EFFECT OF RATE AND SOURCE OF ORGANIC MATERIAL ON THE PRODUCTION POTENTIAL OF SPRING MAIZE (*Zea mays* L.)

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A field experiment was conducted to determine the growth, yield and quality performance of spring maize treated with different rate and source of organic materials i.e. poultry manure (PM) and farmyard manure (FYM) in 2006 under agro-ecological conditions of Faisalabad. The treatments included were 10, 15, 20, 25 and 30 t ha^{-1} FYM and 4, 6, 8, 10 and 12 t ha^{-1} PM. The results indicated that grain yield of 5.6 t ha^{-1} was recorded in plots added with 12 t ha^{-1} PM and it was statistically same as obtained with 10 t ha^{-1} PM. The increase in yield was attributed to increase in cob length, cob diameter and number of grains per cob. Grain protein percentage (8.15) was also maximum where 12 t ha^{-1} PM was applied. Effects of different treatments on growth and yield parameters of maize are discussed.

Keywords: Maize; organic material; yield.

INTRODUCTION

Maize is an important cereal crop of Pakistan and ranks third in production after wheat and rice. In the advanced countries, about 90% of maize is used for making animal feed and other industrial products. Unlike in the developed countries, the same percentage (80-90) of maize is used as food in the third world (Rajoo, 1998).

Maize is a multipurpose crop, provides food for human beings, feed for animals and poultry and fodder for livestock. It has high nutritional value as it contains about 72% starch, 10% protein, 4.8% oil, 8.5% fibre, 3% sugar and 1.7% ash (Chaudhary, 1993). It is a rich source of raw material for industry where it is being extensively used for the preparation of by products like corn starch, corn oil, dextrose, corn syrup, corn flakes, cosmetics, wax, alcohol and tanning material for leather industry.

In Pakistan, it is grown on an area of 1.02 million hectares with the annual grain production of 2.96 million tones and average grain yield of 2893 kg ha^{-1}. This yield is much lesser than the other countries of the world (GOP, 2007).

In spite of substantial fertilizer use in Pakistan, the crop yield is not increasing correspondingly, which reflect low fertilizer use efficiency (FUE). There are some problems related to chemical fertilizers such as inadequate supply or even unavailability of fertilizer at the time of need, adulteration and high cost (Ahmad, 1994). Further, continuous use of fertilizers creates potential polluting effect in the environment (Oad *et al.*, 2004). Synthesis of chemical fertilizers consumes a large amount of energy and money. However, an organic farming with or without chemical fertilizers seems to be possible solution for these situations (Prabu *et al*., 2003).

The biggest obstacle to inorganic fertilizer use is its cost. High cost does not favor the use of fertilizers if the yield response and grain price is not high enough, it makes its use unprofitable (Tolessa and Friesen, 2001). Under intensive agriculture, the use of inorganic fertilizers has not been helpful because it is associated with soil acidity, nutrient imbalance and reduction in crop yield (Kang and Juo, 1980). Worldwide revival of the use of organic manures is completely dependent upon the need to use renewable forms of energy and in order to reducing the costs of fertilizing crops (Seifritz, 1982). Improvement in the public health and environmental conditions are also the strong reasons for advocating the use of organic materials (Ojeniyi, 2000). Keeping in view the above facts, the present study was designed to determine the comparative usefulness of organic manures in increasing maize productivity with high quality produce.

