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EFFECT OF INTEGRATED USE OF NITROGEN ON YIELD AND N UPTAKE OF MAIZE CROP

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Abstract

The present field studies investigated the effect of the integrated use of mineral N and organic N sources (Farm yard manure, Poultry manure and Filter cake) on maize crop. Field experiment was carried out on silty clay loam soil at NIFA Tarnab Peshawar Pakistan during 2005-06. There were 17 treatments with four replications using maize variety Azam as a test material in RCB design. Statistical analysis of the data revealed that integrated application of organic N sources (farmyard manure, poultry manure, filter cake) and mineral N source (urea) resulted an upward trend in the yield of maize crop. Maximum biomass, (9554 $kgha^{-1}$) and stover yield (8136 $kgha^{-1}$) of maize were obtained from those treatments where 100% (FYM) was used. Maximum grain yield (1838 $kgha^{-1}$) was recorded from treatment where 25% farmyard manure (FYM) and 75% mineral nitrogen source (urea) were used. Agronomic efficiency and nitrogen use efficiency was also found higher in the treatments where 25% N from farmyard manure (FYM) and 75% N from mineral N source (urea) was applied. It was concluded that combination of 75% mineral N source and 25% organic N sources (urea) are the best combination for sustainable yield.

Introduction

Among plant nutrients, nitrogen is considered a major element required for high yield of wheat and maize (Ahmad, 2000). Cultivation decreases topsoil contents of organic carbon, total nitrogen and phosphorus in semiarid regions of the world. (Buschiazzo *et al.,* 2000). The farmers are applying chemical fertilizer to overcome the problem of nutrient deficiency and to increase crop yield. However, the chemical fertilizers are expensive and farmers cannot use fertilizers in balanced proportion which have resulted in lower production than the potential demonstrated yield and thus low fertilizer use efficiency (Ahmad, 2000). Under such condition integrated use of mineral and organic N sources can play an important role to sustain soil fertility and crop productivity (Lampe, 2000; Shahban, 2006; Busra *et al.,* 2005; Channabasanagowda *et al.,* 2008).

In Pakistan farm yard manure is the most important organic manure. It is estimated that about 1.5 million tones of nutrients are available from farmyard manure (Bari, 2003). The latest estimates showed a population of about 290 million of poultry birds. The droppings of poultry birds are rich in nutrients and if poultry birds droppings are properly collected can contribute about 101 thousand tones of nitrogen, 58 thousand tones of P_20_5, and 26 thousand tones of K_20 (Bari, 2003). Pakistan sugar industry is producing about 1.2 million tones of filter cake every year and its solid precipitates collected in vacuum and press filters after carbonation and clarification processes (Nadia & Khwaja, 2006). It has been reported that dry matter yield of maize increased with increasing level of sulphitation press mud and decrease with carbonation press mud application (Narwal *et al.,* 1999). Filter cake is a rich source of organic matter, macro and micronutrients. The present study was designed to assess the effect of the application of organic materials i.e. farm yard manure, poultry manure and filter cake along with mineral nitrogen on yield and nutrient uptake in maize.

Materials and Methods

Field experiments were carried out at Research Farms of Nuclear Institute for Food and Agriculture (NIFA) Tarnab Peshawar, Pakistan during 2005-06. The experimental site is located with an altitude of 400m above sea level in NWFP, Pakistan. The experiment was conducted in Randomized Complete Block (RCB) design with four replications having sub-plot size of 4 m x 3.5 m. Maize variety Azam was sown in row to row distance of 70 cm and plant to plant distance of 6 cm. Nitrogen was applied @ 120 kg ha^{-1} from organic and mineral N sources in different proportion. The organic sources used were farm yard manure, poultry manure, and filter cake (Table 1). Composition of various organic sources is given in Table 2. The organic N sources (farmyard manure, poultry manure, filter cake) were applied at sowing time and the mineral N (urea) was applied in three splits i.e. sowing, tillering and at booting stages of crop. P 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 of P and K present in the organic sources. All other cultural practices i.e., weeding, hoeing, irrigation was adopted uniformly as and when required. Before sowing, a composite soil sample was collected from the field and was analyzed for physico-chemical properties (Table 3). 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 Black (1965). Total nitrogen was determined by Kjeldhal digestion method and available P was determined by Olsen Method (Olson et al., 1954). The basic properties of the experimental site is given in Table 3. N use efficiency was derived by the following formula:

$$\text{N use efficiency} = \frac{\text{N-uptake (fertilized plot)- N-uptake (control)}}{\text{Rate of N applied}} \times 100$$

