J. Hortl. Sci.
Vol. 11(2): 151-155, 2017

Growth and yield performance of hybrid hot pepper, chilli (*Capsicum annuum* L.) as influenced by fertigation and polyethylene mulching

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ABSTRACT

A field experiment was conducted at Bengaluru during 2015 to study the effect of fertigation on performance of hybrid chilli (*Capsicum annuum* L.). The trial included nine treatments comprising varying rates and sources of fertilizers, tested with or without mulching. Application of recommended dose of fertilizer (180:120:180 kg NPK/ha) through fertigation using water-soluble fertilizers resulted in higher values for plant height (104.27 cm), number of branches per plant (16.71), leaf area per plant (89.44 dm^2), dry matter per plant (185.49 g), number of fruits per plant (142.7), fruit length (11.13 cm), fruit girth (4.75 cm), fruit weight (1.29 g), yield per plant (184.11 g) and fruit yield (5.03 t/ha) which remained on par with same amount of fertilizer applied using conventional means along with polyethylene mulching. In general, treatments that received fertilizers through fertigation took less number of days to flowering over conventional soil-application of fertilizers. All fertigation treatments recorded higher dry-chilli fruit yield over the conventional soil-application of fertilizers, to a tune of 27.87% to 52.4% over the control.

Key words: Chilli, fertigation, water-soluble fertilizers, mulching, growth, yield

INTRODUCTION

Chilli (*Capsicum annuum* L.), owing to its multiple uses as spice, condiment, vegetable, salad and pickle, is an important and popular crop widely grown throughout the world. In India, chilli is grown under 7.92 lakh hectares, with production of 12.23 lakh tonnes and productivity of 1.55 tonnes per hectare (NHB, 2015). Chilli is a long duration crop needing regular and optimal soil-moisture and nutrient availability throughout the cropping period. Water shortage and low nutrient status causes a noticeable gap in production, reduced plant growth, yield and overall quality. Therefore, adoption of modern irrigation techniques is emphasized to improve water use efficiency and bring greater area under vegetable cultivation. Drip fertigation is an important irrigation-cum-nutrient application method in crop production, particularly in high-value crops like chilli.

Drip fertigation under plastic mulch is an effective way of supplying water and fertilizers in chilli cultivation. Studies carried out elsewhere have indicated that the in onion fertilizer should be applied regularly and timely in small amounts for better plant growth and yield (Neeraja *et al*, 1999). Scientific information on fertigation, especially on *kharif* grown chilli, is very scanty. Hence, the present study was undertaken to determine the effect of fertigation with recommended dose of fertilizers and sources through drip irrigation, along with polyethylene mulching, for commercial production of chilli.

MATERIAL AND METHODS

The experiment was conducted during *kharif* season in 2015 at ICAR-Indian Institute of Horticultural Research, Hessaraghatta, Bengaluru, Karnataka, India. The soil was well-drained sandy loam having an initial organic carbon (0.63 %), pH (5.5), available N (303.18 kg/ha), available P (41.4 kg/ha), available K (366.51 kg/ha) and electrical conductivity (0.24 dSm^{-1}) with available water-holding capacity of 135mm at one meter soil depth.

