

## STUDIES ON EFFECT OF FERTIGATION WITH DIFFERENT LEVELS OF N AND K FERTILIZERS ON GROWTH, YIELD, QUALITY AND ECONOMICS OF EARLY SEASON CAPSICUM (*CAPSICUM ANNUM* L. VAR. *GROSSUM*) UNDER COVER

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### Summary

A field experiment was conducted for three consecutive years (2005-06, 2006-07 and 2007-08) at the Horticulture Experimental Farm, under Precision Farming Development Centre, Department of Horticulture, AAU, Jorhat with an objective to find out the economic dose of N and K through fertigation for polyhouse grown early season capsicum and its effect on growth, yield, quality and economics of cultivation under naturally ventilated polyhouse. Data of three consecutive years revealed that drip irrigation at 100% evaporation replenishment along with supplementation of 100% recommended N and K through fertigation, recorded significantly highest growth attributes, yield attributes and yield of early capsicum grown under cover in I crop, II crop and III crop respectively. Pooled data averaged over the three years revealed that fertigation with 100 % recommended N and K recorded 61.09% increased yield over conventional fertilization. Regarding quality parameters, significantly highest ascorbic acid content were recorded by 100% fertigation level. Study on cost economics revealed that, 100 % recommended N and K as fertigation recorded the highest cost benefit ratio of 1: 1.72. Therefore, it can be inferred that for early season capsicum grown inside naturally ventilated polyhouse, irrigation scheduling at 100% evaporation replenishment through drip irrigation coupled with 100% recommended N and K (120: 60 kg/ha) as fertigation improved the growth, yield and quality of the crop with highest cost benefit ratio (1: 1.72), and may be recommended for the agro-climatic conditions of Jorhat (Assam).

### सारांश

शिमला मिर्च में तीन साल तक (2005-2008) NPK तथा Polyhouse के प्रभाव का अध्ययन कृषि विश्वविद्यालय आसाम के बागवानी विभाग के प्रक्षेत्र में किया गया। परिणामतः ड्रिप सिंचाई तथा संस्तुत NPK का सबसे अच्छा प्रभाव पाया गया। सबसे अधिक आर्थिक लाभ 100% संस्तुत NPK तथा ड्रिप सिंचाई द्वारा 100% वाष्पीकरण रिप्लेसमेंट में पाया गया।

### Introduction

Capsicum (*Capsicum annum* var. *grossum*) also referred to as sweet or bell pepper is a highly priced vegetable crop both in the domestic and international market. It is a cool season crop cultivated for its immature fruits throughout the world. In Assam and entire NE region, capsicum is normally grown during last part of November to March. However, due to continuous rainfall up to October, land preparation and subsequent sowing as well as planting capsicum as early season crop by November becomes delayed in open field condition. Moreover, the crop planted in the month of December faces very cool temperature for a couple of months, which hampers the growth and development and delays maturity of the crop to April. Despite its economic importance, production

of good quality capsicum under open field condition is not possible due to adverse climatic condition. So to increase productivity of good quality produce and for production during early/off season, protected cultivation is an alternative. Introduction of naturally ventilated low cost polyhouse as well as fertigation system has opened the possibility for early augmented production of capsicum compared to open field condition. Because fertigation in addition to controlling the rate and time of nutrient application also activates enhanced mobility, availability and uptake of applied nutrients due to higher soil moisture content, and application of fertilizers in more splits and matching of application rate and time with crop demand through increased splits. Although, information on certain package of practices for protected cultivation are available, but non-availability of scientific information,

especially on optimum nutrition requirement through fertigation, which is very critical for increasing the productivity of quality produce is one of the major constraint. Hence, to determine the economic dose of N and K through drip irrigation for capsicum cultivation under cover, the present study was undertaken.

