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Assessment of Various Growth, Yield and Nutritional Parameters of Tomatoes as Affected by Farmyard Manure Fortified with Potassium Fertilizer

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Abstract: To investigate the effect of different levels of potassium fertilizer with and without use of Farmyard Manure (FYM) on growth, yield and nutrition of tomato a study was carried out in year 2011 in pots. FYM was kept as main plots with five treatments of potassium (0, 60, 90, 120 and 160 kg K_2O/ha) replicated four time. The results indicated that application of FYM and various K levels had significant effect on the growth, yield and nutrient content of tomatoes. The highest yield of tomatoes was (39.05 t/ha) observed in the pots receiving FYM and 41.97 t/ha was found in the treatment receiving K @ 120 kg/ha. The growth parameters including number of flowers per plant, number of fruits per plant and fruit diameter were also found significantly different by the application of FYM and K fertilizer. The mineral nutrition of tomato showed significant effect of FYM and K levels on plant P and K. FYM and K levels also significantly improved soil K content. It may be concluded that the Potassium applied @ 120 kg/ha along with the FYM was effective in improving the tomatoes attributes as well soil K content.

Key words: Potassium, farm yard manure, tomatoes, soil properties

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is the most popular and widely consumed vegetable grown in outdoor fields, greenhouses, tunnels and net houses of world including Pakistan. Climate and edaphic conditions of Pakistan are favorable for high production of good quality of tomatoes. Higher production of tomato depends upon adoption of high yielding varieties, appropriate crop management techniques including precise and balanced fertilization, timely irrigation, control of diseases and insect pests. In Pakistan, the tomato yields are far below the average yield being achieved in many other countries of the world. One of the reasons of low yield in Pakistan is imbalanced fertilizer and giving more importance to nitrogenous and phosphatic fertilizers (Anonymous, 2008). Negligence in use of potassium fertilizers. Tomato uptake of nutrients is more for Potash as compared with cereals (Akhtar *et al*., 2003a). On an average, a tomato crop producing 30 t/ha requires approximately 280, 55 and 540 kg of N, P_2O_5 and K_2O/ha, respectively (Akhtar *et al*., 2003b).

Potassium (K) is the major primary nutrient required by both the plants and animals after nitrogen and phosphorus (Oborn *et al*., 2005). Potassium plays a vital role in photophosphorylation, transportation of photo assimilates, activation of enzymes, turgor maintenance and stress tolerance (Marschner, 1995; Pettigrew, 2008). Adequate potash nutrition has been connected with yield, fruit size, enhanced soluble solids and ascorbic acid concentrations, improving fruit color, shelf life and shipping quality of many horticultural crops (Lester *et al*., 2007). Soils of Pakistan have variable status of K (Nisar and Rashid, 2003). Use of fertilizers in Pakistan is mainly confined to nitrogen and phosphorus, potassium fertilization has been neglected in most of the soils. Organic manures are another major source of nutrients for plants and it also improves the physical condition of the soil. The increase in the microbial activity, anion and cation exchange capacity, organic matter content of soil is attributed to the organic manures. Organic fertilizers increase the yield and quality of agricultural crops in ways similar to inorganic fertilizers (Tonfack *et al*., 2009).

Keeping in view the above points a study was carried with objective to determine the effect of sole and integrated use of Potash on the yield and chemical composition of tomatoes and its influences the soil properties.

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MATERIALS AND METHODS

To study the effect of different dosage of inorganic fertilizers with and without FYM on yield and nutrition of tomatoes a pot experiment was carried out at Department of Soil and Environmental Sciences, Gomal University (31°43'03.12"N 70°50'18.60" E) during year 2011. The experiment was laid out in Complete Randomized Design (CRD) with two factors with FYM as main plots and K levels as sub plots replicated 4 times. Five treatments of Potash including Control (No Potassium), K_2O @ 60, 90, 120 and 160 kg/ha were applied with and without FYM. FYM was applied @ 5 tons per hectares. A basal dose of NP @ 160 and 120 kg/ha, respectively was applied to all treatments. Inorganic source of fertilizer used were Urea, single super phosphate and Sulphate of potash. Soil was collected from Indus river bank and was accurately weighed and 20 kg was filled in the pots. Composition of soil sample and FYM is given in Table 5. The growth and qualitative plant parameters studied included Total yield (kg/pot), number of flowers per plant, number of fruits per plant, Fruit diameter (cm) and fruit pH. Nitrogen, Phosphorus and Potassium concentration in plant was determined (Tel and Hagarty, 1984). While the soil samples were also analyzed for physico-chemical characteristics before sowing and after harvesting of tomatoes for Soil Texture, Bulk density (Blake and Hartage, 1984), Organic matter (Nelson and Sommer, 1982) Electrical conductivity, pH, Nitrogen, Phosphorus and Potassium were determined using the procedures given by Ryan *et al*. (2001).

