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Tomato Fruit Quality as Affected by Different Sources of Phosphorus

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Abstract: The study was conducted to investigate the effect of various combinations of phosphorus from organic and inorganic sources on fruit quality of two tomato cultivars i.e., Falcon and Rio Grande for two years. The response of tomato cultivars was assessed to six combinations viz. 0-0, 100-0, 75-25, 50-50, 25-75 and 0-100% of poultry manure (PM) and Triple Super Phosphate (TSP). All the factors (P source, cultivar and year) alone and in combination significantly ($p \leq 0.05$) affected the fruit quality of tomato fruit. The lowest TSS content (4.10°Brix), Protein (7.05%), Ash (9.80%) and Fat (2.74%) were recorded in fruits of Falcon cultivar in control treatment during 2009. However, lowest fiber content (7.08%) was examined in Rio Grande cultivar in control treatment during 2010. Similarly highest concentration of TSS (4.55°Brix) was noted in Rio Grande cultivar with the application of P source 50-50 ratio. Whereas the fiber content (9.09%) were higher in fruits of Falcon cultivar during 2009. However the protein content (9.75%) and Ash (4.46%) was examined in Rio Grande cultivar with the application of P-source 50-50 and 75-25 ratio, respectively during 2010. The fruit pH and fat content was not significantly affected by the P-source. It was concluded that a combination of PM and TSP at 50-50 and 75-25 ratio may be used as an optimum fertilization dose for obtaining good quality of tomato crop.

Key words: Tomato (*Solanum lycopersicon* Mill), nitrogen, poultry manure, minerals, organic sources, inorganic sources, phosphorus

INTRODUCTION

Tomato (*Solanum lycopersicon* Mill) is widely cultivated crop in Pakistan. The average yield in Pakistan is very low as compared to developed countries. There are many factors responsible for the low production that include the unavailability of high yielding cultivars, costly planting materials and lack of awareness in the use of integrated nutrients and pests management practices. Tomato removes large amount of nutrients from soil through continuous cropping. Whereas the application of chemical fertilizers has detrimental effects on soil, water and air quality, the consumers have realized the importance of nutritious and safer foods (Jolly, 1996). In contrast to mineral fertilizer, organic manures add organic matter to soil resulting in improve soil structures, higher nutrient retention and enhance soil moisture holding capacity and water infiltration (Deksissa *et al*., 2008).

Phosphorus (P) is a major mineral nutrient for plants and requires in many compounds in cells and organelles (Bieleski and Ferguson, 1983). Phosphorus helps to initiate root growth of tomato and these roots stimulates P that helps in better utilization of water and other nutrients in the soil and promotes nutritional quality of the fruit. The higher availability of phosphorus improves the total soluble solids and acidity contents (Abd-Alla *et al*., 1996) by increasing fruit setting.

Poultry manure contains higher amount of both macro and micro nutrients and provides appreciable quantity of plant mineral requirements (Bolan *et al*., 2010). Typically, less than one-third of feed P is utilized by poultry, with the remainder excreted in manure and applied to land for crop use (Patterson *et al*., 2005). The poultry manure readily supplies P to plants than other organic manure sources (Garg and Bahla, 2008). The P fraction is considered about 75% as effective as commercial fertilizers (Charles *et al*., 2007). Organic manures improve the solubility and up take of P from soluble P compounds in soil and enhance the utilization of P from fertilizers. Besides nutrient supply it improves soil-water-plant relation through modifying bulk density, total porosity, soil water relation and consequently, increases plant growth and water use efficiency (Obi and Ebo, 1995).

Previous studies have indicated that the integrated nutrient management i.e., organic and inorganic fertilizer enhanced the quality of vegetables (Kong and Ni, 2006; Qin *et al*., 2005). These observations allowed us to hypothesize that there might have been a synergistic influence of organic and inorganic P sources on the quality of tomato fruit. Therefore, this study was conducted to investigate the effect of poultry manure and TSP amendments on the quality profile of Rio Grande and Falcon tomato cultivars.

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MATERIALS AND METHODS

Experimental site and soil characterization: The study was conducted in district Swat during summer 2009 and repeated in 2010. The site was located at N 34' 56, 34" E 72' 27, 44". The climatic condition of the site was temperate to warm with average monthly rainfall (9 mm) in 2009 and (154 mm) in 2010 during the cropping season from April to September.

