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Efficacy of conventional, solid soluble and liquid fertilizers applied through drip-fertigation on tomato

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ABSTRACT

A field study was conducted during *rabi* seasons at research farm of ICAR Research Complex for Eastern Region, Patna to examine the effects of sources and rates of fertilizers on the growth, yield, economics and fertilizer use efficiency of tomato under drip-fertigation. Three types of fertilizer sources in combination, *i.e.*, conventional fertilizers (F1), conventional with soluble solid fertilizer (F2) and conventional with liquid fertilizer (F3) were applied at three different rates, *viz*., 50% (D1) 75% (D2) and 100% (D3) of recommended doses. The study revealed that root growth parameters were positively influenced by the application of liquid fertilizers. Treatment F3 showed the highest root growth followed by F2. Fertigation with CF + liquid fertilizers (F3) gave the maximum fruit yield of 55.7 t ha^{-1}. Highest B: C ratio of 1.96 was recorded in fertigation with conventional fertilizers (F1). Different fertilizer doses were not significant. However, 50% dose (D1) recorded the highest fertilizer use efficiency (3.7 q/ kg of NPK).

Key words: Tomato, drip-fertigation, fertilizers, growth, yield.

INTRODUCTION

India produces 16.83 million tonnes of tomato of which 6% is produced in Bihar from 4.7 lakh ha of land (Indian Horticulture Database, 5). Major tomato growing districts in Bihar are Patna, Muzaffarpur, Begusarai, Nalanda, Chapra, Vaishali and Buxar. Tomato is an important vegetable crop, which responds to high input and management practices. Fertiliser is a major input influencing yield and economics of crop cultivation. Application of proper dose of fertilizer along with minimizing the loss of nutrients in tomato needs to be studied in the alluvial soils. Fertigation system is known for high productivity of crop and saving of water and nutrients. Water and nutrients are available at rhizosphere nearly at free energy state; hence the genetic potential yield of crop is realized. Fertigation through drip irrigation saves the fertilizer up to 50%. Fertigation has increased the yield of tomato higher than the traditional surface banding method of fertilizer application (Ibrahim, 4). Maximization of crop yield and quality and minimization of leaching below the root zone may be achieved by managing fertilizers concentrations in measured quantity of irrigation water, according to crop requirements (Hagin and Lowengart, 2). Rajput and Patel (8) also reported that fertilizer use in okra can be reduced by 40% through fertigation. Micro-irrigation such as drip irrigation has limited area in Bihar and knowledge on fertigation is still poor especially for vegetable crops. Numerous studies have conducted on fertigation with one types of fertilizer. Combined application of different nutrient sources through fertigation may have effect on the yield and economics in favour of farmers. Comparative analysis of different nutrients sources such as liquid, solid soluble and conventional fertilizers through fertigation on tomato in alluvial soil is a new line of research and has limited reference. A study was conducted with the objectives to compare the efficiency of different types of fertilizers like conventional, solid soluble and liquid (in combination) on growth and yield of tomato and to recommend appropriate fertigation schedule for tomato in recent alluvium of Gangetic plains.

MATERIALS AND METHODS

Field experiment was conducted in recent alluvial plain of fine, Aeric Haplaquepts soil at the research farm of the institute. It is a clay loam soil with bulk density of 1.47 Mg m^3. Soil pH, soil organic carbon, electrical conductivity, available N, P and K are 7.4, 6.5 g kg^{-1}, 0.26 dSm^{-1}, 220 kg ha^{-1}, 32 kg of P_2O_5 kg ha^{-1} and 211 kg ha^{-1} of K_2O, respectively. Experiment was conducted in *rabi* seasons for two years. The recommended dose of fertilizer for tomato is 120:80:80 kg N P K ha^{-1}. Design of experiment was split plot with sources of fertilizers in main plot and doses of fertilizers in sub-plot. Main plot size was 72 m^2 and sub-plot size was 24 m^2. Treatments were randomly allotted within the replications in

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the main plots as well as subplots within the main plots. Different sources and doses of fertilizers were considered in the study. Source of nutrients were conventional (F_1), soluble solid (F_2) and liquid fertilizer (F_3). In case of conventional fertilizers urea, single super phosphate and muriate of potash were considered for nitrogen, phosphorus and potassium nutrients; for soluble solid fertilizer (20:20:20 % NPK) was considered and for liquid fertilizer (13:6:4% NPK) was considered. There were three doses of fertilizer application namely 50% (D_1), 75% (D_2) and 100% (D_3). Forty percent of the dose was given as basal starter through conventional fertilizer in all the treatments. Fertigation schedules were started after three weeks of transplanting of tomato seedlings with the respective fertilizers at weekly intervals (Table 1). Variety of tomato used for this study was Mahyco Hybrid S 41. All other farm operations were done uniformly in all the plots. Root growth parameters were studied in weed-free plots at flowering stage of the crop. Root parameters were measured at three distances from the main stem of the plant at 10 cm interval, core sampler of 10 cm diameter was inserted up to 10 cm depth and the soil was evacuated. Live roots were separated from the soil. Moist free roots were measured for area, diameter and length using root length measuring system (Newman, 6). Days to 50% flowering and days to 50% fruit set were measured in the respective treatments by counting number of plant per plot. Fertilizer use efficiency was calculated from the yield data. Economics of each treatment were worked out through benefit cost analysis. Fertility status of post harvest sample was analyzed to know the soil nutrient status.

