International Journal of Modern Agriculture, Volume 3, No 4, 2014

ISSN: 2305-7246

EFFECT OF VARIOUS FARM MANURE LEVELS ON ROOT PROLIFERATION AND MAIZE GROWTH UNDER DIFFERENT SOIL TEXTURES

Haroon Shahzad[1*], Sana Ullah[1], Muhammad Iqbal[1], Atif javed[1], Sarvet Jehan[1], Sajid Hussain[2], Ali Raza Siddiqui

[1]Institute of Soil & Environmental Sciences, University of Agriculture, Faisalabad.
[2]Department of soil science, University college of Agriculture, University of Sargodha.

Abstract

The physical indices of the soil are major contributor in growth and yield of the crops. Soil texture is a stable soil physical characteristic that has an indirect impact on the crop growth. Present study aims to evaluate the impact of different textures along with organic amendments on root extension of maize that ultimately affect maize growth. Pot study comprises two soils from Faisalabad and Gujranwala origin that are sandy loam and clay loam, respectively, along with application of farm manure at 0, 5, 10 and 15 Mg ha^{-1}. Recommended dose of NPK at 120: 60: 40 was applied in each treatment pot. A significant difference for plant growth parameters shoot (length, fresh weight and dry weight), root (length, fresh weight and dry weight) and 1000 grain weight was observed for application of organic amendment at different rates under different textures. It was observed that as the organic matter increased there was increase in every plant parameter but upto 10 Mg ha^{-1} and then a significant decrease was observed. It was also observed that crop performed better under sandy loam texture as compared to clay loam.

Keywords: texture, manure, root proliferation, maize.

Introduction

After wheat and rice, maize is used as staple meal by large number of human beings in the world that makes it a major source of income for farmers (Tagne *et al*., 2008). In Pakistan maize plays an important role in agricultural economy. Two major provinces Punjab and KPK produces 97% of total production. Maize is cultivated on 1.11 million hectares in Pakistan producing 3.615 Mg average yield per hectare with 4.04 million tones annual production (Govt. of Pakistan, 2009). Maize is short duration crop and can be grown twice round the year as spring and autumn crop. Maize has high nutritional value as it contains 10% protein, 4.5% oil, 80% starch, 3% sugar, 3.5% fiber and 2% mineral (Reddy, 2006).

Soil texture is relative proportion of primary soil separates (sand, silt and clay) is an invariable soil physical characteristic largely influences soil fertility, aeration, water infiltration and retention, hydraulic conductivity and pore size distribution (Miller and Donahue, 1990) indirectly influencing root penetration, proliferation and ultimately growth of plants. Compaction decrease maize growth and had negative effect on root proliferation (Aziz *et al*., 2002). Different types of soil and their properties are important factor that determine the rooting habits of the plants. Soil texture modifies root diameter, development of root hairs and branching pattern of lateral roots. Root penetration is recorded more in sandy soil as compare to fine textured soil in which it is relatively restricted (Tagar and Bhatti, 1996). Soil with high clay content affect germination and emergence of young seedling due to surface crusting resulting in poor crop stand (Brady, 1980). Nutrient availability is also affected by soil texture (Iqbal *et al*., 1999). Sandy soil has low nutrient content than clayey soil due to high adsorption capacity and low leaching losses resulting into higher N, P and K content (Siddique and Hassan, 1991).

Organic matter is the portion of soil that consist of biological residues and is fundamental source of nutrients. Organic manure present in soil largely influence soil chemical and physical properties which indirectly affect root proliferation (Lucas *et al*., 1987). Organic manure reduces soil erosion,

leaching of nutrients and evaporation losses (Malival, 2001). Organic manure play an important role in the maintenance of soil fertility as it release balance nutrient slowly and improve soil physical properties (Singh *et al.*, 1980). Pakistani soils have less than 1 % organic matter (Azad and Yousaf, 1982). Organic farming is preferred curing technique of nutrient depleted and physically degraded soils in the whole world (Delate and camberdella, 2004). Soil organic matter improve soil nutrient availability and increase level of C and N (Adrien, 2006). Baldi *et al.* (2010) evidenced enhanced root growth with compost application than mineral fertilization. Organic manure improves soil physical, chemical and biological characteristics resulting into higher yield and quality of crop (Yolcu *et al*., 2010). Addition of organic matter eliminate the problem of soil compaction that improve development and growth of crop depending upon soil type, amount and nature of organic matter added and soil moisture content (Mamman *et al*., 2007). Organic materials after complete decomposition improve soil structure, hydraulic conductivity and aggregate stability of soil reducing compaction (Gupta *et al*., 1987).