Agronomic efficiency was calculated by the following formula**:**

$$\text{Agronomic efficiency} = \frac{\text{Grain yield (fertilized) – grain yield (control)}}{\text{Rate of fertilizer applied}} \text{ kg}^{-1}$$

Statistical analysis: All data are presented as mean values of four replicates. Data were analyzed statistically for analysis of variance (ANOVA) following the method described by Gomez & Gomez (1984). MSTATC computer software was used to carry out statistical analysis (Russel & Eisensmith, 1983). The significance of differences among means was compared by using Least Significant Difference (LSD) test (Steel & Torrie, 1980).

Table 1. Treatments details used in the experiment.

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

*FYM =Farm Yard Manure. PM= Poultry Manure. FC= Filter Cake
** MN=Mineral nitrogen (Urea)

Table 2. Composition of organic sources used in the experiment.

Organic manures	%N	% P	% K
Farm Yard Manure	0.60	0.44	1.00
Poultry manure	2.87	1.30	1.75
Filter press mud	0.50	0.35	1.00

Table 3. Basic properties of the experimental soil.

Texture	Silty clay loam
pH (1:25 suspension)	8.10
EC (1:25 suspension)	0.62 dS m^{-1}
$CaCO_3$ equivalent	18 %
Organic matter	0.82%
$NaHCO_3$ extra-P	3.5 mg kg^{-1}
% N	0.05%

Results and Discussion

Maize yield: Significant ($p<0.05$) effect on maize biomass was observed due to the differential use of N from different sources (Table 4). Maximum biomass yield (9554 kg $ha^{-1)}$ was observed in those treatments where 100% farmyard manure (FYM) was applied to maize crop and followed by treatments where 25% N was applied from poultry manure (PM) and 75% from mineral source (urea). These results were in agreement with the findings of Silva *et al*., (2006); Patidar & Mali (2001) and Rao & Shaktawat, (2002). Grain yield was also significantly ($p<0.05$) affected by the integrated use of N from organic and mineral N sources (Table 4). Our results indicated that maximum grain yield (1838 kg ha^{-1}) was produced by treatments where 25% farmyard manure (FYM) was supplemented with 75% N from mineral N source (urea) and followed by treatments where 25% poultry manure (PM) and 75% mineral N source (urea) was applied. Our results agree with those reported by Silva *et al*., (2006); Patidar & Mali (2001) and Rao & Shaktawat (2002). Similarly, differential N applied from different sources had a significant ($p<0.05$) effect on stover yield. Our data suggested that maximum stover yield (8136 kg ha^{-1}) was recorded from those treatments where 100% farmyard manure (FYM) was applied to the crop and followed by plots fertilized with 100% poultry manure (PM). (Table 4). Organic material can markedly increase soil productivity by providing essential plants nutrients and by improving physical properties. These results agree with those reported by Silva *et al.* (2006), Patidar & Mali (2001) and Rao & Shaktawat (2002).

Table 4. Effect of integrated use of organic N sources and mineral N source on maize yield.

Treatments	Biomass (kg ha^{-1})	Grain yield (kg ha^{-1})	Stover yield kg ha^{-1}	Agronomy efficiency (kg kg^{-1})
Control	5661 D	875 D	4785 D	------
100% mineral N	7571 BC	1221 C	6351 ABCD	2.88
100% FYM	9554 A	1417 BC	8136 A	4.52
100% PM	8964 ABC	1281 BC	7684 AB	3.38
100% FC	8357 ABC	1357 BC	7000 ABC	4.02
25% FYM + 75% MN	8964 ABC	1838 A	7127 ABC	8.03
25% PM + 75% MN	9143 AB	1603 AB	7540 ABC	6.06
25% FC + 75% MN	8786 ABC	1391 BC	7395 ABC	4.30
50% FYM + 50% MN	8179 ABC	1467 BC	6711 ABC	4.93
50% PM + 50% MN	7125 CD	1312 BC	5813 BCD	3.64
50% FC + 50% MN	7143 CD	1323 BC	5820 BCD	3.73
75% FYM + 25% MN	8375 ABC	1596 AB	6779 ABC	6.00
75% PM + 25% MN	8750 ABC	1293 BC	7457 ABC	3.48
75% FYM + 25% MN	7125 CD	1380 BC	5745 CD	4.21
25%FYM+25%PM+50%MN	7821 ABC	1390 BC	6432ABCD	4.29
25%FYM+25%FC+50%MN	8411 ABC	1530 ABC	6881 ABC	5.45
25%PM+ 25%FC+ 50%MN	7946 ABC	1333 BC	6613ABC	3.82

Means of the same category followed by different letters are significantly different using LSD test ($p \leq 0.05$)

Table 5. Effect of integrated use of organic N sources and mineral N source on maize grain and stover N uptake.