RESULTS AND DISCUSSION

Root growth of tomato showed marked differences among three different fertilizer combination applied through drip systems. Application of 100% recommended dose through CF with liquid fertilizer showed highest root growth followed by CF with solid soluble fertilizers. Lowest root growth was observed under conventional fertilizer. Root surface area was highest in liquid fertilizer application, which was 289 and 140% higher than conventional and solid soluble fertilizer, respectively. Root length was 251 and 126% higher over conventional and solid soluble fertilizers, respectively. Out of total root spread (expressed as root length), 80, 14 and 6 per cent of root length were distributed between 0-10, 10-20, and 20-30 cm from plant stem in the case of liquid fertilizer. The corresponding figures were 50, 29 and 21% for solid soluble fertilizers and 72, 24 and 4% for conventional fertilizers, respectively. At 75%

Table 1. Fertilizer schedule applied for tomato cultivation.

Time of fertilizer application	F1			F2			SSF (kg/ha)	F3			LF (kg/ha)
	Conventional fertilizer			Conventional fertilizer				Conventional fertilizer			
	Urea (kg/ha)	SSP (kg/ha)	MOP (kg/ha)	Urea (kg/ha)	SSP (kg/ha)	MOP (kg/ha)		Urea (kg/ha)	SSP (kg/ha)	MOP (kg/ha)	
Basal (40%)	105.60	200.00	51.20	105.60	200.00	51.20	0	105.60	200.00	51.20	0
1st Week	0	0	0	0	0	0	0	0	0	0	0
2nd Week	0	0	0	0	0	0	0	0	0	0	0
3rd Week	0	0	0	0	0	0	0	0	0	0	0
4th Week	13.20	25.00	6.40	4.40	0	0	20.00	0	7.81	3.47	46.2
5th Week	13.20	25.00	6.40	4.40	0	0	20.00	0	7.81	3.47	46.2
6th Week	13.20	25.00	6.40	4.40	0	0	20.00	0	7.81	3.47	46.2
7th Week	13.20	25.00	6.40	4.40	0	0	20.00	0	7.81	3.47	46.2
8th Week	13.20	25.00	6.40	4.40	0	0	20.00	0	7.81	3.47	46.2
9th Week	13.20	25.00	6.40	4.40	0	0	20.00	0	7.81	3.47	46.2
10th Week	13.20	25.00	6.40	4.40	0	0	20.00	0	7.81	3.47	46.2
11th Week	13.20	25.00	6.40	4.40	0	0	20.00	0	7.81	3.47	46.2
12th Week	13.20	25.00	6.40	4.40	0	0	20.00	0	7.81	3.47	46.2
13th Week	13.20	25.00	6.40	4.40	0	0	20.00	0	7.81	3.47	46.2
14th Week	13.20	25.00	6.40	4.40	0	0	20.00	0	7.81	3.47	46.2
15th Week	13.20	25.00	6.40	4.40	0	0	20.00	0	7.81	3.47	46.2

SSP = Single super phosphate, MOP = Muriate of potash, SSF = Soluble solid fertilizers, LF = Liquid fertilizers.

dose also the performance of liquid fertilizers was superior to conventional and solid soluble fertilizers. Root length was 163,184 and 185% higher with liquid fertilizer than with conventional fertilizers at three sampling distances from the plant. Application of 50% recommended dose through liquid fertilizer showed the highest root growth followed by solid soluble fertilizers. Root surface area was highest in liquid fertilizer application, which was 111 and 20% higher than conventional and solid soluble fertilizers respectively. Root length was 72 and 46% higher over conventional and solid soluble fertilizers, respectively. Out of the total root spread expressed as root length, 49, 29 and 23% of the root length was between 0-10,10-20 and 20-30 cm from the plant stem for liquid fertilizers, 65, 21 and 14% for solid soluble fertilizers and 66, 18 and 16%, respectively for conventional fertilizers (Table 2).

Table 2. Effect of different sources and doses of fertilizers on root growth in tomato.

