Fertigation and plastic mulching in tomato and brinjal – A review

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Received: 14-08-2014 Accepted: 10-08-2015 DOI: 10.5958/0976-0741.2015.00029.X

ABSTRACT

Vegetable production in India is to be increased to improve the nutritional status of the people. Production can be increased through the adoption of technologies like drip irrigation, fertigation and plastic mulching, which increases the water use efficiency and fertilizer use efficiency. It also reduces the labour needed and at the same time increase the yield. Tomato and brinjal are two major crops having significant scope for increasing the production by using these technologies. Nitrogen and potassium are important to the plants and at the same time these fertilizers are very costly. Application of these fertilizers through drip ensures proper utilization and results in better yield. Plastic mulching when used along with drip and fertigation, controls weeds and further increases the efficiency of the system.

Key words: Drip irrigation, Fertigation, Plastic mulching.

Water is a major input for agricultural production. In the current scenario, it is also a scarce resource, and there exists a large gap in terms of water available and its requirement for irrigation. Adoption of modern irrigation techniques which are simple, easy to operate and increase the efficiency of water usage. Drip irrigation is the most effective way to supply water and nutrients to the plant, which not only saves water but also increases yield of fruits and vegetable crops (Tiwari et al., 1998; Hatami et al., 2012; Nadiya et al., 2013; Iqbal et al., 2014). This water saving is because maximum amount of water is stored in the root zone and deep percolation losses are minimized (Singandhupe et al., 2007; Bhogi et al., 2011).

Fertigation is the technique of supplying dissolved fertilizer to crops through an irrigation system. Small applications of soluble nutrients saves labour, reduces compaction in the field, thereby enhancing productivity. Fertigation allows nutrient placement directly into the plant root zone during critical periods in the required dose (Singandhupe et al., 2003; Jat, et al., 2011). Application of high dose of fertilizers not only causes economic loss but also leads to chemical changes in the soil and reduces the yield. Fertilizer requirement can be reduced by 15-25 percent with fertigation through drip without affecting the yield (Hongal and Nooli, 2007).

Mulching is used to cover soil surface around the plants to create congenial condition for the plant growth. Polyethylene mulches are widely used in the cultivation of vegetables. Weed control, temperature moderation, salinity reduction etc are the desirable effects of plastic mulching.

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It also exerts decisive effects on earliness, yield and quality of the crop (Raina et al., 1999; Bharadwaj, 2013).

Vegetable production has made spectacular increase in recent years in India, but inspite of this progress the per capita consumption of vegetables in India is only about 210 g/day/person, which is far below the minimum dietary requirement of 300 g/day/person (Singh and Chaubey, 2013). Eventhough the humid tropical weather favours cultivation of a wide range of summer vegetables, a number of constraints including shortage of water, labour etc. limit the cultivation. Tomato (Lycopersicon esculentum Mill.) and eggplant (popularly known as brinjal in India) are two important vegetables which are grown India. Ripe tomato is a good source of minerals and vitamins, especially vitamin ‘C’ and carotenoids, which are consumed through out the world in the form of fresh as well as processed products (Chauratia et al., 2005). Brinjal (Solanum melongena L.) is a tropical vegetable believed to be a native of India. It can be grown on different kinds of soil but does best in well-drained silt loams or clay loams with a pH of 5.5-6.5. When these crops are grown as irrigated crops, farmers generally use surface methods of irrigation. Drip irrigation along with plastic mulching is effective in increasing the yield when compared with surface irrigation (Sunilkumar and Jaikumaran, 2002; Tiwari et al., 2003). Several studies have been done all over the world to analyse the effect of drip irrigation, fertigation and plastic mulching on vegetables. Here an attempt is made to summarise the available literature giving emphasis to tomato and brinjal. The various aspects of drip, fertigation and mulching are brought under different heads.
Effect of drip line spacing: Studies are being done to optimize the drip line spacing in vegetables. A maximum yield of 121.1tha\(^{-1}\) was obtained for tomato from the treatment in which both the lateral and row spacing were 1m, and was irrigated with a seasonal irrigation water amount of 551mm, a quantity based on the percentage of canopy cover. This was compared with 2-m lateral spacing in which two plant rows (twin rows) were planted 0.35m on either side of the lateral with a row spacing of 0.70m across the drip lateral and 1.30m in the inter row between each set of two rows. There was not only water saving of 60mm, but also 40% cost reduction compared with the twin-row design. The yearly return on the design including one lateral for each row was US$ 1590 ha\(^{-1}\) higher than the return on the twin-row design (Cetin et al., 2008). The benefit cost ratio for a treatment in which one lateral was given for each row of chilli crop was 3.8 when compared with 3.9 for treatment in which one lateral was provided in between two rows of crops. This was mainly due to the reduction in investment cost of the drip system in the second case (Nadiya et al., 2013).