Organic fertilizer cannot used as alternate of chemical fertilizer because it cannot meet crop nutritional demand over the large area due to unlimited availability, slow release of nutrient, low nutrient composition and high labor requirement (Tolera *et al*., 2005). Only application of organic manure is found inadequate to sustain crop productivity as manure has relatively low nutrient contents and their slow release. Integrated application may be beneficial to improve soil health and crop yield (Palm *et al*., 1997). Integrated use of organic and inorganic manures sustains the productivity of soil and crops in an integrated cropping system (Hegde, 1998). Combined application of organic and inorganic manures restores and sustains soil health and productivity in the long run, also meet the nutritional needs of crops (Satyajeet *et al*., 2007).
On the bases of above discussion, the current study was envisaged with objectives to evaluate the role of organic matter in different texture soils on root proliferation and maize growth.

Materials and methods
A field experiment was conducted to evaluate the effect of different texture and manure rates on maize growth and root proliferation at wire house research area of Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad. Two soil textures, i.e. sandy loam and clay loam were used for this study. These soil was taken from surface layer (0-15 cm) of University research field and from Nandipur near Gujranwala air dried, ground, well mixed and passed through a 2 mm sieve and analyzed for different pre-sowing soil characteristics according to the analytical methods described by US Salinity Lab. Staff (1954). Particle size analysis of these samples was carried out using hydrometer method (Gee and Bauder 1986) and soil textural class was determined by following the International textural triangle (Moodie *et al.*, 1959) and results are presented in table 1 and table 2.

10 kg soil was added to each pot with polythene lining and was treated with farm manure at 0, 5. 10 and 15 Mg ha^{-1}. Mineral fertilizer was added at 120: 60: 40 kg ha^{-1} N: P: K. Total dosage of phosphorus and potassium was as basal but nitrogen was applied in three splits. 8 seeds were sown in each pot that were thinned to 5 after germination. Irrigation and plant protection measures were carried out as and when required. Crop was harvested at maturity and plant yield and growth parameters were recorded and treatment means were compared using least significant difference test (Steel and Torrie, 1980).

Table 1: Particle-size analysis of soils

Determination	Unit	Value	
		S_1	S_2
Sand	%	53	39
Silt	%	26	24
Clay	%	21	37
Textural class	-	Sandy loam	Clay loam

Table 2. Physical and chemical characteristics of soil used for study

		Sand Loam	Clay Loam
Parameter	**Unit**	**Amount**	**Amount**
Bulk density	Mg m^{-3}	1.48	1.56
EC_e	dS m^{-1}	1.45	1.43
pH		7.9	8.1
Saturation percentage	%	35.5	44.1
Na^+	me L^{-1}	3.58	2.98
$Ca^{2+} + Mg^{2+}$	me L^{-1}	10.15	8.99
CO_3^{2-}	me L^{-1}	0.72	0.98
HCO_3^-	me L^{-1}	8.2	9.1
Cl^-	me L^{-1}	4.80	5.23
SO_4^{2-}	me L^{-1}	0.78	0.81
Organic carbon	%	0.49	0.71
NO_3^{-1} nitrogen	mg kg^{-1}	4.3	5.3
Available phosphorus	mg kg^{-1}	7.85	9.1
Available potassium	mg kg^{-1}	114.6	138.1

Results and discussion

Soil texture is an important soil physical property and is indicator of other soil physical properties like aeration, porosity, water and nutrient holding capacities. It affects root penetration, proliferation and ultimately growth of plants. Manure not only improves organic matter and nutrient carrying capacity of soil but indirectly improves plant growth by improving soil structure. A pot experiment was conducted to assess the role of soil textural classes and organic matter levels on root proliferation and growth of maize at wire house ISES following CRD under factorial arrangement. The results of experiment are described below.

Shoot Length (cm)

Shoot length is generally considered as indication of plant growth. Data pertaining to the effect of different textured soils and manure rates on shoot length of maize is given in (Fig. 1). Which clearly indicates that application of manure rates with increasing level has significant effect on plant height.