### Materials and Methods

Fertigation experiments were conducted at the Horticulture Experimental Farm, under Precision Farming Development Centre, Department of Horticulture, Assam Agricultural University, Jorhat for three consecutive years (2005-06, 2006-07 and 2007-08). The soil of the experimental area comprised of well-drained sandy loam soil with 57% organic carbon, medium in available N (282.4 kg/ha) and available P (55.6 kg/ha), low in available K (135.0 kg/ha), and acidic in reaction ( $P^H=4.6$ ). Capsicum seedling of variety California wonder were planted in crop geometry of 45 cm row-to-row and 45 cm plant-to-plant inside naturally ventilated polyhouse in the month of October for early crop. The polyhouse was oriented in the north-south direction and constructed with locally available bamboo and covered with U.V. stabilized LDPE film of 200 micron thickness as cladding material. The treatments comprised of  $T_1 = 100\%$  RD of N and K through fertigation,  $T_2 = 75\%$  RD of N and K through fertigation,  $T_3 = 50\%$  RD of N and K through fertigation and  $T_4 = 100\%$  RD of N and K through conventional fertilization. The recommended dose of N and K were 120: 60 kg/ha and the N and K fertilizers used in the fertigation were from urea and potassium chloride sources respectively. The source of phosphatic fertilizer was from single super phosphate and recommended dose of P (60 kg/ha) for all the treatments were applied as basal dose at final land preparation. Thus a total of four treatments were laid out in randomized block design with three replications.

The drip system used for the study comprised of laterals (12 mm) at 45 cm apart with a spacing of 45 cm between online emitters having a discharge rate of 2 litres per hour. Fertigation scheduling was done based on the critical stages of growth and the interval of fertigation also varied with successive growth stages. Desired amounts of fertilizers were dissolved in 10 litres of water and the fertilizer solutions were applied along with the irrigation water through drip irrigation

in all the fertigation treatments (Treatments  $T_1$ ,  $T_2$  and  $T_3$ ) via ventury having an injection rate of 25.17 litres per hour. While applying fertilizers through fertigation the rate was adjusted so that the concentration of Nitrogen and Potassium does not exceed 250 PPM and 300 PPM respectively. The fertigation schedules used in the study were given in Table 1. Total 60 drips were operated for fertigation with the last drip coinciding 15 days before harvest and the calculated water requirement is 76 m<sup>3</sup>/ha.

The drip application time was determined as per evapotranspiration rate of Jorhat during the crop growing season, which corresponds to cent per cent evaporation replenishment. Observations on different growth and yield parameters were recorded from five randomly sampled plants from each treatment. For evaluation of quality parameters mature green capsicums were taken from each treatment. Ascorbic acid was analyzed by 2, 6-dichlorophenolindophenol visual titration method as described in A.O.A.C. (1975). Collected data were analyzed statistically as per Panse and Sukhatme (1985).

### Results and Discussion

A reference to the pooled data (Table 2) revealed that all the growth attributes of capsicum grown under cover showed significant improvement in terms of plant height, branches/plant, leaves/plant, plant canopy spread, and leaf area/plant owing to fertigation with N and K as compared to conventional soil fertilization, indicating the importance of fertigation. Among all the fertigation treatments, fertigation with 100% recommended N and K @ 120: 60 kg/ha produced significantly highest plant height, branches/plant, leaves/plant, canopy spread and leaf area/plant, which is significantly superior than the conventional fertilization (control). Significant effect of fertigation with 100% and 125% N and K @ 120: 60 kg/ha on growth attributes of chilli were also reported by Muralikrishnaswamy *et al.* (2006). They reported at par result with 100% and 125% fertigation level.

Fertigation with N and K showed great impact on yield attributes and yield of capsicum as compared to conventional soil fertilization (Table 3 & 4). The yield attributes viz, fruit length, fruit girth, number and average weight of fruits/plant, and fruit yield/ plant of capsicum were responsive due to variation in fertigation level. 75% and 100% fertigation level with

recommended N and K were found significantly superior in terms of the yield attributing parameters compared to 60% fertigation level and conventional soil fertilization. Among all the treatments, fertigation with 100% recommended N and K @ 120 : 60 kg/ha recorded the highest fruit length, fruit girth, fruit number and average weight of fruits/plant, and yield/plant as compared to 75% and 50% fertigation level, which is significantly superior over conventional soil fertilization with 100% recommended N and K.