RESULTS AND DISCUSSION

Results obtained for the plant and soil for the sole and integrated efficacy of Potash and FYM has been categorically discussed in the subsequent paragraphs under respective headings.

Growth and yield attributes: The Growth and yield aspects of tomatoes in terms of fruit yield, fruit diameter, number of flowers per plant and number of fruit per plants are presented in Table 1. Probing into the results reveal that FYM does not show any significant effect upon fruit diameter. However results obtained for number of flowers/plant (34.14), number of fruits/plant (29.86) and fruit yield (tons/ha) 39.05 have shown significant variation amongst the means of pots with and without FYM. It has been observed that for all the traits the value was greater when FYM was applied. While application of K_2O @120 kg/ha showed Fruit diameter size increased (3.99) indicating increase in pulp and the same dose also enhanced yield i.e., 41.97 tons/ha. Further increase in Potash level i.e., K_2O @160 kg/ha has shown its effect on growth i.e. increase in flowers numbers (42.66) as well as number of fruits (36.66), but the yield and fruit pulp was reduced. Similar results of increase in number of flowers per plants by the application of FYM over commercial fertilizers have been reported in an another study (Kandil and Gad, 2010). Also the results of tomato yield were in agreement with the study carried out by some other workers who reported significantly increase in tomato yield by the application of different levels of potassium fertilizers Rao and Subramanian (1991), Majumdar *et al*. (2000).

Table 1: Composition of original soil and FYM used in the experiment

	Values	
Particular	Soil	FYM
Soil texture	Sandy Clay loam	
Bulk density	1.33 (g/cm^3)	
Total N	0.024 (%)	18.24 (%)
P	5.13 (mg/kg)	0.65 (%)
Available K	135.3 (mg/kg)	0.86 (%)
pH	8.27	7.12
ECe	2.81 (dS/m)	7.82 (dS/m)
Organic matter	0.48 (%)	48.1 (%)

Fruit pH and nutrients concentration in tomatoes: While peering other attributes like fruit pH, nitrogen, Phosphorus and Potassium concentrations different trend has been observed (Table 2). The results showed significant increase in N, P and K percentage with the application of FYM, while the fruit pH was found non significant ($p<0.05$). Maximum pH (4.01) was observed when no FYM was applied. The increase in rate of K decreased the pH of tomatoes. Decreased in pH is an important feature in processing of tomatoes as pH below 4.3 reduces the risk of bacterial contamination (Fontes *et al*., 2000). The results were supported by the findings of a study in which non significant effect of fruit pH between commercial fertilizer and manures has been recorded (Meaza *et al*., 2007). While N, P and K uptake by the plants have been significantly influenced by the application integrated FYM. Application of FYM enhanced Nitrogen (2.64%), Phosphorus (0.34%) and Potassium (2.49%) in plant.

FYM applied in combination with the different rate of inorganic fertilizer was found to be the most favorable interaction treatment for N, P and K concentration in various parts of tomato plants (Mohsen *et al*., 2006). The positive effect of manure added to soil may promote the activity of bacteria which enhances the availability of N, P and also improves the nutrients absorption capacity of tomato roots (Bertand *et al*., 2008). Application of K treatments have increased the fruit acidity from 4.7 to 3.93. Similarly the effect of potassium fertilizers showed that percent nitrogen was also increased initially but remained at 2.45 @ 120 kg/ha and 160 kg/ha of potash. But in case of percent phosphorus the results showed significant difference, with the maximum value of 0.36 % observed @ 120 kg/ha of K_2O. Surprisingly the K uptake by the plants showed non-significant difference amongst the different potassium levels. However the highest value of 2.30% was found in pots receiving K @ 160 kg/ha.

Table 2: Growth and yield parameters of tomatoes as influenced by the application of FYM and potassium fertilizer

