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Effect of different sources and levels of potassium on root characters of paprika (*Capsicum annuum* var. *longam*) cv. KtPl-19 under drip fertigation system

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ABSTRACT : Paprika is one of the important natural colourants next to turmeric. Fertigation application through drip fertigation is known to play a vital role in enhancing the productivity and quality of many horticultural crops. In this view, studies on paprika (*Capsicum annuum* var. *longam*) were carried out at the College orchard, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, during 2006-2009 to find out the effect of different sources and levels of potassium with reference to root characters of paprika. From the study, it was observed that the crop paprika responded well to the fertigation treatments. The experiment was conducted for two seasons *viz.*, season I (June, 2007-Jan., 2008) and season II (July, 2008-Feb., 2009) to get the concurrent result. Drip fertigation with water soluble fertilizer at 100 per cent RDF using MAP, Multi-K and SOP (T_7) recorded the highest root dry weight, root length and root volume. It was followed by the treatment T_6 and T_4 during both season I and season II.

Key Words : Paprika, *Capsicum annuum* var. *longam*, Drip fertigation, Root characters

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Capsicum in a fresh state is very rich in vitamin C (ascorbic acid), as was shown by Szent Gyorgyi, the Hungarian scientist, who was awarded the Noble prize in 1937 for isolating vitamin C from paprika fruits (Anu and Peter, 2000). Paprika is classified into two forms, the non-dried vegetable type called as 'sweet paprika' (Bell pepper types) and the dried non-pungent types as 'spice paprika' (Verma and Joshi, 2000). Synthetic colour and flavouring substances hitherto added in various food and cosmetic preparations are reported to be carcinogenic and, therefore, banned in many countries. This has resulted in huge demand for chilli and paprika oleoresin with high natural colourant and mild pungency. The world trade in paprika type oleoresin is showing a growing trend in recent years. Besides it can reduce the fertilizer usage, minimize leaching by rain and excessive irrigation and maximize the fertilizer use efficiency. Recently use of SOP which supplies sulphur apart from K is also known to improve the yield and quality of certain horticultural crops (Ramesh Kumar, 2004 in banana and Ananthi, 2002 in chillies). Paprika contains remarkable amount of the colouring material and is used as colourant in processed foods as they get the nod over synthetic products in the food colourant market (Prasath and Ponnuswami, 2008). Dried paprika powder and paprika oleoresin are the natural colour sources exempted from certification and can be used directly (Marmion, 1979). The application of paprika and its oleoresin as a colour additive frequently overlaps its use as a spice. The commercial importance of paprika both as a spice and a vegetable with large scale cultivation in both tropical and subtropical regions are increasing at an alarming rate. Paprika requires heavy manuring for proper growth and producing high yields (Anonymous, 1995). With this background, an investigation was taken up to determine the effect of certain aspects of fertigation involving water soluble and conventional fertilizers in paprika cv. KtPl-19 with reference to root characters of paprika.

RESEARCH PROCEDURE

A field experiment was conducted at the University Orchard, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. The experiment was laid out in Randmized Block Design with three replications on clayey loam soil with pH of 8.1 and EC of 0.80 ds/m and available chemical constituents of 217.0, 17.0, 382.0, 8.40, 2.15, and 5.20 kg/ ha N, P, K, Ca, Mg and S, respectively. The treatments T_1- 100 per cent recommended normal fertilizer applied to soil with furrow irrigation, T_2- Drip fertigation with water soluble fertilizer at 50 per cent RDF using polyfeed + urea + MOP, T_3- Drip fertigation with water soluble fertilizer at 75 per cent RDF using polyfeed + urea+ MOP, T_4- Drip fertigation with water soluble fertilizer at 100 per cent RDF using polyfeed + urea+ MOP, T_5- Drip fertigation with water soluble fertilizer at 50 per cent RDF using MAP + Multi–K + SOP, T_6- Drip fertigation with water soluble fertilizer at 75 per cent RDF using MAP + Multi-K + SOP, T_7- Drip fertigation with water soluble fertilizer at 100 per cent RDF using MAP + Multi-K + SOP (water soluble fertilizers = MAP (12% N and 61%P), MOP (60% K), SOP (50% K and 18% S), Multi K (13 % N and 45 % K) and Polyfeed (19 % N, 19 % P and 19 % K) were taken up for the experiment. The spacing adopted was 60cm between rows and 45 cm between plants. The fertilizer dose of N: P: K @ 120:100:120 kg per hectare was applied uniformly for all the experiments. Other cultural practices and plant protection measures were given according to the recommendation of Tamil Nadu Agricultural University, Coimbatore. The data were subjected to statistical analysis (Panse and Sukhatme, 1985) and the results are presented in Table 1.