Soil characterization: The soil and poultry manure factors were analyzed both years (2009 and 2010) and were presented in below paragraph:

1: **Poultry manure (2009-10):** OM (3.45-3.25%), N (3.36-3.15%), P (1.80-1.74%), K (2.65-2.91%) and soil pH (7.5-7.44)
2: **Soil (2009-10):** OM (0.69-1.14%), N (0.034-0.055%), P (0.0086-0.0094%), K (0.019-0.021%) and soil pH (6.91-6.82)

Experimental design and crop fertilization: The experiment was laid in Randomized Complete Block Design (RCBD) with three factors and replicated four times. The factors included P-source (PM and TSP), cultivar (Falcon and Rio Grande) and two consecutive years of cultivation. The tomato cultivars were fertilized with PM and TSP in various combinations viz. 0-0 (control), 100-0, 75-25, 50-50, 25-75, 0-100 in percent. Each of these combinations provided 60 kg/ha of P to the crop. The experimental plot was ploughed and disked three times and the beds were prepared manually. The PM was applied one month before seedling transplantation, while the TSP was applied at time of seedling transplantation. The seedlings were transplanted on both sides of two-meter wide and five meter long beds with a distance of 60 cm on the bed. The plants were irrigated just after seedling transplantation and further irrigation were made as per plant requirement during the whole cropping season. The N and K requirements of the crop was fulfilled from PM, Urea and Sulphate of Potash. Weeds were controlled manually in all plots. Corrective measures were taken for the control of pest and diseases. At each harvest the yield was calculated the fruit were analyzed for mineral contents.

Analytical techniques: Tomato fruit juice pH from each treatment was recorded with electronic pH meter. The Total Soluble Solids (°Brix)) of tomato fruit was analyzed by refractro-meter (Kernco, Instruments Co. Texas).

Proximate composition

Crude protein: On dried fruits samples, the protein content was calculated by total nitrogen according to the Kjeldahl method, using the conversion factor 6.25 (Kjeldahl, 1883).

Crude fat: Soxhlet apparatus was used for the determination of crude fat content on dried weight basis in tomato fruit. Approximately 1 g of moisture free sample was taken and wrapped in filter paper and placed in a clean thimble and then introduced in the extraction tube. A previously cleaned and dried 250 mL round bottom flask was weighed and filled up with anhydrous petroleum ether (40-60°C Bp). The flask was then connected with the extraction tube. Heater was started for the extraction of fat. The fat was extracted repeatedly with 4-6 siphoning. The flask was then dried at 105°C for 2 h. Finally it was cooled and weighed again. The percent oil content of the sample was calculated with the following equation:

$$\text{Crude fat (\% DW)} = \frac{(\text{Wt. of beaker + ether extract})-(\text{Wt. of beaker})}{\text{Wt of sample}} \times 100$$

Ash content: Ash is the residue that remains after the complete oxidation of all the organic matter at a temperature ranging from 500 to 600°C. Clean empty crucibles were placed in muffle furnace at 550°C for an hour then cooled in desiccator and weight of empty crucibles was noted (W_1). One gram of each sample was put in crucibles (W_2). The samples were charred over the burner with the help of blowpipe. The crucibles were then placed in muffle furnace at 550°C for 6-8 h. After the complete ignition the furnace was turned off. The crucibles were cooled and weight (W_3). The ash was calculated as follows:

$$\text{Ash (\%)} = \frac{W_3 - W_1}{\text{Wt. of sample}} \times 100$$

Crude fiber: Digestion of weight samples with acid was done. One gram free of fat sample was added in 200 mL 2.5% HCl solution and then boiled at 95°C for 120 min. Digest filtration was done with the used of hot distilled water and linen cloth. A volume of 200 mL of 2.5% NaOH solution was made and boiled for 120 min. Gooch Crucible set with asbestos pad was used for filtration and was then washed for some time with hot distilled water and 50 mL alcohol and ether, (25 mL) to remove the alkali. Drying of crucibles in oven was done at 10-120°C and then cooled in desiccator and weight (W_1). Ignition was then carried out at 6000°C till ashing and weight was taken as (W_2). Percentage crude fiber was calculated as:

$$\text{\% Crude fiber (DW)} = \frac{(W_1 - W_2)\times 100 - \text{Crude fiber weight}}{\text{Wt. of sample}}$$

Statistical analysis: The combine analysis was conducted for different parameters and was subjected to analysis of Variance (ANOVA) technique to observe the differences among the treatments and their interactions.

In cases of significant differences the means were compared using Least Significant Difference (LSD) test. Statistical computer software for computing the ANOVA and LSD was assessed through Statistix 8.1 (Jan *et al.*, 2009).

RESULTS AND DISCUSSION

Fruit juice pH: The fruit juice pH was significantly ($p \leq 0.05$) varied between tomato cultivars and years, whereas fertilizer treatments non-significantly affected fruit juice pH (Table 1). Similarly the interactions among cultivars, fertilizer treatments and years were also non-significant regarding fruit juice pH. The Fig. 1 clearly indicated that Falcon cultivar showed less fruit juice pH (4.14) with the application of 100-0 (PM-TSP) ratio during 2010. However the higher fruit pH (4.30) was noted in fruits of Rio Grande cultivar in control treatment during 2009. The Falcon cultivar contained lower fruit juice pH than Rio Grande due to a genetic factor and that might be influenced by different weather conditions and cultural practices (Javanmardi and Kubota, 2006). However, the application of phosphorus from either source poultry manure or Triple Super Phosphate non-significantly affected fruit juice pH. The results were in line with the Carrijo and Hochmuth (2000) and Oke *et al.* (2005) that the application of phosphorus rates had no effect on tomato fruit juice pH.

