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EFFECT OF INTEGRATED USE OF FARM YARD MANURE AND UREA ON YIELD AND NITROGEN UPTAKE OF WHEAT

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ABSTRACT

The effect of integrated use of urea and Farm Yard Manure (FYM) on yield and N uptake of wheat was assessed in a field experiment carried out on a silty clay loam soil in Peshawar valley of North West Frontier Province, Pakistan during 2001-02. Urea and FYM were combined in a way to supply N at 120 kg ha^{-1} from both sources in 0:0, 100:0, 75:25, 50:50, 25:75 and 0:100 ratios arranged in a RCB design with four replications. Wheat (variety: Ghaznavi) was planted in rows. Data on biological, grain and straw yields of wheat were recorded. Samples of grain and straw were also analyzed for total N to determine its uptake by the crop. The results indicated that maximum biological (10952 kg ha^{-1}), straw (7710 kg ha^{-1}), and grain (3242 kg ha^{-1}) yields of wheat were obtained in treatment receiving N from urea and FYM in 75:25 ratio. The next higher yield was obtained in treatment receiving N from the two sources in 50:50 ratio. Comparing with other fertilizer treatments, the yields were significantly lower in treatments where N from urea source was below 50 %. Similarly, the N uptake in grain (47.66 kg ha^{-1}) and straw (19.28 kg ha^{-1}) was also significantly ($P<0.05$) greater in treatments receiving 75 or 50 % N from urea and 25 or 50% from FYM. The data on crop yields and N uptake in response to integrated use of urea and FYM supported each other. The residual soil organic fertility after crop harvest was proportional to the level of FYM used. Our data thus suggest that integrated use of urea and FYM at 75:25 or 50:50 ratios (N basis) has produced maximum yields and is therefore recommended for profitable wheat yield and sustainable soil fertility.

Keywords: Farm Yard Manure, Urea, Nitrogen Uptake, Wheat, Yield.

INTRODUCTION

The use of organic materials in combination with inorganic fertilizers to optimize nutrient availability to plants is a difficult task as organic materials have variable and complex chemical nature. This requires the understanding and knowledge about the chemical composition, particularly the nutrient content and C quality of organic materials and its interaction with inorganic nutrient sources. Unfortunately, there has been little synthesis of the integrated effects of organic materials on net nutrient management. Numerous trials have compared the yields from a given amount of inorganic fertilizer (A), an organic material (B), and their combination (A+B), and in many situations (A+B) have produced higher yields than A or B alone. It should not be surprising that the combination does better because more total nutrients have been added than A or B alone.

A four years experiment in India (Goyal et al., 1992) suggested that the yields of pearl millet (Pennisetum glaucum), N uptake, and N recovery after 4 years of the experiment were greater with the combination of FYM, or sesbania green manure and urea compared with urea alone but less when wheat straw was combined with urea. The decrease in yields with wheat straw even after 4 years was related to net N immobilization that would be expected from a material with a C/N ratio of 102 (Shah and Khan, 2003). The authors attributed the higher N use in the combined sesbania or FYM with urea to the immediate availability of N from urea and its delayed releases from the organics, achieving greater synchrony with crop demand. Goyal et al. (1992) further described that the higher yield produced by the sesbania plus urea and FYM plus urea compared with urea's applications alone could reflect a residual effect after 4 years of applying the organic materials. They found no differences in total soil C in plots receiving organic inputs compared with fertilizer alone following four annual additions of 2.7, 3.8, and 12 t ha^{-1} of sesbania, FYM, or wheat straw, respectively. Organic treatments did have higher levels of soil microbial biomass C and N, but yield differences from the different organic treatments were not related to the soil microbial biomass. Mittal (1992) found that maize yields obtained from the 100 % leucaena (Leucaena leucocephala) and 100 % urea treatments were similar the first 2 years but were slightly higher in the leucaena plots the third year.

