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MITIGATIVE EFFECT OF DIVERSE USE OF NITROGEN SOURCES ON BULK DENSITY, ORGANIC MATTER AND GRAIN YIELD OF HYBRID MAIZE

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ABSTRACT

A number of factors are responsible for low yield of maize. Inappropriate crop nutrition management and poor soil fertility are the most important than others. Two year field trail was conducted to determine the mitigative effect of diverse use of nitrogen sources on bulk density, organic matter and grain yield of hybrid maize (*Zea mays* L.) at the Agronomic Research Area, University of Agriculture, Faisalabad during autumn 2008 and 2009. Experiments were laid out in a randomized complete block design (RCBD) with factorial arrangement having 3 replications with a net plot size of 3m x 5m. Treatments comprised two hybrids:H_1 (Pioneer-30Y87) and H_2 (Pioneer-31R88) with combination of six nitrogen sources S_0: Control (0) kg N ha^{-1}, S_1:Urea (50%) + Poultry manure (50%), S_2: Urea (50%) + Farm Yard Manure (50%) , S_3: Urea (50%) + Pressmud of sugarcane manure (50%), S_4: Urea (50%) + Compost (50%), S_5: Urea (50%) + (PM+FYM+PMS+ Compost) 50% . The hybrid maize varieties showed no significant effect on bulk density and organic matter for 2008 and 2009. The effect of nitrogen sources was significant in both seasons for bulk density and organic matter. Bulk density maximum in S_0: Control (0) kg N ha^{-1} treatment where no nitrogen applied and minimum in S_1: Urea (50%) + Poultry manure (50%) treatment combination while antagonistic effect was observed for organic matter. Hybrid maize H_1(Pioneer - 30Y87) produced better grain yield (6.14 t ha^{-1}) during 2008 when nitrogen sources S_1: Urea (50%) + Poultry manure (50%) was applied in combination as compared to grain yield (6.08 t ha^{-1}) in hybrid H_2 (Pioneer -31R88) during 2009. While maximum grain yield (7.05 t ha^{-1}) and (6.92 t ha^{-1}) was found in nitrogen sources S_1: Urea (50%) + Poultry manure (50%) treatment combination in 2008 and 2009 as compared to minimum grain yield (3.73 t ha^{-1}) where no nitrogen applied (S_0 : Control 0 kg N ha^{-1}) treatment, respectively.

Key words: Nitrogen sources, Hybrid maize, Grain yield, Bulk density, Organic matter

INTRODUCTION

Maize is ranked third among the cereal crops in the world after wheat and rice. In Pakistan it is grown on an area of one million hectares with the total production of 4.2 million tons (GOP, 2011). Mohsin *et al*., (2012) conducted an experiment on integrated use of mineral fertilizers and organic material having treatments i.e. control, 100% N through FYM, 25% N through urea and 75% N through FYM, 50% N through urea and 50% N through FYM, 75% N through urea and 25% N through FYM and 100% N through urea. They found that combination of 50% N through urea and 50% N through FYM should be used for spring maize in order to get maximum yield. Poultry manure at the rate of 5 t ha^{-1} and 10 t ha^{-1} enhanced the maize production by 39-43% immediately and on residual basis it increased yield 73 and 93%. Combination of 5 t ha^{-1} cocca pod ash and poultry manure 10 t ha^{-1} gave the highest yield of 6.5 and 5.58 t ha^{-1} on weight basis (Ayeni *et al.,* 2010). Elfstrand *et al*., 2007 carried out a field experiment by using organic sources of nutrients. The results showed that organic sources of nutreints supply both essential nutrients and also gave a positive interaction of nutrients with chemical fertilizers to increase their efficiency and to improve the soil structure.

Pressmud from the sugarcane is also a useful source of fertilizer as well as some chemicals, its usefulness is based on nutrient content of mud and spent wash (Partha and Sivasubramanian, 2006). Agronomic efficiency and nitrogen use efficiency can be enhanced by using the combination of 75% nitrogen (urea) +25% organic sources like farm yard manure (Shah *et al*., 2010).