Total soluble solids (°Brix): The mean data indicated that tomato cultivars and fertilizer treatment significantly ($p<0.05$) affected the total soluble solids of tomato fruit, whereas years variation was non-significant. All the interaction regarding TSS among cultivars, fertilizer treatment and years were found non-significant (Table 2). The results (Fig. 2) revealed that higher total soluble solids (4.55°Brix) were observed in the fruits of Rio Grande cultivar with the application of 50-50 PM and TSP during 2010. The Falcon cultivar contained lower TSS (4.10°Brix) in the fruits of control treatment during 2009. Total soluble solids comprised of sugars, acids and other components in tomato fruit (Balibrea *et al.*, 2006). The variation in total soluble solids in the tomato cultivars might be under the genetic controlled and affected by the response of mineral concentration (Benard *et al.*, 2009). The organic substrates increased total soluble solids in one cultivar but decreased in the other cultivar due to its great genetic variability (Riahi *et al.*, 2009). The combine application of organic and inorganic source of phosphorus significantly increased total soluble solids of tomato fruit. The increased in tomato °brix content might be the effect of organic manure instead of inorganic phosphorus fertilizer application on total soluble solids of tomato fruit (Oke *et al.*, 2005). The organic manure increased electric conductivity of the soil and this could have beneficial effect on total soluble solids level (Cuartero and Fernandez, 1999).

Table 1: Analysis of Variance for the effect of phosphorus sources on fruit pH of tomato cultivars

Source	df[a]	Mean square	p-value
Year (Y)	1	0.012	0.0002
Cultivars (C)	1	0.180	0.0000
C x Y	1	0.002	0.1931
Treatment (T)	5	0.002	0.1250
Y x T	5	0.000	0.8033
C x T	5	0.000	0.8391
Y x C x T	5	0.000	0.7945
Error	66	0.001	
Total	95		

[a]df: Degree of freedom

Table 2: Analysis of Variance for the effect of phosphorus sources on fruit TSS (°Brix) of tomato cultivars

Source	df[a]	Mean square	p-value
Year (Y)	1	0.002	0.6678
Cultivars (C)	1	0.202	0.0079
C x Y	1	0.060	0.1399
Treatment (T)	5	0.123	0.0012
Y x T	5	0.012	0.8166
C x T	5	0.024	0.4812
Y x C x T	5	0.002	0.9970
Error	66	0.027	
Total	95		

[a] df: Degree of freedom

Table 3: Analysis of Variance for the effect of phosphorus sources on fruit protein content (%) of tomato cultivars

Source	df[a]	Mean square	p-value
Year (Y)	1	0.045	0.0047
Cultivars (C)	1	0.120	0.0000
C x Y	1	0.002	0.5420
Treatment (T)	5	0.156	0.0000
Y x T	5	0.004	0.4425
C x T	5	0.009	0.0763
Y x C x T	5	0.004	0.4825
Error	66	0.004	
Total	95		

[a]df: Degree of freedom

Crude protein content (%): The crude protein content was significantly ($p \leq 0.05$) affected by tomato cultivars, fertilizer treatments and years (Table 3). No significant response was noted in the interactions among cultivars, fertilizer treatments and years regarding crude protein content. The variation in tomato cultivars indicated that higher crude protein content (9.50%) was noted in cultivar Rio Grande in the treatment of 50-50 and 25-50, respectively during 2010 (Fig. 3). The lowest crude protein content (7.05%) was recorded in fruits of Falcon cultivar in unfertilized plants in the year 2009. The results indicated that Rio Grande cultivar contained higher crude protein content than Falcon cultivar. The Rio Grande cultivar utilized the soil mineral nutrients more efficiently due to genetic variability (Payne, 1987) and ultimately resulted in more fruit protein content as compared to Falcon. Similarly the integrated nutrient management positively affected the plant metabolism that was responsible for protein formation. The physiological