Yields from the 25 % Leucaena-25 % urea combinations were higher than the 100 % leucaena treatment during all 3 years suggesting the superiority of the combined application of the organic and inorganic nutrient sources. In another study, Jones et al. (1997) reported that maize yields and N use were higher for gliricidia (Gliricidia sepium) residues than for leucaena residues. Although having similar amounts of N, gliricidia residues resulted in a large and rapid net N mineralization while Leucaena exhibited initial net immobilization followed by net mineralization probably of higher polyphenol content in the later. Additions of inorganic N with the residues produced an increase in yields and N use efficiency with leucaena but not with gliricidia. The higher yields obtained from gliricidia was attributed mainly to better synchrony of nutrient availability to crop demand. Addition of inorganic N to leucaena improves synchrony by increasing the N supply at the initial stages of net immobilization resulting from applications of leucaena.

It is generally believed that combining organics with inorganic fertilizer will increase synchrony and reduce losses by converting inorganic N into organic forms. Studies have shown that it is not always true. For example, Janzen and Schaalje (1992) found that fertilizer N losses were twice as large as when green manure plus fertilizer was applied to barley. Their interpretation was that green manure promoted high levels of nitrate and available C in the soil, enhancing de-nitrification. However, losses were reduced with smaller repeated applications of green manure, implying that the use of high quality green manure as partial substitution for inorganic fertilizer rather than addition to inorganic fertilizer may increase nutrient use efficiency. Xu et al. (1993) found large losses of 25 to 41% of N added from leucaena prunings. They attributed this to de-nitrification. It was also found that losses were greater when materials were incorporated rather than surface applied (Xu et al., 1993; Jones et al., 1997). Ganry et al. (1978) also concluded that large applications of low quality straw can result in large losses of fertilizer N through de-nitrification. (Shah et al., 2002). These results thus indicate that N losses can be quite high from both organic and inorganic sources, contrary to the popular belief that application of organic resources will result in fewer losses.

Application of organic materials alone or in combination with inorganic fertilizer helped in proper nutrition and maintenance of soil fertility (Salim et al., 1988; Talashiker and Rinal, 1986). Hussain et al. (1988) reported that organic manures increased the efficiency of chemical fertilizers. Beneficial effects of farm yard manure on crop production through improved fertility and physical properties of soil is an established fact (Singh and Sarivastore, 1971).

This paper reports the influence of urea and FYM in various combinations on crop and N yields of wheat in Peshawar valley of North West Frontier Province, Pakistan.

MATERIALS AND METHODS

A field experiment was conducted at the Research Farm of NWFP Agricultural University, Peshawar during 2001-02 to assess the influence of integrated use of urea and FYM on crop and N yield of wheat. Urea and FYM to supply total N of 120 kg ha-1 in different ratios i.e., 0:0 (T1), 100:0 (T2), 25:75 (T3), 50:50 (T4), 75:25 (T5), and 0:100 (T6) ratios.

The treatments were arranged in a randomized complete block design with four replications. Well-rotten FYM was obtained from the University Dairy Farm and analyzed for total N. A field low in soil fertility was selected at the Research Farm. Composite soil sample at 0-30cm was collected from the experimental field and analyzed for soil characteristics (Table-1).

Table-1. Some characteristics of soil of the experimental site.

Characteristic	Unit	Value
Clay	%	32.80
Silt	%	53.20
Sand	%	14.00
Textural class	-	Silty Clay Loam
pH (1:5)	-	8.40
E.C (1:5)	dSm^{-1}	0.18
Organic matter	%	0.98
Total N	%	0.07
Total mineral N	$\mu g\ g^{-1}$ soil	16.63

The field was thoroughly prepared. Lay-out was carried out according to the experimental plan, with treatment plot size of 10 m x 4 m. Urea and FYM at appropriate ratios were uniformly distributed in relevant treatment plots and thoroughly mixed into the soil. Treatments (T5 and T6) requiring N from urea below 60 N ha^{-1} received all the urea N at sowing time while those (T2 and T3) requiring N from urea above 60 kg N ha^{-1}, received 60 kg N at sowing time and the remaining urea N as a second dose with 2nd irrigation. A basal dose of P at 90 kg P_2O_5 and K at 60 kg K_2O ha^{-1}, was also applied to each treatment plot uniformly at the time of sowing.

