

Growth and Yield of Maize Influenced by Organic Amendments in Marginal Soils

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Abstract--A field trial was conducted to study the influence on growth and yield of maize by different organic amendments in marginal soils. The addition of FYM or PM in marginal soils enhanced the maize grain yield by 17- 20 %. The use of bio-fertilizers in combination with FYM or PM resulted in further enhancement in maize grain yield up to 49 %. Maximum biological yield and grain yield of maize was noted with the application of FYM or PM 8 tons ha⁻¹ + bio-fertilizer 1 + bio-fertilizer 2.

Keywords-- Bio-fertilizers, Farm Yard Manure (FYM), Grain yield, Maize, Marginal soils

I. INTRODUCTION

Maize is an important crop grown worldwide to fulfill the demands of human nutrition and livestock feed. In Pakistan maize is cultivated in both spring and autumn seasons and also a key source of income for the farmers in developing countries. Despite of claimless and favorable climatic conditions in the country the average grain yield per unit area of maize is very low as compared to other maize producing countries. Many factors are responsible for low yield of maize like: limited resources, imperfect management of available resource and lack of farmer's interest towards the adaptation to technological advancements because of the higher expenditure requirements. Shifting towards intense cropping system and dependence on the inorganic sources for plant nutrition greatly disturbed the soil health. The poor attention of researchers for developing long term strategies to improve the production potential of marginal soils is among the key reasons for low yield which negatively contributes in average per hectare yield of maize. Organic amendments improve the soil structure soil physical properties and provide a better medium for plant growth and development which ultimately enhance the crop yield and also provides the basis for sustainable agriculture (Hemalatha, et al. 2000).

Mehdi et al, (2007) also explained that the addition of organic materials in salt affected soils of highly significance in their reclamation by improving soil structure, increasing organic carbon contents of soil, recycling of plant nutrients and by reducing soil pH and sodicity. Similarly the role of bio-fertilizers is of prime importance in building up soil fertility and reclaiming the distractive soil structure through the production of adhesive substances and organic acids from decomposing organic materials by beneficial soil micro-organisms. According to a review, bio-fertilizers increased the N, P and K contents of maize seed by 130, 113 and 100 % respectively (Biari et al., 2008). The poor level of awareness among farming communities about the constructive use of manures and bio-fertilizers is a big constraint in enhancing the production potential of marginal soils. The aim of the present study is to evaluate the potential of various organic amendments for enhancing the maize yield in marginal soils.

II. MATERIALS AND METHODS

The experiment was conducted at farmer field under the local conditions of Faisalabad, Pakistan. Treatments were arranged in Randomized Complete Block Design with three replications and net plot size of 6 m × 4.8 m was maintained. Seed bed was prepared by two ploughings followed by planking. In the month of March maize hybrid "Pioneer-32B33" was sown on 75 cm apart ridges. Seed treatment with bio-fertilizers was done 30 minutes before the seed sowing and 10 % sugar solution was used as sticker to stick maximum inoculant contents with seed. Recommended dose of N, P and K was used i.e. 150, 120 and 60 kg ha⁻¹, respectively. Full dose of P, K and one third of N was applied at the time of manure application. Remaining dose N was applied in two splits with 2nd and 3rd irrigation.

Adequate pest control measures were taken to control the weeds and insect pests. Data was recorded on plant height (cm), number of cobs per plant, number of grains per cob, thousand grain weight, grain yield and biological yield of maize. The data collected was analyzed statistically by applying Fisher's analysis of variance technique and treatments' means were compared by least significant difference (LSD) test at 5% level of probability (Steel *et al.*, 1997). Detail of experimental treatments is given below.

Table 1:
Experimental treatments

T₁: Control (Without any organic amendment)
T₂: PM 8 tons ha ⁻¹
T₃: FYM 8 tons ha ⁻¹
T₄: PM 8 tons ha ⁻¹ + bio-fertilizer 1
T₅: FYM 8 tons ha ⁻¹ + bio-fertilizer 1
T₆: PM 8 tons ha ⁻¹ + bio-fertilizer 2
T₇: FYM 8 tons ha ⁻¹ + bio-fertilizer 2
T₈: PM 8 tons ha ⁻¹ + bio-fertilizer 1 + bio-fertilizer 2
T₉: FYM 8 tons ha ⁻¹ + bio-fertilizer 1 + bio-fertilizer 2

PM= poultry manure, FYM= farm yard manure, bio-fertilizer 1 = azotobacter, bio-fertilizer 2 = pseudomonas

Table 2:
Chemical analysis of experimental soil

Please add some values.....marginal soils

III. RESULTS AND DISCUSSIONS PLANT HEIGHT

The statistical analysis of data shows non-significant effect of treatments on plant population of maize. The significant effect of different organic amendments on plant height of maize was recorded. As the plant height is a genomic factor but it is also greatly influenced by environmental conditions, nutritional status and physical and chemical properties of the growth medium. Maximum plant height (191.33 cm) was recorded in those plots where FYM 8 tons ha⁻¹ was added and seed inoculation was done with mixture of both the bio-fertilizers. It was also statistically similar with plant height obtained with the application of PM 8 tons ha⁻¹ + bio-fertilizer 1 + bio-fertilizer 2 were added to improve the soil health. The application of FYM or PM in the absence of seed treatment with bio-fertilizers also resulted in significant increase (22- 30 cm) in plant height compared to control treatment. Minimum plant height (146 cm) of maize was recorded in those plots where no manure and bio-fertilizer was applied. These results are in accordance with Panwar, (1991); Biari *et al.*, (2008) and Garg and Bahla (2008).

