RESEARCH ARTICLE OPEN ACCESS

Drip Fertigation in Sweet Pepper: A Review

Roma Kumari*, Dr. Arun Kaushal**
*M-Tech Student, Department of Soil and Water Engineering, Punjab Agricultural University, Ludhiana, Punjab, India-141004
** Professor, Department of Soil and Water Engineering, Punjab Agricultural University Ludhiana, Punjab, India -141004

ABSTRACT
Sweet Pepper is one of the most important vegetable crops 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. Adoption of modern irrigation technique like drip irrigations is needed to be emphasized to increase water use efficiency and covering more area under irrigation. Drip fertigation is the most effective way to supply water and nutrients to the plants which not only saves water but also increases yield of fruits and vegetable crops. As reported by different research workers of the world, adoption of drip fertigation in sweet pepper 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*:** Drip irrigation, Fertigation, Sweet Pepper, Water use efficiency, Yield

I. INTRODUCTION
Sweet pepper (*Capsicum annuum* L.*var. grossum*) is commonly known as Capsicum, Shimla Mirch, green pepper, cherry pepper or bell pepper and it belongs to Solanaceous group of vegetables. It is very rich in vitamins A and C. Capsicum is one of the most important vegetable crops grown extensively throughout the world especially in the temperate countries [1]. The crop is very sensitive to environmental factors [2]. Owing to its sensitivity to environmental factors, its yield is affected significantly. Sweet pepper is more sensitive to environment (especially soil moisture and temperature).The plant grows at soil temperatures between 18^0C and 35^0C [3]. In India, capsicum is grown for its mature fruits and is widely used in stuffing and baking. It is also used in salad, noodles and soup preparation. The pressure on agriculture is increasing due to population growth in India which has touched 126 Crores thereby creating a need to improve agriculture production which includes vegetables. In vegetable production water and nutrients are the two most critical inputs and their efficient management is important not only for higher productivity but also for maintaining quality. Among the various irrigation methods used for water application, micro irrigation systems particularly, drip method is most efficient and increasingly adopted worldwide. Drip irrigation is an irrigation method that saves water by allowing water to drip slowly to the root of plants, either onto the soil surface or directly onto the root zone, through a network of valves, pipes, tubing and emitters. Drip irrigation has the greatest potential for the efficient use of water and fertilizers. For minimizing the cost of irrigation and fertilizers, adoption of drip irrigation with fertigation is essential which maximize the nutrient uptake while using minimum amount of water and fertilizer.

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 use efficiency, fertilizer use efficiency and yield are increased by adopting drip irrigation as compared with the conventional methods [4].

II. REVIEW OF LITERATURE
A review of drip fertigation effects on sweet pepper is being presented under following sub-heads:
2.1 Effect of drip irrigation on growth and yield of Sweet Pepper
2.2 Drip ferigation in sweet pepper
2.3 Effect of drip fertigation on water use efficiency and fertilizer use efficiency
2.4 Economic viability of drip fertigation

2.1. Effect of Drip Irrigation on Growth and Yield of Sweet Pepper
Antony and Singhdhupe [5] conducted study on impact of drip and surface irrigation on growth, yield and WUE (water use efficiency) of bell pepper. The experiment was laid out in randomized block design

(RBD) with three replication. Irrigation treatments included surface IW/CPE (1.2, 1.0, 0.8 and 0.6) and drip (100, 80, 60 and 40).It was observed that 100% drip irrigation gave maximum yield in bell pepper grown in loamy soil of humid subtropical region. At 100% drip treatment plants had more height and more number of branches as compared to surface irrigated plants.

Sharma et al. [6] 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 F1 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.

Sezen et al. [7] studied the effect of drip irrigation regimes on yield and quality of field grown bell pepper. Irrigation regimes consisted of three irrigation intervals based on three levels of cumulative pan evaporation (Epan) values (I1, 18-22 mm; I2, 38-42 mm and I3,58-62 mm) were used. The maximum yield of 33.14 t/ha in the year 2002 and 35.3 t/ha in the year 2003 growing season was obtained from irrigation interval of 3-6 days and plant-pan coefficient of 1.0.