Treatments	%N in grain	%N in stover	N uptake in grain (kg ha^{-1})	N uptake stover (kg ha^{-1})	Nitrogen use efficiency
Control	1.112 G	0.2325 A	9.735 E	11.16B	----
100% MN	1.220 CD	0.2600 A	14.92D	16.05 AB	8.39
100% FYM	1.240 BC	0.2375 A	17.57BCD	19.49 A	13.46
100% PM	1.180 DE	0.2550 A	15.10 D	19.31 A	11.25
100% FC	1.148 E-G	0.2375 A	15.56 CD	16.51AB	9.31
25%FYM+ 75% MN	1.237 BC	0.2625 A	22.77 A	18.83A	17.25
25% PM+75% MN	1.245 BC	0.2700 A	19.94 AB	20.35 A	16.15
25% FC + 75% MN	1.280 B	0.2625 A	18.39 BCD	19.61 A	14.25
50% FYM + 50% MN	1.245 BC	0.2725 A	18.26 BCD	17.84 AB	12.66
50% PM + 50% MN	1.142 E-G	0.2775 A	14.96 D	16.19 AB	8.54
50% FC + 50% MN	1.255 BC	0.2625 A	16.58 BCD	15.28 AB	9.13
75% FYM + 25% M N	1.148 E-G	0.2725 A	18.31 BCD	18.42 A	13.19
75% PM + 25% MN	1.158 E-G	0.2325 A	14.94 D	17.45 AB	9.57
75% FYM + 25% MN	1.168 EF	0.2475 A	16.11 BCD	14.25 AB	7.88
25%FYM+25%PM+50%MN	1.420 A	0.2500 A	19.73 ABC	15.79 AB	12.13
25%FYM+25%FC+50%MN	1.220 CD	0.2325 A	18.67 BCD	16.37 AB	11.78
25%PM + 25%FC+50%MN	1.125 FG	0.2250 A	14.98 D	15.26 AB	7.78

Means of the same category followed by different letters are significantly different using LSD test ($p \leq 0.05$)

Nitrogen concentration in grain and stover: Nitrogen concentration in grain and stover was significantly ($p<0.05$) affected by the integrated use of organic and mineral N (Table 5). Maximum grain N concentration was recorded in treatments where 25% N was applied from farmyard manure (FYM), 25% from poultry manure (PM) and 50% from mineral fertilizer (urea). Similarly, maximum stover N concentration was recorded in treatments where 50% N was applied from poultry manure (PM) and 50% from mineral fertilizer (urea). Similar results were reported by Silva *et al.*, (2006), Patidar & Mali (2001) and Rao & Shaktawat, (2002).

N-uptake in maize grain and stover: The effect of different combination of organic N sources and mineral nitrogen on N uptake in maize grain and stover was significant ($p<0.05$). Maximum N-uptake in grain was found in treatments combinations of 25% farmyard manure (FYM) + 75% mineral nitrogen (urea). Similarly, in maize stover, N-uptake was more in treatments where 25% poultry manure (PM) and supplemented with 75% N mineral source (urea) and followed by the treatments fertilized with 25% N from filter cake (FC) and 75% from mineral source (urea). These results are in agreement with those of Silva *et al*., (2006), Patidar & Mali (2001) and Rao & Shaktawat (2002).

Agronomic and nitrogen use efficiency: The results indicated that maximum agronomic efficiency of 8.03 g/kg was found in treatments where 25% N was applied from farmyard manure (FYM) supplemented with 75% from mineral source (urea) and followed by the treatment where 25% poultry manure (PM) and 75% mineral source (urea) was applied (Table 4). Nitrogen use efficiency is considered as the recovery of the applied fertilizer by the harvested crop. Similar trend was also observed for nitrogen use efficiency. Our result indicated that maximum nitrogen use efficiency (NUE) was found in treatments where 25% N was applied from farmyard manure (FYM) and 75% from mineral source (urea) and followed by the treatments of 25% N from poultry manure (PM) and 75% N from mineral source (urea). Similar results were also reported by Akbar *et al.* (1999), Patidar & Mali (2001) and Rao & Shaktawat (2002).

