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EFFECT OF VARIOUS FERTIGATION SCHEDULES AND ORGANIC MANURES ON TOMATO (*LYCOPERSICON ESCULENTUM* MILL.) YIELD UNDER ARID CONDITION

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ABSTRACT
Effect of various fertigation schedules and organic manures on tomato (*Lycopersicon esculentum* Mill.) was evaluate yield and fertilizer use efficiency under arid condition. The results showed that application of compost 5 t ha^{-1} + 2 t ha^{-1} lignite significantly increased the average fruit weight, fruit yield per plant, fruit yield and fertilizer use efficiency. Daily method of fertigation maximum increased average fruit weight, fruit yield per plant, fruit yield and fertilizer use efficiency over conventional method of fertilizer application. Highest average fruit weight, fruit yield per plant and fruit yield were registered with 100% recommended dose of NPK as compared to 2/3rd recommended dose of NPK fertilizer. It can be concluded that application of compost 5 t ha^{-1} + 2 t ha^{-1} lignite, daily method of fertigation and 100% recommended dose of NPK fertilizer resulted better as compare to other treatments. These results are only indicated and based on one-year experimentation and required to arrive at more consistent and definite conclusion for recommendation to the farmers.

INTRODUCTION

Land and water are the indispensable resources of life system. Water is a vital component for successful vegetable production. The reason why fertigation has become the state of art in plant nutrition particularly in arid environments is that nutrients can be applied in the correct dosage and at the required time appropriate for each specific growth stage. Fertilizers applied under conventional methods of irrigation are generally not efficiently used by the crop (Cassel *et al.* 2001; Hebbar *et al.*, 2004). Proper fertigation management requires the knowledge of soil fertility status and nutrient uptake pattern of the crop. Monitoring of soil and plant nutrient status is an essential safeguard to ensure maximum crop productivity. Since fertigation enhances the fertilizer use efficiency owing to the frequent application of fertilizer directly into the soil where root activity tends to be concentrated and hence reduction in fertilizer rate is possible without compromising on the yield of crop.

Soil organic carbon is a crucial factor for realizing higher yield of vegetables in the arid areas where excessive application of chemical fertilizers alone may affect soil health and sustainable productivity. Addition of organic manures like FYM, compost, vermicompost etc. can play a vital role in the sustenance of soil fertility and crop production. Moreover, the application of organic manure as source of some portion of required nutrients will have positive impact on soil physical and chemical properties which ultimately increases the productivity. Subbiah *et al.* (1985) obtained higher yields of tomato and eggplant with combined application of FYM and fertilizers. Since the availability of most of the organic manures is declining day by day, so it becomes imperative to search for possible alternate organic source that can sustain soil health and crop production. Humic acid from liginite is the most concentrated form of organic material and it is ready source for carbon and nitrogen. Reports have indicated that enriching organic manure with lignite or humic acid from lignite improves the physical, chemical and biological properties of the soil and influences plant growth (Sangeetha and Singaram, 2007). Tomato (*Lycopersicon esculentum* Mill.) is one of the most popular and widely grown vegetable crops in the world. In India, tomato is grown in 16 states with a total area of 6.34 lakh hectares and the production of 12.43 lakh tonnes with average productivity of 19.6 tonnes per hectares (Anonymous 2010). The maximum productivity of 25 tonnes per hectares has been achieved in Andhra Pradesh and Karnataka while Rajasthan has minimum productivity level of 5 tonnes per hectares. Water and nutrient management are the key factors for successful cultivation of vegetable crops and tomato responds well to nutrient and irrigation regime. Fruit quality is equally vital aspect requiring consideration as it is the major price determining factor in the market. Improvement in quality can be induced through genetic manipulation and agronomic management. Under agronomic management water and fertilizer are the major techniques governing the fruit physiognomy and chemical composition. However, very little information is available regarding such systems under Rajasthan. This region has a typical arid condition, low organic matter in soil and scarcity of water so difficult demanding intensive promotion of drip irrigation system. Keeping the above mentioned facts in view, an attempt has been made to study the response of tomato under drip fertigation system in arid condition of Rajasthan region.