Ngouajio et al. [8] studied the timing of drip irrigation initiation affects irrigation water use efficiency and yield of bell pepper under plastic mulch. Irrigation treatments were initiated at pepper transplanting (S0), after transplant establishment (S1), at first flower (S2), at first fruit (S3) and at fruit ripening (S4).The control treatment was received only enough water to apply fertigation (FT).Withholding irrigation did not affect pepper plant except FT treatment, but increased leaf chlorophyll content .Withholding irrigation until S4 saved 50% and 41% of irrigation started at transplanting. Irrigation water use efficiency was maximum at S4 (59.1 kg/ha mm) and S3 (24.1 kg/ha mm) in 2003 and 2004, respectively.Results revealed that withholding irrigation until first fruit may help to maintain pepper yield while reducing irrigation cost.

Lodhi [9] conducted a field experiment in the Department of Soil and Water Engineering ,PAU, Ludhiana in 2008-09 to study the effects of low tunnel environment on growth and yield of drip irrigated sweet pepper (*Capsicum annuum* L. *var .grossum*).The experiment was laid out in split plot design keeping five irrigation treatements (drip irrigation with IW/CPE ratio of 0.60(I1),0.75(I2),0.90(I3),furrow irrigation with paired row planting (I4) and single row planting(I5), in main plots and replicated three times. The air temperature,soil temperature ,dry matter accumulation, number of fruits per plant ,fruit size ,sweet pepper early yield ,total yield, WUE and benefit cost ratio were observed highest in H2 and I2 treatments. The highest plant height and leaf area index, plant height, dry matter accumulation, number of days to flowering, fruit initiation, fruit maturity and fruit girth, while the effect of their interaction was found to be non significant. There was also significant effect of irrigation, tunnel height and their interaction on number of fruits per plant, fruit length, sweet pepper yield and WUE.Highest economic returns were achieved in 75 cm low tunnel height drip irrigated with IW/CPE ratio of 0.75.

2.2. Drip Fertigation in Sweet Pepper

Marcussi et al. [10] conducted an experiment to study the macronutrients accumulation and portioning in fertigated sweet pepper plants .Experiment was laid out in a randomised block design with four replications. The period of largest extraction of nutrients for the plant occurred from 120 to 140 (days after the seedling transplant) DAT, which coincides with the highest accumulation of dry photomass.The highest Mg and Ca accumulation occurred in the leaves while N, K, S and P were mostly accumulated in fruits .Only 8 to 13% of the total amount of accumulated macronutrients at 140 DAT were observed macronutrients (60% of the macronutrients accumulated during the whole cycle). P, Ca and S were the most absorbed nutrients at the end of cycle.

Contreras et al. [11] observed the effect of different nitrogen-phosphorus-potassium (NPK) dosage applied by fertigation and two types of irrigation water on the soil-plant system of a pepper crop. Six different treatments were established, three rates of NPK (0, 50 and 100% of total concentration extracted by the crop) applied by fertigation and two types of water (0.7 and 2.6 dS m^{-1}).The crop showed a positive response to an increase of NPK concentration solution.

Kamaruddin et al. [12] studied the response of fertigation on capsicum growth under naturally ventilated tropical greenhouse .A fertilizer recipe by using a cooper formulation was developed and tested for capsicum growth under green house in the lowlands. Capsicum of big star variety was planted in the coco peat media. Water with fertilizer solution was automatically supplied to the root zone for 20 minutes, 6 times per day .The performances of capsicum growth in term of stem diameters, plant height and leaf width against time were measured. The relationship between leaf and stem growth against time were found to be linear, while the height versus was exponential.

Gupta et al. [13] conducted an experiment to study the comparative performance of drip irrigation and fertigation over conventional methods of irrigation and fertilizers application in Capsicum var.