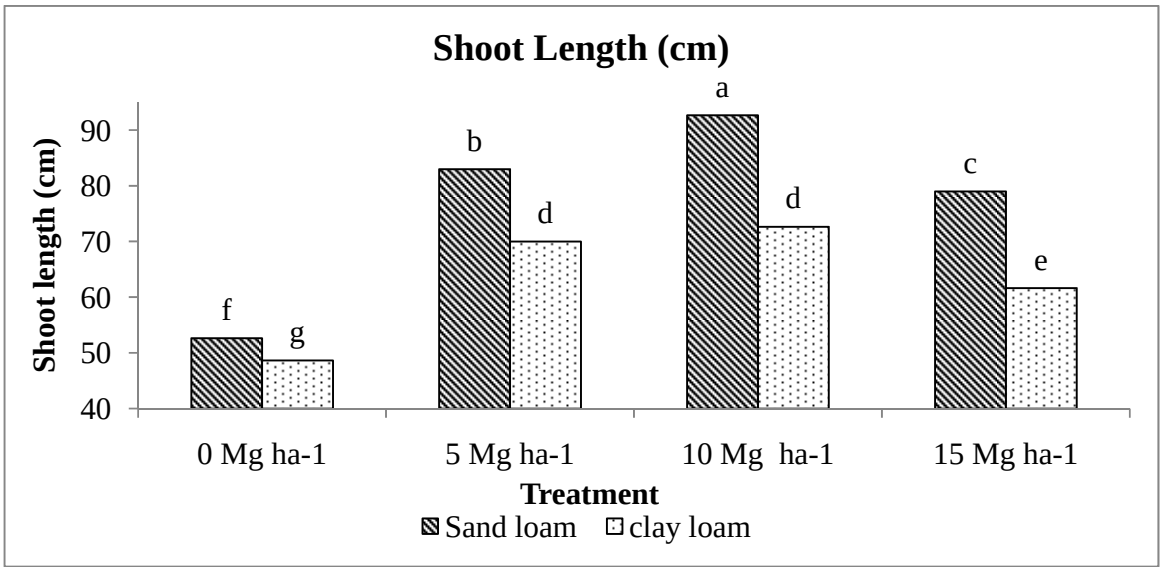

Fig. 1: Effect of soil texture and different manure rates on shoot length (g)

Maximum shoot length was observed where farm yard manure was applied at rate of 10 Mg ha^{-1} followed by 5 Mg ha^{-1}, followed by 15 Mg ha^{-1} and minimum shoot length was observed in 0 Mg ha^{-1}. As regard different soil textural classes, maximum shoot length was observed in Sand loam soil and minimum in Clay loam soil. Interaction of various farm yard manure levels with soil texture was significant. Our results are in close agreement with those reported by (Aziz *et al*., 2002; Lucas *et al*., 1987) who found that soil textural classes and rates of farm yard manure have significant effect on shoot length of plants. Ohu *et al*., (2001) supported our results by reporting the same results of enhancement in plant height with manure application as compared to that of control. Mamman *et al*., (2007) pointed out more shoot length with increasing manure levels due to enhanced availability of moisture for more evapotranspiration with enhanced plant growth. Siddique and Hassan (1991) reported maximum shoot length in sandy clay loam and sandy loam soils than fine textures.

Shoot Fresh Weight (g)

Maize is also used as fodder of the livestock. Increase in the shoot weight means increased fodder yield. The amendment used to enhance fodder yield is necessary to fulfill the livestock requirement and due to that increased size the photosynthesis increased. Data regarding shoot fresh weight showed that different farm yard manure levels and soil textural classes have significant effect on shoot fresh weight (Fig. 2).

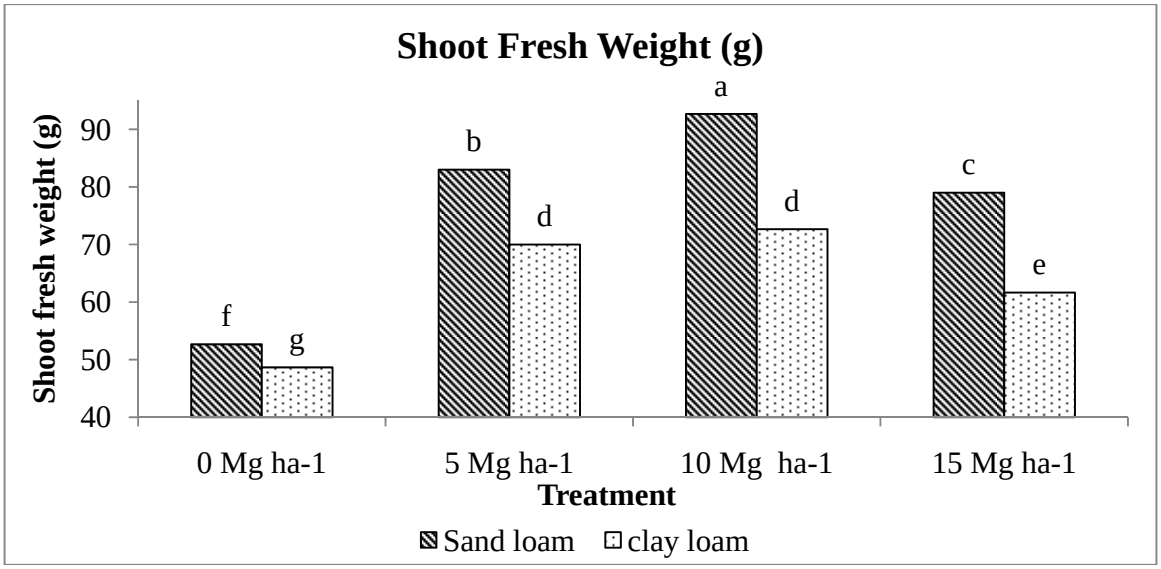

Fig. 2: Effect of soil texture and different manure rates on shoot fresh weight (g)

Data regarding farm manure levels 10 Mg ha^{-1} presented maximum fresh weight of shoot followed by 5 Mg ha^{-1} and 15 Mg ha^{-1} with minimum shoot fresh weight in 0 Mg ha^{-1}. In case of soil textural classes, sandy loam soil produced more shoot weight than clay loam texture. Interaction of various farm yard manure levels with soil texture was significant. Our results are in close agreement with those reported by (Baldi *et al*., 2010; Yolcu *et al*., 2010) who found that soil textural classes and rates of farm yard manure have significant effect on shoot fresh weight of plants. (Aziz et al., 2002; Lucas et al., 1987) favored our findings presenting more shoot growth and weights with application of manure.