	Dose	Surface area (sq. mm)	Av. dia. (mm)	Root length (mm)
		Root depth 0-10 cm		
F1	D1	161.4	0.56	221.4
	D2	268.0	0.66	359.6
	D3	327.9	0.69	431.6
F2	D1	149.0	0.40	244.1
	D2	314.2	1.13	367.4
	D3	340.5	0.52	624.1
F3	D1	587.4	0.69	788.7
	D2	630.1	0.49	1203.0
	D3	957.0	0.66	1395.0
$CD_{0.05}$		5.79	0.037	9.34
		10-20 cm		
F1	D1	235.0	1.21	168.4
	D2	234.5	0.73	214.1
	D3	340.3	1.31	289.1
F2	D1	324.1	1.12	222.9
	D2	593.0	0.61	616.9
	D3	430.9	0.64	838.6
F3	D1	769.8	0.67	1009.0
	D2	590.2	0.49	1142.0
	D3	1022.0	0.54	1832.0
$CD_{0.05}$		5.00	0.045	30.30
		20-30 cm		
F1	D1	168.9	0.92	162.7
	D2	224.8	0.49	295.0
	D3	264.0	0.84	425.1
F2	D1	224.8	0.49	226.8
	D2	239.0	0.76	291.3
	D3	283.9	1.06	425.1
F3	D1	168.0	0.62	234.9
	D2	235.0	1.21	168.4
	D3	356.0	0.73	423.9
$CD_{0.05}$		1.68	0.051	1.67

F1= Conventional fertilizers, F2 = CF with solid soluble fertilizers, F3 = CF with liquid fertilizers

The yield was varying from 51.61 to 56.5 t ha^{-1} among nutrient sources and from 53.7 to 54.3 t ha^{-1} due to nutrient doses. The difference in yield between F1 and F3 was 5 t ha^{-1} was non-significant. Nine per cent higher yield was recorded in F3 as compared to F1. Veeranna *et al*. (9) observed that fertigation with soluble fertilizers at 80% recommended dose produced significantly higher dry fruit yield of chilli over other treatments. The yield in different types of fertilizers was non-significant. Highest fruit yield of 55.7 t ha^{-1} was recorded with 100% dose. Corroborative findings were reported by Hebber *et al*. (3) under drip fertigation in tomato. Liquid fertilizer with conventional fertilizer recorded the highest yield followed by solid soluble fertilizers with conventional fertilizers. The difference in yield among doses was also non-significant (Table 3). Among different doses, 75% of recommended doses recorded the highest fruit yield of tomato (55.2 t ha^{-1}) in the first year and in the pooled data, both 75 and 100% doses recorded same yield (52.1 t ha^{-1}). Hence, application of 50% recommended dose proved to be sufficient for the optimum yield and it also saved 50% of fertilizer through fertigation. Similar findings were recorded by Gupta *et al*. (1) under the fertigation studies on tomato.

Among sources of nutrients, the difference in fertilizer use efficiency was non-significant, whereas in case of nutrient doses it was differing significantly. The doses such as 50, 75 and 100% were differing significantly. The highest fertilizer use efficiency (FUE) was recorded in F3 followed by F2 and the lowest FUE was recorded with F1. Ibrahim (4) observed that fertigation significantly reduced the cost of production compared with surface banding fertilizer application.

Sources and doses of nutrients produced significant difference in B:C ratio. Fertigation with conventional fertilizer recorded highest B:C ratio, which was 58% higher than F3 and 42% than F2 and varied significantly. Fertilizer combination in F2 was differing significantly from F3 by 42%. Nutrient doses have recorded significant difference in B: C ratio. Highest B:C ratio was observed with F1 followed by F2. Whereas, lowest B:C ratio was recorded with D3. The B: C was recorded highest in D1, which was 12% higher than that of D3. A similar finding was recorded by Prabhakar *et al*. (7). Cost of conventional fertilizer was lower as compared to soluble solid and liquid fertilizers. Lowest B:C ratio in D3 might be due to higher cost of liquid fertilizer compared to conventional and soluble solid fertilizers.

The study indicates that fertigation with CF + liquid fertilizers (F3) gave the maximum yield though it was not significant. However, B:C ratio was maximum in fertigation with conventional fertilizers (F1). Different fertilizer doses did not differ significantly. However, 50% dose (D1) recorded the maximum fertilizer use efficiency and B:C ratio. CF + LF showed highest root growth followed by CF + SSF. The study revealed that root growth parameters are positively influenced by the application of liquid fertilizers. The study indicated that 50% of the fertilizers applied irrespective of the types gave maximum fertilizer use efficiency. No significant yield difference was found between 100 and 50% of the quantity applied which indicated that further lower doses can be tried in future with different fertilizers through fertigation.

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Table 3. Effect of different sources and doses of fertilizers on days to flowering and fruit set in tomato.

Treatment	Days to 50% flowering	Days to 50% fruit set	Yield (t/ ha)	FUE (q/ kg of NPK)	B:C ratio
		Main Plot			
F1	38.11	44.56	49.0	2.58	1.96
F2	38.78	45.00	50.5	2.62	1.76
F3	42.44	47.89	55.7	2.92	1.40
$CD_{0.05}$	0.69	0.80	NS	NS	0.22
		Sub Plot			
D1	39.33	45.89	50.9	3.70	1.76
D2	39.78	45.56	52.1	2.53	1.70
D3	40.22	46.00	52.1	1.90	1.60
$CD_{0.05}$	NS	0.92	NS	0.10	0.08

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