Adejumo *et al.* (2010) conducted an experiment to evaluate the relative effect of municipal solid waste (MSW) and cassava waste along with inorganic fertilizer on maize crop yield in lead affected soils. It was concluded that use of compost increased yield compared to inorganic fertilizers. Higher dose of MSW caused to increase plant height, dry matter yield, leaf area and grain yield. It was also observed that there was a significant reduction in soil lead concentration of all compost rates used. The maize root analyzed showed the uptake of lead by roots move in compost applied field compared to inorganic fertilizers. Therefore it was concluded that different composites can be used for restoration of lead sites.

Organic matter (O.M.) and the total N status declined with application of fertilizer N alone but increased with integrated use of fertilizer N and O.M. build up in S status was mostly through the organic S fertilizer. The use of FYM and green manure increased the K availability in the soil. The combined application of O.M. and inorganic N sustained the productivity even at lower level of N application. Incorporation of 5 t FYM and 6 t green manuring saved 70-80 kg N ha^{-1} (Muneshwar *et al*., 2001).

A number of factors are responsible for low yield of the crop. Inappropriate crop nutrition management and poor soil fertility are the most important factors responsible for the low yield. Soil fertility can be enhanced through the application of mineral fertilizers as well as with the addition of O.M. to the soil. Nevertheless, imbalanced use of fertilizer without the application of organic manure and without knowing the requirements of crops and fertility status of soil causes the problem such as deterioration of soil structure, environmental and ground water pollution etc. Similarly continuous use of chemical fertilizer caused the depletion of soil fertility. Organic matter improves the soil health and availability of nutrients. Organic materials are available in large amounts in the form of farm waste, city waste, poultry litter and industrial waste (food, sugar, cotton and rice industry).

MATERIALS AND METHODS

During autumn 2008 and 2009 two year field experiment was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad to determine the mitigative effect of diverse use of nitrogen sources on bulk density, organic matter and grain yield of hybrid maize (*Zea mays* L.) Experiments were laid out in a randomized complete block design (RCBD) with factorial arrangement comprising three replications with a net plot size of 3m x 5m. Treatment comprised two hybrids: H_1 (Pioneer-30Y87) and H_2 (Pioneer-31R88) with combination of six nitrogen sources S_0: Control (0) kg N ha^{-1}, S_1:Urea (50%) + Poultry manure (50%), S_2: Urea (50%) + Farm Yard Manure (50%) , S_3: Urea (50%) + Pressmud of sugarcane manure (50%), S_4: Urea (50%) + Compost (50%), S_5: Urea (50%) + (PM+FYM+PMS+ Compost) 50% . A recommended doze of fertilizer was applied. Urea was used as inorganic nitrogen source in split doses at the rate of 250 kg N ha^{-1} (half at sowing and half in two equal splits-half at knee height and remaining half at tasseling. All the organic sources i.e. farm yard manure, pressmud of sugarcane, compost and poultry manure were applied three week before sowing. Recommended 100 kg P ha^{-1} and 100 kg K ha^{-1} was applied at sowing some from organic sources (poultry manure, farm yard manure, pressmud of sugarcane and compost) and remaining from inorganic sources: i.e. Single Super Phosphate (SSP) and Sulphate of Potash (SOP). Soil sample were analyzed chemically for their nutrients status before sowing of crop. All other cultural practices were kept normal and uniform for all the treatments. Harvesting was done made on 25 November 2008 and 10 November 2009.