Water saving and water use efficiency with drip: Singandhupe et al. (2003) reported that there was 3.7–12.5% higher fruit yield with 31–37% saving of water while using drip system in tomato crop when compared to surface irrigation. Water use efficiency in drip irrigation, on an average was 68% and 77% higher over surface irrigation in two consecutive year trials. Aujla et al. (2007) reported that 50% water saving could be achieved through drip irrigation in brinjal while obtaining 4% yield increase as compared to furrow irrigation. Drip irrigation with fertigation in Brinjal gave superior fruit yield and saved 37-49% water when compared to surface irrigation Goswami et al. (2006). Sivanappan (1979) gave similar findings in brinjal, tomato and chilli.

Effect of drip irrigation on yield: Rajbir et al. (1999) reported that drip irrigation at 80% pan evaporation gave significantly higher fruit yield in tomato (45.57 tha\(^{-1}\)) compared with surface irrigation (29.43 tha\(^{-1}\)). Aujla et al., 2007 studied the effect of various irrigation levels and nitrogen levels in brinjal, and came out with the conclusion that fruit yield was maximum at irrigation level of 75% of furrow irrigation and 120 kg Nitrogen per hectare. According to Manjunatha (2004), plant height, branches and fruits/plant were better under drip irrigation than under surface irrigation in brinjal with a fruit yield of 26.2 tha\(^{-1}\) and water-production efficiency of 69.3 kg/ha-mm.

Fertigation: Two important inputs to agriculture are water and fertilizers. Their application is interrelated and also affects the growth and yield of plants. In fertigation through drip system, the fertilizers are also applied to the rootzone of the plants and the improved application efficiency of fertigation is as a result of small and controlled amount of fertilizers applied as against the earlier practice of placing large amount of fertilizers in the beds at the beginning of the season (Dangler and Locascio, 1990). Fertigation reduces the use of fertilizers and at the same time increases the yield in most of the vegetables (Tiwari et al., 2003; Vijayakumar et al., 2010).

Effect of fertigation on growth parameters: Hebbar et al. (2004) reported that the total dry matter (TDM) production and leaf area index (LAI) of tomato crop were significantly higher in drip irrigation (165.8 g and 3.12, respectively) over furrow irrigation (140.2 g and 2.25, respectively) while water soluble fertilizer (WSF) fertigation recorded a TDM and LAI OF 181.9 g and 3.69 respectively. Application of high dose of fertilizers not only cause economic loss, but also it leads to chemical changes in soil and reduces the yield (Hongal and Nooli, 2007).

Effect of fertigation on yield attributes: Fruit yield of 45.7 tha\(^{-1}\) was obtained for tomato with application of recommended dose of fertilizers using polyfeed (19:19:19), MAP (12:60:0) and urea through fertigation, which was 22-27% higher compared to the crop which was provided with ordinary fertilizers through soil application (Prabhakar and Hebbar, 1996). In brinjal, highest yield of 42.33 tha\(^{-1}\) was recorded in drip irrigation at 75% of recommended N and K with maximum shoot length and number of branches per plant when compared to other levels of irrigation and fertigation (Vijayakumar et al., 2010). When different irrigation levels and nitrogen application levels were compared in brinjal, the highest yield (which was 23% higher) was obtained at 75% of surface irrigation and 120 kg nitrogen per hectare with the saving of 25% water and 30 kg N ha\(^{-1}\) as compared with the maximum yield obtained in furrow irrigation (Aujla et al., 2007).