After thorough seed-bed preparation and fertilizer application, wheat (variety: Ghaznawi) was planted in rows 30 cm apart with the help of seed drill on November 15, 2001. The crop was irrigated from canal when needed and weeds were removed. At maturity, on 15.5.2002, 2 m^2 areas at each treatment plot were harvested. After sun drying, the bundles were threshed mechanically. Grain and straw weight were recorded. Grain and straw samples were taken and analyzed for N to determine N uptake by wheat crop.

Soil and plant analysis

Total N in soil, grain and straw samples was determined by the Kjeldhal method of Bremner and Mulvaney (1982). The mineral N (NH_4-N, and NO_3-N) in soil was determined by the steam distillation method of Keeney and Nelson (1982). Organic C in soil was determined by the modified method of Walkely-Black as described in Nelson and Sommers (1982). Soil texture was determined by the Bouyocous hydrometer method (Moodie et al., 1954). Soil pH and EC were determined in soil-water suspension (1:5) with the help of pH meter

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(McLean, 1982) and Electrical Conductivity Meter (Rhoades, 1882), respectively.

Statistical analysis

The procedures of Steel and Torrie (1984) were followed for statistical analysis of the data.

RESULTS AND DICUSSION

The results obtained on the effect of integrated use of urea and FYM on yield and nitrogen uptake of wheat are presented and discussed below:

Biological, straw and grain yield of wheat

Biological yield

The results showed that all fertilizer treatments significantly ($P<0.05$) increased the biological yield of wheat compared with the control treatment (Table-2). The maximum biological yield of 10952 kg ha^{-1} was obtained in treatment receiving N from urea and FYM in 75:25 ratio followed by those receiving the same in 50:50, 100:0, and 0:100 ratio. The biological yield was minimum (5199 kg ha^{-1}) in the control receiving no urea or FYM. The treatment receiving 100 % N from urea had significantly lower yield compared to those receiving N from urea and FYM in 75:25 or 50:50 ratio. The biological yield was further reduced significantly when N from urea and FYM were added in 25:75 ratio. The treatment receiving 100 % N from FYM and 0% N from urea showed significantly lower yield compared with other fertilizer treatments. These results indicated that the yield of biological mass was more in response to combined application of urea and FYM contributing N in 75:25 or 50:50 ratio. Reducing the level of N from urea to 25 % with 75 % that from FYM was not supporting higher biological yield and resulted in significantly lower yield compared with that receiving 100 % N from urea alone. These findings are in agreement with Negi and Mahajan (2000) and Mishra (2000) who reported significant increases in wheat grain and straw yields with addition of FYM to inorganic fertilizers as compared to no FYM.

Straw yield

Like biological yield, the straw yield of wheat was also significantly greater in treatment receiving N from urea and FYM in 75:25 ratio followed by that receiving the same in 50:50, 100:0 and 25:75 ratios. Treatment receiving 100 % N from FYM without any urea was better only than the control with respect to straw yield. These results indicated that under the given experimental conditions, combined application of FYM and urea significantly improved straw yield of wheat only when the N contribution from urea was 50 % or greater. Farm yard manure alone did not prove as effective as urea alone. Reducing the level of N from urea source to 25 % with the remaining from FYM did not produce higher straw yield than treatment receiving 100 % N urea source. Urea was indicated as a quick and more potent source of nitrogen for increasing the vegetative growth as compared to FYM but the combination of the two sources in 50:50 or 75:25 ratios was found more effective.