Nishat-1. The experiment consisted of 16 treatment combinations replicated four times. The treatments include 4 levels of irrigation viz., 100%, 80% and 60% ET through drip and 100% surface irrigation; and four levels of fertigation viz., 100%, 80% and 60% recommended NPK through fertigation and 100% recommended NPK through manual. Surface irrigation and manual fertilizers application were treated as control. Irrigation schedule for drip irrigation was based on estimated crop water requirement using pan evaporation data, crop coefficient, pan coefficient and percentage wetted area of the crop root zone. Observations were recorded for various growth and yield attributes. Economics of the system under Kashmir conditions was also studied. In case of growth and yield attributes, drip irrigation at 80% ET water along with 80% recommended NPK as fertigation was found significantly superior over all other treatment combinations with maximum fruit yield (366.48 q/ha). It was further concluded that by adopting drip irrigation system, the highest income of Rs. 2,82,026/- could be generated in capsicum as against Rs. 1,69,990/- realized under conventional method. Benefit cost ratio was also noticed maximum (3.33: 1) with the same treatment combination i.e. 80% ET through drip + 80% recommended NPK through fertigation.

Bassiony et al. [14] conducted experiment on sweet pepper plant to evaluate the different rates of potassium fertilization (50, 100 and 200 kg/fed) as potassium sulphate in addition to foliar application by potassium oxide (2 and 4 cm/L) and potassium humate (4 gm/L) as a simulative dose. The highest potassium fertilization rate (200 kg/fed) gave the tallest sweet pepper plants, the highest number of leaves and branches per plants and the highest fresh and dry weights of leaves as well as the highest total yield. The obtained results reported that the fruit measurements expressed as fruit length, average fruit weight and vitamin C content, as well as leaves chemical composition (N, P, K and total chlorophyll) were increased with increasing potassium fertilization rate and spraying sweet pepper plants with potassium humate at rate of 4 gm/L markedly increased vegetative growth, yield, fruit quality and chemical composition. It is noticed that favourable effects of the potassium on the growth, total yield and fruit parameters were obtained when sweet pepper plants fertilized with 200 kg/fed.

Brahma et al. [15] 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).

Khan et al. [16] studied growth and yield of capsicum under different levels of nitrogen and phosphorus fertigation during November 2009 to March 2010 at the Research Farm of Sher-e-Bangla Agricultural University, Dhaka. The treatments were 4 levels of N (0, 50, 100 and 150 kg /ha) and 3 levels of P (0, 30 and 60 kg\ ha). Plant height at first flowering and at first harvest, number of branches at first flowering and number of fruits per plant increased significantly with increasing nitrogen doses up to 100 kg N\ ha. However, plant height at final harvest and number of branches at first and final harvest increased significantly up to 150 kg N\ ha(N treatment). On the other hand plant height at first flowering and number of branches at first harvest increased significantly with increasing levels of P up to the treatment P_1 (30 kg P ha^{-1}), whereas plant height and number of branches at final harvest and number fruits per plant enhanced significantly up to the treatment P_2 (60 kg P ha^{-1}). It is noticed that combined effect of nitrogen and phosphorus, the maximum plant height at final harvest were obtained from N_2 P_2 (100 kg N + 60 kg P ha^{-1}). On the other hand, maximum number of fruits per plant was found in the treatment combination N_3 P_1 (150 kg N + 30 kg P ha^{-1}).Gupta et al. (4) studied the quality, water and fertilizer use efficiency of capsicum under drip irrigation and fertigation. The experiment was carried out in a factorial RBD consisted of 16 treatment combinations replicated four times. The treatment include four levels of irrigation viz.,100,80 and 60% ET through drip and 100% surface irrigation; and four levels of fertilizers application viz., 100,80 and 60%

of recommended NPK through fertigation and 100% recommended NPK through manual. Surface irrigation and manual fertilizer application were treated as control. The results revealed that there was significant improvement in the yield, quality, water and fertilizer use efficiencies of capsicum under drip irrigation and fertigation .The combined effect of drip irrigation and fertigation was found superior than their individual effects .The treatment combination of 80% ET through drip irrigation and 80% recommended NPK through fertigation registered maximum fruit yield (366.48 q/ha).