The highest yield/plant under 100% fertigation level is positively correlated with highest marketable yield (t/ha) consecutively during three years of study (Table 4). Fertigation with 100% recommended N and K @ 120: 60 kg/ha increased the marketable yield by 25.90%, 72.40% and 70.90% in the year 2005-06, 2006-07 and 2007-08 respectively over conventional fertilization. Increased marketable yield in Capsicum with 100% recommended N and K might be owing to continuous supply of required quantity of nutrients in the root zone of the crop, which creates favourable conditions for growth and development of the crop by way of increasing metabolic activities in the plant system and resulted in maximum yield. The results are in conformity with the findings of Castellanos et

al. (1999).

Regarding fruit quality, fertigation treatment significantly influenced the ascorbic acid content of capsicum grown under cover (Table 4). During the three consecutive years of study, fertigation with 100% recommended N and K @ 120 : 60 kg/ha produced significantly highest ascorbic acid content compared to conventional fertilization, while the lowest ascorbic acid content were recorded by 50% fertigation level. Fertigation with N and K significantly influenced the cost of cultivation (Table 5) of early capsicum grown under cover. Economic analysis of different treatments revealed that the highest cost benefit ratio of 1:1.72 was recorded by 100% recommended N and K fertigated through drip. This was followed by 75% recommended N and K (1:1.41). Corroborative finding were also reported by Tumbare and Bhoite (2002). However study on Nitrogen and Potash fertilizer used efficiency (Table 5) revealed that fertigation with 75% recommended N and K recorded highest fertilizer used efficiency compared to 100% fertigation treatment, which is closely followed by 50% fertigation level, implying progressively higher N and K losses with increasing rates of N and K, while lowest fertilizer used efficiency was recorded by conventional soil

Table 1. Fertigation schedule for early season capsicum grown inside polyhouse

Parameters	Early vegetative stage				Early flowering/ fruiting stage			Fruit bulking stage		Fruit harvesting stage
	5	15	25	35	45	55	65	75	85	
Days after planting	5	15	25	35	45	55	65	75	85	
Duration	10	20	30	40	50	60	70	80	90-180	
Fertigation (numbers in 10 days)	2	2	3	4	3	4	5	5	32	
Urea/plant (g)	0.15	0.15	0.2	0.2	0.2	0.2	0.15	0.13	0.12	
MOP/plant (g)	0.05	0.05	0.045	0.045	0.075	0.07	0.07	0.07	0.07	
Time of operation (min)	20	20	24	24	23	23	22	20	20	
Fertilizer dissolving rate (g/lit)	10.71	10.71	11.90	11.90	12.42	12.42	9.74	9.28	8.57	

Table 2. Growth attributes of capsicum influenced by different fertigation levels inside polyhouse

Treatments	Plant height (cm)				Branch/Plant				Leaves/plant				Canopy Spread (cm)			
	2005-06	2006-07	2007-08	Pooled Mean	2005-06	2006-07	2007-08	Pooled Mean	2005-06	2006-07	2007-08	Pooled Mean	2005-06	2006-07	2007-08	Pooled Mean
T <sub>1</sub> = 100% RD of N & K	38.30	42.00	41.60	40.20	6.70	12.40	13.00	10.70	959.5	1083.9	880.0	1008.9	44.87	46.08	53.03	47.99
T <sub>2</sub> = 75% RD of N & K	36.40	37.40	39.40	37.70	6.40	10.20	11.20	9.20	808.4	295.2	762.0	849.0	41.70	43.10	50.44	45.08
T <sub>3</sub> = 50% RD of N & K	35.00	34.60	36.10	35.20	6.30	9.60	10.60	8.80	427.6	42.8	450.0	415.3	40.53	41.97	46.20	42.90
T <sub>4</sub> = Conventional Fertilization (Control)	33.10	32.40	33.70	33.00	5.90	9.20	9.50	8.20	363.5	450.6	520.0	428.6	37.03	38.03	44.67	39.91
CD(0.05)	2.66	2.11	3.61	2.46	N8	1.02	1.09	0.79	27.26	2.96	3.03	99.41	0.85	1.08	2.93	1.60

Table 3. Growth and yield attributes of capsicum influenced by different fertigation levels inside polyhouse