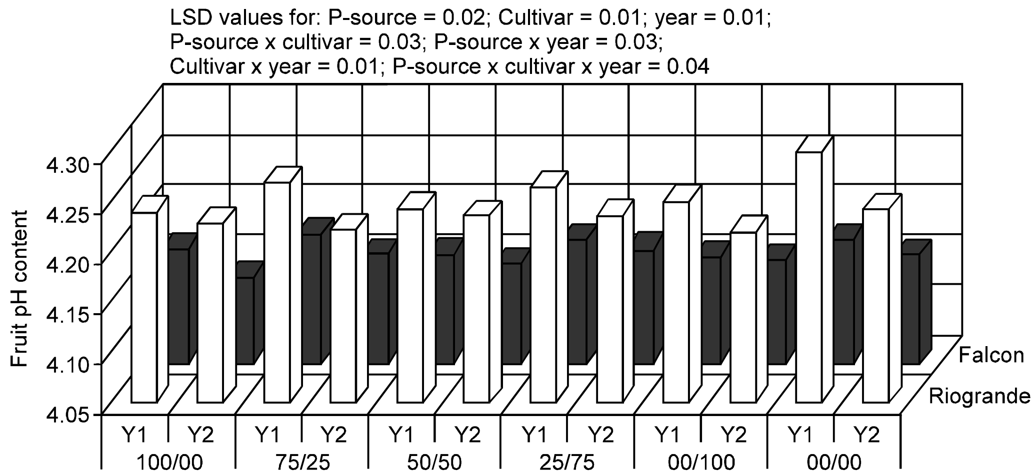

Fig. 1: Fruit pH content as affected by the organic and inorganic phosphorus amendments on tomato cultivars. Y1 and Y2 represent 1st and 2nd year of cultivation, respectively

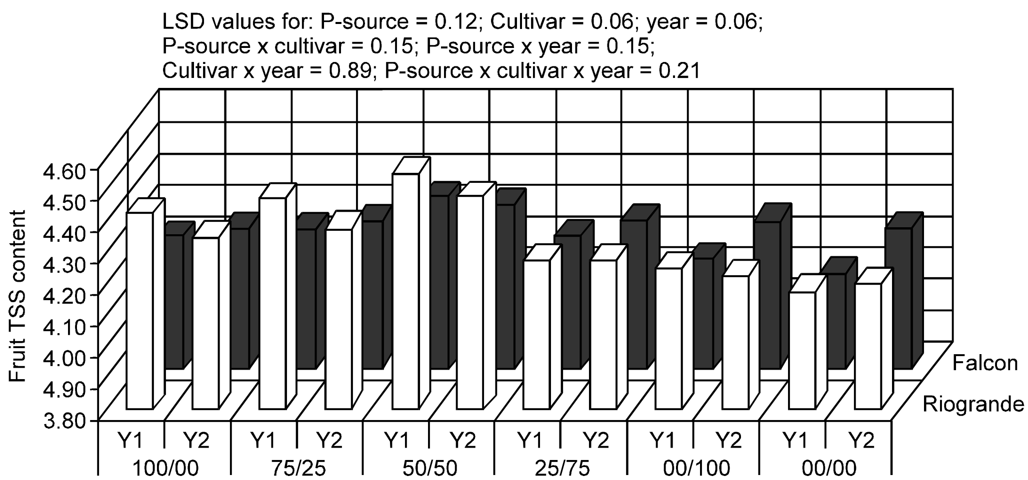

Fig. 2: Fruit TSS content (°Brix) as affected by the organic and inorganic phosphorus amendments on tomato cultivars. Y1 and Y2 represent 1st and 2nd year of cultivation, respectively

processes i.e., photosynthesis, synthesis of amino acids and proteins were improved with the addition of organic and inorganic fertilizer (Sarhan, 2008). The addition of organic matter increased the electric conductivity (EC) that helped in increased fruit mineral content of tomato fruit (Dorais *et al.*, 2001) ultimately increased protein content. The phosphorus concentration in soil highly responded to plants protein content (Singh and Dukey, 1991) as poultry manure increased the phosphorus availability and ultimately increased protein content of soybean (Tomar *et al.*, 2004). The favorable weather and high soil organic matter affected the protein content in tomato fruit because water as essential component for microorganism that utilized and dissolved nutrients (Golueke, 1991).

Fruit ash (%): Fruit Ash content was significantly ($p \leq 0.05$) affected by tomato cultivars, fertilizer treatments and years (Table 4). All the interactions among cultivars, fertilizer treatments and years were non-significant. The figure 4 showed that higher percent fruit Ash (14.46%) in tomato fruit was recorded in cultivar Rio Grande in treatment of 75-25 ratio of PM and TSP during 2010. While the lowest percent fruit Ash (9.80%) was recorded in fruits of Falcon cultivar in unfertilized plants in the year 2009. The tomato percent fruit Ash content, index of mineral content was genetically varied across all the fertilizer levels (Oloyede *et al.*, 2012). The possible reason for the improvement in fruit Ash might be the high utilization of soil nutrients (Mauromicale *et al.*, 2011) by Rio Grande cultivar. The application of organic and inorganic phosphorus fertilizer significantly affected the percent fruit Ash content. The application of poultry manure enhanced (electric conductivity (EC) resulted in higher nutrient absorption that increased fruit Ash content and other quality parameter in tomato fruit

LSD values for: P-source = 0.35; Cultivar = 0.20; year = 0.20;
P-source x cultivar = 0.50; P-source x year = 0.50;
Cultivar x year = 0.29; P-source x cultivar x year = 0.71

