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RESEARCH PAPER

Response of tomato to different fertigation levels and schedules under polyhouse

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Abstract : An experiment was conducted to study the effect of fertigation levels and schedules on growth, yield and nutrient uptake of tomato under polyhouse. The treatments included 3 fertigation levels (F_1- 60% of RDF, F_2- 80% of RDF, and F_3- 100% of RDF) and 3 fertigation schedules (S_1- 6 equal splits of RD of NPK at every 18 days interval, S_2- 9 equal splits of RD of NPK at every 12 days interval, S_3-12 equal splits of RD of NPK at every 9 days interval). The results indicated that fertigation of 100 per cent RD of NPK (300:150:150 N, P_2O_5, K_2O kg/ha) in 12 equal splits at every 9 days interval up to 120 DAT was found significantly superior in case of growth, yield attributes and fruit yield of tomato. However, it was at par with 80 per cent RD of NPK (240:120:120 N, P_2O_5, K_2O kg/ha) in 12 equal splits at every 9 days interval up to 120 DAT. Similarly, significantly maximum nitrogen, phosphorus and potassium uptake by tomato plant was registered with fertigation of 100 per cent of RDF and 12 equal splits of NPK at every 9 days interval up to 120 DAT. It was further concluded from the study that fertigation of 80 per cent RD of NPK (240:120:120 N, P_2O_5, K_2O kg/ha) in 12 equal splits at every 9 days interval upto 120 DAT was found to beneficial for higher growth and fruit yield of tomato under polyhouse condition during summer season.

Key Words : Tomato, Fertigation levels, Schedules, Growth, Yield, Nutrient uptake

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INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is an important and widely grown solanaceous vegetable crop around the world and belongs to the family Solanaceae. It is considered an important source of vitamin A,C and minerals (Hari, 1997). Apart from this, lycopene is valued for its anti-cancer property. Polyhouse is a framed or inflated structure covered with transparent or translucent polythene papers, large enough to grow crops under partial or fully controlled environmental conditions to get optimum growth and productivity.

Fertigation is an excellent method of optimizing the utilization of water and nutrients to improve the sustainability of polyhouse tomato. It allows frequent, uniform and precise application of nutrients through drip directly into the zone of maximum root activity as per need of crop which results into higher yield. In addition, it saves the fertilizers, time and labour. The concentration of NPK of the nutrient solutions and the application time and intervals are of vital importance for adequate uptake and optimal growth of tomato. However, it is very necessary to determine the time and frequency of fertilizer application through drip at appropriate stages

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of crop under polyhouse condition during summer season.

MATERIAL AND METHODS

The present investigation was carried out during summer season of 2013 and 2014 at Department of Agronomy, Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.). The soils of the experimental site was sandy clay in texture having pH-7.70, organic carbon 0.53 per cent with low in available nitrogen (254.7 kg ha^{-1}), medium in available phosphorus (19.73 kg/ha) and very high in available potassium (369.5 kg/ha). Similarly, low in iron (4.44 mg/kg) and zinc (0.49 mg/kg) and moderate in manganese (2.35 mg/kg) and copper (1.49 mg/kg). The field capacity, permanent wilting point and bulk density were 22.74 per cent, 11.37 per cent and 1.39 g/ cm^3, respectively. The experiment was laid out in Split Plot Design and replicated thrice with nine treatment combinations. The treatments included 3 fertigation levels *viz*., (F_1-60% of RDF, F_2-80% of RDF, and F_3-100% of RDF) and 3 fertigation schedules *viz*., (S_1- 6 equal splits of RD of NPK at every 18 days interval, S_2- 9 equal splits of RD of NPK at every 12 days interval, S_3- 12 equal splits of RD of NPK at every 9 days interval).