MATERIALS AND METHODS

A field experiment was conducted at Niche area of Excellence Farm, SKRAU, and sand in texture containing 80.85, 20.91 and 240.00 kg ha^{-1} available nitrogen, phosphorus and potassium, respectively in 0-15 cm soil depth with pH 8.89, EC 0.30 dSm^{-1} dehydrogenase activity 3.80 ugTPF g^{-1} soils and organic carbon 790 mg kg^{-1}. The experiment was laid out in split-split plot design with four replications, assigning twenty four treatments consisting of four sources of organic manures (compost 10 t ha^{-1} (O_1), compost 5 t ha^{-1} + 2 t ha^{-1} lignite (O_2), compost 5 t ha^{-1} + 1 t ha^{-1} lignite(O_3) and control (O_4)), three methods of fertilizer application (conventional (M_1), weekly (M_2), and daily (M_3)) and two doses of inorganic fertilizer (180 : 90 : 120 NPK kg ha^{-1} (F_1) and 120 : 60 : 80 NPK kg ha^{-1} (F_2)). Compost alone and enriched with lignite were applied 21 days before transplanting as per the treatment combinations in their respective plots, mixed and irrigated. The recommend doses of P_2O_5 according to treatment were applied manually three days before planting. Thirty days old Hissar Lalit tomato seedlings were planted in the crop geometry of 40 cm row to row and 40 cm plant to plant spacing. Irrigation and fertilizer applied through computerizes fertigation system by maintaining the following fertigation schedules (Table 1).Total 96 drip cycles were applied and continued up to 15 days before harvest coinciding with the critical stage of growth. All the agronomic practices and plant protection measures were adopted as per recommendation. The fruit yield obtained for each treatment was divided by quantity of nutrient applied.

$$FUE= \frac{\text{Yield (kg/ha)}}{\text{Total quantity of nutrient applied (kg/ha)}}$$

RESULTS AND DISCUSSION

Yield and nutrient content parameter of tomato crop as influenced by application of different types of organic manures, methods of fertilizer application and doses of NPK fertilizers are presented in (Table 4). A perusal of data indicated that the average fruit weight, per plant and fruit yield of tomato increased significantly with the incorporation of compost 5 t ha^{-1}+ 2 t ha^{-1}lignite (O_2) over control . Treatment O_2, O_1 and O_3 registered an increase in fruit yield of tomato in order of 55.5, 44.38 and 28.90 percent, respectively over O_4 treatment. Enrichment of compost with lignite might have resulted in increased humic acid content, which being a ready source of carbon and nitrogen, resulted in gradual and consistent release of nutrients due to better microbial activity. Corroborative results were also reported by Singh (2007) and Kiran *et al.* (2010) in brinjal; Berova *et al.* (2010) in sweet pepper.

With the change in methods of fertilizer application from conventional to weekly and daily resulted in significant increase in the fruit yield of tomato (Table 4). In terms of per cent increase, daily and weekly method of fertilizer application recorded an increase of 22.6, and 13.38 per cent over conventional method of fertilizer application respectively. The present findings are in good accordance with the results of Vjekoslav *et al.* (2010). The yield of tomato decreased significantly with the decrease in dose of inorganic fertilizer from 100% recommended doses to 2/3[rd] recommended dose. A significantly higher fruit yield of tomato was recorded with 100% recommended dose of NPK fertilizers (F_1) as compared to 2/3[rd] recommended dose of NPK fertilizer (F_1), registering, an increase of 6.43 per cent. Similer type of results have also been reported by Badr *et al.* (2010) in tomato.