They also observed significant effects of organic amendments on maize plant height. They explained the reason that the addition of manures and bio-fertilizers enhance the biological activity in plant rhizosphere which leads to continuous release of nutrients and resulted in maximum plant growth and development.

Cobs Per Plant:

Number of cobs per plant has a great contribution in economic yield of maize but it's a genetically controlled factor to a large extent. Non-significant effects of different organic amendments were recorded on number of cobs per plant of maize.

Number Of Grains Per Cob:

Number of grains per cob was significantly affected by various organic amendments. Maximum grains per cob (481- 494 grains) was counted on the cobs taken from the plants grown in those plots where PM 8 tons ha⁻¹ or FYM 8 tons ha⁻¹ was applied and seed treatment was done with mixture of both the bio-fertilizers to improve the soil health and to enhance the biological activity in the plant rhizosphere. The lowest number of grains per cob (301 grains) was counted on the cobs taken from control treatment. The effect of FYM or PM in combination with bio-fertilizer 1 was found similar with the effect of FYM or PM in combination with bio-fertilizer 2. While significantly higher number of grains per cob was observed with the application of FYM or PM in combination with mixture of bio-fertilizers than using FYM or PM alone. Mehdi *et al.* (2007) and Rehman *et al.*, (2008) also explained that the release of organic acids from decomposed organic manures by the activity of beneficial microbes in plant rhizosphere enhance the uptake of essential plant nutrients and results in formation of healthy cobs with maximum number of grains.

1000 Grain Weight:

Grain weight of unit grains largely determines the crop economic yield. Grain weight of maize is greatly influenced by assimilates production and their unloading in the economical portion of the plant. Maximum grain weight (269 g) was weighted from cobs taken from plants of those plots where Farm yard manure FYM 8 tons ha⁻¹ + bio-fertilizer 2 was applied and it was statistically similar with rest of the bio-fertilizer treatments. Lowest grain weight (229.33 g) was recorded in control treatment. The use of bio-fertilizers in combination with FYM or PM caused significant increase (10- 17.93 %) in thousand grain weight as compared to control plots.

Sial et al, (2007) found that organic manure application in combination with inorganic fertilizers enhance the assimilates production and there storage in economical parts of plants.

Grain Yield:

Maximum grain yield was obtained by using Farm yard manure FYM and PM in combination with mixture of both the bio-fertilizers. It differed statistically with rest of the experimental treatments. A significant increase (20.19 %) in grain yield was also recorded with the application of FYM 8 tons ha⁻¹ and it was statistically similar with the application of PM 8 tons ha⁻¹. The use of FYM + bio-fertilizer 1/ bio-fertilizer 2 or PM + bio-fertilizer 1/ bio-fertilizer 2 resulted in more increase (27- 32 %) in grain yield as compared to alone application of FYM or PM. Similarly, further improvement (46- 49 %) in grain yield was recorded when FYM or PM was applied in combination with bio-fertilizer 1 + bio-fertilizer 2. The lowest grain yield (5.17 tons ha⁻¹) was recorded in control treatment. These results are in similarity with Bocchi and Tano (1994) and Kader et al, (2002). They reported that the addition of manures and seed treatment with Azotobacter increased the availability of nutrients and optimized the plant growth which resulted in higher grain yield.

Biological Yield:

Biological yield was also significantly affected by various organic amendments in marginal soils.

Minimum above ground biomass production was noted in those plots where no addition of manure and bio-fertilizer was done to improve the soil health. Maximum biological yield was obtained when FYM or PM was applied in combination with bio-fertilizer 1 + bio-fertilizer 2. It was also statistically at par with the biological yield recorded with the application of FYM or PM in combination with bio-fertilizer 1/bio-fertilizer 2. The application of FYM or PM alone also resulted in significant increase in biological yield but it was statistically lower than the biological yield obtained when FYM or PM was applied in combination with seed treatment with bio-fertilizer 1+ bio-fertilizer 2. These results are supported by Biari et al. (2008) who reported that inoculation of maize seed with bio-fertilizers enhanced the shoot dry weight from 63- 115 percent. Zhang et al, (1998), also found that integrated nutrient management in corn maximizes its grain yield by enhancing plant dry matter production.

IV. CONCLUSION

The addition of FYM or PM is helpful to improve the health of marginal soils for maize production. Use of mixture of various bio-fertilizers in combination with FYM or PM enhanced the grain yield of maize in marginal soils.