The naturally ventilated polyhouse was oriented in north-south direction and covered with UV stabilized LDPE film of 200 micron thickness as cladding material. The four week old healthy and uniform tomato seedlings were transplanted at the spacing of 60 cm x 50 cm on the raised beds. Fertigation was started 12 days after transplanting through automatic fertigation unit as per treatment. The fertigation was done by using water soluble fertilizer (19:19:19 NPK grade) and urea (46.6% N). All the agronomic practices and plant protection measures were adopted as per recommendation. Observations on different growth and yield parameters were recorded from five randomly sampled plants from each treatment.

The method used for estimation of N was Microkjeldhal (Parkinson and Allen, 1975), for P Vanadomolybdate yellow colour method in nitric acid system (Jackson, 1973) and for K Flamephotometer (A.O.A.C., 2012). For this purpose the tomato plants were sundried first for a period of 10 days and then kept in hot air oven at 65 ^{0}C till constant weight was obtained. The dried plant samples were grinded in stainless still willey mill to fine powder and used for chemical analysis of N, P and K content.

RESULTS AND DISCUSSION

A reference to two years data (Table 1) on the growth attributes studied, plant height, number of primary branches/plant, number of leaflets/plant and leaf area/ plant were influenced significantly by different fertigation levels and schedules. These parameters showed better

Table 1 : Growth attributes of tomato as influenced by different treatments

Treatments	Plant height (cm)		Number of primary branches/plant		Number of leaflets/ plant		Leaf area/plant (dm^2)	
	2013	2014	2013	2014	2013	2014	2013	2014
Fertigation levels								
F_1 – 60% of RDF	200.51	216.12	13.07	13.53	70.33	72.68	84.08	84.54
F_2 – 80% of RDF	207.37	219.08	14.38	14.31	76.09	74.75	86.26	89.73
F_3 – 100% of RDF	210.60	223.83	15.11	14.62	80.60	78.65	88.07	97.65
C.D. (P=0.05)	3.64	2.06	0.76	0.32	3.15	0.65	0.84	3.62
Fertigation schedules								
S_1 – 6 equal splits (18 days interval)	204.38	217.52	13.24	13.91	70.91	74.13	84.97	85.86
S_2 – 9 equal splits (12 days interval)	206.68	219.54	14.34	14.20	74.91	75.15	85.92	91.07
S_3 – 12 equal splits (9 days interval)	207.42	221.97	14.99	14.36	81.20	76.81	87.51	94.98
C.D. (P=0.05)	1.85	1.75	0.67	0.16	2.26	0.66	0.77	2.27
Interaction A x B								
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

NS=Non-significant

performance with increasing fertigation level and frequent application of NPK. Among the fertigation levels, the fertigation of 100 per cent RDF recorded significantly higher growth parameters *viz*., plant height (210.60 and 223.83 cm), number of primary branches/plant (15.11 and 14.62), number of leaflets/plant (80.60 and 78.65) and leaf area/plant (88.07 and 97.65 dm^2), whereas minimum values of these parameters were registered with fertigation of 60 per cent RDF. Among the fertigation schedules, the fertigation of 12 equal splits of NPK at every 9 days interval up to 120 DAT registered significantly maximum growth attributes *viz*., plant height (207.42 and 221.97 cm), number of primary branches/ plant (14.99 and 14.36), number of leaflets/plant (81.20 and 76.81) and leaf area/plant (87.51 and 87.51 dm^2), while lowest values of these parameters were noticed with fertigation of 6 equal splits of NPK at every 18 days interval up to 120 DAT. This might be due to adequate and frequent supply of nitrogen, phosphorus and potassium through drip irrigation in the vicinity of root zone up to 120 days after transplanting meet out the nutritional requirement of crop leads to maximum absorption and translocation of nutrients resulted in increased cell multiplication and enhanced the net assimilation rate and hence, more plant height, number of primary branches/plant, number of leaflets as well as leaf area/plant. Similarly due to favourable microclimatic conditions created inside the polyhouse that enhanced photosynthesis and respiration leads to increased these attributes. These results are with the conformity of Kavitha *et al*. (2007); Brahma *et al*. (2009); Yasser *et al*. (2009) and Feleafel and Mirdad (2013).