Table 1: Fertigation schedule for tomato

Physiological stage	Day	N	K_2O	Day × N	Day × K_2O
	F_1- First dose-180 : 0 : 120 kg NPK ha^{-1}				
Planting-Flowering	25	0.8	0.30	20.00	7.50
Flowering-Fruitset	20	1.05	0.80	21.00	16.00
Fruitset-Ripening	25	1.40	1.06	35.00	26.50
Ripening-Harvesting	35	1.80	1.39	63.00	48.61
	F_2- Second dose-120 : 0 : 80 kg NPK ha^{-1}				
Physiological stage	Day	N	K_2o	Day × N	Day × K_2o
Planting-Flowering	25	0.51	0.23	12.75	5.75
Flowering-Fruitset	20	.067	0.55	13.40	11.00
Fruitset-Ripening	25	0.90	0.80	22.50	20.00
Ripening-Harvesting	35	1.15	1.04	40.25	36.40
	Quantity of fertilizer applied (g) on the Daily bases:				
Physiological stage	Day	F_1-180:0:120gm NPK/256m^2		F_2-120:0:80gm NPK/256m^2	
		Urea	KNO_3	Urea	KNO_3
Planting-Flowering	25	38.73	17.45	24.61	13.36
Flowering-Fruit set	20	50.84	46.55	28.24	32.00
Fruit set-Ripening	25	67.78	61.66	36.93	46.55
Ripening-Harvesting	35	87.15	80.89	46.90	60.50
	Quantity of fertilizer applied (g) on weekly bases:				
Physiological stage	Day	F_1-180:0:120gm NPK/256m^2		F_2-120:0:80gm NPK/256m^2	
		Urea	KNO_3	Urea	KNO_3
Planting-Flowering	25	271.14	122.18	24.61	93.55
Flowering-Fruit set	20	355.87	325.82	28.24	224.00
Fruit set-Ripening	25	474.49	431.61	36.93	325.82
Ripening-Harvesting	35	610.06	566.20	46.90	423.50

Combined effect of organic manures and methods of fertilizer application

Data presented in Table 2 and depicted Fig. 1 revealed that the yield of tomato was significantly influenced by the combined effect of different types of organic manures and methods of fertilizer application. A significant increase in the yield of tomato was observed with the change of method of fertilizer application from conventional to weekly and daily at all the treatments of organic manures. The treatment combination O_2M_3 gave the maximum yield of 178.53 q ha^{-1} whereas minimum yield of 94.31 q ha^{-1} was recorded with O_4M_1 treatment combination. These findings are in confirmation to the results of Selim *et al.,* (2010) in potato. The highest yield of tomato recorded under compost 5 t ha^{-1} + lignite 2 t ha^{-1} with daily drip fertigation could be ascribed to high rate of microbial transformation due to better availability of organic carbon and nitrogen for heterotrophic organisms, resulting in, buffering effect, improved soil aggregation, aeration, release of organic acids etc. which might have acted as stimulant for supply of crop nutrients during the course of microbial decomposition and enabled the crop to utilize nutrient and water more efficiently.

Combined effect of method of fertilizer application and doses of NPK fertilizers

Significant influenced fruit weight, fruit yield per plant and

Table 2: Combined effect of organic manures and methods of fertilizer application on yield (q ha^{-1}) of tomato

Methods of fertilizer application	Organic manures O_1	O_2	O_3	O_4
M_1	128.01	148.25	125.64	94.31
M_2	158.84	166.44	132.75	104.62
M_3	171.00	178.53	150.38	118.16
	SEm ±	CD (5%)		
M at the same level of O	2.20	6.41		
O at the same level of M and both at different level	2.19	6.58		

Table 3: Combined effect of methods of fertilizer application and doses of NPK fertilizers on yield (q ha^{-1}) of tomato

Doses of inorganic fertilizers	Methods of fertilizer application M_1	M_2	M_3
F_1	129.80	146.46	156.03
F_2	118.31	134.86	153.00
	SEm ±	CD (5%)	
F at the same level of M	1.76	5.06	
M at the same level of F and both at different level	1.92	5.54	

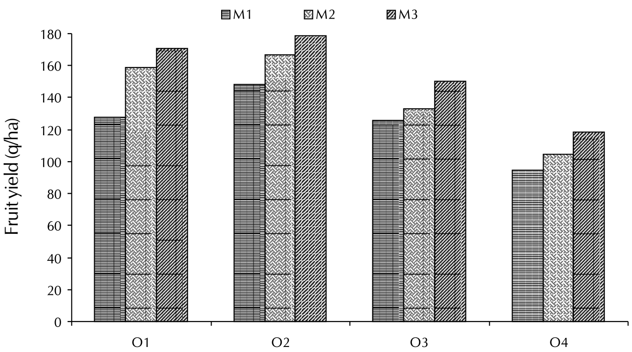

Figure 1: Combined effect of organic manures and methods of fertilizer application on yield (q/ha) of tomato