Grain yield

The grain yield of wheat was significantly ($P<0.05$) greater in N fertilized (from either source) than in the control treatment (Table-2). Like biological or straw yields, the maximum grain yield of 3242 kg ha^{-1} was obtained in treatment receiving N from urea and FYM in 75:25 ratio followed closely by 3199 kg in treatment receiving N from the two sources in 50:50 ratio, and values for these two treatments were not significant. Treatments receiving N solely from urea or 25 % from urea and 75 % from FYM produced comparable yields but were significantly lower than in treatments 3 and 4 (T3 and T4). Treatment receiving N solely from FYM produced significantly lowest grain yield compared with other fertilizer treatments. Rathore et al. (1995), Dudhat et al. (1996), Kumar and Singh (1997) and Vyas et al. (1997) reported similar observations of getting higher yields of wheat grain with combined application of FYM and inorganic fertilizers.

Table-2. Biological, grain and straw yield of wheat as affected by integrated use of urea and Farm Yard Manure (FYM).

#	Treatment		Biological	Straw	Grain
	%N from Urea	%N from FYM	**Yield** (kg ha^{-1})		
T1	0	0	5199 f	3877 e	1322 d
T2	100	0	9002 c	6433 c	2569 b
T3	75	25	10952 a	7710 a	3242 a
T4	50	50	10158 b	6959 b	3199 a
T5	25	75	8544 d	6205 c	2339 b
T6	0	100	7531 e	5601 d	1930 c
LSD			376.8	283.5	291.7

Means with different alphabets in the same column indicate significant difference ($\alpha=0.05$).

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Nitrogen concentration in grain and straw of wheat

Nitrogen concentration in grain

Data on N concentration in wheat grain showed variable response to different fertilizer treatments (Table-3). For example T6, T2 and T5 produced significantly ($P<0.05$) greater N concentration in wheat grain compared with the control (T1). It was noted that maximum N concentration of 1.56% was found in T6 receiving 100% N from FYM. The next highest N concentration of 1.53% was found in T2 receiving 100% N from urea. Unlike crop yields, the N concentrations in wheat grains in T3 and T4 were at par with that in T1. Our results are in agreement with the findings of Vyas et al. (1997) who reported that application of FYM significantly increased N uptake and grain and straw yields of wheat. Also the application of N and P fertilizers significantly improved the grain and straw yields of wheat and protein content in its grain.

Nitrogen concentration in straw

The nitrogen concentration in wheat straw also showed variable response to different fertilizer treatments (Table-3). The maximum N concentration of 0.30% in straw was observed in T6 which was significantly greater than that in the control (T1) but was at par with that in T4 and T5. Differences between T2, T3 and T1 were not significant ($P<0.05$). The N concentration in straw showed relatively little variability among treatments probably most of the N from straw has been translocated to grains by the time of crop maturity.

Table-3. Nitrogen concentration in grain and straw of wheat as affected by integrated use of urea and FYM.

#	Treatment		Grain	Straw
	%N from Urea	%N from FYM	% Nitrogen	
T1	0	0	1.46 d	0.26 bc
T2	100	0	1.53 b	0.27 bc
T3	75	25	1.47 cd	0.25 c
T4	50	50	1.48 cd	0.28 ab
T5	25	75	1.49 c	0.28 ab
T6	0	100	1.56 a	0.30 a
LSD			0.0252	0.0243

Means with different alphabets in the same column indicate significant difference (α=0.05).

Nitrogen uptake in grain and straw of wheat

Nitrogen uptake in grain

Nitrogen uptake in wheat grain and straw (total crop uptake) followed similar pattern of response to various combinations of fertilizer treatments (Table-4). The results showed that N uptake by wheat crop were significantly greater in N fertilized than in the control treatment. The maximum N uptake of 66.94 kg ha^{-1} by wheat crop was obtained in treatment (T3) receiving 75% N from urea and 25% from FYM. The treatment (T5) receiving 50% N each from urea and FYM produced comparable results with T3. The next highest N uptake was obtained in T2 and T5. Significantly lowest N uptake was obtained in treatment (T6) receiving 100% N from FYM comparing with other fertilizer treatments.