The data about following traits like; bulk density, organic matter and grain yield (t ha^{-1}) were recorded. Data regarding all the traits were collected using standard procedures and analyzed by using Fisher's analysis of Variance technique. LSD test at 5% probability was used to compare the differences among treatments means (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

Bulk density (g cm^{-3}): Bulk density decreased with increase in organic matter of soil. The hybrid maize varieties showed no significant effect on bulk density for 2008 and 2009. (Table 1a) shows the effects of nitrogen sources on bulk density were significant in both seasons. Nitrogen source S_0 (1.38 g cm^{-3}) gave maximum bulk density as compared to minimum in S_1 (1.30 g cm^{-3}) for 2008 with similar results in 2009. Low bulk density was due to availability of organic matter to soil at proper time and in proper proportions. These results are similar to the findings of Diaz-Zortia (2000) and Hossain *et al.* (2004).

No significant interactions of maize hybrids and incorporated nitrogen sources were observed for both years.

Differences in year 2008 (Table 1b) between S_2 vs S_4, S_3 vs S_4, S_4 vs S_5, were found to be significant for bulk density (g cm^{-3}). Differences between S_0 (Control) vs S_1, S_2, S_3, S_4, S_5 (nitrogen sources), S_1 vs S_2, S_1 vs S_3, S_1 vs S_4, S_1 vs S_5 were highly significant from each other for bulk density (g cm^{-3}). The contrast for S_2 vs S_3, S_2 vs S_5, S_3 vs S_5, on bulk density (g cm^{-3}) was found to be not significant. Differences during 2009 among S_2 vs S_5 were significant for bulk density (g cm^{-3}). The contrast for S_0 (Control) vs S_1, S_2, S_3, S_4, S_5 (nitrogen sources), S_1 vs S_2, S_1 vs S_3, S_1 vs S_4, S_1 vs S_5 was found to be highly significant for bulk density (g cm^{-3}) while S_2 vs S_3, S_2 vs S_4, S_2 vs S_5, S_3 vs S_4, S_3 vs S_5, S_4 vs S_5 not significant for bulk density (g cm^{-3}).

Organic matter (%): Organic matter has multi dimensional effects on soil. Soil organic matter increased with decreasing bulk density and vice versa. The hybrid maize varieties had no significant influence on organic matter for 2008 and 2009 (Table 2a).

The effect of nitrogen sources was significant for both seasons. Organic matter was maximum in nitrogen source S_1 (0.89%) and (0.88%) and minimum organic matter was noted in S_0 (0.71%) and (0.70%) with a similar trend for 2009. Improvement in organic matter was due decomposition of nitrogen sources and

increasing N availability to soil at proper times. These results are identical to the findings of Hao *et al*. (2002); Halvorson *et al.* (2002).

Table 1a. Effect of hybrid maize and incorporated nitrogen sources on bulk density (g cm^{-3})

Treatments	2008	2009
A-Hybrids		
H_1 : Pioneer-30Y87	1.34	1.33
H_2 : Pioneer-31R88	1.33	1.34
LSD = 0.05	NS	NS
B-Nitrogen Sources		
S_0 : Control 0 kg Nha^{-1}	1.38^{a}	1.38^{a}
S_1: Urea (50%) + Poultry manure (PM) (50%)	1.30^{d}	1.28^{d}
S_2: Urea (50%) + Farm Yard Manure (FYM) (50%)	1.33^{c}	1.33^{c}
S_3: Urea (50%) +Pressmud of sugarcane (PS) (50%)	1.33^{bc}	1.33^{c}
S_4: Urea (50%) + Compost (C) (50%)	1.34^{bc}	1.35^{b}
S_5: Urea (50%) + (PM + FYM+PS+ Compost) 50%	1.35^{b}	1.33^{c}
LSD = 0.05	0.02*	0.018*
C-Interaction (H x NS)		
H_1S_0	1.8	1.38
H_1S_1	1.30	1.28
H_1S_2	1.34	1.33
H_1S_3	1.32	1.32
H_1S_4	1.34	1.35
H_1S_5	1.35	1.33
H_2S_0	1.39	1.38
H_2S_1	1.30	1.28
H_2S_2	1.33	1.33
H_2S_3	1.34	1.34
H_2S_4	1.35	1.35
H_2S_5	1.33	1.33
LSD =0.05	NS	NS

