Original Article

EVALUATION OF RESIDUAL EFFECT OF FARMYARD MANURE WITH NITROGEN AND PHOSPHOROUS (NP) ON SUCCEEDING MAIZE AFTER WHEAT

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ABSTRACT

In the study, the residual effect of farmyard manure (FYM) given to previous wheat was evaluated on the next maize crop. A three-crop based experiment maize (control)-wheat-maize from summer 2007 (Kharif) to summer 2008 (Kharif) was performed. Standard dose of FYM was given to the field of intermediate wheat crop. Different NP doses were applied in the four treatments. Residual effect of FYM was estimated out on seven parameters *viz*; plant height (cm), ear height (cm), cob length (cm), grain row/cob, grains/row, 1000 grains weight (gm) and grain yield/plot (kg). All the parameters exhibited significant results after FYM application except grains/row. Except the ear length, replications remained non-significant. Plant height, cob length and grain yield/plot exhibited fairly significant results with different treatments, while other four parameters remained non-significant. No interaction found between treatments, and before and after FYM application except in 1000 grains weight. Overall 21.37% increase in grain yield/plot was observed. We suggest the application of N 90 kg ha^{-1} + P 60 kg ha^{-1} (T2) and N 120 kg ha^{-1} + P 80kg ha^{-1} (T3) with standard dose of FYM (6000 kg ha^{-1}) on the previous crop to get better yield of upcoming maize crop in arid regions of Pakistan.

***Key words**: Residual effect, Farmyard manure, NP Fertilizers, Maize, Wheat.*
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INTRODUCTION

Maize (*Zea mays* L.) plays a significant role as being consumed as cereal crop and forage source for livestock. In Pakistan very low land area is under cultivation of maize. During

the year 2008-9, this crop was grown over an area of about 1.052 M.ha with an average yield of 3415 kg ha^{-1} in Pakistan (GOP, 2009). Low soil fertility is a major constraint for better crop yield in District Kotli, AJK. More often, the application of inorganic fertilizers has been widely used to increase the crop yields. Farmers of the area use farmyard manure (FYM) as a cheaper alternative. Strip cropping or crop rotation can also increase soil fertility but at low levels. Use of both organic and inorganic fertilizers plays an important role in the maize crop production. Sustaining soil organic carbon (SOC) is of prime factor in terms of cycling plant nutrients and improving the soils physical, chemical and biological properties and has strong relationship with crop productivity (Lal and Kimble, 1997). Agricultural utilization of organic materials, particularly FYM has been a rather common traditional practice (Shen *et al*., 1997), as it enhances the SOC level, which has direct and indirect effect on soil physico-chemical properties (Lado *et al*., 2004). Moreover; the nutritional profile is suitable to overcome health hazards of malnutrition and hyperglycemia (Muhammad et al., 2011) because of the natural ingredients and religious practice of Ramdan fasting (Nagra et al., 2011).

Environmental degradation threat has produced a renewed interest in organic fertilizers, such as animal manures. In addition, the soil organic matter conservation is one of the most important limiting factors for sustainability development in semiarid regions (Silva *et al*., 2006). It was also verified that manure increased water retention and availability, and P, K, and Na contents in the soil layer from 0-20 cm, but did not influence pH, calcium, organic matter contents and the sum of bases (Silva *et al*., 2006). As fodder, maize requires large amount of organic and inorganic fertilizer application (Lakho *et al*., 2004).

FYM provides soils with micro and macronutrients and also improves soil physicochemical properties of the soil and makes it more productive (Rasool *et al*., 2008). The FYM usefulness has long been recognized in the maintenance of organic matter status, the amelioration of physical and biochemical properties of the soil (Swift and Sanchez, 1984). Agboola (1974) showed that reduction in soil organic matter content