Shoot Dry Weight (g)

Maize shoot is chopped and used as livestock feed but on a minor level. Majorly maize shoot is used as fuel of the hearth in villages of Pakistan saving trees being cut for this purpose. Data regarding shoot dry weight showed that different farm yard manure levels and soil textural classes have significant effect on shoot dry weight (Fig. 3). Data presents maximum shoot dry weight in treatments fertilized with 10 Mg ha^{-1} farm manure followed by 5 and 15 Mg ha^{-1}, respectively, that are significantly higher than control. When texture was taken in account then sandy loam performed better than clay loam. Interaction of various farm yard manure levels with soil texture was significant. Our results are in close agreement with those reported by (Iqbal *et al*., 1999; Hegde, 1998) who found that soil textural classes and rates of farm yard manure have significant effect on shoot dry weight of plants. (Aziz et al., 2002; Lucas et al., 1987) favored our findings presenting more shoot growth and weights with application of manure.

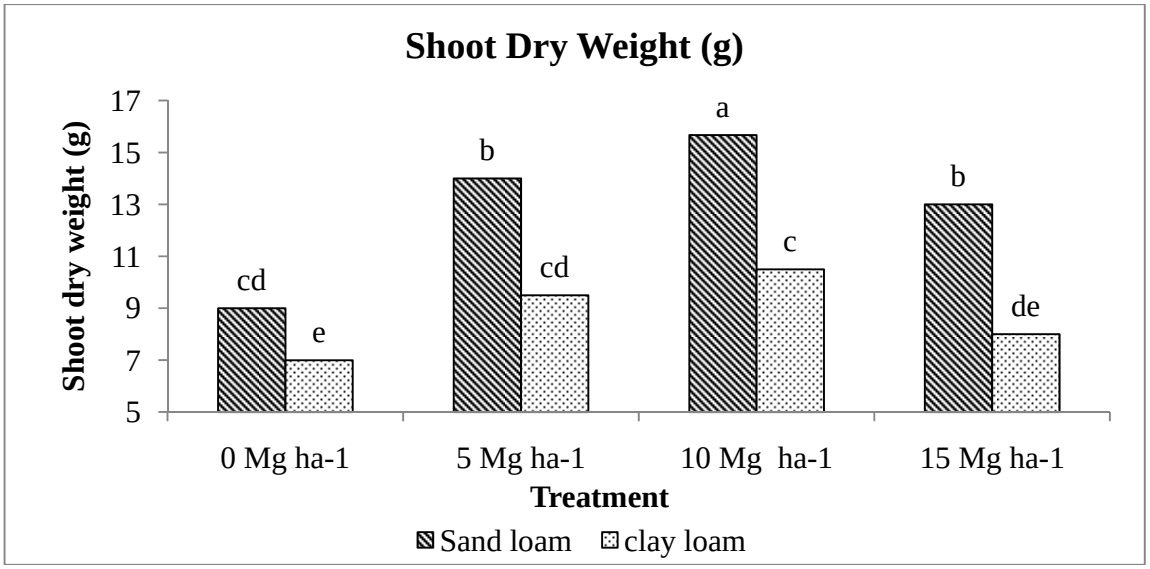

Fig. 3: Effect of soil texture and different manure rates on shoot dry weight (g)

Root Length (cm)

Root is the vital organ of plant for nutrient absorption. More the length of root higher will be its nutrient uptaking capability increasing plant growth. So the factors that enhance root growth are responsible for more plant growth. Fig (4) present root penetration data giving idea that pots treated with 10 Mg ha^{-1} farm manure supported roots to extend than 5 and 15 Mg ha^{-1} that are also significantly longer than control. In case of textural class sand loam soils provided less resistance for penetration to root yielding longer roots than clay loam. Our results are in close agreement with those reported by (Tagar and Bhatti, 1996; Siddique and Hassan, 1991; Baldi *et al*., 2010; Yolcu *et al*., 2010) who found that root penetration of crop is affected by soil texture as well as subsoil. Root penetration is recorded more in sandy soil as compare to fine textured soil in which it is relatively restricted. Use of organic manure affect root growth by increasing inorganic ions and humic substances (Canellas et al., 2002) which induce proliferation of lateral roots and root hairs and cause higher differentiation rate of root cells (Rose et al., 2001).