Fertigation of NPK with different levels and schedules significantly influenced the yield attributing parameters of polyhouse tomato. A perusal of pooled data (Table 2) indicated that fertigation of 100 per cent RDF recorded significantly higher number of fruits/plant (74.13, 67.50 and 70.82) and fruit weight/plant (4.85, 4.43 and 4.64 kg) as compared to rest of the fertigation levels during both the years and on pooled mean, respectively, however it was at par with fertigation of 80 per cent RDF. While lowest number of fruits/plant and fruit weight/plant was noticed under the fertigation of 60 per cent RDF during the study of experimentation. Among the fertigation schedules, fertigation of 12 equal splits of NPK at every 9 days interval up to 120 DAT exhibited significantly maximum number of fruits/plant (72.54, 66.30 and 69.44) and fruit weight/plant (4.80, 4.24 and 4.52 kg) during both the years and on pooled mean, respectively. While lowest number of fruits/plant and fruit weight/plant was noticed with the fertigation of 6 equal splits of NPK at every 18 days interval up to 120 DAT during the period of investigation. This might be due to adequate and continuous split application of nutrients throughout the crop growth period enhanced growth attributes accompanied with more physiological activities and absorbed PAR reflected in higher photosynthetic rate and translocation of assimilates towards reproductive

Table 2: Yield attributes and yield of tomato as influenced by different treatments

Treatments	Number of fruits/plant			Fruit weight/plant (kg)			Fruit yield/unit of polyhouse (t)		
	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled
Fertigation levels									
F_1 – 60% of RDF	56.85	52.20	54.51	3.43	3.00	3.21	11.24	9.51	10.37
F_2 – 80% of RDF	71.96	65.40	68.68	4.61	4.24	4.43	14.96	13.42	14.19
F_3 – 100% of RDF	74.13	67.50	70.82	4.85	4.43	4.64	15.72	14.07	14.90
C.D. (P=0.05)	3.04	2.91	2.16	0.27	0.21	0.16	0.85	0.67	0.74
Fertigation schedules									
S_1 – 6 equal splits (18 days interval)	62.16	56.90	59.55	3.81	3.53	3.67	12.44	11.20	11.82
S_2 – 9 equal splits (12 days interval)	68.24	61.80	65.03	4.28	3.91	4.09	13.92	12.38	13.15
S_3 – 12 equal splits (9 days interval)	72.54	66.30	69.44	4.80	4.24	4.52	15.56	13.42	14.49
C.D. (P=0.05)	1.06	1.62	1.21	0.08	0.11	0.09	0.33	0.35	0.30
Interaction A x B									
C.D. (P=0.05)	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.

parts resulted an increase in yield attributes.