leads to nutrient imbalances that can affect growth and yield in crop plants. Soil fertility can be maintained by using organic manure (compost) either alone or in combination with inorganic fertilizer (John *et. al.*, 1996). In general, manures undergo rapid mineralization especially under dry weather, high soil moisture, good aeration and drainage conditions (Mota, 2004). The fact that the residual effects of manure are dependent upon all these variables probably explains the discrepancies among authors on the effects of cattle manure on yield of various crops. The residual effect depends, for example, on the trait under study, the year when assessment is done (Raramurthy & Shivashankar, 1996), and the sequence of crops grown (Minhas *et al*., 1994). Lakho *et al*., (2004) studied the effect of organic manure in combination with inorganic fertilizers and found the superiority of 3000 kg FYM ha^{-1} in combination with 120 kg N ha^{-1}. Reddy (2004) found composted poultry manure supply on the preceding crop (groundnut) produced higher maize growth and yield than the other residual effect treatments.

Efficacy of FYM was improved by supplementation with synthetic fertilizers (Murwira, 1995). Nutrients present in organic matter are not fully available to the crops in the season of its application (Ramamurthy & Shivashankar, 1996). Rasool *et al*. (2008) confirmed the grain yield and uptake of NPK by both maize and wheat was higher with the application of FYM and inorganic fertilizers than in control plots. Experiments performed by Negassa *et al*. (2001) exhibited that there were significant residual effects of FYM and NP fertilizers applied in 1997 on maize grains yields in 1998. They suggested the integrated use of properly managed FYM and low rates NP fertilizers for maize production

Meena *et al*. (2007) found that FYM as a source of P was statistically superior to other treatments of inorganic fertilizers. Iqbal *et al*. (2007) found that FYM amendments increased soil P and K in all type of soil systems. Kaur and Benipal (2006) observed that maximum value of fixed K was observed with FYM treated soil than rice straw treated soil at both the temperatures. Monacoa *et al*. (2008) noticed that FYM applications caused the greatest increase in soil organic matter content, potentially mineralizable N

and potential soil microbial biomass (SMB), whilst return of maize straw produced the largest increase in potential soil respiration but had less effect on total soil organic C and SMB. Garg and Bahl (2008) conclude that poultry manure more readily supplies P to plants than other organic manure sources.

The objective of the study is to evaluate the residual effects of FYM on corn, previously cultivated with wheat, to identify manure efficiency in order to enhance crop production and evaluation of the residual effect of applied fertilization on different parameter including grain yield in cultivars

MATERIALS AND METHODS

Provision of selected varieties

Grains of maize (*Zea mays* L. variety Islamabad White) and wheat (*Triticum aestivum* L. variety Inqlab-91) were obtained from National Agriculture Research Center (NARC), Islamabad.

Research farm

Experiments were conducted at the research farm of Department of Agriculture and Planning, Azad Jammu and Kashmir (AJK), Kurti, Kotli.

Environmental conditions

The altitude of investigated area is 600 to 760 meters measured by GPS. It lies between longitude 73° 33'57" to 73° 53'17"N and Latitude 33° 29'22" to 33° 40'44" E and its climate is of subtropical type. The average rainfall of the year recorded up to 99.4mm. The maximum rainfall occurs during the months of June and July (249.7 mm to 236 mm) while Minimum rainfall occurs during October and November, (26.4mm to 15.0mm.). The average maximum and minimum temperature of the year recorded as 28.7°C and 15.5°C respectively. May and June were the hottest months of the year showing 36.4°C and 38.0°C respectively. Minimum temperature was recorded during January and December was 4.8 and 6.0 respectively. The average maximum and minimum humidity

of the year was 70.0% and 48.9% respectively. Maximum humidity occurs during the months of August and January i.e. 83.8% and 79.3% respectively while minimum prevails during the months of April and May, 33.8% and 30.5% respectively.

Experimental design and field preparation

It is a three-crop experiment representing Maize-Wheat-Maize from Kharif 2007 to Kharif 2008. First maize crop was cultivated in Kharif 2007, followed by the wheat crop cultivation in winter 2007 (Rabbi Crop), which in turn is followed by Maize crop in Kharif 2008. Plots were supplied with four treatments (Table 1) and each treatment was checked independently for three times. Experimental area consisted of twelve plots with a size of 70m each plot. Fine seedbed was prepared. Line sowing of maize was done according to Abouziena, *et al*. (2008) with some modifications (plant-plant distance 25cm and row-row distance 75cm). In wheat sowing, Abbas *et al*. (2009) method was followed with some modifications (plant-plant distance 10cm and row-row distance 30cm.

