Effect of fertigation on Capsicum (*Capsicum annuum* L. var. *grossum*): A review

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Abstract

Capsicum is one of the most important vegetable crop grown in India. Water has been identified as one of the scarcest inputs, which can severely restrict its growth unless it is carefully conserved and managed. Use of modern techniques such as drip irrigation is likely to increase the water use efficiency. Fertigation optimizes the use of water and fertilizer enabling to harness high crop yield, simultaneously ensuring a healthy soil and environment. As reported by different research workers of the world, adoption of drip fertigation in Capsicum results in saving of fertilizer up to 25 per cent, water saving up to 40 percent significant increase in yield, significant increase in water use efficiency and better quality produce.

***Keywords*:** Capsicum, Fertigation, Water use efficiency, Yield

Introduction

Capsicum (*Capsicum annuum* var. *grossum*) also referred to a sweet and bell pepper is a highly priced vegetable crop both in domestic and international market. It is a cool season crop cultivated for its immature fruits throughout the world (Brahma *et al.* 2010). Sweet pepper is big in size as compared to hot pepper and shape of the fruit is bulky and blunt with three to four lobes besides having thick walls (Sreedhara *et al*. 2013). The unique taste quality and health-promoting properties of the fruit, conditioned by the presence of antioxidants and mineral components contribute in human diets (Buczkowska *et al*. 2016). Fertigation system is most suitable approach for cultivation of capsicum. Fertigation allows nutrient placement directly into root zone around the plants through a dripper network with the help of emitters near consumptive use of plants during critical periods of nutrient requirement. Losses of water and nutrient can be minimized substantially as fertigation is economically feasible, socially and environmentally acceptable (Tiwari *et al*. 2013). Fertigation provides a variety of benefits to the users like high crop productivity, fruit quality, resource use efficiency, environmental safety and flexibility in field operations, effective weed management and successful crop cultivation on fields with undulating topography (Godara *et al*. 2013). Replacing soils by soilless growing media is to overcome plant protection problems, soil borne pathogens and environmental regulations against ground water pollution with nitrate pesticides (Nagaraj *et al*. 2015). Coconut coir is an inexpensive soilless media with suitable water and air retension capacity (Ameri *et al*. 2012). Soilless media resulted in better control of plant nutrition and elimination of plant diseases that are caused by soil

(Mazahreh *et al*. 2015). Proper fertigation management requires the knowledge of fertigation rate and nutrient uptake by the crop to ensure maximum crop productivity. Nitrogen fertilizer (N) is needed for proper vegetative growth of the plants. Deficiencies of fertilizer (N) causes decrease in yields. Phosphorus fertilizer (P) is a must for the normal development of the roots, flowers, fruits and seeds. Adequate phosphorus enhances early fruit ripening. Potassium fertilizer (K) causes plants to mature more quickly, improves its overall quality and fights diseases. Water and Fertilizer use efficiency and yield are increased by adopting drip irrigation as compared with the conventional methods.

Review of literature

A review of drip fertigation effects on sweet pepper is being presented under the following sub-heads:

1. Effect of drip fertigation on growth and yield of Capsicum
2. Effect of drip fertigation on water use efficiency and fertilizer use efficiency
3. Effect on capsicum grown in soilless media
4. Economic viability of drip fertigation

Effect of drip fertigation on growth and yield of Capsicum

Brahma *et al*. (2010) conducted a field experiment 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).

Kanwar *et al*. (2013) investigated the growth and yield attributing characters of sweet pepper (*Capsicum annuum* L.) under black polyethylene mulch and revealed that use of 80% RDF through fertigation with black polythene mulch was effective for stem girth, number of pickings, days to last picking. Whereas 100% RDF through fertigation with black polythene mulch was found moderately effective for plant height and number of

branches plant^{-1}. They found that highest fruit length, fruit girth, fruit weight, number of fruits plant^{-1}, fruits weight plant^{-1} and fruit yield plot^{-1}of sweet pepper was found with the use of 80% RDF through fertigation.

Tiwari *et al*. (2013) conducted an experiment on different fertigation levels on morpho-physiological characters and yield of capsicum under greenhouse condition. The experiment was conducted in RBD design comprising of four treatments *viz.,* control, 60 per cent, 80 per cent and 100 per cent fertigation levels under the polyhouse conditions. Observations were taken plant height, stem girth, secondary branches, dry matter production, days to first flowering, days to first fruiting and fruit yield. Significantly maximum fruit yield per ha was obtained with T_3 (80% RDF) and minimum in control.

Sharma *et al.* 2012 conducted an experiment to study the effect of three irrigation regimes (100%, 80% and 60% of crop water requirement) through drip and flood irrigation along with four mulches treatments (white, yellow, black and without mulch) on weed incidence and yield of capsicum F_1 hybrid 'Indra'. It was reported that 60% water applied through drip along with black plastic mulch was most effective in quelling weed. While yellow plastic with 80% water applied through drip was moderately effective against quelling weed.

Biwalkar *et al.* (2015) examined the response of coloured sweet pepper variety Syngenta Yellow (*Capsicum annuum* L. var. *grossum*) to fertigation and irrigation levels under naturally ventilated greenhouse. They studied that fertigation @ 120 per cent produced maximum plant height (191.77 cm), leaf area index (4.34 cm^2) and dry matter (24.15%). They concluded that Syngenta Yellow variety of capsicum with 120% fertigation produced maximum yield (168.74 t ha^{-1}) and Syngenta Red variety with 120% fertigation produced fruit length (10.37 cm), fruit width (9.20 cm), fruit girth (32.13 cm), pericarp thickness (0.84 cm), fruit weight (221.80 g).

