^{-1}

Treatment	Straw N-uptake kg ha^{-1}		
	Years		Mean
	05-06	06-07	
control (no-nitrogen)	13.02o-q	6.488r	9.756 H
120 kg N ha^{-1} from MN	28.85bc	23.33d-i	26.09 A
120 kg N ha^{-1} from FYM	27.63cd	13.83m-q	20.73BCD
120 kg N ha^{-1} from PM	25.05c-g	11.82pq	18.43DEF
120 kg N ha^{-1} from FC	20.52h-k	10.73q	15.63 FG
25% FYM+ 75% MN	31.58ab	19.81i-l	25.69 A
25% PM+ 75% MN	33.15a	21.74f-j	27.44 A
25% FC+ 75% MN	34.05a	21.81f-j	27.93 A
50% FYM+ 50% MN	26.27c-e	17.44j-n	21.86 BC
50% PM+ 50% MN	25.55e-f	18.10j-m	21.82 BC
50% FC+ 50% MN	24.73e-h	17.74j-n	21.23BCD
75% FYM+ 25% MN	25.05e-g	14.27m-q	19.66CDE
75% PM+ 25% MN	21.20g-j	12.71o-q	16.95EFG
75% FC+ 25% MN	16.73k-o	13.65n-q	15.19 G
25% FYM+ 25% PM+ 50% MN	25.95e-f	19.82i-l	22.89 B
25% FYM+ 25% FC+ 50% MN	23.00e-i	15.93l-p	19.47CDE
25% PM+ 25% FC+ 50% MN	16.13l-o	17.94j-n	17.03EFG
Mean	24.61a	16.30b	

Mean in same column followed by different letters are significantly different at 5% level of probability using DMR test
LSD value at 5% for year=2.144; LSD value at 5% for treatment=2.609
LSD value at 5% for interaction=3.690

Conclusion

Integrated use of organic and inorganic nitrogen performed better than the use of organic and inorganic nitrogen sources alone in terms of improving crop yields of wheat. The integration of organic nitrogen and mineral nitrogen in the ratio of 25:75 enhanced the yield of wheat. For higher grain yield the mineral fertilizer must be applied and their ratio should not be less than 75% of mineral N. The agronomic efficiency and nitrogen use efficiency increased with the use of organic and mineral N the ratio of 25:75.

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