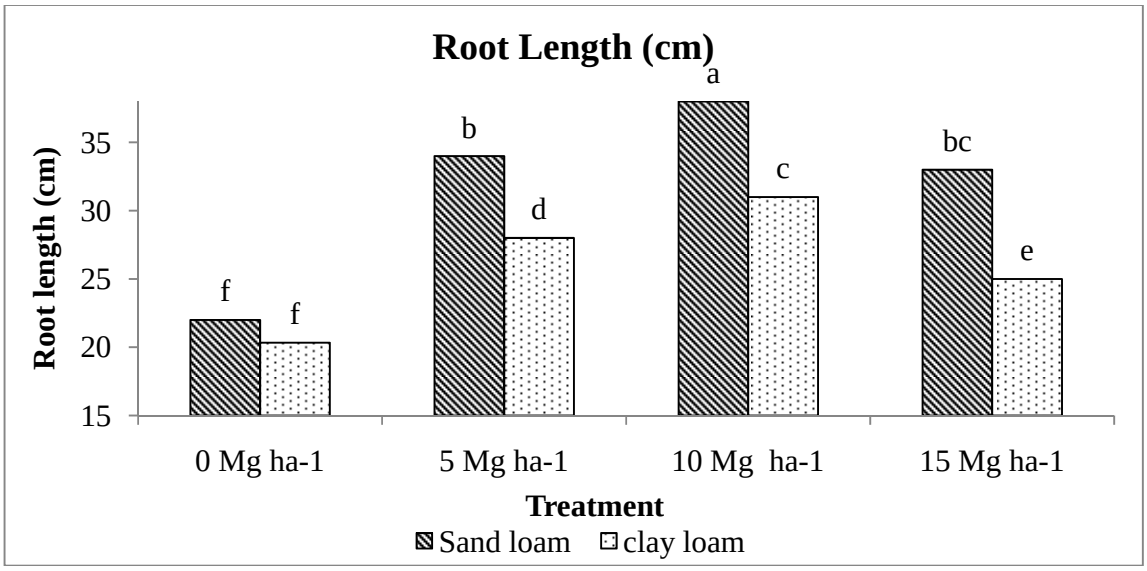

Fig. 4: Effect of soil texture and different manure rates on root length (g)

Root Fresh weight (g)

More the length of root there will be higher weights. Root weight is also indication of growth of the plant because plant will be healthier if its root is providing it with proper nutrition which is possible when root is in close interaction with the soil solution. Fig (5) presents data about the variation in root weights with application of different amendments. If farm manure is considered then the pot treated with 10 Mg ha^{-1} yielded more root weight than 5, 15 and 0 Mg ha^{-1}. While sand loam texture also allow more root penetration than clay loam resulting into more weights. Interaction of various farm yard manure levels with soil texture was significant. Our results are in close agreement with those reported by (Tagar and Bhatti, 1996 ; Mamman *et al*., 2007) who found that soil textural classes and rates of farm yard manure have significant effect on root fresh weight of plants. Manure increase root growth by enhanced inorganic ions and humic substances that induce root proliferation resulting into more weights (canellas et al., 2002). Rose et al. (2001) supports our results by presenting more root growth due to addition of organic matter that act as buffer in soil providing favorable environment for root establishment.