Treatments

Four treatments with three replications were designed (Table). These treatments were given to all the three crops' fields before sowing. FYM was given only to wheat @ 150 monds ha^{-1} (1 mond = 40Kg) which was grown between the two maize crops of 2007 and 2008. Residual effect of this FYM was checked in the last phase of study in maize crop (in Kharif 2008) and compared to control (Kharif 2007).

Parameters studied

Following parameters were studies during the experiment; plant height (cm), ear height (cm), cob length (cm), grain row/cob, grains/row, 1000 grains weight (gm) and grain yield/plot (kg).

Data analysis

The experimental design was two factors Randomized Complete Block Design (RCBD). Analysis of Variance (ANOVA) and Latin Square Design (LSD) was estimated 5% level of significance by using the MSTATC program.

Table: Treatments representing different doses of fertilizers given to the fields of all the three crops

Treatments	Dose	Treatments	Dose
T_o	Control (no treatment given)	T_2	N 90 kg ha^{-1} + P 60 kg ha^{-1}
T_1	N 60 kg ha^{-1} + P 40 kg ha^{-1}	T_3	N 120 kg ha^{-1} + P 80kg ha^{-1}

T=treatment, T_o= control, N=Nitrogen, P=Phosphorous.

RESULTS

The results of all the parameters discussed one by one are only for maize crop, before and after FYM application of wheat crop.

Plant height (cm)

Lowest plant height (183.0) was seen in control (T_o) and highest in T3 (192.33) before FYM application while after FYM application on wheat crop, plant height shown by maize was lowest (198.33) seen in T1 and highest (200.83) exhibited by T3. Statistically very highly significant difference was seen before and after FYM application in plant height (*P* value 0.00), on the other hands, there is no significant interaction between treatments, and before and after FYM application. The coefficient of variation was 1.45% (Fig. 1). LSD value at α=0.050 for treatments is 3.481 and T_o (190.92, A) T2 (195.08, A) and T3 (196.58 A) showed similar pattern but they do differ non-significantly with T1 (194.16, AB).

Ear length (cm)

The lowest ear length (87.66) in T2 and highest (90.33) was seen in T1 before FYM application while lowest (97.33) in T1 and highest (102.0) was observed in T3 after FYM application. Highly significant results were obtained before and after FYM application with a *P* value of 0.000, while replications took part significantly (*P* value 0.334). The coefficient of variation was 3.44% (Fig. 2). LSD value for treatments was non-significant at 5 %α. Both before (89.83, B) and after (99.25, A) differed each other significantly (Fig. 2).

Cob length (cm)

The lowest cob length (12.46) in T_o and highest (13.20) was seen in T2 before FYM application while lowest (12.76) in T1 and highest (13.60) was observed in T3 after FYM application. Significant results were obtained before and after FYM application with a *P* value of 0.0336, while treatments take part relatively in highly significant manner (*P* value 0.0040). The coefficient of variation was 2.39% (Fig. 3). LSD value for treatments was 0.385. T_o (12.73, B) and T1 (12.75, B) were non-significant to each other like T2 (13.28, A) and T3 (13.36, A), but both T_o and T1 differ significantly to T2 and T3. FYM application before and after of its application have the value as 0.2727. Both before (12.88, B) and after (13.18, A) differed each other significantly (Fig. 3).

Grain rows/cob

The lowest cob length (12.66) in T_o and highest (14.0) was seen in T2 before FYM application while lowest (14.66) in T_o and T1 and highest (16.0) was observed in T2 and T3 after FYM application. Highly significant results were obtained before and after FYM application with a *P* value of 0.001. On the other hands treatments exhibited non-significant impact (*P* value 0.262). The coefficient of variation was 8.54% (Fig. 3). LSD value for treatments was non-significant while for the FYM application before and after of its application has the value as 1.072. Both before (13.33, B) and after (15.33, A) differed each other significantly (Fig. 4).