Effect of drip fertigation on water use efficiency and fertilizer use efficiency

Solaimalai *et al.* reported that drip fertigation recorded higher use efficiency of water and fertilizers, minimum losses of N due to leaching, supplying nutrients directly to root zone in available forms, control of nutrient concentration in soil solution and saving in application cost.

Gupta *et al.* reported that the highest water use efficiency (29.40 q/ha-cm) was observed with the treatment combination of 60% ET through drip + 80% recommended NPK through fertigation. The fertilizer use efficiency was found maximum (NUE-4.89 q/kg N, PUE-6.53 q/kg P and KUE-9.79 q/kg K) with the treatment combination of 80% ET through drip + 60% recommended NPK through fertigation.

Kaushal *et al.* reported that the drip irrigation adoption increases water use efficiency (60-200%), saves water (20-60%), reduces fertilization requirement (20-33%) through fertigation, produces better quality crop and increases yield (7-25%) as compared with conventional irrigation.

Sharma *et al.* conducted a field experiment to study the effect of drip irrigation and nitrogen fertigation on guava crop. The result showed that water use efficiency (WUE) was greatly influenced by drip irrigation and

nitrogen fertigation. Maximum WUE (35.1 kg/ha-mm) was noted in the treatment which was irrigated with drip at 80% ETC. The lowest WUE (23.2 kg/ha-mm) was noted in the conventional irrigation system.

Effect on capsicum grown in soilless media

Nagaraj *et al.* 2015 conducted an experiment on study the effect of different soilless growing media on growth and yield parameters of bell pepper (*Capsicum annuum* var. *grossum*) cv. Indira under shade house. The experiment was laid out in a spilt plot design. The seven different soilless growing media were selected *viz.*, cocopeat, rice husk, sawdust separately as M_1, M_2 and M_3 treatments and these media mixed with 1:1 proportion of vermicompost on volume basis as M_4, M_5 and M_6 treatments with sandy loam soil as M_7 (control) with two replications. The different observations on each treatment were taken such as number of days to flowering, number of 50 per cent flowering, plant height, number of branches and yield. The result shows that sandy loam soil was found best growth parameter. The highest yield was found in sandy loam soil (88.62 t ha^{-1}) and lowest yield was observed sawdust (62.00 t ha^{-1}).

Lozano *et al.* 2005 studied green pepper fertigation in soilless culture. *Capsicum annuum* were cultivated in perlite for two consecutive years in an unheated greenhouse on the coast of Granada (Spain). Both crops were begun in spring, the traditional season for green peppers in the zone. The first year, four different K levels in the nutrient solution were maintained constant throughout the growing cycle. Only the treatment with 1.5mmol/l of K^+ gave less yield than the rest, although the treatment with 3 mmol/l of K^+ had developmental problems in the early growth phases before recuperating and providing statistically the same yield as the other two treatments (6 and 4.5 mmol/l of K^+). The second year, two treatments were applied. For the first, 5 mmol/l of K^+ were applied over the entire growth cycle, an intermediate quantity with respect to the two treatments that proved best the first year. In the second treatment, the same solution was used until before the first harvest, when the amount was reduced to 2.75 mmol/l of K^+ until the end of the season. In this second year, no differences were found in yield between the two treatments.

Economic viability of drip fertigation

Kaushal *et al.* conducted a field experiment to study the economics of growing sweet pepper under low tunnels .The experiment was laid out in split plot design keeping four irrigation treatments (drip irrigation with IW/CPE ratio of 0.60 (I_1), 0.75 (I_2), 0.90 (I_3) and furrow irrigation with paired row planting (I_4), in main plots and three different low tunnel heights 45 cm (H_1), 60 cm (H_2) and 75 cm (H_3) in sub plots and replicated three times. The treatment combination of I_2H_2 treatment gave maximum benefit-cost ratio (2.93 without subsidy) and (3.05 with maximum subsidy) in drip irrigation.

Singh *et al*. conducted a field experiment in the year 2010-11 to study the effect of different levels of irrigation and fertigation on drip irrigated bell pepper (*Capsicum annuum* L. var. *grossum*). The experiment was laid out in split plot design keeping three fertigation treatments (100% (F_1), 80% (F_2) and 60% (F_3) of

recommended fertilizers) in main plots and three irrigation treatments (drip irrigation with 1.0 (I_1), 0.8 (I_2) and 0.6 Potential evapotranspiration (PET) (I_3) in sub plots. The result showed that the average fruit weight (49.34 g), fruit volume (41.11cm^3), benefit cost (B/C) ratio (2.55) and yield (189.27 q/ha) were found to be maximum with 80% recommended dose of fertilizers and 0.8 PET water application. Better results were found in case of drip irrigation treatments as compared with CT (conventional treatment). The gross income from drip irrigation system and CT was Rs.283905/ha and Rs.230475/ha respectively. Higher benefit cost ratio in case of drip irrigation system (2.55:1) as compared to CT (2.07:1) suggests better returns from drip irrigation system. Kaushal *et al.* reported that the subsidy and technical support to farmers acts as an incentive to adopt drip irrigation on a large scale in India. Sharma *et al*. reported that the benefit-cost (B: C) ratio was maximum (2.84) in drip fertigation with 100 per cent ETC.

Conclusion

Considerable research work has been carried out on drip fertigation for sweet pepper production during past several years. However, still a lot of work remains to be done which is summarized below and needs to be investigated- Kinds of fertilizer to be used for drip fertigation in sweet pepper, Fertigation scheduling in drip fertigated sweet pepper, Optimum dose of irrigation and fertilizer in drip fertigated sweet pepper, Evaluation of emitter clogging problem in using drip fertigated sweet pepper, Economical viability of drip fertigated sweet pepper under different agro-climatic regions.

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