MATERIALS AND METHODS

Investigations were carried out at the Agronomic Research Area, University of Agriculture, Faisalabad on a sandy clay loam soil having 0.049% N, 5.08 ppm available phosphorus and 180 ppm potassium. The experiment was laid out in Randomized Complete Block Design and replicated thrice. The treatments included were 10, 15, 20, 25 and 30 t ha^{-1} FYM and 4, 6, 8, 10 and 12 t ha^{-1} PM. Net plot size was 3 m x 4 m. Seedbed was prepared by cultivating the soil 2-3 times with tractor mounted cultivator each followed by planking. Maize single cross hybrid (32-W-86) was sown on 16th of February in 2006. Sowing was done by dibbling method (by placing 2 seeds manually per hill at 20 cm apart hills) on 75 cm apart ridges. In this experiment the crop was completely dependent upon the farmyard manure and poultry manure for its requirement of N, P and K. Analysis of Poultry and Farmyard manure was carried out to determine the NPK percentage in them. Whole amount of FYM and PM was incorporated in the soil at the time of pre-sowing irrigation. In addition to rainfall received during the growing period of the crop, a total of eleven irrigations were applied as and when needed at different plant growth stages till the physiological maturity of the crop. First irrigation was applied twenty five days after sowing the crop while subsequent irrigations were applied with fifteen days intervals till flowering and from flowering to seed formation irrigations were applied with seven days interval due to high water requirement of spring maize crop. Thinning was done at 3-4 leaf stage to maintain a single plant at each hill. Crop was kept free of weeds by hoeing twice to avoid weed-crop competition. All other agronomic practices were kept normal and uniform for all the treatments.

Table 1. Effect of rate and source of organic material on agronomic and quality characteristics of spring maize

Treatments	Cob length (cm)	Cob diameter (cm)	No. of grains per cob	1000-grain weight (g)	Grain yield (t ha^{-1})	Biological yield (t ha^{-1})	Protein content (%)
T_1 = 10 t ha^{-1} (FYM)	14.85 h	3.55 g	321.52 g	198.00 d	3.70 g	12.99 f	7.36 d
T_2 = 15 t ha^{-1} (FYM)	15.16h	3.59 gf	323.97 g	201.79 d	3.81 f	13.02 f	7.43d
T_3 = 20 t ha^{-1} (FYM)	16.71 f	3.63 f	330.00 f	210.05 c	4.47 d	14.19 d	7.69 c
T_4 = 25 t ha^{-1} (FYM)	18.55 d	3.88 d	355.52 d	214.78 c	4.78 c	14.66 c	7.78 c
T_5 = 30 t ha^{-1} (FYM)	20.89 b	4.04 bc	384.36 b	243.64 a	5.29 b	16.15 b	7.99 b
T_6 = 4 t ha^{-1} (PM)	15.92g	3.59 gf	325.58 g	202.04 d	4.10 e	13.85 e	7.49 d
T_7 = 6 t ha^{-1} (PM)	17.73 e	3.75 e	346.99 e	212.17 c	4.52 d	14.32 d	7.69 c
T_8 = 8 t ha^{-1} (PM)	19.26 c	3.97 c	369.08 c	233.10b	4.86 c	14.84 c	7.94 b
T_9 = 10 t ha^{-1} (PM)	21.17b	4.09 ab	385.06 b	244.16 a	5.33 ab	16.40 b	8.03 ab
T_{10} = 12 t ha^{-1} (PM)	22.05 a	4.13 a	389.46 a	246.59 a	5.60 a	17.16 a	8.15 a
LSD 5 %	2.1	0.07	4.18	5.05	0.10	0.33	0.13

Means in a column not sharing the same letters differ significantly from each other at 5% probability level.

RESULTS AND DISCUSSION

Cob length of maize was significantly affected by the application of different rates of farmyard and poultry manure (Table 1). The maximum cob length (22.05 cm) was recorded in plots of T_{10} treatment where 12 t ha^{-1} poultry manure was applied at the time of sowing. Treatments; T_5 and T_9 were statistically at par with each other, which gave cob length 21.17 cm and 20.89 cm, respectively. While, the minimum cob length (14.85 cm) was observed in T_1 treatment, where 10 t ha^{-1} FYM was applied.

Cob diameter is an important yield contributing parameter in maize. It contributes substantially to grain yield of maize, because it influences both number of grains per ear and grain size. Largest cob size (4.13 cm) was recorded in plots of T_{10} treatment, where 12 t ha^{-1} poultry manure was applied (Table 1) at the time of sowing. However, it was statistically at par with treatment T_9 producing cob diameter 4.09 cm. While, the minimum cob diameter (3.55 cm) was observed in T_1 treatment, where 10 t ha^{-1} FYM was applied.

