RESPONSE OF TOMATO CULTIVARS TO DIFFERENT ORGANIC FERTILIZERS UNDER AGRO-CLIMATIC CONDITIONS OF MINGORA, SWAT

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ABSTRACT:- An experiment was conducted at Agricultural Research Institute (ARI) Mingora, Swat during 2013 to study the effect of different organic fertilizers of tomato cultivars under the agro-climatic conditions of Mingora, Swat. The experiment was conducted in randomized complete block design with split plot arrangements having four treatments with three replications. Almost all the traits showed significant differences for organic fertilizers and varieties, while their interactions had a varied response. The analyzed data showed that poultry manure gave maximum yield (24.65 tha^{-1}), followed by FYM (24.38 tha^{-1}) and mushroom compost (24.11 tha^{-1}) while minimum was recorded in plots where no organic fertilizer was used. The results revealed that cultivar, Rio Grand showed maximum number of plant survival percentage (98.33%), days to flowering (40.73), number of flowers plant^{-1} (6.23), number of fruit plant^{-1} (25.67), fruit weight (8.84 kg), number of leaves plant^{-1} (83.66), fruit size (64.70 cm^3) and total yield (25.67 t ha^{-1}) in Farm Yard Manure (FYM). Considering the overall performance, it was found that the tomato cultivar Rio Grand was promising for yield and other characters where FYM was applied.

Key Words: Tomato; Genotypes; Organic Manure; Production; Agronomic Characters; Yield Components; Pakistan.

INTRODUCTION

Tomato (*Lycopersicon esculentum* mill) is one of the most important edible and highly nutritious vegetable crop. It belongs to family Solanaceae. It lines next to potato and sweet potato regarding area and produce (FAO, 2009). Tomato was cultivated in tropical, subtropical and temperate climate (FAO, 2006). China, United States of America, India, Egypt, Turkey, Iran, Mexico, Brazil and Indonesia are the leading tomato producing nations (FAO, 2006). It is a frequently consumed vegetable in many countries, becoming the main sources of different nutrients, providing health benefits for human bodies (Willcox et al., 2003). This crop requires warm weather and plentiful sunshine for optimum growth. Production of different vegetable crops such as onion, potato, tomato, pea for commercial purposes was recently popularized in the country by introducing promising varieties. Tomato crop is suitable in environmental conditions of Khyber Pakhtunkhwa due to its climate. Fertilizer and manures have significant role for production and yield of tomato crop. Fertilizer improves the biochemical and physiological changes in crop which have direct link for crop yield and its quality related components. Special attention must be given

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to the growth regarding the effects of FYM. Nitrogen has been found by many researchers, as an imperative factor influencing tomato yield and its quality (Ameer et al., 2008; Asi and Amjad, 1985; Mehla and Saini, 1986). The organic fertilizers improve the soil organic matter and plant soil-water interaction by enhancing the fertility as well as porosity. It ameliorates the activity of microbes in the soil and enhances the water holding capacity and lowers the leaching of important salts into the soil. Fertilizer and organic manure and pesticides are being used to enhance the yield and quality of the crops which in turn have a significant role on the economy. Tomato cultivation requires a balanced flow of essential nutrients that can be supplied by the application of inorganic or organic manure or both. However, farmers are showing their interest in organic farming because they are more aware of the residual effect of chemicals used in the crop production and their influence in environmental degradation. Besides, the excessive use of inorganic fertilizer causes risk to public health and to the environment. However, the combine use of both organic and inorganic fertilizer increases the yield as well as keeps the environment safe (Hsieh et al., 1996).

Therefore, the present research was undertaken to identify best performing tomato variety for Swat area and compare yield and yield components of tomato under organic fertilizers application.

MATERIALS AND METHOD

To study the response of tomato cultivars to different organic fertilizers, under the agro-climatic conditions of Mingora, Swat, an experiment was carried out at Agricultural Research Institute (ARI) Mingora, Swat during April, 2013. The nursery beds were thoroughly prepared and well rotten FYM was applied. The following treatments included varieties Rio Grand, Early Rio Grand, F_1 hybrid-176 and T-1359 and control (without treatments), FYM (25 t ha^{-1}), poultry manure (PM, 25 t ha^{-1}) and mushroom compost (MC, 25 t ha^{-1}).