RESEARCH ANALYSIS AND REASONING

The findings of the present study as well as relevant discussion have been presented under the following heads :

Root dry weight (g) :

Significant differences were observed among different fertigation treatments in the present study for the triat root weight. The treatment T_7 registered the highest values for root weight (5.48 g at vegetative stage, 7.07 g at flowering stage and 7.30 g at harvesting stage) in the pooled mean analysis. It was followed by T_6 (5.15 g at vegetative stage, 6.07 g at flowering stage and 6.61 g at harvesting stage). While, the lowest root weight of 3.80 g (vegetative stage), 4.52 g (flowering stage) and 4.58 g (harvesting stage) were recorded by the treatment T_1 (control). Drip fertigation with water soluble fertilizers at 100 per cent RDF using MAP, Multi-K and SOP (T_7) showed significantly higher root weight of 5.62 g (season I) and 5.74 g (season II) at vegetative stage, 7.40 g (season I) and 7.50 g (season II) at flowering stage and 7.55 g (season I)

Table 1 : Effect of fertigation on root characters at different stages of crop growth in paprika cv. KtPl-19

Treatments	Root dry weight (g)									Root length (cm)								
	Vegetative stage			Flowering stage			Harvesting stage			Vegetative stage			Flowering stage			Harvesting stage		
	Season		Mean	Season		Mean	Season		Mean	Season		Mean	Season		Mean	Season		Mean
	I	II		I	II		I	II		I	II		I	II		I	II	
T_1	3.76	3.88	3.80	4.56	4.68	4.52	4.66	4.70	4.58	16.50	17.62	17.06	20.70	21.80	21.25	22.80	24.00	23.40
T_2	4.21	4.33	4.13	5.24	5.35	5.08	5.37	5.54	5.20	15.58	16.70	16.13	19.78	20.88	20.33	21.88	23.08	22.47
T_3	4.86	4.98	4.85	5.42	5.69	5.51	6.34	6.42	6.22	13.62	14.74	14.18	17.33	18.43	17.88	19.43	20.63	20.01
T_4	5.00	5.12	5.13	5.63	5.76	5.64	6.46	6.55	6.46	12.20	13.32	12.75	15.72	16.82	16.27	17.82	19.03	18.41
T_5	4.65	4.77	4.57	5.13	5.59	5.34	5.83	5.95	5.75	14.63	15.75	15.19	18.36	19.46	18.91	20.46	21.66	21.04
T_6	5.20	5.32	5.15	6.21	6.31	6.07	6.62	6.70	6.61	12.00	13.12	12.56	14.93	16.03	15.48	17.03	18.23	17.63
T_7	5.62	5.74	5.48	7.40	7.50	7.07	7.55	7.67	7.30	11.02	12.14	11.58	13.23	14.23	13.73	15.33	16.53	15.93
S.E. ±	0.022	0.023	0.356	0.033	0.032	0.470	0.034	0.034	0.478	0.072	0.072	0.071	0.096	0.096	0.095	0.096	0.096	0.095
C.D. (P=0.05)	0.047	0.049	0.733	0.071	0.070	0.968	0.073	0.073	0.974	0.157	0.157	0.155	0.209	0.209	0.208	0.208	0.209	0.208
C.D. (P=0.01)	0.066	0.069	0.996	0.100	0.098	1.315	0.103	0.102	1.324	0.220	0.220	0.218	0.293	0.292	0.292	0.297	0.292	0.291

and 7.67 g (season II) at harvesting stage. It was followed by T_6 (5.20 g and 5.32 g at vegetative stage, 6.21 g and 6.31 g at flowering stage and 6.62 g and 6.70 g at harvesting stage during season I and II). Whereas, the control (T_1) showed the lowest root weight of 3.76 g (season I) and 3.88 g (season II) at vegetative stage, 4.56 g (season I) and 4.68 g (season II) at flowering stage and 4.66 g (season I) and 4.70 g (season II) at harvesting stage during the season I and II, respectively (Table 1).

Root length (cm) :

Pooled mean data analysis showed that the highest root length of 17.06 cm, 21.25 cm and 23.40 cm at vegetative, flowering and harvestings stage, respectively was observed by the control treatment T_1. It was closely followed by T_2 (16.13 cm at vegetative stage, 20.33 cm at flowering stage and 22.47 cm at harvesting stage). The lowest root length values of 11.58 cm (vegetative stage), 13.73 cm (flowering stage) and 15.93 cm (harvesting stage) were noticed with the treatment T_7.

Similar trend was also noticed with seasonal mean values for the root length. Control (T_1) treatment recorded the highest root length at all the three stages of plant growth (16.50 cm and 17.62 cm, 20.70 cm and 21.80 cm and 22.80 cm and 24.00 cm) during both the seasons. It was followed in order by the treatment T_2 15.58 cm (season I) and 16.70 cm (season II) at vegetative stage, 19.78 cm (season I) and 20.88 cm (season II) at flowering stage and 21.88 cm (season I) and 23.08 cm (season II) at harvesting stage. While, the lowest root length of 11.02 cm (season I) and 12.14 cm (season II) at vegetative stage, 13.23 cm (season I) and 14.23 cm (season II) at flowering stage and 15.33 cm (season I) and 16.53 cm (season II) at harvesting stage were recorded by T_7 (Table 1).