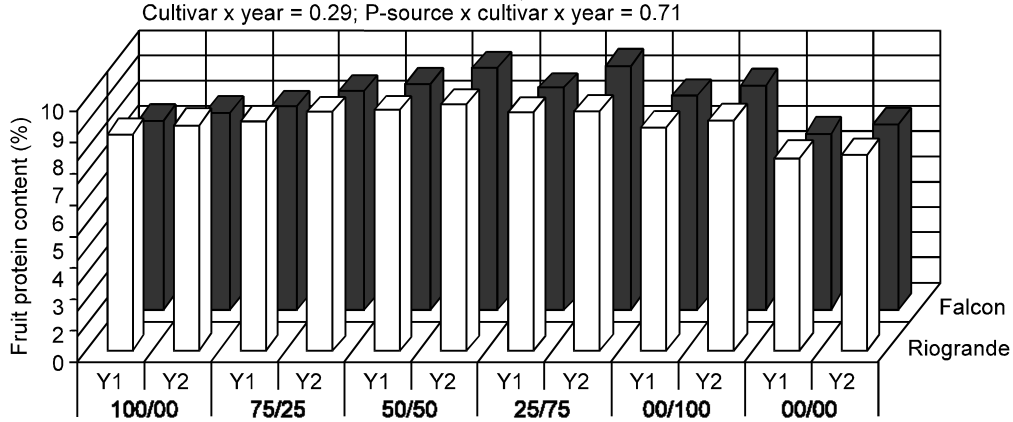

Fig. 3: Fruit protein content (%) as affected by the organic and inorganic phosphorus amendments on tomato cultivars. Y1 and Y2 represent 1st and 2nd year of cultivation, respectively

LSD values for: P-source = 0.54; Cultivar = 0.31; year = 0.31;
P-source x cultivar = 0.77; P-source x year = 0.77;
Cultivar x year = 0.44; P-source x cultivar x year = 1.09

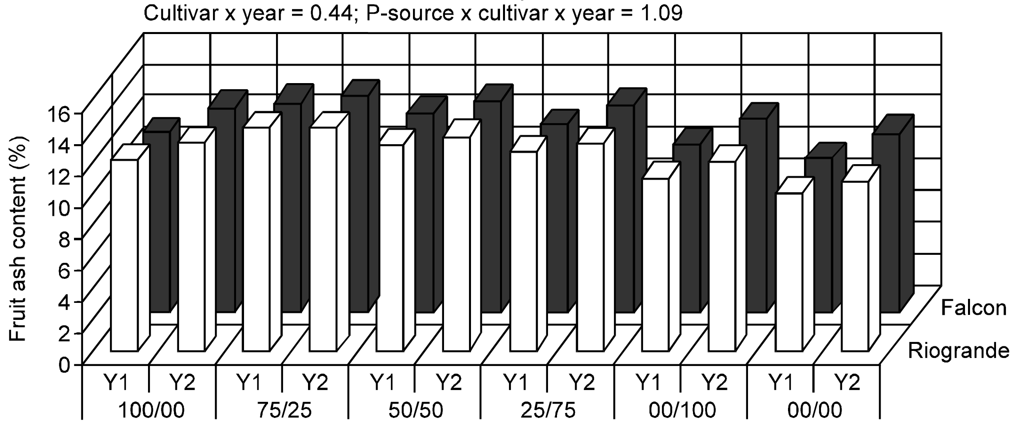

Fig. 4: Fruit Ash content (%) as affected by the organic and inorganic phosphorus amendments on tomato cultivars. Y1 and Y2 represent 1st and 2nd year of cultivation, respectively

Table 4: Analysis of Variance for the effect of phosphorus sources on fruit Ash content (%) of tomato cultivars

Source	df[a]	Mean square	p-value
Year (Y)	1	22.061	0.0002
Cultivars (C)	1	2.940	0.0346
C x Y	1	1.832	0.0933
Treatment (T)	5	24.057	0.0000
Y x T	5	0.993	0.1803
C x T	5	0.450	0.6168
Y x C x T	5	0.044	0.9964
Error	66	0.632	
Total	95		

[a]df: Degree of freedom

(Mauromicale *et al.*, 2011). The application of chemical fertilizer played a vital role in food security, however chemical fertilizer application caused degradation of soil quality, by soil hardening (Lai *et al.*, 2002) and limited the absorption of minerals from the soil resulted in decreased fruit Ash content. Similarly the higher ash content during 2010 might be the availability of higher mineral nutrients from soil due to higher moisture content that enhanced soil mineral availability (Van veen and Kuikman, 1990).