The experiment was conducted in randomized complete block design with split plot arrangements having four treatments with three replications. The nursery beds were thoroughly prepared and well rotten FYM was applied. The beds 5m x 80m were resided 10 cm above the soil. The tomato seeds were sown in beds at 4" distance in soil after sowing FYM was then applied and frequently irrigated with sprinkler till germination. During transplanting the manures were incorporated into the soil. Poultry manure was divided in two split doses i.e., half dose before transplanting the seedlings and second half during 1st flowering of tomato plants. Plant to plant and row to row distance was 40 cm and 1m respectively. Transplantation was carried out on May 13, 2013. When the seedlings attain a height of 9-12 cm in the nursery bed, they were transplanted to the field. At the seedling stage, each plant had approximately 4-7 leaves. After transplanting, thorough irrigation was given. The experiment was ended on August 25, 2013. Regular culture practices viz., hoeing, irrigation and weeding were carried out throughout the experiment.

Data was recorded on plant survival percentage, days to flowering,

number of flowers plant^{-1}, number of fruit plant^{-1}, number of leaves plant^{-1}, fruit size (cm^3), fruit weight (kg) and total yield (t ha^{-1}).

Statistical Analysis

The data was analyzed by using computer software STATISTIX-8.1. After getting significant results, means were compared by using the above mentioned software at 5% level of probability (Steel et al., 1997).

RESULTS AND DISCUSSION

Plant Survival Percentage

Statistical analysis showed that the effects of plant survival percentage in tomato were significantly different ($P \leq 0.05$) affected by varieties and fertilizer, whereas their interactive effects were also significant (Table 1). Maximum survival percentage (94. 00) was observed by Rio Grand, while minimum plant survival percentage (82.00) was observed in T-1359. The remaining varieties exhibited medium performance. The positive change in above attribute under organic fertilizer might be due to the fact that PM, MS and FYM enhanced the rate of germination and fasten their metabolic process. These results are in conformity with those of Obi and Ebo (1995) who used both nitrogen and mushroom compost and observed increase in plant survival percentage. It increases the moisture retaining capacity of the soil, which enhances the availability of nutrients uptake by plants, increasing the quality and quantity of the fruits. These findings agree with Awad et al. (2002) and Ameer et al. (2008), who concluded that high doses of organic fertilizers improve the growth of newly established seedlings.

Days to Flowering

Statistically significant differences ($P \leq 0.05$) were observed regarding the effects of days to flowering among different varieties whereas their interactive effects were non-significant (Table 2). The mean data enunciated maximum days to flowering (40.73) were observed by Rio Grand by application of FYM. Similarly, minimum number of days to flowering (35.26) was found in T-1359. Lower values were recorded in other varieties. The increase in the initiation of flower is because of genetic variability of the climatic condition, cultivars and soil environmental, which may have caused the flower formation thus by stimulating hormonal system which is responsible for early flowering. These results were supported by findings of Akanbi et al. (2002) who noticed that organic manures are abiotic factors and

Table 1. Effects of different organic fertilizer on plant survival percentage

Variety	Fertilizers				
	FYM	PM	MC	Control	Mean
Rio Grand	98.33	98.00	97.33	94.00	96.917[a]
Early Rio Grand	92.00	90.67	90.67	89.00	90.583[b]
F_1 hybrid-176	88.00	88.00	87.33	86.00	87.333[c]
T-1359	86.00	86.00	86.00	82.00	84.000[d]
Mean	91.083[a]	90.667[a]	89.333[b]	87.750[c]	

LSD for fertilizer: 0.8079, LSD for varieties: 0.8079, LSD for fertilizer × varieties: 1.6158.
Means followed by same letters do not differ significantly

Table 2. Effects of different organic fertilizer on days to flowering

Variety	Fertilizers				
	FYM	PM	MC	Control	Mean
Rio Grand	40.73	40.40	38.88	38.14	39.541[a]
Early Rio Grand	37.83	37.66	37.60	37.20	37.575[b]
F_1 hybrid-176	37.03	36.90	36.63	36.06	36.658[c]
T-1359	35.86	35.80	35.76	35.26	35.675[d]
Mean	37.867[a]	37.692[ab]	37.222[b]	36.669[c]	

LSD for fertilizer: 0.5269, LSD for varieties: 0.5269, LSD for fertilizer × Varieties: 1.0539
Means followed by same letters do not differ significantly

species of tomato plants.