Grains/row

The lowest grains/row (24.66) in T_o and highest (26.0) was seen in T2 and T3 before FYM application while lowest (24.66) in T_o and T1 and highest (27.33) was observed in T3 after FYM application. No significant results were obtained in the experiment before and after FYM applications expect treatments, which exhibited non-significant results (*P* value 0.064). LSD values for FYM comparison for before and after its application at α=0.050 is 1.072 and showed significant results before (13.33, B) and after (15.33, A) FYM application. The coefficient of variation was 5.77% (Fig. 5).

1000 grains weight (gm)

The least 1000-grain weight (182.0) in T_2 and highest (185.0) in T3 before FYM application while least 1000-grain weight (193.33) in T_o and highest (200.0) in T2 was observed. Results showed highly significant values before and after FYM application with *P* value 0.000, while treatments (*P* value 0.421) and interactions between before and after FYM and treatments showed non-significant results (*P* value 0.314). The coefficient of variation was 2.09% (Fig. 4). LSD values for FYM comparison for before and after its application at α=0.050 is 3.493 and showed significant results before (183.76, B) and after (197.25, A) FYM application (Fig. 6).

Grain yield/plot (kg)

Yield always remains the desired parameter. The least yield per plot (23.0) in T_o and highest (27.66) in T3 before FYM application, while least yield per plot (29.33) in T_o and highest (34.0) in T3 was seen FYM application. Highly significant results were seen before and after FYM application and as well for treatments with the 0.00 *P* value. The coefficient of variation was 5.12% (Fig. 7). Non-significant results were obtained in interaction between before and after FYM application and treatments (0.252). LSD value at α=0.050 for treatments is 1.354. T2 (30.16, A) and T3 (30.83, A) showed non-significant results but these are significantly different from T_o (26.16, B), while T1 (28.66, AB) showed non-significantly different results from all other treatments. LSD values for FYM comparison for before and after its application at α=0.050 is 0.557 and

showed significant results with before (26.16, B) and after (31.75, A) its application (Fig. 7).