Mean values in column not comprising the same letter vary significantly at probability (P=0.05) *=Significant at 5% level
NS = Non significant

Table 1b. Differences of hybrid maize and incorporated nitrogen sources bulk density (g cm^{-3})

Contrasts	2008	2009
S_0 VS S_1,S_2,S_3,S_4,S_5	**	**
S_1 VS S_2	**	**
S_1 VS S_3	**	**
S_1 VS S_4	**	**
S_1 VS S_5	**	**
S_2 VS S_3	NS	NS
S_2 VS S_4	*	NS
S_2 VS S_5	NS	*
S_3 VS S_4	*	NS
S_3 VS S_5	NS	NS
S_4 VS S_5	*	NS

S_0: (Control), S_1 : Urea (50%) + Poultry manure (50%), S_2 : Urea (50%) + Farm Yard Manure (50%), S_3 : Urea (50%) + Pressmud of sugarcane (PS) (50%), S_4 : Urea (50%) + Compost (50%), S_5 : Urea (50%) + (PM+ FYM+ PS+ Compost) 50%
Mean values in column not comprising the same letter vary significantly at (P=0.05); *=Significant at 5% level **=highly Significant at 5% level; NS = Non significant

Interactions of maize hybrids and incorporated nitrogen sources were not significant for both years.
In 2008 differences (Table 2b) between S_0 (Control) vs S_1, S_2, S_3, S_4, S_5 (nitrogen sources)S_1 vs S_2, S_1 vs S_3, S_1 vs S_4, S_1 vs S_5 were found to be highly significant for organic matter content (%). Differences between S_2 vs S_3, S_2 vs S_4, S_2 vs S_5, S_3 vs S_4, S_3 vs S_5, S_4 vs S_5 were not significant from each other for organic matter content (%). Differences for 2009 among S_2 vs S_4, were significant for organic matter content (%). The contrast for S_0 (Control) vs S_1, S_2, S_3, S_4, S_5 (nitrogen sources), S_1 vs S_2, S_1 vs S_3, S_1 vs S_4, S_1 vs S_5, S_2 vs S_3, S_2 vs S_5 was found to be highly significant for organic matter content (%) while S_3 vs S_4, S_3 vs S_5, S_4 vs S_5, was not significant for organic matter content (%).

Grain yield (t ha^{-1}): Grain yield in both 2008 and 2009 was significantly influenced by hybrid maize varieties and nitrogen sources. Data in (Table 3a) shows that in both years, hybrid H_1 (6.14 t ha^{-1} and 6.08 t ha^{-1} in 2008 and 2009, respectively) produced higher grain yield compared to lower in hybrid H_2 (6.0 t ha^{-1} and 5.91 t ha^{-}

[1]), respectively. This was followed by S_2 (urea + FYM) source which increased grain yield over the incorporated nitrogen sources .These results are similar to the findings of Mohsin *et al*., (2012); Shah *et al*., (2009) and Waseem *et al.*, (2007).

Table 2a. Effect of hybrid maize and incorporated nitrogen sources on organic matter content (%)