Saving of fertilizers in fertigation: Singandhupe et al., 2003 reported that application of nitrogen through the drip in ten equal splits at 8-days interval saved 20-40% nitrogen as compared to the furrow irrigation and nitrogen application in two equal splits (as in conventional method). The water and fertilizer saving in vegetables through drip fertigation is around 40-70% and 30-50% respectively (Rakha, and Mahavishnan, 2008).

Effect of mulching: Mulch materials improve conservation of soil moisture during dry period (Gilsha Bai et al., 1998, Luchov et al., 1988) and minimize soil erosion, weed problems and nutrient loss (Clough et al., 1990). Beneficial effects of mulching like earliness in yield (Decoteau et al., 1989) and reduction in insect and disease problems (Greenough et al., 1990) was also reported. Black plastic mulch is most commonly used in agriculture. It was reported that there was 15% moisture conservation in brinjal (Manjari Gota) due to black polyethylene mulching and 20% saving in a Mahyco variety (NCPAH, 1991). Clear plastic mulch also used in some areas due to its increased soil warming characteristics.
Research has shown that white or aluminum reflective mulch also repels aphids which spread some virus diseases in vine crops such as squash (Bharadwaj, 2013).

**Effect of fertigation and mulching on weed control and yield**: Black plastic mulch was most effective in weed control in tomato and brinjal and resulted in more crop growth and higher fruit yield when it was compared with organic mulches like cassava peel, giant star grass and guinea grass straw (Asiegbu, 1991). A fruit yield of 57.89 t ha\(^{-1}\) was obtained through fertigation when compared to an yield of 45.57 t ha\(^{-1}\) under drip alone (Rajbir et al., 1999). Results obtained by Hatami et al. (2012) demonstrated that polyethylene mulch had a significant effect on weed density. The best treatment of mulch for yield increase, early yield and weed control was the mulch application of full ridge and half furrow when compared with similar other treatments. Tiwari et al. (1998) reported that 100% irrigation requirement met through drip irrigation along with black plastic mulch gave the highest yield in okra with 72% increase in yield as compared to furrow irrigation. Vijayakumar et al., (2010) reported that highest water use efficiency of 111.5 kg ha\(^{-1}\)mm\(^{-1}\) and nitrogen and potassium use efficiencies were recorded with drip irrigation at 75% pan evaporation and 75% N and K fertigation.

**Fertigation automation**: The demand for fertilizers depends on the stage of crop growth. A fertigation scheduling plan is often compounded by the changing demands of fertilizer requirements of growing plants. Automation systems based on the use of sensors have been developed for fertigation by various researchers. Kaur and Kumar (2013) developed a Microcontroller for inputting the fertilizers into the mixing tank based on the pH and EC level in the mixing tank solution. pH and EC level of fertilizer solution is maintained on the basis of output readings of EC and pH sensors. An automatic feeding system for fertilizers based on the measurement of essential nutrients in the soil was developed by Boopathy et al. (2014) for effective growth and increase in yield.

**CONCLUSION**

Drip irrigation is preferred over conventional methods of irrigation because of its high water application efficiency, mainly because of reduction in conveyance losses, deep percolation losses and evaporation losses. Uniform application of water to the rootzone of the crop helps in maintaining optimum moisture in the root zone and at the same time proper soil aeration is available. This helps in increasing the production. Fertiliser application through drip system (fertigation) helps in proper utilization of fertilizers, saves labour and increases the productivity. Mulching can make effective change in increasing horticultural crop production in water scarcity regions. Plastic mulching using black polyethylene is recommended for vegetables and has the advantages of attaining earliness in production, better fruit quality and greater total yield.

**REFERENCES**