Number of Flowers Plant^{-1}

Results revealed significant varia-tions (P≤ 0.05) regarding the effects of varieties, whereas non-significant difference were found in their interaction (Table 3). Maximum number of flowers plant^{-1}(6.23) was observed in FYM, while PM showed the value of 5.81. Similarly, minimum number of flowers plant^{-1} (4.73) was found in T-1359. The maximum number of flowers in tomato plants might be due to deposition of organic matter and microbial activity of the soil, leading the tomatoes in a bunch or clusters. These findings are in close correspondence with Solaiman and Rabbani (2006) who published a report that organic manure may augment both vegetative stage and reproductive growth of tomato plant, which resulted in the form of more flowers plant^{-1}, fruits plant^{-1} and attained more fruit weight of tomato.

Number of Fruits Plant^{-1}

The analyzed data exhibited statistically non-significant differences (P≤ 0.05) in term of the effects of fertilizer and varieties while interaction was significant. Maximum numbers of fruit plant^{-1} (25.67) were observed in F_1 hybrid-176 in FYM followed by Rio Grand (-25.37) in MC (Table 4). Minimum number of fruits plant^{-1} (23.13) was observed in control in T-1359. The number of flowers may enhance the number of fruits plant^{-1}, which will lead to an increase in the total yield of the plant and enhanced the chances to give rise to more fruits by the plants treated with organic

Table 3. Effects of different organic fertilizer on number of flowers plant^{-1}

Variety	Fertilizers				
	FYM	PM	MC	Control	Mean
Rio Grand	6.23	5.81	5.73	5.61	5.8467[a]
Early Rio Grand	5.55	5.55	6.23	5.49	5.7067[ab]
F_1 hybrid-176	5.49	5.49	5.16	5.09	5.3658[bc]
T-1359	5.50	5.09	5.51	4.73	5.2075[bc]
Mean	5.6925[a]	5.6608[a]	5.5467[ab]	5.2267[c]	

LSD for fertilizer: 0.3799, LSD for varieties: 0.3799, LSD for fertilizer × varieties: 0.7598
Means followed by same letters do not differ significantly

Table 4. Effects of different organic fertilizer on number of fruits plant^{-1}

Variety	Fertilizers				
	FYM	PM	MC	Control	Mean
Rio Grand	24.17	24.60	25.37	24.07	24.627[a]
Early Rio Grand	23.93	23.63	24.58	24.47	24.083[b]
F_1 hybrid-176	25.67	24.93	24.33	23.82	24.657[a]
T-1359	23.58	23.53	23.42	23.13	23.395[c]
Mean	24.177[a]	24.087[a]	24.221[a]	23.797[a]	

LSD for fertilizer: 0.3162, LSD for varieties: 0.3162, LSD for fertilizer × varieties: 0.6324
Means followed by same letters do not differ significantly

manures and also due to differences in varieties among various cultivars. Present results are in line with Tonfack et al. (2009) who reported that carbon contents increase the capacity of soil by cation exchange, which contributes to increase the number of fruits plant^{-1}.

Number of Leaves Plant^{-1}

Statistically analysis showed significant (P≤0.05) effects of fertilizer. While varieties and their interaction effects were non-significant (Table 5). Maximum number of leaves plant^{-1} (83.66) was observed by Rio Grand in PM followed by same variety in MC. While minimum number of leaves plant^{-1} (69.10) was found in T-1359 cultivated under control. The increased number of leaves plant^{-1} may be due to more N intake, which finally enhanced the vegetative growth and the number of leaves plant^{-1}. These conform with those of Brown (1995), who reported that the application of organic fertilizer might increase the vegetative growth and produced maximum number of leaves plant^{-1}.

Fruit Size (cm^3)

The analyzed data showed statistically significant differences (P≤ 0.05) for the effects of fertilizer and varieties while interaction effects were significant (Table 6). Maximum fruit size (64.70 cm^3) was observed by Rio Grand in FYM. Minimum fruit size (60.51 cm^3) was observed in T-1359 cultivation control. Fruit size of cultivars might be increased by application of organic fertilizer due to the supplement of calcium and potassium to the plants which caused elongation in the size of tomato fruits. Masarirambi et al. (2009) found that the increase in the size of the fruit might be due to physiological fitness. Similarly, organic fertilizers

Table 5. Effects of different organic fertilizer on number of leaves plant^{-1}

Variety	Fertilizers				
	FYM	PM	MC	Control	Mean
Rio Grand	83.07	83.66	83.53	80.80	82.766[a]
Early Rio Grand	79.93	77.27	74.90	76.33	77.108[b]
F_1 hybrid-176	75.53	74.87	74.33	72.27	74.250[c]
T-1359	71.23	72.07	70.60	69.10	74.250[d]
Mean	77.465[a]	77.443[a]	75.842[ab]	74.625[b]	