Significant effect of fertigation was observed on the fruit yield of tomato inside polyhouse (Table 2). Pooled data averaged over the two years revealed that the fruit yield of tomato increased significantly with increasing level of fertigation and extended application of NPK. The maximum fruit yield/unit of polyhouse (15.72, 14.07 and 14.90 t) was recorded under the fertigation of 100 per cent RDF during both the years and on pooled mean, respectively. However it was at par with 80 per cent RDF indicating 20 per cent saving of fertilizers. While, fertigation of 60 per cent RDF produced significantly minimum fruit yield/unit of polyhouse (11.24, 9.51 and 10.37 t) during both the years and on pooled mean, respectively. The increased magnitude in fruit yield/unit of polyhouse under the fertigation of 100 per cent RDF over 60 per cent RDF was 28.49, 32.41 and 30.40 per cent during both the years and on pooled mean. Among the fertigation schedules, fertigation of 12 equal splits of NPK at every 9 days interval upto 120 DAT recorded significantly higher fruit yield/unit of polyhouse (15.56, 13.42 and 14.49 t) during both the years and on pooled mean respectively. While, fertigation of 6 equal splits of NPK at every 18 days interval up to 120 DAT produced significantly minimum fruit yield/unit of polyhouse (12.44, 11.20 and 11.82 t). The extent of increase in fruit yield/ unit of polyhouse under fertigation of 12 equal splits of NPK at every 9 days interval up to 120 days after transplanting was 20.05, 16.54 and 18.43 per cent over the fertigation of 6 equal splits of RD of NPK at every 18 days interval up to 120 days after transplanting during both the years and on pooled mean, respectively. This might be due to frequent application of required quantity of nutrients directly in vicinity of the root zone throughout crop growth period increased the nutrient use efficiency which enhanced growth and yield attributes and improved tomato fruit yield. Similarly the favourable microclimatic conditions maintained inside polyhouse helps to change the phase of plant from juvenile to reproductive phase and significantly contributed to higher fruit yield of tomato. These results are in the line of Tumbare *et al*. (2004); Singh *et al.* (2013); Hasan *et al*. (2014) and Singh *et al*. (2015).

The nutrient uptake by tomato plant was significantly influenced by different fertigation treatments (Table 3). A two years data showed that fertigation of 100 per cent RDF recorded significantly maximum total nitrogen uptake (226.26 and 218.42 kg/ ha), phosphorus uptake (74.64 and 69.26 kg/ha) and potassium uptake (302.05 and 291.02 kg/ha) by tomato plant as compared to rest of the fertigation levels, whereas, fertigation of 60 per cent RDF noticed significantly lowest nitrogen, phosphorus and potassium uptake by tomato plant during both the years. Among the fertigation schedules, the fertigation of 12 equal splits of NPK at every 9 days interval up to 120 DAT registered significantly maximum

Table 3 : Nutrient uptake by tomato plant as influenced by different treatments

Treatments	Total nutrient uptake (kg/ha)					
	Nitrogen		Phosphorous		Potassium	
	2013	2014	2013	2014	2013	2014
Fertigation levels						
F_1 – 60% of RDF	147.93	136.15	47.31	42.46	190.91	175.43
F_2 – 80% of RDF	185.14	180.19	59.93	55.42	243.67	235.43
F_3 – 100% of RDF	226.26	218.42	74.64	69.26	302.05	291.02
C.D. (P=0.05)	13.82	6.91	3.65	1.74	20.62	9.70
Fertigation schedules						
S_1 – 6 equal splits (18 days interval)	162.78	155.41	53.02	48.42	212.40	201.75
S_2 – 9 equal splits (12 days interval)	183.49	178.54	59.71	55.50	241.04	235.06
S_3 – 12 equal splits (9 days interval)	213.06	200.81	69.15	63.21	283.20	265.07
C.D. (P=0.05)	5.94	3.57	1.63	1.09	8.58	6.02
Interaction A x B						
C.D. (P=0.05)	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.

total nitrogen uptake (213.06 and 200.81 kg/ ha), phosphorus uptake (69.15 and 63.21 kg/ha) and potassium uptake (283.20 and 265.07 kg/ha) by tomato plant during both the years. The adequate and continuous supply of nutrients throughout the crop growth period resulted in maximum dry matter production with increased nutrient concentration in fruit, leaf and stem reflected on more uptake by plant. These findings are in the line of Tumbare *et al*. (2004), Montemurro *et al*. (2007), Al-mohammadi and Al-zhubi (2011), Feleafel and Mirdad (2013).

From the present investigation. it could be inferred that to achieve the maximum fruit yield of tomato, application of 80 per cent recommended dose of fertilizer (240:120:120 N,P_2O_5,K_2O kg ha^{-1}) through fertigation in 12 equal splits at every 9 days interval up to 120 days after transplanting found most suitable under polyhouse condition during summer season.

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