Fig. 1. Effect of treatments on plant height (cm) of maize after FYM application

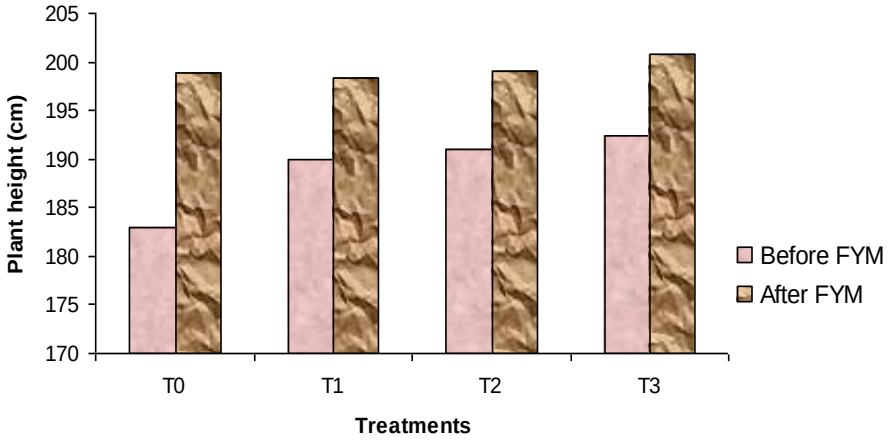


Fig. 2. Effect of treatments on ear length (cm) of maize after FYM application

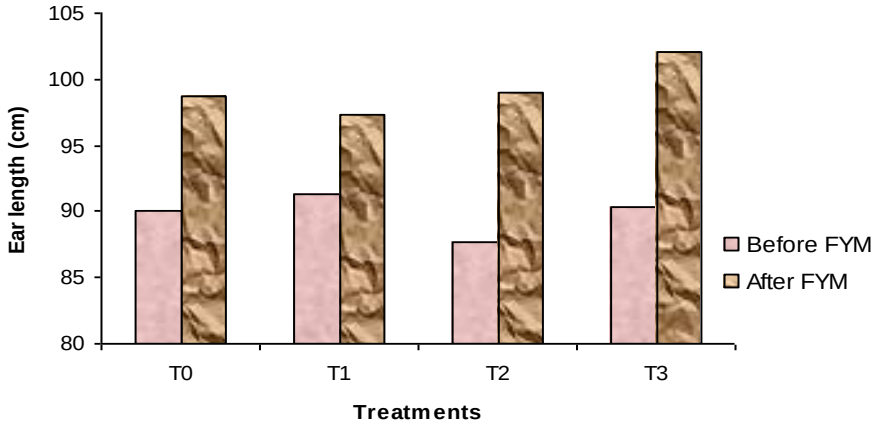


Fig. 3. Effect of treatments on cob length (cm) of maize after FYM application

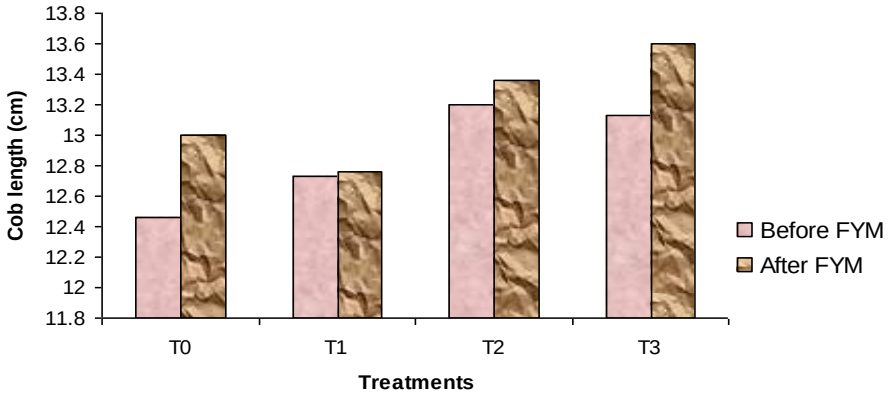


Fig. 4. Effect of treatments on grain rows/cob of maize after FYM application

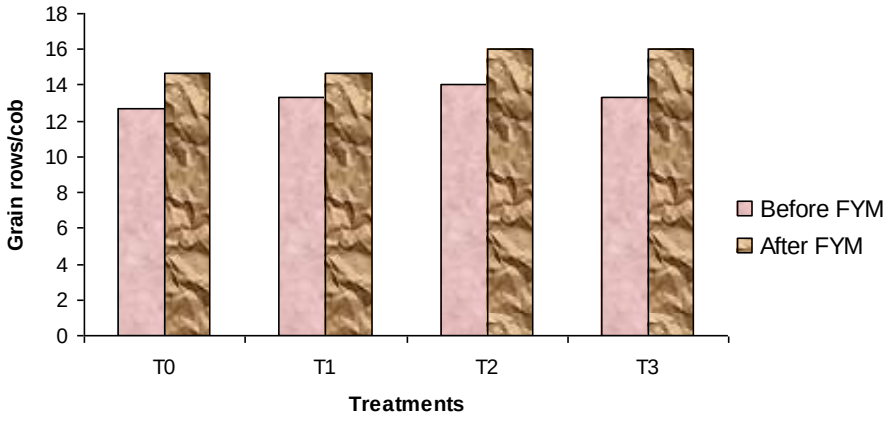


Fig. 5. Effect of treatments on grains/row of maize after FYM application

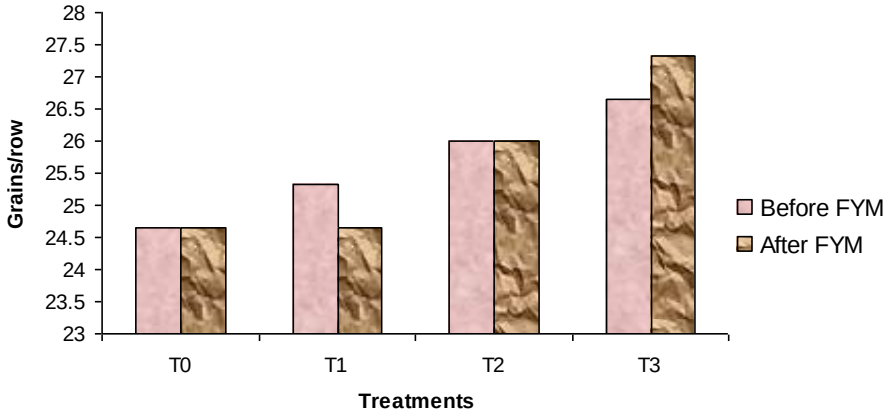


Fig.5 Effect of treatments on grains/row of maize after FYM application

Fig. 6. Effect of treatments on 1000 grains weight (gm) of maize after FYM application

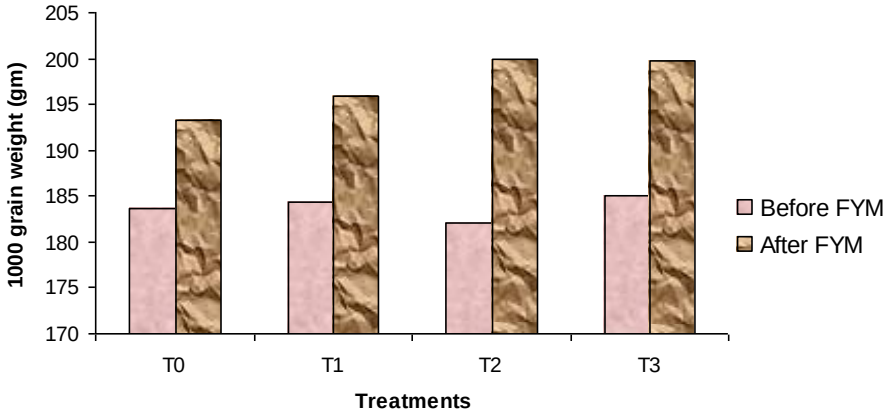
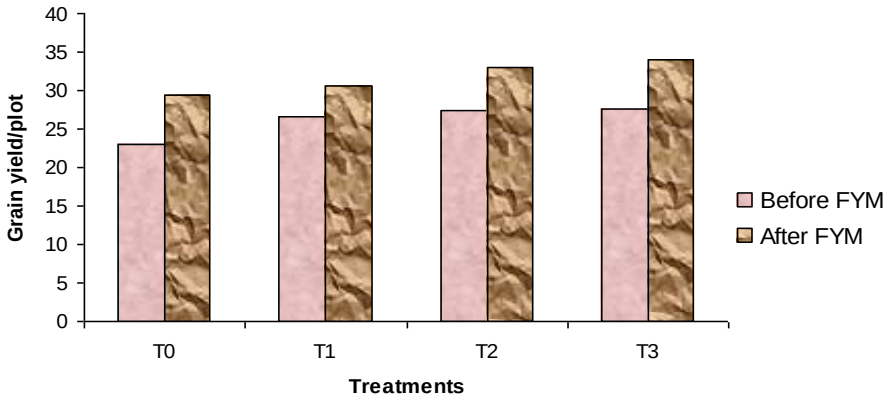


Fig. 7. Effect of treatments on grains yield/plot (kg) of maize after FYM application



DISCUSSION

FYM application is a traditional method in the improvement of soil fertility. Direct application of fresh manure is discouraged as it will most likely harm the plants. It is recommended to leave it to rot at least for six months. The residual effect of organic fertilizers on yield has been found to be positive in corn (Raramurthy & Shivashankar, 1996). Silva *et al.* (2004) studied the direct effect of FYM application on corn and found increased grain yield in two corn cultivars. This is in accordance with our results. We found that the parameters 1000 grains weight (gm) and grain yield/plot (kg) representing 7.1% and 21.37% increase respectively due to residual effect of FYM application on the previous wheat crop. We detected an increase in other physical parameters which determine crop quality.