Field Survey 2013-15
Means followed by same letters do not differ significantly

Table 6. Effects of different organic fertilizer on fruit size **(cm^3)**

Variety	Fertilizers				
	FYM	PM	MC	Control	Mean
Rio Grand	64.70	63.19	62.56	62.65	63.274[a]
Early Rio Grand	62.56	62.72	62.54	61.73	62.387[b]
F_1 hybrid-176	61.50	61.70	62.80	61.20	61.801[c]
T-1359	61.19	60.96	62.82	60.51	60.873[d]
Mean	62.489[a]	62.180[a]	62.141[a]	61.525[b]	

LSD for fertilizer: 0.5563, LSD for varieties: 0.5563, SD for fertilizer × varieties: 1.1125
Means followed by same letters do not differ significantly

performance was far better than inorganic fertilizer because inorganic fertilizer supplies only NPK whereas organic manures provided full supplement nutrition to plant.

Fruit Weight (kg)

Statistically significant differences ($P \leq 0.05$) were found for fruit weight affected by fertilizers and varieties as well as by their interaction. Fruit were treated with FYM showed maximum weight (8.84 kg) in Early Rio Grand as compared to control. Minimum fruit weight (8.11 kg) was found in Rio Grand cultivated in PM (Table 7). The mean data showed maximum fruit weight. This might be due to the genetic structures cultivars and plant health. Similar result was reported by Unlu and Podem (2009) who found that FYM was more beneficial than NPK as more fruit weight was observed in tomato. Performance of tomato plants was more pronounced in organic manures than the inorganic manures.

Total Yield (t ha^{-1})

Data revealed that total yield exhibited significant ($P \leq 0.05$) effects for fertilizers, varieties as well as for their interactive effects (Table 8). Maximum yield (25.67 t ha^{-1}) was found for Rio Grand by application of FYM and minimum yield (23.53 t ha^{-1}) was in T-1359 in control. The increase in tomato yield might be due to more nitrogen intake and availability of more carbon for plant that caused the increase yield and genetic attributes of each cultivar. The result matched with previous finding of Palm et al. (1997) who reported that dose of organic manure can be used by plants for contributing efficiently to all the

Table 7. Effects of different organic fertilizer on fruit weight **(kg)**

Variety	Fertilizers				
	FYM	PM	MC	Control	Mean
Rio Grand	8.46	8.11	8.78	8.82	8.5417[b]
Early Rio Grand	8.84	8.84	8.81	8.79	8.8192[a]
F_1 hybrid-176	8.77	8.76	8.75	8.75	8.7575[a]
T-1359	8.74	8.73	8.76	8.71	8.7350[a]
Mean	8.7025[ab]	8.6092[b]	8.7750[a]	8.7667[a]	

LSD for fertilizer: 0.5563S, LSD for varieties: 0.5563, LSD for fertilizer × varieties: 1.1125
Means followed by same letters do not differ significantly

Table 8. Effects of different organic fertilizer on total yield (t ha^{-1})

Variety	Fertilizers				
	FYM	PM	MC	Control	Mean
Rio Grand	25.67	25.50	24.60	24.27	25.008[a]
Early Rio Grand	24.58	24.53	24.47	24.50	24.520[b]
F_1 hybrid-176	24.55	24.60	23.82	24.40	24.342[b]
T-1359	22.73	23.97	23.58	23.53	23.454[c]
Mean	24.382[ab]	24.650[a]	24.117[b]	24.175[b]	

LSD for fertilizer: 0.2959, LSD for varieties: 0.2959, LSD for fertilizer × varieties: 0.5917
Means followed by same letters do not differ significantly

growth traits and increased the growth and yield. The desirable achievements in the yield of tomato might be due to the application of organic fertilizers rather than the inorganic. In organic fertilizer plants have better chance to utilize the nutrients from the soil (Akanbi et al. 2002).

It can thus be concluded that maximum production was observed in cultivar, Rio Grand under FYM, whereas, cultivar T-1359 resulted in lowest production and tomatoes grown under organic manure showed maximum growth and yield as compared to control.

It is, therefore, recommended that as performance of Rio Grand cultivar was better than other cultivars under the agro-climatic condition of Mingora, Swat, farmer should grow this cultivar for better production. Moreover, organic manure is recommended for best production of tomato crop.