Treatments	Leaf area/Plant (cm <sup>2</sup> )				Fruit length (cm)				Fruit girth (cm)				Fruits Plant			
	2005-06	2006-07	2007-08	Pooled Mean	2005-06	2006-07	2007-08	Pooled Mean	2005-06	2006-07	2007-08	Pooled Mean	2005-06	2006-07	2007-08	Pooled Mean
T <sub>1</sub> = 100% RD of N & K	100.57	101.66	101.26	101.16	8.87	9.10	9.10	9.02	6.92	7.27	7.23	7.14	5.80	17.62	15.40	12.94
T <sub>2</sub> = 75% RD of N & K	87.19	90.06	89.16	88.81	7.93	8.20	8.37	8.17	6.46	6.60	6.57	6.54	5.50	15.58	13.50	11.53
T <sub>3</sub> = 50% RD of N & K	83.95	83.36	83.66	83.66	6.53	6.73	6.60	6.62	6.12	6.17	6.00	6.10	5.00	10.00	8.60	7.87
T <sub>4</sub> = Conventional Fertilization (Control)	97.65	87.17	86.81	90.54	7.03	7.10	7.03	7.05	6.27	6.36	6.20	6.28	4.30	11.80	11.50	9.20
CD (0.05)	5.28	2.29	3.62	3.37	1.06	0.51	0.58	0.65	N3	0.57	0.55	0.55	0.48	0.42	1.03	0.87

Table 4. Marketable yield and quality of capsicum influenced by different fertigation levels inside polyhouse

Treatments	Average fruit weight (g)				Yield (g/plant)				Marketable Yield (t/ha)				Ascorbic acid (mg/100g)			
	2005-06	2006-07	2007-08	Pooled Mean	2005-06	2006-07	2007-08	Pooled mean	2005-06	2006-07	2007-08	Pooled mean	2005-06	2006-07	2007-08	Pooled mean
T <sub>1</sub> = 100% RD of N & K	67.24	50.00	57.22	58.15	390.77	883.36	880.00	718.04	19.25	43.60	43.46	35.44	102.48	104.58	104.55	103.87
T <sub>2</sub> = 75% RD of N & K	67.27	48.72	56.67	57.55	378.97	764.60	762.00	635.19	18.70	37.75	37.65	31.37	101.67	102.72	101.75	102.05
T <sub>3</sub> = 50% RD of N & K	62.00	42.00	52.36	52.12	289.30	423.30	450.00	387.53	14.27	20.90	22.22	19.13	44.25	42.46	43.37	43.36
T <sub>4</sub> = Conventional Fertilization (Control)	67.44	43.22	46.35	52.34	310.07	512.34	530.00	450.80	15.29	25.29	25.43	22.00	71.57	69.92	70.72	70.74
CD (0.05)	1.78	2.26	4.42	3.79	44.46	3.65	3.03	32.27	2.20	0.17	0.29	1.67	3.19	2.35	2.53	3.38

Table 5. Fertilizer used efficiency and cost economics of capsicum influenced by different fertigation levels inside polyhouse

Treatments	Nitrogen fertilizer used efficiency (kg yield per kg N fertilizer used)	Potash fertilizer used efficiency (kg yield per kg P fertilizer used)	C:B ratio
T <sub>1</sub> = 100% RD of N & K	776.61	300.69	1:1.72
T <sub>2</sub> = 75% RD of N & K	916.00	354.66	1:1.41
T <sub>3</sub> = 50% RD of N & K	838.28	324.56	1: 0.47
T <sub>4</sub> = Conventional Fertilization (Control)	487.57	188.78	1: 0.71

fertilization. Higher N used efficiency in Bhendi crop drip-fertigated with 50% (60kg Nha<sup>-1</sup>) recommended dose of fertilizer over 75% or 100% (90 or 120 kg N/ha) recommended dose were also reported by Rekha *et al.* (2005).

From the present investigation, it may be inferred that for early season capsicum grown inside naturally ventilated polyhouse, drip fulfillment at 100% evaporation replenishment along with supplementation of 100% recommended N and K

through drip irrigation in 60 splits starting from 5 days after transplanting, with the last drip coinciding 15 days before harvest may be recommended for higher yield of early season capsicum with optimum quality and the highest cost-benefit ratio of 1:1.72 under the agro-climatic condition of Jorhat (Assam).

## References

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