Treatments	2008	2009
A-Hybrids		
H_1 : Pioneer-30Y87	0.81	0.80
H_2 : Pioneer-31R88	0.80	0.80
LSD = 0.05	NS	NS
B-Nitrogen Sources		
S_0 : Control 0 kg Nha^{-1}	0.71 c	0.70 d
S_1: Urea (50%) + Poultry manure (PM) (50%)	0.89 a	0.88 a
S_2: Urea (50%) + Farm Yard Manure (FYM) (50%)	0.82 b	0.83 b
S_3: Urea (50%) +Pressmud of sugarcane (PS) (50%)	0.80 b	0.80 c
S_4: Urea (50%) + Compost (C) (50%)	0.81 b	0.81 c
S_5: Urea (50%) + (PM + FYM+PS+ Compost) 50%	0.81 b	0.79 c
LSD = 0.05	0.03*	0.021*
C-Interaction (H x NS)		
H_1S_0	0.71	0.70
H_1S_1	0.89	0.89
H_1S_2	0.82	0.82
H_1S_3	0.79	0.80
H_1S_4	0.82	0.82
H_1S_5	0.81	0.79
H_2S_0	0.71	0.71
H_2S_1	0.89	0.87
H_2S_2	0.82	0.84
H_2S_3	0.81	0.80
H_2S_4	0.81	0.80
H_2S_5	0.80	0.79
LSD =0.05	NS	NS

Mean values in column not having the same letter vary significantly at P=0.05 *=Significant at 5% level NS = Non significant

Table 2b. Differences of hybrid maize and incorporated nitrogen sources on organic matter content (%)

Contrasts	2008	2009
S_0 VS S_1,S_2,S_3,S_4,S_5	**	**
S_1 VS S_2	**	**
S_1 VS S_3	**	**
S_1 VS S_4	**	**
S_1 VS S_5	**	**
S_2 VS S_3	NS	*
S_2 VS S_4	NS	**
S_2 VS S_5	NS	NS
S_3 VS S_4	NS	NS
S_3 VS S_5	NS	NS
S_4 VS S_5	NS	NS

S_0 : (Control), S_1 : Urea (50%) + Poultry manure (50%), S_2 :Urea (50%) + Farm Yard Manure (50%), S_3 : Urea (50%) + Pressmud of sugarcane (PS) (50%), S_4 : Urea (50%) + Compost (50%), S_5 : Urea (50%) + (PM+ FYM+ PS+ Compost) 50%; Mean values in column having different letters vary significantly (P<0.05)*=Significant (P<0.05); **=Significant (P<0.01);N.S = Non significant

Different nitrogen sources also had a significant effect on grain yield in both years. In 2008 nitrogen sources S_1 (7.05 and 6.92t ha^{-1} in 2008 and 2009, respectively) produced highest grain yield while lowest grain yield was found in S_0 (3.73 and 3.73t ha^{-1}) respectively. These observations are confirming the findings of Mohsin *et al*., (2012); Farhad *et al*., 2009 and Waseem *et al.* (2007).

Significant interactions between maize hybrids and incorporated nitrogen sources were observed during both years. In 2008 maximum grain yield was recorded in

H_1S_1 (7.12 t ha^{-1}) while a minimum was found in the interaction of H_2S_0 (3.57 t ha^{-1}). This was similar for 2009, Rizwan *et al.* (2003) and Sharif *et al.* (2004) also reported similar interactions in maize.

In 2008 differences between S_0 (Control) vs S_1, S_2, S_3, S_4, S_5 (nitrogen sources), S_1 VS S_2, S_1 VS S_3, S_1 VS S_4, S_1 VS S_5, S_2 VS S_3, S_2 VS S_4, S_2 VS S_5, S_3 VS S_4, S_4 VS S_5 were highly significant for grain yield (t ha^{-1}) and S_3 VS S_5 had a non-significant difference for grain yield (Table 3b). In 2009 among S_0 (Control) vs S_1, S_2, S_3, S_4, S_5 (nitrogen sources), S_1 VS S_2, S_1 VS S_3, S_1 VS S_4, S_1 VS S_5, S_2 VS S_3, S_2 VS S_4, S_2 VS S_5 ,S_3 VS S_4, S_3 VS S_5 ,S_4 VS S_5 , S_0 (Control) vs S_1, S_2, S_3, S_4, S_5 (nitrogen sources) differences were highly significant for grain yield (t ha^{-1}) and S_3 VS S_5 the difference for grain yield (t ha^{-1}) was found to be non significant.