Crude fat content (%): The results showed that cultivars and year significantly ($p \leq 0.05$) affected crude fat in tomato fruit, while the fertilizer treatments had non-significantly influenced crude fat content. Similarly the interactive responses of cultivars, fertilizer treatments and years non-significantly affected the crude fat content (Table 5). The results (Fig. 5) showed that more crude fat content (3.45%) was noted in cultivar Rio Grande in treatment 50-50 ratio PM and TSP during 2010. The lower fat content (2.74%) was noted in fruits of Falcon cultivar in control treatment during 2009. However, the used of organic and inorganic source of phosphorus

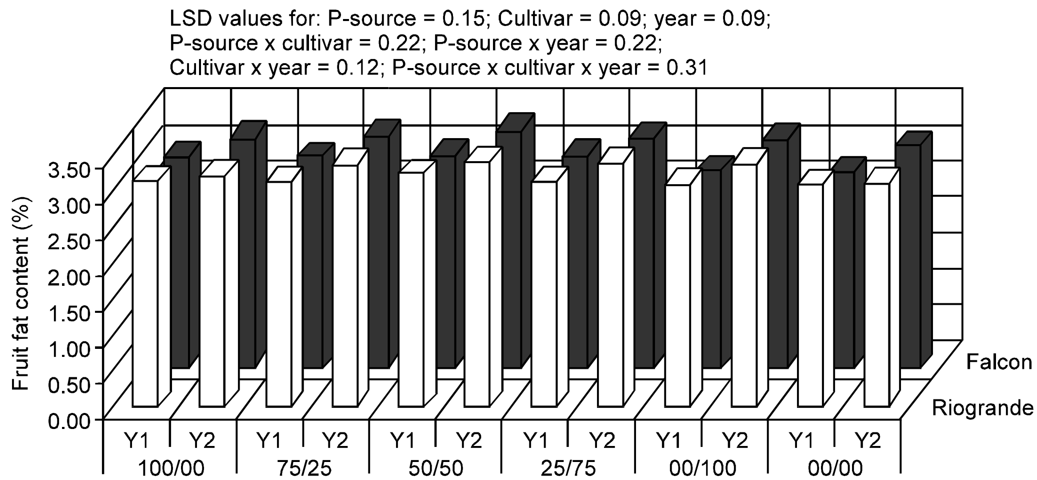

Fig. 5: Fruit Fat content (%) as affected by the organic and inorganic phosphorus amendments on tomato cultivars. Y1 and Y2 represent 1st and 2nd year of cultivation, respectively

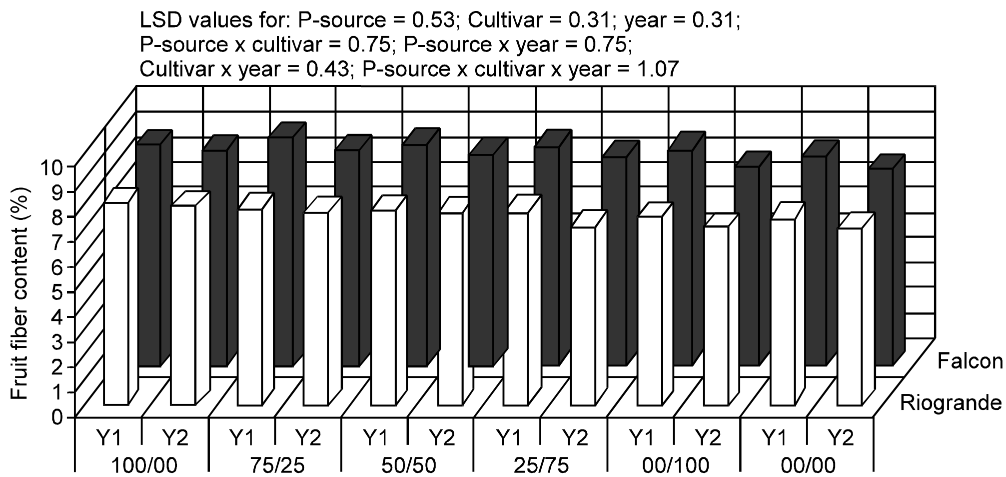

Fig. 6: Fruit fiber content (%) as affected by the organic and inorganic phosphorus amendments on tomato cultivars. Y1 and Y2 represent 1st and 2nd year of cultivation, respectively

Table 5: Analysis of Variance for the effect of phosphorus sources on fruit Fat content (%) of tomato cultivars

Source	df[a]	Mean square	p-value
Year (Y)	1	1.493	0.0000
Cultivars (C)	1	0.990	0.0000
C x Y	1	0.143	0.0919
Treatment (T)	5	0.098	0.0895
Y x T	5	0.020	0.8418
C x T	5	0.012	0.9415
Y x C x T	5	0.014	0.9158
Error	66	0.049	
Total	95		

[a]df: Degree of freedom

Table 6: Analysis of Variance for the effect of phosphorus sources on fruit fiber content (%) of tomato cultivars

Source	df[a]	Mean square	p-value
Year (Y)	1	3.500	0.0485
Cultivars (C)	1	20.341	0.0000
C x Y	1	0.206	0.5528
Treatment (T)	5	1.292	0.0616
Y x T	5	0.095	0.9750
C x T	5	0.093	0.9761
Y x C x T	5	0.028	0.9985
Error	66	0.580	
Total	95		

[a]df: Degree of freedom

showed a non-significant variation regarding crude fat content. The higher crude fat content in Rio Grande might be due to the genetic makeup of the cultivar (Anita, 1997). The significant variation was also noted regarding crude fat content during 2009 and 2010. This variation might be the favorable weather condition for tomato growth that influenced the fat content of the tomato fruit. The dry weather in 2009 might reduce nutrients absorption that eventually decreased the fat concentration (Lavee and Wodner, 1991) in the tomato fruit. The higher precipitation in 2010 increased the metabolic activity that helped in higher fat content (Brighigna *et al*., 1989).