LITERATURE CITED

Akanbi, W.B., M.O. Akande and J.A. Adediran. 2002. Suitability of composted maize straw and mineral fertilizer for tomato production. J. Veg. Sci. 11(1): 57-65.

Ameer, K., M.S. Jilani, A.A. Alizia and K. Waseem. 2008. Performance of different exotic tomato *(Lycopersicon esculentum*) cultivars under the agro-climatic conditions of Dera Ismail Khan. M.Sc. (Hons) Thesis, Deptt. Hort. Fac. of Agric, Gomal Univ. Dera Ismail Khan, Pakistan.

Asi, A.R. and M. Amjad. 1985. Response of various tomato cultivars to different level of fertilizers. J. Agric. Res. 23(2): 93-96.

Awad, A.M., E.A. Tartoura, H.M. EI-fouly and A.I. EI-Fattah. 2002. Response of potato growth yield and quality to farmyard manure, sulphur and gypsum levels application. 2nd Intern. Conf. Horti. Sci. 10-12 Sept. Kafr. EI-Shiekh, Tanta Univ. Egypt. p. 24-39.

Brown, J.E. 1995. Comparison of broiler litter and commercial fertilizer on production of tomato. J. Veg. Crop Prod. 1(1): 53-62.

FAO. 2006. Production yearbook, Basic Data Unit, Statistics Division. Roma, Italy. No. 55. p. 125-127.

FAO. 2009. Statistical Bulletin, Roma, Italy. No. 150. p. 1-2.

Hsieh., C.F., H.C. Fang, K. Nan and K.N. Hsu. 1996. Effect of continuous use of organic manures on the growth and yield of vegetable soybean' and cabbage. Bull Taichung Dist. AgricImprove Sta. Japan. 46: 1-10.

Masarirambi, M.T., N. Mhazo, T.O. Oseni and V.D. Shongwe. 2009. Common physiological disorders of

tomato fruit found in Swaziland. J. Agri. Soc. Sci. 5: 123-127.

Mehla, C.C. and S.S. Saini. 1986. Effect of NPK on plant growth, flowering and yield of cultivar solorgola (*Lycopersicon esculentum* L.) Heryana. J. Hort. Sci. 15: 91-94.

Obi, M.E. and E. P. 1995. The effect of organic and inorganic amendments on soil physical properties and production in a severely degraded sandy soil in southem Nigeria. Bio resource Technol. 51(2-3): 117-123.

Palm, C.A., J.K. Myers and S.M. Nandwa. 1997. Combined use of organic and inorganic nutrient sources for soil fertility main-tenance and replenish-ment. Soil Sci. Society. America. Special Publication. 51: 193-217.

Solaiman, A.R.M. and M.G. Rabbani. 2006. Effects of NPKS and cow dung on growth and yield of tomato. Bulletin of the Institute Trop. Agric. Kyushu Uni. 29: 31-37.

Steel, R.G., D.J.H. Torrie and D.A. Dickey. 1997. Principles and procedures of statistics. A biometrical approach. 3rd edn. McGraw-Hill Publishing Co. Boston, Massachutts. 635 p.

Tonfack, L.B., A. Bernadac, E. Youmbi, V.O.M. bouapouogni, M. Negueg-uim and A. Akoe. 2009. Impact of organic and inorganic fertilizers on tomato vigor, yield and fruit composition under tropical and soil conditions. Fruits, 64: 167.

Unlu, H. and P.H. 2009. Effects of farm manure, microbial fertilizer and plant activator uses on yield and quality properties in organic tomato growing. Ekoloji, 19(73): 1-9.

Willcox, J.K., G.L. Catignani and S. Lazarus. 2003. Tomato and cardiovascular health. Critical Reviews in Food Sci. and Nutr. 43: 1-8.

AUTHORSHIP AND CONTRIBUTION DECLARATION

S. No	Author Name	Contribution to the paper
1.	Mr. Salar Khan Yousafzai	Data collection
2.	Mr. Shah Masaud Khan	Conceived the idea
3.	Mr. Khalil ur Rehman	Field experiment supervision
4.	Mr. Junaid Khan	Overall management
5.	Mr. Sher Aslam Khan	Germplasm collection
6.	Mr. Ijaz Hussain	Data entry and analysis
7.	Ms. Ishrat Naz	Technical input at every step

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