Crop grown with treatment T_{10} (12 t ha^{-1} PM) produced the maximum number of grains per cob, GNC (389.46). On the contrary, the lowest GNC (321.52) were recorded for the crop raised with treatment T_1 (10 t ha^{-1} FYM).

Cob length and cob diameter are important yield contributing parameters in maize. They contribute substantially to grain yield of maize by influencing both number of grains per ear and grain size. The reason of more cob length and cob diameter with 12 t ha^{-1} poultry manure (T_{10}) and 30 t ha^{-1} farmyard manure (T_5) may be due to more photosynthetic activities of the plant on account of adequate supply of N in these treatments. Nitrogen is an essential requirement for cob and kernel growth in maize. A typical view of maize cob is that it serves as a temporary storage organ and as a conveyor of nutrients to the developing kernels (Crawford *et al*., 1982). Therefore, the better development of cobs (length and diameter) will be the index of the better economic yield of maize crop. These results are also supported by the findings of Amjad (1998) and Akhtar *et al.* (1999) who reported a significant increase in cob diameter and cob length with increasing rates of nitrogen from different sources. Different rates and sources of organic material (FYM & PM) significantly affected the 1000-grain weight (Table 1). The crop raised with 12 t ha^{-1} PM (T_{10}) had the maximum 1000-grain weight (246.59 g) but did not differ significantly from the crop fertilized @ 10 t ha^{-1} PM (T_9) and 30 t ha^{-1} FYM (T_5). On the contrary, the minimum 1000-grain weight (198 g) was recorded for the crop grown with 10 t ha^{-1} FYM. Higher rates of poultry manure and farmyard manure helped to increase not only 1000-grain weight but also the number of grains per cob but too low rates discouraged the same (Table 1). Adequate nutrient supply especially of nitrogen from the proper organic source (PM & FYM) might have enhanced the source efficiency (more dry matter accumulation per unit area/time) as well as sink capacity (grain weight). The decrease in 1000-grain weight and number of grains per cob with the application of lower rates of farmyard and poultry manure may be due to low availability of the nutrients especially of nitrogen which might have disturbed the physiological functioning of the maize crop. Comparable significant results were also reported by Gowda and Ibrahim (2001).

Grain yield is the end result of many complex morphological and physiological processes occurring during the growth and development of crop. Effect of different rates and sources of organic material (FYM & PM) on grain yield per hectare, GYH of maize was significant (Table 1). During 2006, crop fertilized @ 12 t ha^{-1} PM (T_{10}) produced the maximum GYH (5.6 t ha^{-1}) but was statistically on a par with T_9, (10 t ha^{-1} PM). The minimum GYH (3.7 t ha^{-1}) was recorded for the crop grown with 10 t ha^{-1} FYM (T_1). The increase in grain yield with 12 t ha^{-1} poultry manure was mainly due to more cob length, cob diameter as well as number of grains per cob and better grain development with the same treatment. Nicholson *et al*. (1999) also opined that increasing rates of manures positively affected maize grain yield.

Biological yield is as a result of nutrient uptake. It is one of the measures of plant growth and it reflects the relative growth rate as regard to net assimilation rate. The crop grown with 12 t ha^{-1} PM (T_{10}) gave the highest biological yield (17.16 t ha^{-1}) but was statistically on a par with T_9 (16.40 t ha^{-1}) treatment (10 t ha^{-1} PM). On the contrary, crop raised with 10 t ha^{-1} FYM (T_1) produced the minimum biological yield (12.99 t ha^{-1}) but did not differ significantly from T_2 (13.02 t ha^{-1}). The increase in biological yield reflects the better growth and development of the plants due to balanced and more availability of nutrients throughout the growing period. These results are in consonance with of Ibeawuchi *et al*. (2007).

The crop grown with 12 t ha^{-1} PM (T_{10}) had the maximum seed protein content, SPC (8.15 %). Contrarily, the lowest SPC (7.36 %) was obtained for the crop grown with 10 t ha^{-1} FYM (T_1). Maximum protein content with 12 t ha^{-1} PM has a very strong relationship with the protein contents of the leaves. It was found that the nitrogen contents of leaves are rapidly converted to protein and during seed development leaf N is transferred to seed for protein production (Strecter, 1972). Therefore, high leaf area index (data not shown) with the same level of poultry manure might be one of the strong reasons for these maximum protein contents with 12 t ha^{-1} PM. This type of improvement in seed protein contents was also reported by Jackson and Smith (1997).