Root volume (ml) :

It was observed that drip fertigation with water soluble fertilizers at 100 per cent RDF using MAP, Multi–K and SOP (T_7) recorded the highest root volume of 1.85 ml at vegetative stage, 3.85 ml at flowering stage and 5.15 ml at harvesting stage. It was followed as next best by drip fertigation with water soluble fertilizers at 75 per cent RDF using MAP, Multi–K and SOP (T_6) which registered root volume of 1.65 ml at vegetative stage, 3.30 ml at flowering stage and 4.35 ml at harvesting stage in the pooled mean analysis. The lowest root volume of 1.00 ml at vegetative stage, 1.35 ml at flowering stage and 2.15 ml at harvesting stage was recorded by control (T_1).

Fertigation treatments showed significant difference for the root volume during both seasons. The treatment T_7 recorded higher root volume of 1.80 ml (season I) and 1.90 ml (season II) at vegetative, 3.80 ml (season I) and 3.90 ml (season II) at flowering stage and 4.80 ml (season I) and 5.50 ml (season II) at harvesting stage. The treatment T_6 ranked as second best and registered root volume of 1.60 ml (season I) and 1.70 ml (season II) at vegetative stage, 3.00 ml (season I) and 3.60 ml (season II) at flowering stage and 4.20 ml (season I) and 4.50 ml (season II) at harvesting stage. Whereas, the lowest root volume of 1.00 ml and 1.00 ml (season I and II), 1.30 ml and 1.40 ml (season I and II) and 2.00 ml and 2.30 ml (season I and II), respectively at vegetative, flowering and harvesting stages of crop growth was recorded by T_1(control) (Table 2).

Root studies comprised of root length, root weight and root volume. Despite, greatly influenced by plant genetics and other environmental factors such as soil aeration and soil hardness, the nutrient distribution in soil determines the root elongation. The root system is the prime link between the plant and the soil. A good root system of the plant responsible for the absorption of water and nutrients, anchorage, synthesis of some plant hormones and storage (Lahav and Turner, 1983). Under drip fertigation system, nearly 80 per cent of the roots were concentrated at upper soil profile (0 to 15 cm) with less tap root length because of the lesser depth of irrigation and continuous availability of moisture in top layer as confirmed very early by Goldberg and Shmueli (1970) in capsicum. However, in surface irrigation the plants produced only fewers

Table 2 : Effect of fertigation on root characters at different stages of crop growth in paprika cv. KtPl-19

Treatments	Root volume (ml) per plant								
	Vegetative stage			Flowering stage			Harvesting stage		
	Season		Mean	Season		Mean	Season		Mean
	I	II		I	II		I	II	
T_1	1.00	1.00	1.00	1.30	1.40	1.35	2.00	2.30	2.15
T_2	1.20	1.30	1.25	2.00	2.10	2.05	2.40	2.50	2.43
T_3	1.50	1.60	1.55	2.10	2.40	2.30	2.50	2.80	2.70
T_4	1.50	1.70	1.60	2.20	3.20	2.65	2.70	2.90	2.76
T_5	1.20	1.30	1.25	2.10	2.20	2.15	2.30	2.70	2.49
T_6	1.60	1.70	1.65	3.00	3.60	3.30	4.20	4.50	4.35
T_7	1.80	1.90	1.85	3.80	3.90	3.85	4.80	5.50	5.15
S.E. ±	0.010	0.011	0.014	0.029	0.032	0.029	0.038	0.042	0.040
C.D. (P=0.05)	0.022	0.024	0.022	0.063	0.070	0.063	0.082	0.092	0.088
C.D. (P=0.01)	0.031	0.034	0.031	0.088	0.098	0.089	0.115	0.129	0.123

fibrous roots of high weight and density but with longer tap roots. The production of lengthier tap roots clearly indicated that the plant strive hard to extract water from deeper layers to meet its water requirement. Under limited water availability conditions, as a result of longer interval between successive surface irrigations, the root length had considerably increased. Drip fertigation at 100 per cent of RDF as MAP, SOP and Multi-K produced higher root weight and mass with more fibrous roots on either side of the tap root. This was due to higher and continuous availability of moisture and horizontal wetting on either side. The root spread was towards the direction of dripper located at the centre of two plants. The findings of Martinz Hemandez *et al*. (1991) did support the results obtained in the present investigation.

Drip fertigation with 100 per cent of RDF as MAP, SOP and Multi-K produced higher root mass growth than surface methods of irrigation and fertilization. Higher and continuous availability of nutrients and moisture in the root zone might have induced root growth, hence, higher root volume was obtained. Growth of the root in plants, in general, is stimulated by availability of phosphorus hence, P application would have encouraged early root growth. Similar results were reported by Besford (1979); Ahmed and Saha (1986); Sathish *et al*. (2012), Kannan *et al.* (2009); Prabhu (2006) and Pandey *et al*. (1996).

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