Roy et al. [17] studied nitrogen and phosphorus efficiency on the fruit size and yield of capsicum. Four levels of N (0, 50,100 and 150 kg/ha) and three levels of P (0, 30 and 60 kg/ha) treatments were given. Length and width of fruit and number of fruits per plant increased significantly with increasing nitrogen doses up to 100 kg N /ha .However, average weight of fruit content increased significantly with increasing levels of P up to 150 kg N/ha.Average weight of fruit and yield increased significantly with increasing levels of P up to the treatment 30 kgP /ha ,whereas length of fruit and number of fruits per plant was increased significantly up to the 60 kg P /ha .Considering the combined effect of Nitrogen and Phosphorus, the maximum significant length of capsicum ,width of capsicum ,number of fruits per plant and average weight of fruit as well as yield were found in the treatment combination of 150 kg N and 30 kg P /ha.

Pandey et al. [18] conducted a field experiment to investigate the effect of drip irrigation, spacing and nitrogen fertigation on yield of Capsicum. The results revealed that drip irrigation enhanced the fruit yield, net income and minimized the time, weeds and diseases of the crop. Closer spacing at 30 cm produced higher yield (58.77%) and net income as compared to 45 cm spacing. Fertigation resulted in maximum yield (10.20 kg/m^2), minimal disease and saved water and total irrigation time as compared to top dressing. The drip irrigation had significantly increased yield (10.50 kg/m^2) and net income (60.30%) as compared to flood irrigation.

2.3. Effect of Drip Fertigation on Water Use Efficiency and Fertilizer Use Efficiency

Solaimalai et al. [19] 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. (4) 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-4.89q/kg N, PUE-6.53 q/kg P and KUE-9.79q/kg K) with the treatment combination of 80% ET through drip + 60% recommended NPK through fertigation.

Tanaskovik et al. [20] conducted the field experiment during the period of May to September in 2002,2003 and 2004 for tomato crop .Five experimental treatments tested in this study included the following : the first three treatment (T1, T2 and T3) included a combination of drip irrigation and fertigation, treatment four (T4) included drip irrigation but with conventional application of fertilizer, and the fifth treatment,(T5)included furrow irrigation practice with conventional application of fertilizer. The results showed that the drip fertigation treatments (T1, T2, and T3) gave significantly higher tomato yields in comparison with treatments T4 and T5. During three years of research treatments under drip fertigation showed almost 28% more water use efficiency in comparison with the treatment with conventional application of fertilizer and drip irrigation and 87% more than the treatment with furrow irrigation and conventional application of fertilizer.

Kaushal et al. [21] 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. [22] 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% ET_C. The lowest WUE (23.2 kg/ha-mm) was noted in the conventional irrigation system.

2.4 Economic Viability of Drip Fertigation

Under drip fertigation system, 100 per cent recommended NPK registered the highest benefit cost ratio (2.17) in chilli **[Tumbare and Bhoite, 23]**. **Ramah et al** [24] conducted a field experiments in the year 2006-07 at Agricultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore to study the effect of varying irrigation regimes and fertilizer levels in maize based cropping system. The experiment was laid out in split plot design keeping three irrigation regimes in main plots viz., I1 - Drip irrigation at 75 % WRc (computed water requirement of crop), I2 - Drip irrigation at 100 % WRc, I3 - Drip irrigation at 125 % WRc and four fertilizer levels in sub plots viz., F1 - 75 % RDF, F2 - 100 % RDF, F3 - 125 % RDF and F4 - Drip irrigation + 100 % RDF by soil application. The gross income (Rs. 3,09,554) was higher in the treatment with 100 per cent WRc with 125 per cent RDF whereas, higher benefit cost ratio of 4.07 was recorded by drip irrigation at 100 per cent WRc with soil application of RDF. Drip irrigation at 75 per cent WRc with 125 per cent RDF (I1F3) recorded higher net profit per mm of water used (Rs. 274), which was followed by same irrigation regime with 100 per cent RDF.