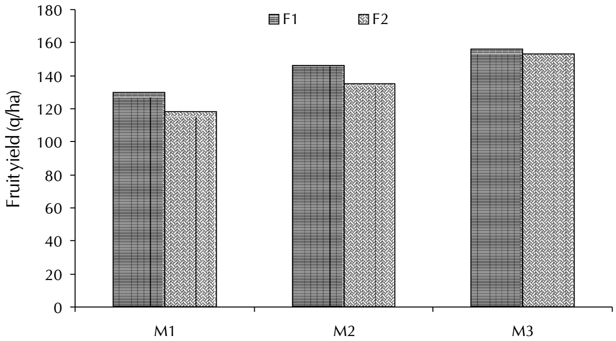

Figure 2: Combined effect of methods of fertilizer application and doses of NPK fertilizers on yield (q/ha) of tomat

Table 4: Effect of organic manures, methods of fertilizer application and fertilizer doses under drip irrigation on average fruit weight, fruit yield, and FUE of tomato

Treatments	Average fruit wt. (g)	Fruit yield per plant (g)	q ha^{-1}	FUE (kg/kg of fertilizer)
(A) Organic manures				
Compost 10 t ha^{-1} (O_1)	57.08	799.51	152.62	48.61
Compost 5 t ha^{-1} + 2.0 t ha^{-1} lignite (O_2)	57.67	812.20	164.40	52.67
Compost 5 t ha^{-1} + 1.0 t ha^{-1} lignite (O_3)	56.13	783.26	136.25	43.49
No addition (Control) (O_4)	55.04	743.37	105.70	33.28
S.Em. ±	0.40	10.02	1.25	0.40
C.D. (5%)	1.28	32.05	4.00	1.29
(B) Methods of fertilizer application				
Conventional method - (M_1)	53.84	695.27	124.05	39.39
Weekly application - (M_2)	57.34	815.69	140.66	44.71
Daily application - (M_3)	58.25	842.79	154.52	49.43
S.Em. ±	0.26	8.93	1.10	0.37
C.D. (5%)	0.75	26.06	3.20	1.09
(C) Doses of NPK fertilizers (kg ha^{-1})				
180 : 90 : 120 NPK (kg ha^{-1}) (F_1)	57.00	796.18	144.10	36.95
120 : 60 : 80 NPK (kg ha^{-1}) (F_2)	55.96	772.99	135.39	52.07
S.Em. ±C.D. (5%)	0.100.27	4.8213.83	1.022.92	0.34 0.98

fruit yield per hactare of tomato due to combined effect of methods of fertilizer application and doses of ferilizer application could be explained on to basis of synergetic effect of time and rate of nutrient application Table 2 and depicted Fig. 2. Corroborative results have also been reported by Vjekoslav *et al*. (2010), Gupta *et al*. (2010). In the study the significantly highest fruit weight, fruit yield per plant and fruit yield per hectare of tomato recorded under daily method of fertigation with 100% recmmended dose of fertilisers could be ascribed to supply nutrients in adequate amount and timely availability. Results of the present investigation are in similar line with those of Tanaskovik, 2005, Cukaliev *et al*. 2008.

Fertilizer use efficiency of tomato increased significantly with the application of compost 5t ha^{-1} + 2 t ha^{-1} lignite over control (Table 4). This might be due to greater multiplication of soil microbes which could have converted organically bound nutrients to inorganic form (Bellakki and Badanur, 1997). Methods of fertilizer application have shown significant impact on fertilizer use efficiency of tomato (Table 4). Higher values of fertilizer use efficiency under drip fertigation as compared to conventional method of fertilizer application can be attributed to favourable nutrient-water interaction in the root zone, which in turn resulted in increased fertilizer use efficiency. These results are in agreement with the findings of several researchers in different vegetable crops such as Badr *et al*. (2010) and Vijayakumar *et al*. (2010). Doses of fertilizer application have shown significant impact on fertilizer use efficiency of tomato (Table 4). A significant increase in fertilizer use efficiency was recorded with the reduction in fertiliser application from 100% recommended dose to 2/3rd recommended dose. As the fertilizer levels decreased the fertilizer use efficiency increased because there was less yield difference (Table 4). The present findings are in good accordance with the results of Selvaraj (1997).