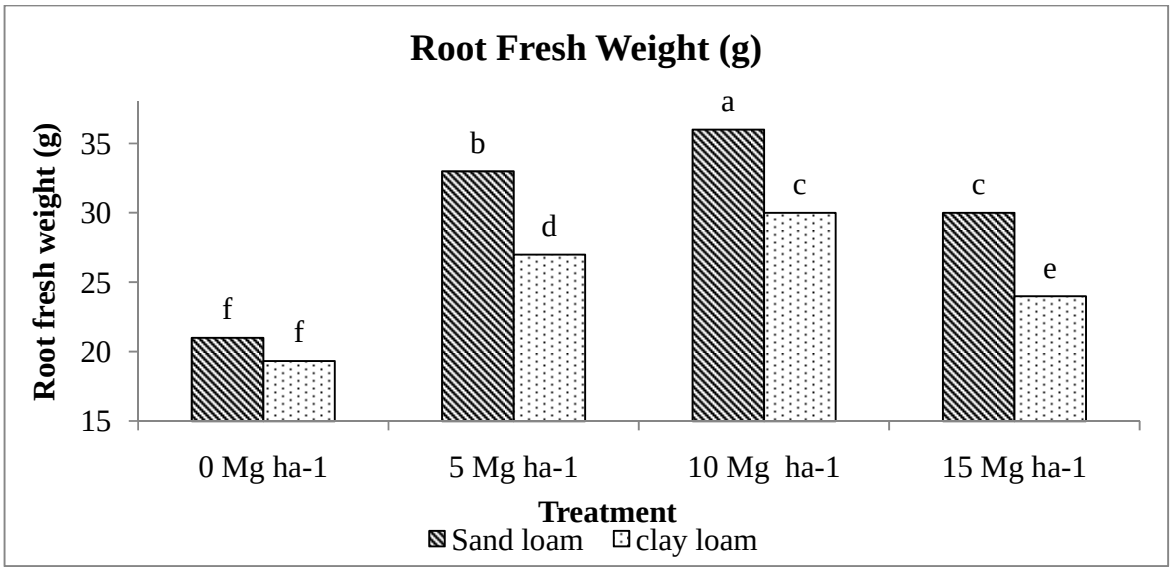

Fig. 5: Effect of soil texture and different manure rates on root fresh weight (g)

Root dry Weight (g)

Root weight is also indication of growth of the plant because plant will be healthier if its root is providing it with proper nutrition which is possible when root is in close interaction with the soil solution. Fig (6) presents data about the variation in root weights with application of different amendments. If farm manure is considered then the pot treated with 10 Mg ha^{-1} yielded more root weight than 5, 15 and 0 Mg ha^{-1}. While sand loam texture also allow more root penetration than clay loam resulting into more weights. Interaction of various farm yard manure levels with soil texture was significant. Our results are in close agreement with those reported by (Tagar and Bhatti, 1996 ; Mamman *et al*., 2007) who found that soil textural classes and rates of farm yard manure have significant effect on root fresh weight of plants. Manure increase root growth by enhanced inorganic ions and humic substances that induce root proliferation resulting into more weights (canellas et al., 2002). Rose et al. (2001) supports our results by presenting more root growth due to addition of organic matter that act as buffer in soil providing favorable environment for root establishment.

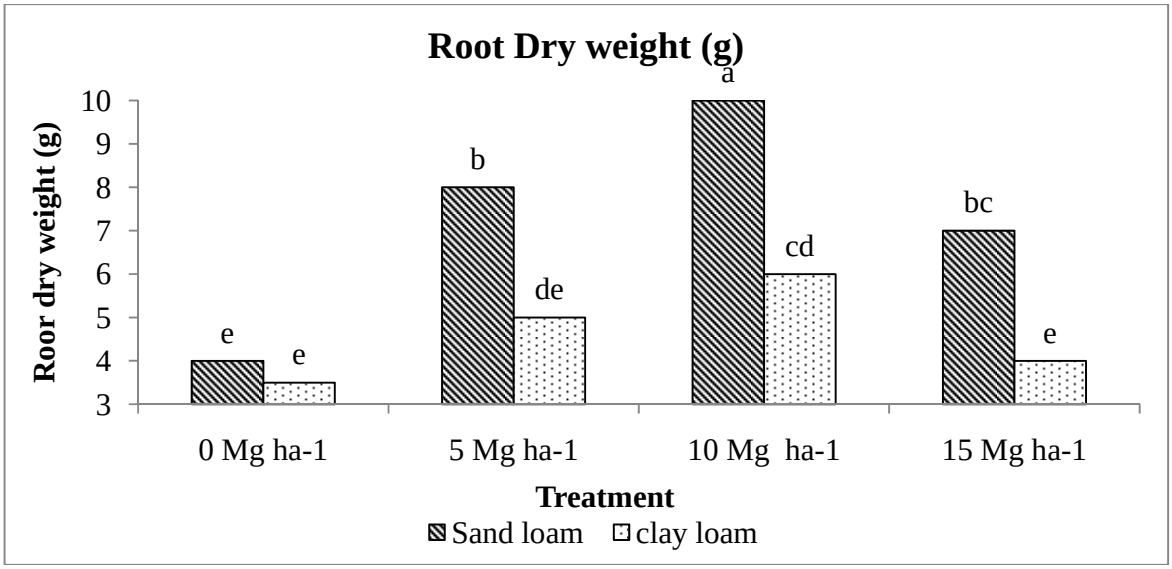

Fig. 6: Effect of soil texture and different manure rates on root dry weight (g)

1000 Grain Weight (g)

Most important thing that is needed by the farmer is grain of the crop that is used as diet. So income that is gained from crop is by selling grain. 1000 grain weight is most important indicator of crop yield. Data regarding 1000 grain weight showed that different farm yard manure levels and soil textural classes have significant effect on 1000 grain weight (Fig. 7). Maximum 1000 grain weight was observed in pot where farm manure was applied at of 10 Mg ha^{-1}, followed by 5, 15 Mg ha^{-1} and minimum 1000 grain weight was observed in 0 Mg ha^{-1}. Textural class also affected yield efficiency of the crop significantly which is evident from results that sandy loam produced significantly higher yields than clay loam. Interaction of various farm yard manure levels with soil texture was significant. Our results are in close agreement with those reported by (Tagar and Bhatti, 1996; Siddique and Hassan, 1991; Baldi *et al*., 2010; Yolcu *et al*., 2010) who found that soil textural classes and rates of farm yard manure have significant effect on 1000 grain weight of plants. Our data is confirmed from the results report of (Zhang *et al.* 2008) of 13.86% more 1000-grain weight in organic manure treatment in comparison with the control.