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Chilli hybrid seedlings ('Arka Meghana') were transplanted in a 90cm-40cm raised bed under paired row system, with plant-to-plant spacing of 45cm in the row, in the last week of July. The experiment was laid out in Randomized Complete Block Design, with nine treatments and three replications. A uniform, basal application of farm yard manure @ 25 tonnes hectare^{-1} was applied prior to transplanting. Treatment details and the amount of various fertilizers applied are given in Tables 1 and 2, respectively. In soil-application treatment, the whole of P and half of N and K were given as the basal dose and the remaining half of N and K was side-dressed 30 and 60 days after transplanting, in equal splits. Urea, Polyfeed (19-19-19) and potassium nitrate (13-0-45) were used as the water-soluble fertilizers for treatments T_1 to T_4; urea, di-ammonium phosphate (DAP) and muriate of potash (MOP) as normal fertilizers for fertigation treatments T_5 and T_6; DAP was used as the source of P_2O_5 in T5 & T6. Twenty per cent solution was prepared, by intermittent stirring for a period of six hours. Then it was allowed to settle down overnight. Next day the clear supernatant solution was used for fertigation. The amount of water present in the residue was estimated, and that quality of P_2O_5 was added while preparing the solution. Urea, single super phosphate and muriate of potash constituted conventional fertilizers for treatment T_9. Drip irrigation system installed by us consisted of 16mm in-line drip lateral with 4 lph output dripper spaced at 40cm. Drip irrigation was imposed depending upon the rate of evaporation and amount of effective rainfall received. At three weeks after transplanting, fertilizers were applied through the drip system as per treatment, at weekly intervals. Desired amounts of fertilizers were dissolved in 20 litres of water and applied via the Ventury system through drip irrigation in fertigation treatments, and were continued upto 20 days prior to completion of the crop growth period. Drip application time was determined based on daily evaporation values collected from the IIHR meteorological observatory, and Epan coefficient of 0.8. Various yield parameters were recorded in five plants, selected randomly replication-wise, in all the treatments. All the agronomic and plant protection measures were followed as per the recommended package of practices (Prabhakar *et al*, 2010a). Experimental data were statistically analyzed (Gomez and Gomez, 1983) and compared using critical difference at 5% level of probability.

RESULTS AND DISCUSSION

All the fertigation treatments resulted in better growth in chilli as seen by the higher plant height at harvest and number of days taken to 50% flowering, compared to conventional soil application of fertilizers (Table 3). Data analysis revealed that application of 100% recommended fertilizer dose, through fertigation using water-soluble fertilizers and mulching (T_1), recorded significantly higher plant height (104.27cm), number of branches per plant (16.71) and leaf area per plant (89.44 dm^2) than most other treatments, but remained on par with T_2, T_5 and T_7. Higher values for plant height and number of branches in fertigation treatments may be attributed to a continuous supply (and consequent, availability) of plant nutrients to the root zone. This is in conformity with findings of Prabhakar *et al* (2010b). The same treatment recorded significantly higher dry-matter production per plant (185.49g) than all the other treatments, except T_5. This is in conformity with findings of Ramachandrappa *et al* (2010) in chilli. Among fertigation treatments, application of 100% recommended fertilizer does through water-soluble fertilizers along with mulching (T_1) recorded the least number of days to 50% flowering (27.77 days), followed by application of 100% recommended dose through normal fertilizers along with mulching (T_5). This indicated that 100% N:P:K fertigation with recommended dose (180:120:180 kg NPK/ha) at weekly intervals resulted in a longer duration of flowering at reproductive stages of growth, than in the other treatments.

Treatments receiving NPK fertigation at the recommended fertilizer dose either using water-soluble (T_1) or normal fertilizers (T_5) along with polyethylene mulching, remained at par for most of the yield-attributing characters and dry-chilli yield (Table 4). Treatment T_1 (wherein fertigation using water-soluble fertilizers at recommended dose was applied along with polyethylene mulch) recorded significantly higher number of fruits (142.74) than the other treatments, but remained on par with T_2, T_5 and T_7. Similar trend was observed with fruit length too where T_1 recorded the highest fruit length of 11.13cm. The same treatment recorded significantly higher fruit girth (4.75 cm) than all other treatments. As for fruit weight, fertigation with 100% recommended fertilizer dose by water-soluble or normal fertilizers, along with mulch treatments, resulted in the same value (1.29g), which remained at

Table 1. Fertigation treatment details

Treat-ment	Details	Fertilizer	Dose of application	Basal dose (NPK kg/ha)	Top-dressing (NPK kg/ha)	Fertigation (NPK kg/ha)	Mulching
T_1	100% RDF	WSF	100% NPK fertigation			180:120:180	Mulch
T_2	75% RDF	WSF	100% NPK fertigation			180:120:180	Mulch
T_3	100% RDF	WSF	100% NPK fertigation			180:120:180	No Mulch
T_4	75% RDF	WSF	100% NPK fertigation			180:120:180	No Mulch
T_5	100% RDF	NF	100% NPK fertigation			180:120:180	Mulch
T_6	100% RDF	NF	100% NPK fertigation			180:120:180	No Mulch
T_7	100% RDF	WSF	100% NK fertigation	120 P		180:0:180	Mulch
T_8	100% RDF	WSF	100% NK fertigation	120 P		180:0:180	No Mulch
T_9	100% RDF	NF	100% NPK soil application	90:120:90	90:0:90		No Mulch