Percent crude fiber: The results (Table 6) showed that tomato cultivars and years significantly ($p \leq 0.05$) affected percent crude fiber content, while the fertilizer treatments showed non-significant variation. Similarly all the interactions among cultivars, fertilizer treatments and years, were also non-significant. More crude fiber content (9.07%) was noted in Falcon cultivar during 2009 with treatment of 75-25 ratio. The lower crude fiber content (7.08%) was recorded in fruits of Rio Grande cultivar during the year 2010. The results (Fig. 6) showed that Falcon cultivar contained higher fiber content as compared to Rio Grande. This variation indicated that crude fiber in tomato fruit was under the genetic controlled (Hernandez *et al*., 2008). The mean data indicated that higher crude fiber content in tomato fruit were noted in 2009 as compared to 2010 due to higher fruit moisture content that decreased fiber content (Samaila *et al*., 2011).

Conclusion: The present findings indicated that Rio Grande was better in fruit quality as compared to Falcon cultivar. Whereas the application of both sources of phosphorus i.e. Poultry manure and Triple Super Phosphate significantly improved fruit quality.

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REFERENCES

Abd-Alla, M., M. Adam, F. Abou-Hadid and B. Iman, 1996. Temperature and fertilizer effects on tomato productivity. Acta Hort., 434: 113-116.

Anita, K.I., 1997. Nutritive value and processing of tomatoes for its effective utilization. M.Sc. Thesis submitted to Department of Food Nutrition, CCS Haryana Agricultural University, Hisar, India.

Balibrea, M.E., C. Martinez-Andujar, J. Cuartero, M.C. Bolarin and F. Perez-Alfocea, 2006. The high fruit soluble sugar content in wild Lycopersicon species and their hybrids with cultivars depends on sucrose import during ripening rather than on sucrose metabolism Funct. Plant Biol., 33: 279-288.

Benard, C., H. Gautier, F. Bourgaud, D. Grasselly, B. Navez, C. Caris-Veyrat, M. Weiss and M. Genard, 2009. Effects of low nitrogen supply on tomato (Solanum lycopersicum) fruit yield and quality with special emphasis on sugars, acids, ascorbate, carotenoids and phenolic compounds. J. Agric. Food Chem., 57: 4112-4123.

Bieleski, R. and I.B. Ferguson, 1983. Physiology and metabolism of phosphate and its compounds. In: Bieleski R, Ferguson IB, eds. Encyclopedia of Plant Physiology. New York: Springer-Verlag, 422-449.

Bolan, N.S., A.A. Szogi, T. Chuasavathi, B. Seshadri, M.J. Rothrock Jr. and P. Panneerselvam, 2010. Uses and management of poultry litter. World's Poult. Sci. J., 66: 673-698.

Brighigna, A., V. Marsilio, G. Vlahov and M.E. De Renzo, 1989. Le olive da tavola: caratteristiche ed attitudini della varieta "Nocellara Messinese" coltivata in Calabria. Industrie Alimentary, XXVIII: 1087-1092.

Carrijo, O.A. and G. Hochmuth, 2000. Tomato responses to preplant-incorporated or fertigated phosphorus on soils varying in Mehlich-1 extractable phosphorus. Hortic. Sci., 35: 67-72.

Charles, C. Mitchell, O. James, Donald, D. Esiyok, B. Okur, S. Delibacak and I. Duman, 2007. Effect of manure doses and growth media on the productivity and mineral composition of rocket leaves (eruca sativa) Improved Crop Quality by nutrient management. J. Dev. in Plant and Soil Sci., 86: 237-240.

Cuartero, J. and R. Fernandez-Munoz, 1999. Tomato and salinity. Sci. Hortic., 78: 83-125.

Deksissa, T., I. Short and J. Allen, 2008. Effect of soil amendment with compost on growth and water use efficiency of amaranth. In: Proceedings of the UCOWR/NIWR Annual Conference: International Water Resources: Challenges for the 21st Century and Water Resources Education Durham, NC.

Dorais, M., D.L. Ehret and A.P. Papadopoulos, 2001. Tomato (*Solanum lycopersicum*) health components: from the seed to the consumer. Phytochem. Rev., 7: 231-250.

Garg, S. and G.S. Bahla, 2008. Phosphorus availability to maize as influenced by organic manures and fertilizer P associated phosphatase activity in soils. Biores. Tech., 99: 5773-5777.

