DRIP IRRIGATION AND POLY-MULCHES EFFECT ON GROWTH AND YIELD OF SWEET PEPPER (CAPSICUM ANNUUM VAR. GROSSUM L.) - A REVIEW

Pravin Kumar Sharma, H.G. Sharma and P.N. Singh
Department of Horticulture,
Indira Gandhi Agricultural University, Raipur - 492012 (Chhattisgarh), India

ABSTRACT

Irrigation is a vital factor in determining the growth and yield of sweet pepper, similarly poly-mulches also effect the crop yield substantially. Various research studies have been conducted by many workers to find out suitable poly-mulches in association with optimum irrigation level and type, so as to minimise the cost of cultivation. The relevant literature available on this aspect has been briefly reviewed. Literature available on irrigation and poly-mulch effect on capsicum growth and development are collected under the following heads (1) Effect on growth, yield and quality (2) Effect on root development (3) Effect on photosynthesis and associated characters (4) Effect on water requirement, water saving and water use efficacy (5) Economic studies.

Sweet pepper (Capsicum annuum var. grossum L.) commonly referred as bell pepper, capsicum or simla mirch, is one of the important vegetable crops in India. The area and production increased by 8.2 and 18.8 percent from 1995-96 to 1996-97 respectively in the country. But in recent years production of pepper in Chhattisgarh is reduced (Anonymous 1999). The main limitations in achieving the maximum yield potential of capsicum are insufficient soil moisture, fluctuation in temperature and use of traditional crop cultivation systems (Sharma 2001). Maximising of the yield is also essential to serve the increasing population of our country. Adoption of recent agritechniques can also help to fulfill the requirement. Drip irrigation is very effective method of irrigation. It improves yield as well as quality of produce with appreciable water saving. Mulching of crop now a days has become very popular among the farmers. It improves crop performance, conserve soil moisture, suppresses weeds growth, minimise nutrients leaching loses, checks excessive evaporation losses, augments production and quality of produce.

In the light of above facts the research work conducted on these aspects has been reviewed as under:

1. Effect on growth, yield and quality: Szabo (1979) highlighted the usefulness of polyethylene film mulches which increased soil temperature by 3-5°C and soil moisture content by 2-3%, suppressed weeds, advanced cropping and increased yields. Black PVC was found to be the best in capsicum crop. Porter and Etzel (1982) suggested that aluminum painted plastic mulch gave higher yield (11.3-17.5 t/ha) of capsicum compared to black plastic mulch (11-13.2 t/ha). Goyal et al. (1984) found lowest plant height and fruit weight of capsicum (cv. Cubanelle) under transparent polymulch, while white, black and silver coated plastic mulch increased yield by 28, 46 and 132 per cent respectively as compared to non-mulch treatment (control). They also noted accelerated flowering and fruit set, under white, black and silver coated plastic mulch. Goyal et al. (1987) reported that growth and yield of sweet pepper were recorded lowest in the non-irrigated plots. Drip, micro-sprinkler and furrow irrigation increased yield by 168, 115.5 and 52 per cent respectively as compared to control during the winter and 186, 119.6 and 85 per cent respectively during summer. Silver coated plastic mulch increased the yield during winter and summer
seasons both. Crespo et al. (1988) noted that the commercial yield of sweet pepper was markedly higher on mulched plot and mulch with drip irrigation plot over unmulched condition. Sander et al. (1988) reported in capsicum and other vegetables that early yield of these crops increased by the use of plastic mulches and plastic mulches with drip irrigation. Vanderwerker and Wilcox (1988) conducted the experiment in capsicum cv. California Wonder and reported that the combination of black polyethylene mulch and irrigation produced maximum yield but frequency of irrigation had little effect on yield when the plants were mulched. High frequency (15 applications) and low frequency (5 applications) of trickle irrigation resulted at par yield when the plants were mulched. The use of mulch without irrigation had a marked effect on yield. Yields from plots that were mulched but not irrigated were give at par yield to those that were sprinkler-irrigated but not mulched. The percentage of marketable fruits was substantial! reduced in the absence of both the irrigations. Liu et al. (1989) found highest marketable yield and net income from plastic mulching in combination with post directed paraquat in drip irrigated pepper. Wivatvangvana et al. (1991) reported that marketable yield of sweet pepper were markedly increased by the use of a silver-grey polyethylene mulch as compared to bare soil (un-mulched) and straw mulch. They further noted that plant growth was also markedly improved by plastic mulch. Thimme and Gowda (1992) found that drip irrigation increased yield of capsicum and many other vegetables as compared to unspecified irrigation methods. Gollifer (1993) in his field trials on the Indian chilli (C. annuum) cultivar B16 A-1 found that the plastic mulch positioned 7 days after transplanting enhanced plant growth which was attributed to reduced weed competition in the soil. Roberts and Anderson (1994) observed lower marketable yield of capsicum cv. California Wonder under than black plastic mulch those from other treatments i.e. white plastic mulch, wheat straw mulch, living rye, spun bonded polypropylene mulch and bare soil. Siti Aishah (1994) found highest fruit yield, number and size of chilli when crop grown under aluminum painted plastic mulch. Welbaum et al. (1994) concluded that drip irrigation increased the average fresh weight of fruits by 48 per cent over control plots (no irrigation and no mulch). Fruit size was not increased further when drip irrigation was used in conjunction with the black plastic mulch. Cebula (1995) recorded that vegetative growth of sweet pepper plants in respect of height, number of leaves per plant, leaf blades area and thickness were higher with transparent mulch film over black. Chandio et al. (1995) found higher yield of many winter and summer vegetables including chilli in drip irrigated plot as compared to furrow irrigated plots further he observed that drip method of irrigation saved irrigation water up to considerable extent. Orzolek (1995) recommended yellow or silver coloured mulch for peppers cultivation, Peppers grown on yellow coloured mulch produced 22 per cent more yield with bigger and healthier fruits. Anonymous (1998) observed that drip irrigation at ET=0.60 and drip irrigation at ET=0.60 + plastic mulch have recorded the maximum plant height of chilli at the harvest among drip irrigation and mulch experiment. Regarding the yield when irrigation was applied through drip the yield increased in all the treatments. The highest yield was recorded in drip irrigation at ET=1.00 + plastic mulch (14.21 t ha\(^{-1}\)) treatment. The water use efficiency of drip irrigation at ET=1.00 + plastic mulch was higher i.e. 0.791 ha\(^{-1}\) cm\(^{-1}\) as compare to control (surface irrigation at ET=1.00) which was 0.35 t ha\(^{-1}\) cm\(^{-1}\) in chilli crop. Flores and Ibarra (1998) reported that harvesting period can be reduced upto 21 days by the use of soil mulch with water saving of
16.48 cm as compared to the control treatment in pepper crop. The highest crop yields were obtained with a blue polyethylene mulch over green and lowest under black polyethylene or unmulched (control) plot. Orzolek (1998a) suggested that colored plastic mulches can provide the same responses as black mulch in addition to promoting healthier plant growth and higher yields. Certain vegetable crops have shown a 10 to 25 per cent increase in yield and improvement in fruit quality also. Orzolek (1998b) conducted experiment with coloured polyethylene mulch on the ground beds of greenhouse using red, yellow, blue and silver coloured mulches and black as the control. All polyethylene mulches were non-degradable and one millimeter thick. He recorded 10.7% increase on yield of capsicum with blue, yellow and silver mulch and 3.5% with red plastic mulch as compared to control black polyethylene mulch.

2. Effect on root development: Goyal et al. (1988) conducted the experiment to see the root distribution pattern of capsicum under different fertigation levels and silver coated plastic mulch in four depth i.e. 0-11, 11-22, 22-33 and 33-44 cm. He observed that fresh weight and percentage distribution value at all the four depths were statistically at par among all the treatments. In all fertigation treatment under mulching the root value were significantly higher (at P = 0.05) for the 0-11 cm soil depth as compared to other soil depths. More than 80% of the roots were more in the 0-22 cm soil depth in all plots, this depth corresponds to the wetting zone under a dripper. Morita and Toyata (1998) observed that root length and density of pepper shows decreasing trend with increased soil depth and it decreases more rapidly below 20 cm.

3. Effect on photosynthesis and associated characters: Wiertz and Lenz (1987) stated that leaf area and dry matter production of sweet pepper (cv. Bell Boy) were negatively affected by low water supply than by low nutrient concentration. They also observed that restricted water and nutrient supply increased stomatal density and leaves produced small epidermal cells. Oh et al. (1989) observed that crop growth rate, net assimilation rate and relative growth rate of capsicum plants during early growth stage were highest in silver polyethylene film. Maximum crop growth rate was observed in the order silver > black > transparent polyethylene film and yield was also highest in silver polyethylene mulch. Decoteau et al. (1990) observed that the surface colour of polyethylene mulches affected the growth of field grown capsicum plants, the amount and quality of upwardly reflected light, and the soil temperature under the mulch. Four (painted) surface colours were evaluated (black, red, yellow and white) plants grown over red mulch were the tallest. The darker (black and red) mulches reflected less total light and more far - red (FR) relative to red (R) light, and soil temperatures recorded in the afternoon and evening were warmer than under the yellow and white mulches. Plant growth responses to mulch surface colour were also observed when soil temperature differences among the munch colour treatments were minimized by placing insulation boards between the mulch surface and the soil. Sensitivity of young plants to high or low FR : R light ratio was demonstrated by exposing plants to 15 minutes of FR or 15 minutes of R light at the end of the photosynthetic period each day for 14 consecutive days in a controlled environment. Plants that received the FR (high FR : R ratio) were 51 percent taller than plants exposed to R (low FR : R ratio) light treatments. The similar responses of plants to differences in FR : R ratio associated with mulch colour and end of day light treatments indicate that growth is affected by relatively small changes in light environment induced by mulch surface colour.