These observations are in accordance with those of Metwally and Khamis (1998) who reported that combination of organic and inorganic N resulted in greater values of apparent net N release than those obtained when each was applied singly. They also reported that N requirements of wheat could not be met by solely from FYM. Their observation that the best mixture ratio between organic and inorganic N sources was 1:1, partially agreed with our findings.

These results suggested that integrated use of urea and FYM performed better than the use of urea or FYM alone in terms of improving crop and N yields of wheat despite the fact that the level of applied N was same i.e. 120 kg N ha^{-1} either alone from urea, FYM or combinations of both. The combined application of urea and FYM at 75:25 or 50:50 ratio based on net N contribution produced excellent results.

Table-4. Total N uptake in grain and straw wheat as affected by integrated use of urea and FYM.

#	Treatment		Grain	Straw	Total
	%N from Urea	%N from FYM	kg N ha^{-1}		
T1	0	0	19.30 e	10.08 c	29.38 d
T2	100	0	39.31 b	17.37 b	56.68 b
T3	75	25	47.66 a	19.28 a	66.94 a
T4	50	50	47.35 a	19.49 a	66.84 a
T5	25	75	34.85 c	17.37 b	52.22 b
T6	0	100	30.11 d	16.80 b	46.91 c
LSD			4.460	1.642	4.830

Means with different alphabets in the same column indicate significant difference (α=0.05).

Soil organic fertility at harvest stage

The soil analysis after wheat harvest showed that mineral N content of soil was significantly greater in the N fertilized than in the control treatment (Table-5). The maximum mineral N content of 29.80 mg kg^{-1} soil was obtained in treatment receiving 100% N from FYM followed by 27.33 mg in treatment receiving 75% N from FYM and 25% from urea, and in both cases the values were significantly greater than in other N fertilized treatments.

Total N content of soil was also highest in treatment receiving 100% N from YYM or 75% from FYM and 25% from urea. The next highest value for total N was obtained for treatment receiving 50% N each from FYM and urea. Total N content of soil in other N fertilized treatments was at par with the control treatment.

Like N, the organic matter content of soil was also highest in treatments receiving 100% N from FYM or 75% N from FYM and 25% from urea. Organic matter contents in the remaining fertilizer treatments were at par with that in the control treatment.

Table-5. Soil organic fertility (0-10cm) at harvest stage of wheat.

#	Treatment		Mineral N (ug g^{-1} soil)	Total N (%)	Organic Matter (%)
	%N from Urea	%N from FYM			
T1	0	0	6.85 e	0.11 d	0.90 c
T2	100	0	12.51 d	0.11 d	0.91 c
T3	75	25	16.32 c	0.13 cd	0.92 c
T4	50	50	21.09 b	0.14 be	0.94 bc
T5	25	75	27.33 a	0.16 ab	0.98 ab
T6	0	100	29.80 a	0.18 a	1.02 a
LSD			2.538	0.025	0.048

Means with different alphabets in the same column indicate significant difference (α=0.05).

CONCLUSION AND RECOMMENDATIONS

Our results suggested that the integrated use of urea and FYM performed better than the use of urea or FYM alone in terms of improving crop and N yields of wheat despite the fact that the level of applied N was same i.e. 120 kg N ha^{-1} either alone from urea, FYM or combinations of both. The combination of urea and FYM at 75:25 or 50:50 ratio based on net N contribution produced excellent results and is therefore recommended for optimum wheat production.

REFERENCES

Dudhat, M. S., D. D. Malavia, R. K. Mathukia, and V. D. Khanpara.1996. Effect of organic manures and chemical fertilizers on wheat and their residual effect on green grain. Gujarat Agric. Univ. Res. J. 22 (1):4-8.

Ganry, F., G. Guiraud, and Y. Dommergues. 1978. Effect of straw incorporation on the yield and nitrogen balance in the sandy soil-pearl millet cropping system of Senegal. Plant and Soil. 50: 647-662.