NF: Normal (conventional) fertilizers, WSF: Water-soluble fertilizers

Table 2. Treatment-wise fertilizers applied (kg/ha) under fertigation

Treatment	Basal dose			Top-dressing		Fertigation				
	Urea	Single super phosphate	Muriate of potash	Urea	Muriate of potash	Urea	DAP	Muriate of potash	Potassium nitrate	NPK 19:19:19
T_1						93.0			133	631
T_2						93.0			133	631
T_3						69.7			99.7	473
T_4						69.7			99.7	473
T_5						289	260	210		
T_6						289	260	210		
T_7		750				280			51.0	
T_8		750				280			51.0	
T_9	195	750	105	195	105					

Table 3. Growth parameters in hybrid chilli as influenced by fertigation and mulching treatments

Treatment	Plant height at harvest (cm)	No. of branches per plant	Leaf area (dm^2/plant)	Dry matter per plant (g)	Day to 50% flowering
T_1	104.27	16.71	89.44	185.49	27.77
T_2	100.95	15.25	84.18	171.08	27.92
T_3	96.91	14.39	75.64	158.17	28.17
T_4	96.63	14.24	71.67	139.96	28.87
T_5	102.87	15.54	87.91	178.71	27.82
T_6	97.43	13.94	74.43	154.82	28.64
T_7	100.83	15.78	86.40	177.29	27.88
T_8	96.26	14.31	72.02	150.19	28.86
T_9	85.85	11.35	60.95	115.95	29.15
CD (*P*=0.05)	4.19	1.58	5.51	6.62	1.49

Table 4. Effect of fertigation and mulching treatments on yield and yield parameters in hybrid chilli

Treatment	No. of fruits per plant	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Fruit yield per plant (g)	Day fruit yield (t/ha)
T_1	142.7	11.13	4.75	1.29	184.11	5.03
T_2	139.0	10.60	4.53	1.24	172.49	4.72
T_3	129.7	9.77	4.46	1.16	150.39	4.46
T_4	126.3	9.52	4.29	1.09	137.62	4.28
T_5	142.2	10.77	4.50	1.29	183.46	4.84
T_6	125.5	9.56	4.29	1.14	143.44	4.23
T_7	140.7	10.58	4.46	1.25	175.84	4.81
T_8	122.4	9.34	4.22	1.12	137.12	4.22
T_9	106.8	8.36	3.95	1.08	115.36	3.30
CD (*P*=0.05)	4.22	0.70	0.20	0.17	7.9	0.32

par with most of the treatments, except T_4 and T_9. Fruit yield per plant was significantly higher in T_1 (184.11g), which remained at par with only T_5 (183.46g) and T_7 (175.84g).The same treatments also recorded higher dry-fruit yield compared to the other treatments, showing that application of 100% recommended dose of fertilizers using water-soluble or normal fertilizer, along with mulch, is beneficial for improving yield-attributing characters and, finally, dry-chilli yield. Soil application of the recommended dose of phosphorus while supplementing nitrogen and potash using water-soluble fertilizer through fertigation, in combination with polyethylene mulch, also resulted in higher values for all the yield-attributing characters and dry-chilli yield. Soil application of normal fertilizer without mulch recorded minimum values for all the yield-attributing characters and final yield. All fertigation treatments recorded higher chilli dry-fruit yield over conventional soil-application of fertilizers, to a tune of 27.87% to 52.4%. This may be attributed to a high fertilizer-use efficiency attained with application of water-soluble fertilizers (Mohanaramya *et al*, 2010). Similar results were reported by Muralikrishnasamy *et al* (2008) and Leela Rani *et al* (2015) in chillies, and, Sanchita *et al* (2010) in capsicum (sweet/bell peppers).

From this study, it can be concluded that dry chilli yield in *kharif* grown crop at weekly fertigation with nitrogen, phosphorus and potash at the recommended dose (180:120:180 kg NPK/ha) through water-soluble fertilizers or conventional fertilizer along with polyethylene mulching, was found to be higher.

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(MS Received 14 July 2016, Revised 11 December 2016, Accepted 30 December 2016)