Table 3a. Effect of hybrid maize and incorporated nitrogen sources on grain yield (t ha^{-1})

Treatments	2008	2009
A-Hybrids		
H_1 : Pioneer-30Y87	6.14 a	6.08 a
H_2 : Pioneer-31R88	6.0 b	5.91 b
LSD = 0.05	0.02*	0.05 *
B-Nitrogen Sources		
S_0 : Control 0 kg Nha^{-1}	3.73 f	3.73 e
S_1 : Urea (50%) + Poultry manure (PM) (50%)	7.05 a	6.92 a
S_2 : Urea (50%) + Farm Yard Manure(FYM) (50%)	6.63 b	6.57 b
S_3 : Urea(50%) +Pressmud of sugarcane(PS) (50%)	6.40 d	6.33 c
S_4 : Urea (50%) + Compost (C) (50%)	6.19 e	6.16 d
S_5 : Urea (50%) + (PM + FYM+PS+Compost) 50%	6.43 c	6.28 c
LSD = 0.05	0.05*	0.87*
C-Interaction (H x NS)		
H_1S_0	3.57 l	3.57 j
H_1S_1	7.12 a	7.02 a
H_1S_2	6.91 c	6.80 b
H_1S_3	6.59 f	6.45d e
H_1S_4	6.69 e	6.65 c
H_1S_5	6.01 i	6.01 g
H_2S_0	3.90 k	3.90 i
H_2S_1	6.99 b	6.82 b
H_2S_2	6.35 g	6.35 e
H_2S_3	6.21 h	6.21 f
H_2S_4	5.70j	5.66 h
H_2S_5	6.85 d	6.56 cd
LSD = 0.05	0.04*	0.2*

Mean values in column not having the same letter vary significantly at P=0.05 *=Significant at 5% level

Table 3b. Differences of hybrid maize and incorporated nitrogen sources on grain yield (t ha^{-1})

Contrasts	2008	2009
S_0 VS S_1,S_2,S_3,S_4,S_5	**	**
S_1 VS S_2	**	**
S_1 VS S_3	**	**
S_1 VS S_4	**	**
S_1 VS S_5	**	**
S_2 VS S_3	**	**
S_2 VS S_4	**	**
S_2 VS S_5	**	**
S_3 VS S_4	**	**
S_3 VS S_5	NS	NS
S_4 VS S_5	**	**

S_0 : (Control), S_1 : Urea (50%) + Poultry manure (50%), S_2 : Urea (50%) + Farm Yard Manure (50%), S_3 : Urea (50%) + Pressmud of sugarcane (PS) (50%), S_4 : Urea (50%) + Compost (50%), S_5 : Urea (50%) + (PM+ FYM+ PS+ Compost) 50% ; Mean values in column not having the same letter vary significantly at P=0.05 **=highly Significant at 5% level
NS = Non significant

Conclusions: On the basis of two year study it was concluded that the hybrid maize had no significant effect on bulk density and organic matter for 2008 and 2009. The effect of nitrogen sources was significant in both seasons for bulk density and organic matter. Bulk density high in S_0 : Control (0) kg N ha^{-1} treatment where no nitrogen applied and low in S_1: Urea (50%) + Poultry manure (50%) treatment combination while antagonistic effect was observed for organic matter. Hybrid maize H_1 (Pioneer - 30Y87) produced better grain yield (6.14 t ha^{-1}) during 2008 as compared to grain yield (6.08 t ha^{-1}) in hybrid H_2 (Pioneer -31R88) during 2009. While maximum grain yield (7.05 t ha^{-1}) and (6.92 t ha^{-1}) was found in nitrogen sources S_1: Urea (50%) + Poultry manure (50%) treatment combination in 2008 and 2009 as compared to minimum grain yield (3.73 t ha^{-1}) where no nitrogen applied (S_0 : Control 0 kg N ha^{-1}) treatment, respectively.

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