Goyal, S., M. M. Mishra, I. S. Hooda, and R. Singh. 1992. Organic matter – microbial biomass relationship in field experiments under tropical conditions: Effects of inorganic fertilization and organic amendments. Soil Biol. Biochem. 24: 1081 -1084.

Hussain, T. G. Jullani, and M. Z. Iqbal. 1988 .Integrated use of organic and inorganic N fertilizer in rice-wheat cropping system. Pak. J. Soil Sci. 3:19-23.

Janzen, H. H., and G. B. Schaalji. 1992. Barley response to nitrogen, non nutritional benefits of legume green manure. Plant and Soil. 142: 19-30.

Jones, R. B., S. S. Snapp, and H. S. K. Phombeya. 1997. Management of leguminous leaf residues to improve nutrient use efficiency in the sub-humid tropics. P.239-250. In G. Cadisch and K. Giller (ed) Driven by nature: Plant litter quality and decomposition. CAB Int. Wallingford, England.

Kumar, R., and C. M. Singh. 1997. Crop yields and economics under fertilizer resource constraints along with different FYM application in maize-wheat cropping sequence. J. Hill Res.10 (2):103-107.

Metwally, S. M., and M. A. Khamis. 1998. Comparative effects of organic and inorganic nitrogen sources applied to a sandy soil on availability of N and wheat yield. Egyp. J. Soil Sci. 38 (1-4):35-54.

Mishra, V. K. 2000. Water expense and nutrient use efficiency of wheat and winter maize as influenced by integrated nutrient management. Agropedology. 10 (1): 1-5.

Mittal, S. P., S. S. Grewal, Y. Agrihotric, and A.D. Sud. 1992. Substitution of nitrogen requirement of maize through leaf biomass of Leucaena Leucocephala: Agronomic and Economic Considerations. Agrifor. Syst. 19:207-216.

Moodie, C. D., D. W. Smith, and R. A. McCreerry. 1954. Laboratory Manual for Soil Fertility. Washington State College, Monograph. : 31-39.

Negi, S. C., and G. Mahajan. 2000. Effect of FYM, planting methods and fertilizer levels on rainfed wheat. Crop Res. Hisar. 20 (3) 534-536.

Rathore, R. L., S. J. Chipde, and A.R. Pal. 1995. Direct and residual effects of bio-organic and inorganic fertilizers in rice-wheat cropping system. Ind. J. Agron. 40(1): 14-19.

Salim, M. S., M. Mian, and Mahmoodul Hassan. 1988.Annual technical report of project improvement of soil productivity through biological mean. Pak. Agric. Res. Council, Islamabad.

Shah, Z., and A. A. Khan. 2003. Evaluation of crop residues for mineralizable nitrogen in soils. Sarhad J. Agric. 19(1): 81-92.

Shah, Z., R. Ullah, and T. Hussain. 2002. Can crop residue and glucose carbon stimulate dentrification and N mineralization in soil under submerged conditions? Pak. J. Soil Sci. 21(1-2): 20-26.

Singh, K., and Sarivastore. 1971. Effect of organic manure in Soil fertility as shown by nutrient availability and crop yield response in Potato New Pro. Symp. on soil evaluation, New Delhi.

Talashiker, S. C. and O.P. Rinal. 1986. Studies on increasing in combination with city solid waste. J. Ind. Soc. Soil Sci. 34:780-784.

Vyas, S. H., M. M. Modhwadia, and V. D. Khanpara. 1997. Integrated nutrient management in wheat. Gujarat Agric. Univ. Res. J. 23 (1):12-18.

Xu, Z. H., P. G. Saffigna, R. J. K. Myers, and L. Chapman. 1993. Nitrogen cycling in leucaena (Leucaena Leucocephala) alley cropping in semi- arid tropics : I. Response of maize growth to addition of nitrogen fertilizer and plant residues. Plant and Soil. 148:73-82.