Comparison of different rates of FYM and PM indicated that even three times dose of FYM than PM could not perform equally well in regard of yield and quality of maize, therefore PM should preferably be used @ 10 t ha^{-1} to get maximum economic yield of high quality produce.

REFERENCES

Ahmad, N. 1994. Integrated plant nutrition system improves fertilizer use efficiency (FUE) crop productivity and environment. P. 28-46. Proc. 4th National congress of Soil Science. May 24-26, 1992, Islamabad, Pakistan.

Akhtar, M. and J.A. Silva. 1999, Agronomic traits and productivity of sweet corn affected by nitrogen and intercropping. Pak. J. Soil Sci., 16:49-52.

Amjad, A. 1998. Effect of nitrogen and magnesium on growth yield and quality of hybrid maize. M.Sc. Thesis, Department of Agron., University of Agriculture, Faisalabad.

Chaudhary, A.R. 1993. Maize in Pakistan. Punjab Agri. Res. Cord. Board, Univ. Agri., Faisalabad, Pakistan.

Crawford, T.W., V.V. Rending and F.E. Broadbent. 1982. Sources; fluxes and sinks of nitrogen during early reproductive growth of maize (*Zea mays* L.). Plant Physiology, 70:1654-1660.

GOP. 2007. Economic Survey of Pakistan 2006-07. Ministry of Finance, Islamabad. Pakistan.

Gowda, A. and A. Ibrahim. 2001. Studies on organic sources of nutrient and amendment with lime on productivity of maize. University of Agriculture Sciences (Bangalore), 30:99-100.

Ibeawuchi, I.I., F.A. Opara, C.T. Tom and J.C. Obiefuna. 2007. Graded replacement of inorganic fertilizer with organic manure for sustainable maize production in Owerri Imo State, Nigeria. Federal University of Technology.

Jackson, D.R. and K.A. Smith. 1997. Animal manure slurries as a source of nitrogen for cereals: effect of application time on efficiency. Soil Use and Management, 13:75-81.

Kang, B.T. and A.S.R. Juo. 1980. Management of low activity clay soils in Cavenness F. Tropical Root crops: Research Strategies for the 1980s Ottawa, Ontario, IDRC. Pp. 129-133.

Nicholson, F.A., B.J. Chambers, K.A. Smith and R. Harrison. 1999. Spring applied organic manure as a source of nitrogen for cereal crops: Experiments using field scale equipment. Journal of Agricultural Sciences, 133:353-363.

Oad, F.C., U.A. Buriro and S.K. Agha. 2004. Effect of organic inorganic fertilizer application on maize fodder production. Asian Journal of Plant Sci., 3:375-377.

Ojeniyi, S.O. 2000. Effect of goat manure on soil nutrients and Okra yield in a rain forest area of Nigeria. Applied Tropical Agriculture, 5:20-23.

Prabu, T., P.R. Narwadkar, A.K. Sanindranath and M. Rafi. 2003. Effect of integrated nutrient management on growth and yield of okra cv. Parbhani K-ranti. Orissa J. Hort., 31 (1): 17-21.

Rajoo, R.K. 1998. Maize the golden grain of Himachal Pradesh.

Seifritz, W. 1982. Alternative and Renewable source of Energy In Optimizing Yields. The Role of Fertilizers. In: Proceedings of 12th IPI Congress. Pp 153-163.

Strecter, J.G. 1972. Nitrogen nutrition of field grown plants. I. Seasonal Varieties in nitrate reductase, glutamate, dehydrogenase and nitrogen constituents of plant parts. Agon.J. 64: 315-9.

Tolessa, D. and D.K. Friesen. 2001. Effect of enriching farm yard manure with mineral fertilizer on grain yield of maize at Banko, Western Ethiopia. Seventh Eastern and Southern Africa Regional Maize Conference: 335-337.