4. Effect on water requirement,
water saving and water use efficiency: Palevitch et al. (1979) reported that drip irrigation providing only 250 m$^2$ water/1000 m$^2$, resulted in a high yield (400 kg/1000 m$^2$) of capsicum. He further stated that irrigation during flowering and fruit maturation appeared to be crucial for maximum yield. Palevitch et al. (1980) stated that 150-180 m$^2$ of irrigation water through drip in paprika plants gave good yields 265-400 kg dry red fruits/1000 m$^2$. By increasing the amount of water up to 250 m$^2$ the yield of 300-450 kg/1000 m$^2$ was achieved. Applying higher amount of water did not produce a significant increase in yield. Irrigation during the fruit maturation stage appears essential to obtain higher yield. Sivnappan and Padmakumari (1980) found that the drip system increased the yield of chilli by 44 per cent besides water saving to the extent of 62 per cent when compared with conventional method. Goyal et al. (1987) concluded that seasonal net irrigation requirement (NIR) was estimated to be 34.1 cm for winter and 35.2 cm for summer sweet pepper. Over all irrigation efficiency was 37 per cent for furrow, 65 per cent for sprinkle and 84 per cent for drip irrigation based up on actual gross application and NIR. Wiertz and Lanz (1987) noticed that yield of sweet pepper (cv. Bell Boy) were negatively affected by low water supply then by low nutrient concentration. Fruit quality was best with continuous water supply and low nutrient concentration. Gutal et al. (1990) concluded in his experiment that 50 per cent of the wetted area gave the highest yield of 2.89 t ha$^{-1}$ in capsicum cv. Pant C-I under drip method of irrigation. The percent increase in yield over the control (in 100% of the cropped area was wetted) was 28 per cent and 63.4 per cent less water was used than in control. Wivatvangvana et al. (1991) indicated that drip irrigation significantly increased muskmelon yields compared with furrow irrigation. Further, drip irrigation produce a higher yield per unit of water applied than furrow system in various crops like sweet pepper tomato etc. Anonymous (1994) reported that the yield of chilli was increased 44 per cent over conventional method whereas, 62 per cent water saving was observed with drip irrigation method as compared to conventional method. Prabhakar et al. (1998) in his field trails obtained highest red chilli yield in fully irrigated crops where scheduling of irrigation at 40 mm depth at a 0.75 IW/CPE ratio was compared with 0.25 or 0.50. Further stated that this treatment also had the highest water use efficiency of 96.6 kg ha$^{-1}$ cm$^{-1}$.

5. Economic studies: Goyal (1983) reported that the required man-hours/ha were 2868.2 and 3029.0, respectively, in plastic mulched and non-mulched plots of summer capsicum under drip irrigation. Wivatvangvana et al. (1991) indicated that the amount of labour needed to weed, the crop was substantially reduced when plastic mulch was used as compared with bare soil or straw mulch. Narayan et al. (1992) found that the mulched capsicum crop recorded 16.4 per cent higher gross returns compared with the crop without mulch. Among the systems of irrigation there was not much difference with respect of gross returns. However the level of irrigation influenced gross returns considerably. Irrigation at higher level (0.8 CPE) recorded maximum gross return is sweet pepper (cv. California Wonder).

CONCLUSION
The above review reveals that different irrigation regimes and mulches are effective in improving quality and yield of output. The poly-mulches can be effectively used with drip or other methods of irrigation. Ultimate results of improvement in yield and quality are change in water use efficiency and economy of the crop. At the end it is necessary to mention that lot more work is required to evaluate different poly-mulch colour, so that the results.
of these studies may become beneficial in future for our farmers.

REFERENCES

Anonymous (1994). *Drip Irrigation in India. INCID, Constituted by Ministry of Water Resources, Govt. of India, New Delhi* July: 1