Farmers rely on FYM mainly from cattle dung as a cheaper and easily available alternative fertilizer particularly for maize production (SMP, 1995). In corn, the residual effect of organic matter improved the plant height, dry matter production at different stages of crop growth and yield attributing characters of corn like number of cobs/plant,

100 grain weight, harvest index and protein contents of grain (Raramurthy & Shivashankar, 1996). The environmental conditions of our research farm were providing superb conditions for the excellent physical attributes of the soil (given above). Manure increased soil water retention by 5-48%. Field soil water content was increased by 10-22% (Miller *et al*., 2002), while other scientists verified similar results (Arriaga & Lowery, 2003). Long-term application of dairy manure at a rate of 20 tons ha^{-1} increased soil inorganic P forms and maintained organic P fractions (Tran and Dayegamiye, 1995).

Fertilizers contain important quantities of the primary plant nutrients which are nitrogen and phosphorus and it is derived from a plant or animal residue or byproduct or natural material deposits. Negassa, *et al*. (2005) supplemented low rates of NP fertilizers with farmyard manure (FYM) in the maize based farming system of western Oromia and found significant residual effects of FYM and NP fertilizers applied in 1997 on maize grain yields in 1998. We also found a significant increase in plant height, cob length and grain yield/plot exhibited with different treatments of N and P fertilizers doses.

We got best results with T3 (120 kg ha^{-1} N with 80 kg ha^{-1} P with 150 monds ha^{-1} FYM) which are in accordance with Lakho *et al*. (2004). They recommended the application of 3000 kg FYM ha^{-1} with 120 kg N ha^{-1} as best combination for getting higher yield of maize as he found that physical productivity, revenue productivity, net benefit and cost-benefit ratio were greater by applying this treatment as compared to other treatments. Reddy (2004) found composted FYM supply on the preceding crop (groundnut) produced higher maize growth and yield. Intercropping with leguminous plants can also increase grains yield up to 26.90% in arid regions enhancing five of the presently studied parameters (Kayani *et al*., 2010). Rasool *et al*. (2008) found the grain yield and uptake of N, P and K by both maize and wheat was higher with the application of FYM and inorganic fertilizers. Ayoola and Makinde (2008) suggested that decomposed cow dung, fortified with N can be applied at 2.5 t ha^{-1} as it increases soil N, P and K contents by 25, 1 and 62%, respectively.

Environmental factors affect plant growth. Most important among them are temperature, rainfall and light. Growth and development of Plant is controlled by its internal regulators that are severely affected by environmental conditions. Jonesa and Thorntonb (2003) mentioned potential environmental threats which will appear in future and their effect on maize production. They also stressed for the assessment of vulnerable farming system at tropics. Environmental factors of our research farm's locality are superb for maize crop production and can be referred as ideal in respect to temperature, humidity, rainfall etc. Mann, *et al*. (2002) found that regional differences in temperature and rainfall effects on stand establishment and yield of maize, with possible effects on soil organic carbon.

Soil physico-chemical properties creates suitable environment for the availability and uptake of the nutrients and is enhanced by organic manures. We recommend 90 kg ha^{-1} N with 60 kg ha^{-1} P or 120 kg ha^{-1} N with 80 kg ha^{-1} P with 150 monds ha^{-1} FYM application on the previous crop to get better yield of upcoming maize crop in arid and semi-arid regions of Pakistan.

CONCLUSION

Manure is an excellent organic fertilizer having advantage of adding balanced nutrients to soil due to the presence of Nitrogen, Phosphorous, Potassium, trace nutrients and soil microbes. It increases fertility and water holding capacity of the soil by adding organic matter to the soil which improves soil structure and texture. Additional NP fertilizers along with FYM enhance above said factors and enhance soil physical and chemical properties for crop productions. We suggest 120 kg ha^{-1} N with 80 kg ha^{-1} P as a best fertilizers for the most nutrient deficient soils while 90 kg ha^{-1} N with 60 kg ha^{-1} P for optimal soils with 150 monds ha^{-1} (6000 kg ha^{-1}) FYM application on the previous crop to get better yield of next maize crop in arid and semi-arid regions.

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