Kaushal et al. [25] 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 (I1),0.75(I2) ,0.90 (I3) and furrow irrigation with paired row planting (I4), in main plots and three different low tunnel heights (45 cm (H1)),60 cm (H2) and (75 cm (H3)) in sub plots and replicated three times.The treatment combination of I2H2 treatment gave maximum benefit-cost ratio (2.93 without subsidy) and (3.05 with maximum subsidy) in drip irrigation.

Kaushal and Singh [26] carried out field evaluation of drip irrigation at farmers field in Hoshiarpur district of Punjab. Water Saving/scarcity of water, yield increase, labour saving, decrease in weed growth,energy saving, quality improvement, subsidy available and uniform irrigation were the major factors associated with adoption of drip irrigation as reported by 75-100 per cent of the farmers.

Singh et al. (27) 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(F1), 80(F2) and 60(F3) % of recommended fertilizers) in main plots and three irrigation treatments (drip irrigation with 1.0(I1), 0.8(I2) and 0.6 Potential evapotranspiration (PET) (I3) 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. (21) 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. (22) reported that the benefit-cost (B: C) ratio was maximum (2.84) in drip fertigation with 100 per cent ET_C.

III. 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 :(a) Kinds of fertilizer to be used for drip fertigation in sweet pepper. (b) Fertigation scheduling in drip fertigated sweet pepper. (c) Optimum dose of irrigation and fertilizer in drip fertigated sweet pepper.(d) Evaluation of emitter clogging problem in using drip fertigated sweet pepper.(e) Economical viability of drip fertigated sweet pepper under different agro-climatic regions.

REFERENCES

[1] A. K. Manchanda, B. Singh, Effect of plant density and nitrogen on yield and quality of bell pepper *(Capsicum annuum L)*, *Indian J Hort*, *44*, 1987,250-252.

[2] R. Bhatt, M.S. Rao and N.Anand, Response of bell pepper to irradiance photo synthesis, reproductive attributes and yield, *Indian J Hort*, *56*, 1999, 62-66.

[3] Anonymous, *Package of practices for cultivation of vegetable crops*, Pp 35-37, 2009, Punjab Agricultural University, Ludhiana.

[4] A. J. Gupta, M. F. Ahmed and F. N. Bhat, Studies on yield, quality, water and fertilizer use efficiency of capsicum under drip irrigation and fertigation, *Indian J Hort*, *67*, 2010, 213-218.

[5] E. Antony, R. B. Singandhupe, Impact of drip and surface irrigation on growth, yield and WUE of Capsicum (*Capsicum annuum L.*),*Agric Water Mgmt*, *65*, 2004, 121-132.

[6] P. K. Sharma, H. G. Sharma and P. N. Singh ,Effects of methods/ levels and coloured plastic mulches on weeds incidence in capsicum(*Capsicum annuum* L. *var .grossum*) crop, *Agric Sci Digest 24*, 2004,42-44.

[7] S. M. Sezen, A. Yazar and S. Ekar, Effect of drip irrigation regime on yield and quality of field grown bell pepper, *Agric Water Mgmt*, *81*,2006,115-131.

[8] M. Ngouajio, G. Wang and R. G. Goldy, Timing of drip irrigation affects irrigation water use efficiency and yield of bell pepper under plastic mulch, *Hort Tech*, *18*, 2008, 397-402.

[9] A.S. Lodhi ,*Studies on the effect of low tunnel environment on growth and yield of drip irrigated sweet pepper* (*Capsicum annuum* L. *var .grossum*) ,M.Tech thesis., Punjab Agricultural University, Ludhiana, 2009.