Golueke, C.G., 1991. The BioCycle Guide to the Art and Science of Composting. The JG Press Inc., Emmaus, Pennsylvania.

Hernandez, S.M., E.M. Rodriguez Rodriguez and C. Diaz Romero, 2008. Chemical composition of tomato (*Lycopersiconesculentum*) from Tenerife, the Canary Islands Food Chem., 106: 1046-1056.

Jan, M.T., P. Shah, P.A. Hollington, M.J. Khan., Q. Sohail, 2009. Agriculture Research: Design and Analysis. 1st ed. Dept. of Agronomy, KPK Agric. Univ. Peshawar, Pakistan.

Javanmardi, J. and C. Kubota, 2006. Variation of lycopene, antioxidant activity, total soluble solids and weight loss of tomato during postharvest storage. Postharvest Bio. Techn., 41: 151-155.

Jolly, D.A., 1996. Consumer profiles of buyers and non-buyers of organic produce. pp: 121-126. In Proceeding of the Organic Farming Symposium, 22-23 January 1992, University of California, Division of Agriculture and Natural Resources, Publication 3356.

Kjeldahl, J., 1883. A new method for the determination of nitrogen in organic matter. Z. Anal. Chem., 22: 366.

Kong, W.J. and W.Z. Ni, 2006. Effects of integrated fertilization with commercial organic mature and chemical fertilizers on heavy metal balance in soil-rape cropping system. J. Soil and Water Conservation, 20: 32-35.

Lai, C.M., K.L. Liu, X.D. Wang, G.X. Zhao and C.H. Zhang, 2002. Effect of fertilization management on soil enzyme activities related to the C, N, P and S cycles in soils. In: 17th WCSS, 14-21, Thailand, pp: 391.

Lavee, S. and M. Wodner, 1991. Factors affecting the nature of oil accumulation in fruit of olive (*Olea europaea* L.) cultivars. J. Hortic. Sci., 66: 583-591.

Mauromicale, G.A.M., G. Longo and A.L. Monaco, 2011. The effect of organic supplementation of solarized soil on the quality of tomato fruit. Scientia Hortic., 129: 189-196.

Obi, M.E. and P. Ebo, 1995. The effect of organic and inorganic amendments on soil physical properties andproduction in a severely degraded sandy soil in southern Nigeria. Biores. Techn., 51: 117-123.

Oke, M., T. Ahn, A. Schofield and G. Paliyath, 2005. Effects of phosphorus fertilizer supplementation on processing quality and functional food ingredients in tomato. J. Agric. Food Chem., 53: 1531-1538.

Oloyede, F.M., G.O. Agbaje, E.M. Obuotor and I.O. Obisesan, 2012. Nutritional and antioxidant profiles of pumpkin (*Cucurbita pepo* Linn.) immature and mature fruits as influenced by NPK fertilizer. Food Chem., 135: 460-463.

Patterson, P.H., P.A. Moore. Jr and R. Angel, 2005. In: Phosphorus: Agriculture and the Environment. J. T. Sims and A. N. Sharpley, Eds. American Society of Agronomy, Madison, WI., pp: 635-682.

Payne, R.C., 1987. Seed and cultivar identification. Seed Sci. Techn., 15: 641-644.

Qin, D.Z., M.G. Xu, J.M. Li, H.P. Shen and P.N. Huang, 2005. Effect of chemical fertilizer combine with manure on increasing quality and yield of Mat Rush. Soils and Fertilizers, 5: 25-28.

Riahi, A., C. Hdider, M. Sanaa, N. Tarchoun, M. Ben Kheder and I. Guezal, 2009. Effect of conventional and organic production systems on the yield and quality of field tomato cultivars grown in Tunisia. J. Sci. Food Agric., 89: 2275-2282.

Samaila, A., E.B. Amans, I.U. Abubakar and B.A. Babaji, 2011. Nutritional quality of tomato (*Lycopersicon esculentum* Mill) as influenced by mulching, nitrogen and irrigation interval. J. Agric. Sci., 3: 266-270.

Sarhan, T.Z., 2008. Effectof biological fertilizers, animal residues and urea on growth and yield of potato plant c.v. Desiree (*Solanumtuberosom* L.). Ph.D Dissert., Hort. Sci. and Landscape Design (Vegetable). Univ. of Mosul, College of Agric. and Forestry, Iraq.

Singh, V.K. and O.P. Dukey, 1991. Response of maize to application of nitrogen and phosphorus. Current Res. Univ. Agric. Sci., 20: 153-154.

Tomar, S.S., R. Singh and P.S. Singh, 2004. Response of phosphorus, sulphur and Rhizobium inoculation on growth, yield and quality of soybean. Prog. Agric., 4: 72-73.

Van Veen, J.A. and P.J. Kluikman, 1990. Soil structural aspects of decomposition of organic matter by micro-organisms. Biogeochem., 11: 213-233.