Conclusion

It is concluded from the results that the integrated use of mineral N source (urea) and organic N sources (farmyard manure, poultry manure, filter cake) performed better than the sole application of organic N sources and mineral N source in terms of improvement of maize crop yield. Combination of 75:25 mineral N source and organic N sources are the best combination for getting higher grain and N yield of maize crop.

References

Ahmad, N. 2000. Fertilizer scenario in Pakistan: Policies and development In: *Proc. of conf. Agric. and fertilizer use*. 2000. Feb. 15-16, NFDC, Islamabad, 1999.

Akbar, F., A. Wahid, S. Akhtar, A.N. Ahmad and F.M. Chaudhry. 1999. Optimiztion of method and time of N application for increased N use efficiency and yield of maize. *Pak. J. Bot.,* 31: 337-341.

Bari, A. 2003. *Organic and inorganic nitrogen management for wheat and its residual effect on subsequent maize crop*. Ph.D. thesis Department of Agronomy, Agric. University, Peshawar, Pakistan.

Black, C.A. 1965. Methods of Soil analysis part-II. *Amer. Soc. Agron.* Inc. Madison, Wisconsin U.S.A.

Buschiazzo, D.E., G.G. Hevia and E.N. Hepper. 2000. Cultivation effects on phosphate forms and sorption in loess soils of Argentina. *Soil. Sci*., 165: 427-436.

Busra, M., A.M. Ranjha, M. Abid and M. Iqbal. 2005. Soil physical properties and wheat growth as affected by tillage and farm manure. *Pak. J. Agric.,* 42: 56-58.

Channabasanagowda, N., K.B. Patil, B.N. Patil, J.S. Awaknavar, B.T. Ninganur and R. Hunje. 2008. Effect of organic manures on growth, seed yield and quality of wheat. *Karnataka J. Agric. Sci*., 21: 366-368.

Gomez, K.A. and A.A. Gomez.1984. *Statistical procedures for agricultural research*. Wiley, New York, 680 pp.

Lampe, S. 2000. Principal of integrated plant nutrition management system. In: *Proc. of Symp. Integrated Plant Nutrition Management* (Nov. 8-10), NFDC, Islamabad, 1999.

Moodi, C.D., H.W. Smith and R.A. Mccreery.1959. *Laboratory Manual for Soil Fertility*. State College Washington Mimeograph, 31-39.

Nadia, M. Akbar and M.A. Khwaja. 2006. *Sustainable Development Policy Institute (SDPI) Islamabad, Pakistan*.

Narwal, R.P., D.R.S.Antil, A.P.Gupta and D.Pal. 1999. Effect of sulphitation and carbonation press mud cake and nitrogen on the corn yield, nutrients uptake and soil properties. Annals of Agri. Biol. Res., 4(2): 151-156.

Olsen, S.R., C. Cole, F. Wantanabe and L. Dean. 1954. Estimation of available P extraction with $NaHCO_3$ USDA Circ. 939. Washington DC.

Patidar, M. and A.L. Mali. 2001. Integrated nutrient management in sorghum and its residual effect on wheat. *Indian J. Agric. Sci*., 71: 587-590.

Rao, S.S. and M.S. Shaktawat. 2002. Residual effect of organic manure, phosphorus and gypsum application in preceding groundnut (*Arachis hypogea*) on soil fertility and productivity of Indian mustard (*Brassica juncea*). *Ind. J. Agron*., 47: 487-494.

Richard, L.A. 1954. *Diagnosis and Improvement of Saline and Alkali Soils*. Agric. Hand Book-60. pp. 101-129.

Russel, D.F. and S.P. Eisensmith. 1983. *MSTATC*. Crop Soil Science Department, Michigan State University, USA.

Shaaban, S.M. 2006. Effect of organic and inorganic nitrogen fertilizer on wheat under water regime. *J. Appl. Sci. Res*., 2: 650-656

Silva, P.S., L. Silvaj, F.H.T. Oliveira and D. Sousaakf. 2006. Residual effect of cattle manure application on green ear yield and corn grain yield. *Hort. Brasileria*, 24: 166-169.

Steel, R.G.D., and J.H. Torrie. 1980. *Principles and procedures of statistics: A Biometrical Approach*. McGraw Hill, New York, pp. 186-187.

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