[10] F. N. Marcussi, R. V. Boas, L. D. Godoy and R. Goto, Macronutrient accumulation and portioning in fertigated sweet pepper plants , *Sci Agric (Piracicaba,Braz),61*,2004,62-68.
[11] J. L. Contreras, P. Galindo, J. J. Catala and M. L. Segura, Response of greenhouse pepper crop to fertilizer levels and different qualities of irrigation water, *Acta Horti700*, 2006, 203-206.
[12] R. Kamarudin, I. H. Rukunudin and N. A. Hamid, Response of fertigation on capsicum growth under naturally ventilated tropical green house, Acta *hort 710*, 2006, 275-280.
[13] A. J. Gupta, M. A. Chattoo and F. N. Bhat, Techno-economic evaluation of drip irrigation and fertigation practices in capsicum under kashmir conditions, *Veg Sci*, *36*, 2009, 309-314.
[14] E. M. Bassiony, Z. W. Fawzy, E. H. Abd El-Samad and G. S. Riad, Growth, yield and fruit quality of sweet pepper plants (*Capsicum annuum* L.) as affected by potassium fertilization, *Amer Sci*, 6, 2010, 722-729.
[15] S. Brahma, L. Saikia, P. Barua, T. Hazarika and B. Sharma ,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,*Veg Sci ,37*, 2010, 160-163.
[16] M. S. Khan, S. S. Roy and K. K. Pall, Nitrogen and phosphorus efficiency on the growth and yield attributes of capsicum, *Acad J Plant Sci*, 3, 2010, 71-78.
[17] S. S. Roy, M. S. I. Khan and K. K. Pall, Nitrogen and phosphorus efficiency on the fruit size and yield of capsicum, *J Exp Sci*, *2*, 2011, 32-37.
[18] A. K. Pandey, A. K. Singh, A. Kumar and S. K. Singh, Effect of drip irrigation, spacing and nitrogen fertigation on productivity of capsicum (*Capsicum annuum* L.), *Environ Eco*, 31, 2013, 139—142.
[19] A. Solaimalai , M. Baskar, A. Sadasakthi and K. Subburamu ,Fertigation in high value crops, *Agric Rev ,26*, 2005,1-13.
[20] V. Tanaskovik, O. Cukaliev, D. Romic and G. Ondrasek ,The influence of drip fertigation water use efficiency in tomato crop production, *Agric Conspec Sci ,76*, 2011,57-63.
[21] A. Kaushal, R. Patole and K. G. Singh, Drip irrigation in sugarcane*:* A review, *Agri Rev*, *33*, 2012, 211–219.
[22] S. Sharma, A. Halder, S. K. Patra and R. Ray , Effect of drip irrigation and nitrogen fertigation on water use efficiency (WUE) and cost economics of guava *cv*. Khaja, *Prog Horti ,44* , 2012, 136-141.
[23] A. D. Tumbare, S. U. Bhoite, Effect of solid soluble fertilizers applied through fertigation on the growth and yield of chilli (*Capsicum annuum* L.), *Indian J Agri Sci*, *72*, 2002, 109-111.
[24] K. Ramah, P. Santhi and K. Ponnuswamy, Economic viability of drip fertigation in maize (*Zea mays* L.) based cropping system, *Madras Agric J*, *97*, 2010, 12-16.
[25] A. Kaushal, A. S. Lodhi and K. G. Singh, Economics of growing sweet pepper under low tunnels, *Prog Agric*, *11*, 2011, 67-72.
[26] A. Kaushal, G. Singh, Field evaluation of drip irrigation for kinnow crop, *Prog Hortic*, *43*, 2011, 302-306.
[27] S. Singh, R. Sharda, P.P. S. Lubana and C. Singla ,Economic evaluation of drip irrigation system in bell pepper (*Capsicum annuum* L. *var. grossum*),*Prog Agri , 43* , 2011,289-293.