	Fruit diameter (cm)			No. of flowers per plants			No. of fruits per plants			Fruit yield (t/ha)		
Treat	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean
T1	3.15^{b}	3.64^{ab}	3.39^{c}	16.00^{e}	22.66^{de}	19.33^{c}	12.33^{e}	19.66^{de}	16.00^{c}	21.32^{f}	30.07^{e}	25.69^{e}
T2	3.57^{ab}	3.71^{ab}	3.64^{bc}	26.66^{cde}	32.66^{abcd}	29.66^{b}	22.00^{cd}	27.00^{bcd}	24.50^{b}	27.87^{e}	35.37^{cd}	31.62^{d}
T3	3.78^{a}	3.96^{a}	3.87^{ab}	32.33^{bcd}	34.66^{abc}	33.50^{ab}	29.33^{abc}	32.33^{ab}	30.83^{a}	31.25^{de}	39.10^{bc}	35.17^{c}
T4	3.98^{a}	3.99^{a}	3.98^{a}	35.33^{abc}	38.00^{ab}	36.66^{a}	31.00^{ab}	33.66^{ab}	32.33^{a}	35.43^{cd}	48.51^{b}	41.97^{a}
T5	3.87^{a}	3.99^{a}	3.93^{ab}	34.66^{abc}	42.66^{a}	38.66^{a}	31.33^{ab}	36.66^{a}	34.00^{a}	35.47^{cd}	42.23^{a}	38.85^{b}
Mean	3.67^{a}	3.86^{a}		29.00^{b}	34.13^{a}		25.20^{b}	29.86^{a}		30.26^{b}	39.05^{a}	

Different letters represent significant differences according to least significant difference (p = 0.05)

Table 3: Fruit pH and Nutrients concentration of plants as influenced by the application of FYM and potassium fertilizer

	Fruit pH			Nitrogen (%)			Phosphorus (%)			Potassium (%)		
Treat	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean
T1	4.15	4.00	4.07	1.87^{c}	2.62^{a}	2.25	0.12^{b}	0.33^{a}	0.22^{c}	1.46^{b}	2.39^{a}	1.93
T2	4.01	3.93	3.97	2.02^{bc}	2.58^{ab}	2.30	0.20^{ab}	0.34^{a}	0.27^{bc}	1.68^{ab}	2.50^{a}	2.09
T3	4.02	3.85	3.93	2.21^{abc}	2.70^{a}	2.45	0.27^{a}	0.34^{a}	0.31^{ab}	1.78^{ab}	2.49^{a}	2.13
T4	3.95	3.86	3.90	2.23^{abc}	2.66^{a}	2.45	0.31^{a}	0.36^{a}	0.33^{a}	1.79^{ab}	2.50^{a}	2.14
T5	3.92	3.82	3.87	2.22^{abc}	2.64^{a}	2.43	0.31^{a}	0.33^{a}	0.32^{ab}	2.06^{ab}	2.55^{a}	2.30
Mean	4.01	3.89		2.11^{b}	2.64^{a}		0.24^{b}	0.34^{a}		1.75^{b}	2.49^{a}	

Different letters represent significant differences according to least significant difference (p = 0.05)

Table 4: Effect of sole and integrated use of FYM on macro nutrients status of soil

	Total Nitrogen (%)			Phosphorus (mg/kg)			Potassium (mg/kg)		
Treat	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean
T1	0.02	0.032	0.028	6.78	8.74	7.75	128.4^{d}	178.36^{b}	153.38^{b}
T2	0.032	0.035	0.033	6.02	9.50	7.76	143.2^{cd}	199.23^{a}	171.22^{a}
T3	0.030	0.053	0.0415	6.29	9.73	8.01	142.96^{cd}	197.56^{a}	170.27^{a}
T4	0.031	0.043	0.037	5.83	10.43	8.13	147.90^{c}	211.8^{a}	179.85^{a}
T5	0.028	0.042	0.035	6.45	9.25	7.85	150.17^{c}	204.63^{a}	177.40^{a}
Mean	0.028	0.041		6.27	9.53		142.5^{b}	198.3^{a}	

Different letters represent significant differences according to least significant difference (p = 0.05)

Macro nutrients status of soil: The effect of sole and integrated use of FYM on the primary macro nutrients status of soil has been shown in Table 3. Which depicts that nitrogen and phosphorus contents in the soils were non-significantly influenced with FYM application i.e., 0.041% N and 9.53 mg P/kg was recorded in FYM receiving pots which was greater than those without FYM. Similarly the different levels of K fertilizers also showed non significant difference in the N and P status of soil. Potassium content of soil was significantly increased by the application both FYM and K levels. The highest K value of 198. 3 mg/kg was found in the soil using integrated FYM and inorganic K. Similarly, the K levels also influenced the K concentration in soil with highest 179.5 mg/kg found in the pots receiving K fertilizer @ 120 kg/ha. In another study the release of available potash ranged from 49.5 mg/kg in control treatment of 100% NPK sole, while 186.5 mg/kg was recorded in soil with 1% FYM (Kaur and Benipal, 2006). Available K level in soil increases due to application of FYM (Dhanorkar *et al*., 1994).

Conclusion: Integrated application of FYM with K fertilizer showed a great influence on the yield and quality of tomato. Also the macronutrients content of soil were significantly improved. Application of K fertilizer @ 120 kg/ha along with FYM gave maximum value for growth parameters, yield and nutrients concentration in plant.

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