Table 1
Yield and yield components of maize

Treatments	Plant height (cm)	Number of cobs per plant	Number of grains per cob	1000 grain weight (g)	Grain yield (t ha ⁻¹)	Biological yield (t ha ⁻¹)
Control (recommended NPK dose)	146.00 d	1.06	301.00 d	229.33 c	5.17 e	6.69 d
Poultry manure 8 tons ha ⁻¹	168.00 c	1.26	373.33 cd	246.01 bc	6.08 d	8.15 c
Farm yard manure (FYM) 8 tons ha ⁻¹	176.33 bc	1.13	387.33 bcd	254.67 ab	6.21 cd	8.47 bc
Poultry manure 8 tons ha ⁻¹ + biofertilizer 1	183.67 ab	1.20	457.33 abc	253.00 ab	6.83 b	9.55 abc
Farm yard manure (FYM) 8 tons ha ⁻¹ + biofertilizer 1	187.00 ab	1.20	451.33 abc	264.67 ab	6.90 b	9.21 abc
Poultry manure 8 tons ha ⁻¹ + biofertilizer 2	183.67 ab	1.20	473.67 ab	258.62 ab	6.61 bcd	9.70 ab
Farm yard manure (FYM) 8 tons ha ⁻¹ + biofertilizer 2	185.33 ab	1.20	455.67 abc	269.00 a	6.78 bc	9.34 abc
Poultry manure 8 tons ha ⁻¹ + Azotobaiter+ biofertilizer 2	187.33 ab	1.20	494.00 a	265.33 ab	7.59 a	10.36 a
Farm yard manure (FYM) 8 tons ha ⁻¹ + Azotobaiter+ biofertilizer 2	191.33 a	1.26	481.33 a	260.33 ab	7.71 a	10.56 a
LSD value	13.26	0.28	93.15	20.18	0.59	1.41

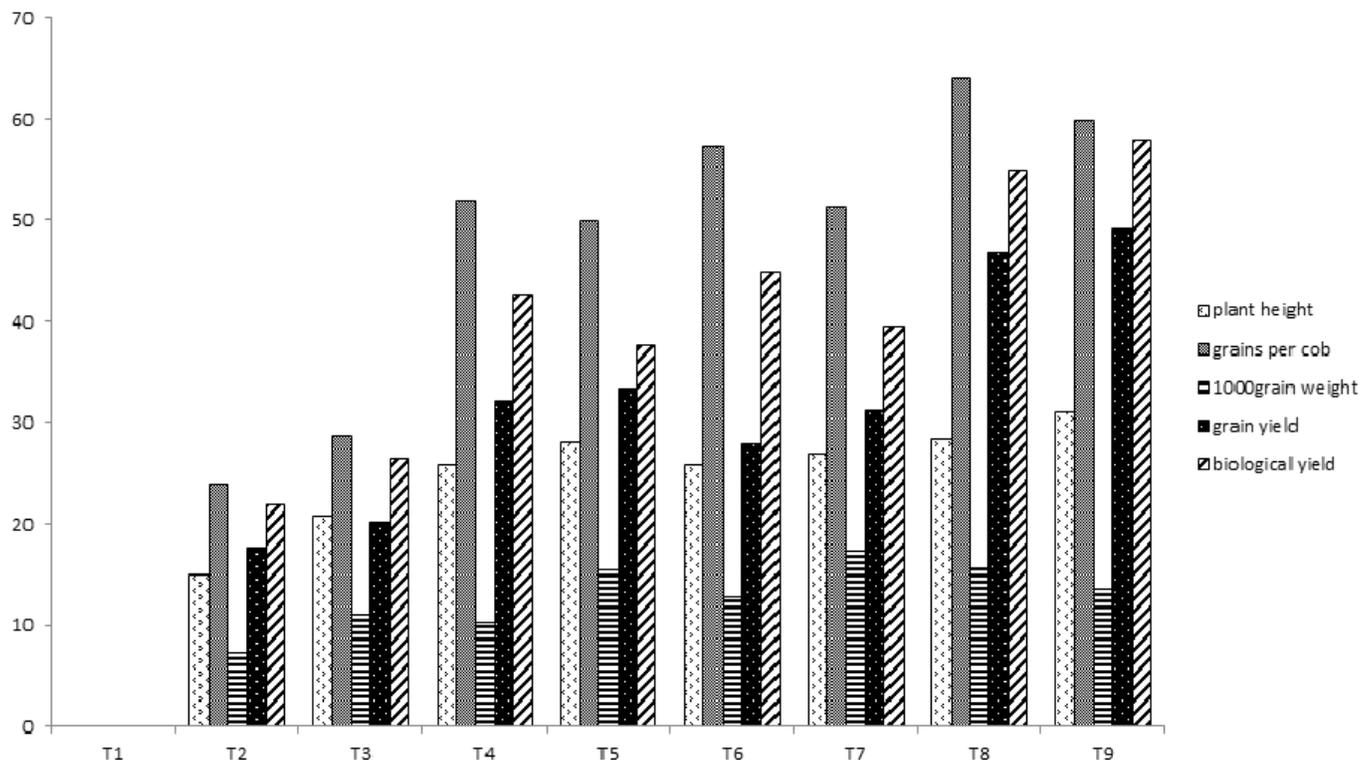


Fig 1: Increase in yield and yield components over control

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