REFRENCES

Anonymous (2010). Indian Horticulture Database. 2010. Tomato. National Horticulture Board. Ministry of Agriculture. GOI. Gurgaon. (Eds. Mistry, N.C., Singh, Brijandra and Ghardi, C.P.). pp. 14-15.

Badr, M. A., Abou Hussein, S. D., El-Tohamy, W. A. and Gruda, N. 2010. Nutrient uptake and yield of tomato under various methods of fertilizer application and levels of fertigation in arid lands. *Gesunde. P. Flanzen*. **62:** 11-19.

Bellakki, M. A. and Badanur, V. P. 1997. Long term effect of integrated nutrient management on properties of vertisols under dry land Agriculture. *J. Indian Soc. Soil Sci.* **45:** 438-442.

Berova, M., Karanatsidis, G., Sapundzhieva, K. and Nikolova, V. 2010. Effect of organic fertilization on growth and yield of pepper plant (*Capsicum annum L.*). *Folia Horticulture. Ann.* **22(1):** 3-7.

Cassel, S. F., Sharmasakar, S., Miller, S. D., Vance, G. F, and Zhang, R. 2001. Assessment of drip and flood irrigation on water and fertilizer use efficiencies for sugar beets. *Agric Water Manage.* **46:** 241.

Cukaliev O., Tanaskovik V., Kanwar R. S., Heng Kheng, Lee and Mukaetov, D. 2008. Irrigation and fertigation effects on nitrogen use efficiency & tomato yield. *International Agricultural Engineering Journa.* **17(1-4):** 19-26.

Gupta, A. J., Ahmed, N., Bhat, F. N. and Chattoo, M. A. (2010). Production of hybrid tomato for higher income under drip irrigation and fertigation in Kashmir valley. *Indian J. Hant.* **67(1):**127-131.

Hebbar, S. S., Ramachandroppa, B. K., Nanjappa, H. V. and Prabhakar, M. 2004. Studies on NPK drip fertgation in field grown tomato (*Lycopersicumesculantum* Mill.). *European Journal of Agronomy.* **21(1):** 117-127.

Kiran, J., Vyakarana, B. S., Raikar, S. D., Ravikumar, G. H. and Deshpande, V. K. 2010. Seed yield and quality of brinjal as influenced by crop nutrition. *Indian J. Agric. Res.* **44(1):** 1-7.

Sangeetha, M. and Singaram, P. 2007. Effect of lignite humic acid and inorganic fertilizers on growth and yield of onion. *The Asian Journal of Soil Science.* **2(1):** 108-110

Selim, E. M., El-Neklawy, A. S. and Soad El-Ashry, M. 2010. Beneficial effects of humic substances on soil fertility to fertigated potato grown on sandy soil. *Libyan Agriculture Research Center Journal Internation.* **1(4):** 255-262.

Selvaraj, P. K., 1997. Optimization of irrigation scheduling and nitrogen fertigation for maximizing water use efficiency of turmeric in drip irrigation. PhD Thesis, Tamil Nadu Agricultural University, Coimbatore.

Singh, Dilip. 2007. Effect of farm yard manure, chemical and biofertilizers on growth, yield and quality of brinjal (*Solanummelongena* Linn.) cv. PusaKranti. Ph. D. Thesis. S.K.R.A.U., Bikaner.

Subbiah, K., Sundararajan, S., Muthuswami, S. and Perumal, R. 1985. Responses of tomato and brinjal to varying levels of FYM and macronutrients under different fertility status of soil. *South Indian Horticulturalist.* **33:** 198-205.

Tanaskovic, V., Cukaliev, O. and Iljovski, I., 2007. Effect of irrigation method and regime of irrigation and fertilization on tomato yield. Anniversary Yearbook of the Faculty of Agricultural Sciences and Food, "60 years Faculty of Agricultural Sciences and Food, Skopje, *Macedonia*. **53:** 137-14.

Vijayakumar, G., Tamilmani, D. and Selvaraj, P. K. 2010. **Irrigation and Fertigation Scheduling under Drip Irrigation in Brinjal (*Solanum melongena* L.) Crop. *IJBSM,*** 1(2): **72-76.**

Vzekoslav, T., Ordan, C., Domor, r. and Gabriyel, O. 2011. The influence of drip fertigation on water use efficiency in tomato crop production. *Agriculture Cospectus Scientiificus*. **76(1):** 57-63.