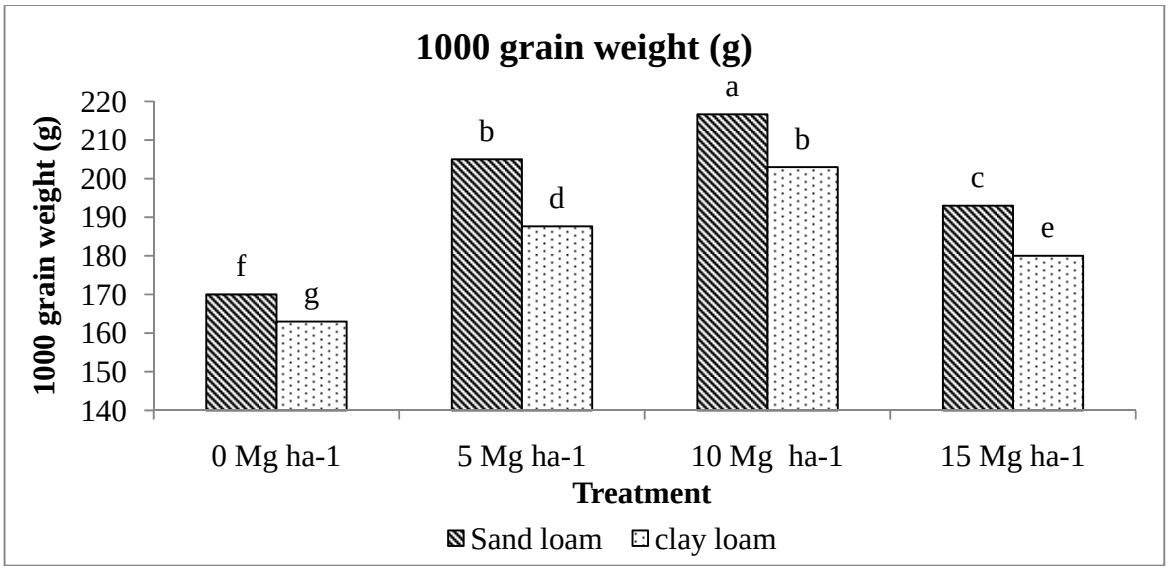

Fig.7: Effect of soil texture and different manure rates on 1000 grain weight (g)

Conclusion:

Keeping in view the results obtained from study it was concluded that soil textural classes and different rates of farm yard manure levels significantly influenced the most of growth and yield parameters of maize crop. As regard different farm manure levels, maximum shoot length, shoot fresh and dry weights were observed where it was applied at 10 Mg ha^{-1}, followed by 5 Mg ha^{-1}, followed by 15 Mg ha^{-1} and minimum were observed in 0 Mg ha^{-1}. As regard different soil textural classes, maximum shoot length, shoot fresh and dry weight was observed in Sand loam soil and minimum in Clay loam soil.

References

Adrien, N.D. 2006. Mixed paper mill sludge effects on corn yield, nitrogen efficiency and soilproperties. publications of the European communities. Agron. J. 98: 1471-1478. 26.

Anonymous. 2009. Pakistan Economic Survey 2008-09. Ministry of Finance, Islamabad, Pakistan.p. 22.

Azad, M.I. and M.V. Yousaf. 1982. Recycling of organic matter to improve the soil productivity. Pak. J. Agric. Res. 22:15-18.

Aziz, T., A. Hassan, A. Wakeel and M. Iqbal. 2002. Growth response of two maize cultivars to soil compaction and texture.Pak. J. Agri. Sci .39(2): 94-99.

Baldi, E., M. Tosellli, D.M. Eissenstat and B. Marangoni. 2010. Organic fertilization leads to increased peach root production and lifespan. Tree Physiol., 30: 1373-1382.

Brady NC, Weil RR (1999). Nature and properties of soil, 12th Ed. Prentice-Hall, Inc. Pearson Education, Upper Saddle River, NJ, USA.

Canellas, L.P., F.L. Olivares, A.L.O. Facanha and A.R. Facanha. 2002. Humic acid isolated from earthworm compost enhance root elongation, lateral root emergence and plasma membrane H^+-ATPase activity in maize roots. Plant Physiol., 130: 1951-1957.

Delate, K. and C.A. Camberdella. 2004. Agroecosystem performance during transition to certified organic grain production. Agron. J., 96: 1288-1298.

Gee, G.W., and J.W.Bauder. 1986. Particle-size analysis. P. 383 - 411. In; A.L. Page (ed.). Methods of soil analysis, Part 1, Physical and mineralogical methods. Second Ed., Agronomy Monograph 9, American Society of Agronomy, Madison, WI, USA.

Gupta, S.C., E.C. Schneider, W.E. Larson, and A. Hadas. 1987. Influence of corn residue on compression and compaction behavior of soils. Soil Sci. Soc. Am. J., 51: 207-212.

Hegde, D. M., 1998. Integrated nutrient management for production sustainability of oil seeds: A review. Journal of oil seeds Research, 15: 1 - 17.

Iqbal, M.S., A. Hassan and M. Abid. 1999. Effect of soil texture and compaction on nutrient uptake and growth of maize. Pak.J. Agri. Sci. 36(3-4): 154-160.

Lucas. W.J. 1987. functional aspects of cellsin root apices. In: Root development and function, Seminar Series 30. Gregory PJ, Lake JV, Rose DA eds. Cambridge University Press, pp. 27-52.

Malival, P.L. 2001. Agronomy at a glance.Agrotech Publishing Academy, Udaipur. pp.3-15.

Mamman, E., J.O. Ohu, and T. Crowther. 2007. Effect of soil compaction and organic matter on the early growth of maize (*Zea mays*) in a vertisol.Int. Agrophysics21: 367-375.

Miller, R.W. and R.L. Donahue. 1990. Soils: An introduction to soils and plant growth. Prentice-Hall Inti.Inc., Washington, DC, USA.p.52-79.

Moodie, R.E., R.W. Smith and R.A. Macgreery. 1959. Laboratory Manual of Soil Fertility. State College Washington, Mimeograph, Pullman, Washinghton, USA. p.175.

Ohu J.O., Arku A.Y., and Mamman E., 2001.Modeling the effect of organic materials incorporated into soils before load applications from tractor traffic. Ife J. Technol., 10(1), 9-18.

Palm, C.A., R.K. Myres and S.M. Nandwa, 1997. Combined use of organic and inorganic nutrient sources for soil fertility maintenance and replenishment 1997. In: Replenishing soil fertility in Africa. Soil Sci. Soc. Am. J., 51: 193- 218.

Reddy, S.R. 2006. Agronomy of field crop. 2nd Ed. (Kalyani Publishers) Pp: 213

Rose, E., B. Rarthes, C. Martias, H. Tiessen and P.L.G. Vledk. 2001. Organic matter management for soil conservation and productivity restoration in Abrica, special assure managing organic matter in tropical soils; scope and limitations. Proceeding of a workshop organized by the center of development research Univ. Bonn. Germany. 7-10 June 1999. Nutri.Cycl Agro-ecosys 61(12): 159-170.

Satyajeet, R. K., Nanwal and Yadav, V. K. 2007.Effect of integrated nutrient

management in nitrogen, phosphorus and potassium concentration, uptake and productivity in pearl millet. Journal of Maharastra Agricultural Universities, 32: 186 - 188.

Siddique, G. and A. Hassan. 1991. Growth response of "Mazenta"(fodder) to N-sources and rates in different textured saline-sodic soils. Pak. J. Agri. Sci. 28(I): 8286.

Singh, L., R.N.S.Verma, and S.S. Lohia. 1980. Effect of continuous application of farmyard manure and inorganic fertilizers on some chemical properties of a semi-arid soil of India.Journal of Indian Society of Soil Science, 28: 170 – 172.

Steel, R.G.D. and I.H. Torrie. 1980. Principles and Procedures of Statistics. McGraw Hill Book Co. Inc., New York, USA.

Tagar, S. and A. Bhatti. 1996. Physical properties of soil. P.113-144. In: E. Bashir and R. Bantel. (Eds.). Soil Science.National Book Foundation, Islamabad, Pakistan.

Tagne, A., T.P. Feujio and C. Sonna. 2008. Essential oil and plant extracts as potential substitutes to synthetic fungicides in the control of fungi. International Conference Diversifying crop protection, 12-15 October La Grande-Motte, France.

Tolera, A, Tam ado, T. and Part, L. M. (2005) grain yield and LER or Maize climbing been intercropping as affected by organic and population density in Western Oromia. Ethiopia Asian journal of plant sciences 4 (5) 458-465.

U. S. Salinity Laboratory Staff. 1954. Diagnosis and improvement of saline and alkali Soils.

USDA Hand Book No. 60. Washington, DC, USA.

Yolcu, H., A. Gunes, M. Dasci, M. Turan, Y. Serin, 2010. The effects of solid, liquid and combined cattle manure applications on yield, quality and mineral contents of common vetch and barley intercropping mixture. Ekoloji, 19: 71-81.

Zhang, Q., Y. Chen, G. Jilani, I.H. Shamsi and Q. Yu, 2008. Model AVSWAT apropos of simulating non-point source pollution in Taihu lake basin. J. Haz. Mat., 174: 824-830.