Original Research Article

Role of Colour Plastic Mulching and Drip Irrigation Levels on Water Saving and Economics of French bean (*Phaseolus vulgaris* L.)

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**A B S T R A C T**

An experiment was conducted to examine the effect of different plastic colour mulches viz., white on black, silver on black and complete black on water saving and yield of French bean (*Phaseolus vulgaris* L.) variety Arka Komal under different drip irrigation levels at Raichur, is situated in the Northeastern dry zone which comes under Zone II in region-1 of Karnataka. The treatments were laid in split plot design with four replications and sixteen treatments. The irrigation levels used were 60, 80, 100 and 120 per cent of ET. The depth of water applied for 60, 80, 100 and 120 per cent of ET was 110.94 mm, 147.92 mm, 185.10 mm and 222.09 mm, respectively. The per cent of water saving over 100 per cent ET was 40.06, 20.08 and 19.98 for 60, 80 and 120 per cent ET, respectively. The cost benefit ratio of French bean was highest in white on black plastic mulch with 80 per cent ET.

**Keywords**

Drip irrigation, Evapotranspiration, Plastic colour mulches, Water use efficiency

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**Introduction**

Water management efficiency is a key issue for sustainable agriculture development. The relationship between yield and applied water will allow improving the management of water resources under water scarcity. Drip irrigation is one method of on-farm water application optimizing the water use for crop production. Drip irrigation has proved to be a success in terms of water and increased yield in a wide range of crops.

Drip irrigation system was used to maximize yield and quality by taking the advantage of the management control provided by drip irrigation. This technology not only uses each drop of water most efficiently but also results in good crop growth and yield advantage due to stable moisture content maintained always in the root zone of the crop by way of frequent irrigation at shorter intervals. The drip irrigation method is characterized by low rate of water application over a long period of time at frequent intervals into the plant root zone.

Drip irrigation is being used in row crops such as cabbage, potato, cassava, etc. in water scarcity areas. There is considerable saving of irrigation water by adopting drip irrigation method, since water can be applied almost precisely and directly in the root zone without
wetting the entire surface area (Bafna et al., 1993). The benefits of drip irrigation may include better crop survival, minimal yield variability and improved crop quality (Martin et al., 1994).

Plastic mulching has become a globally applied agricultural practice for its instant economic benefits such as higher yields, earlier harvests, improved fruit quality and increased water-use efficiency. The sustainability of plastic mulching remains vague in terms of both an environmental and agronomic perspective. The quantification of micro plastics in soil remains challenging due to the lack of appropriate analytical techniques. The cost and effort of recovering and recycling used mulching films may offset the aforementioned benefits in the long term. French bean (Phaseolus vulgaris L.) is an important vegetable crop belonging to the family Fabaceae and originated in Central and South America (Swiader et al., 1992). It is also known as kidney bean, snap bean, pinto bean, green bean, navy bean, pole bean, wax bean, string bean (Hossain, 2007).

Materials and Methods

The experiment was carried out during rabi 2016-17 at research field, College of Agricultural Engineering, Raichur. The experiment was laid out in split plot design with 16 treatments and 4 replications on black soil. The main treatments were irrigation levels viz., drip irrigation at 60 per cent ET (I1), drip irrigation at 80 per cent ET (I2), drip irrigation at 100 per cent ET (I3) and drip irrigation at 120 per cent ET (I4) along with different coloured plastic mulches as sub treatment viz., white on black plastic mulch (M1), silver on black plastic mulch (M2), black plastic mulch (M3) and without mulch (M0). The irrigation was applied daily based on the cumulative pan evaporation data of previous day and information obtained from the agrometeorological data. The objective of the experiments was to find out suitable irrigation level and colour plastic mulch for water saving and economics of French bean.

Treatment details

Main treatments

I1- water application at 60 per cent ET using drip irrigation
I2- water application at 80 per cent ET using drip irrigation
I3- water application at 100 per cent ET using drip irrigation
I4- water application at 120 per cent ET using drip irrigation

Sub-treatments

M0 –Without mulch
M1– White on black plastic mulch
M2 – Silver on black plastic mulch
M3 –Black plastic mulch

Results and Discussion

Water is a basic resource on earth for all living organisms including mankind and for development and survival of plant community. Drip irrigation can potentially provide high application efficiency and achieve high application uniformity. Both are important in producing uniformly high crop yields and preserving water quality when both water and chemicals are applied through the irrigation system.

Water saving through drip irrigation

The experimental results revealed that there was considerable amount of water saving by using different irrigation levels.
**Table 1** Depth of water applied to French bean under different levels of drip irrigation during *Rabi* 2016-17

| Month                     | Depth of water applied at different irrigation levels, mm |
|---------------------------|---------------------------------------------------------|
|                           | $I_1$ (60% ET) | $I_2$ (80% ET) | $I_3$ (100% ET) | $I_4$ (120% ET) |
| **28 to 31<sup>st</sup> October 2016** | 1.03           | 1.37           | 1.72           | 2.06           |
| **November, 2016**        | 19.80          | 26.41          | 33.07          | 39.67          |
| **December, 2016**        | 50.25          | 67.01          | 83.78          | 100.56         |
| **January, 2017**         | 39.86          | 53.13          | 66.53          | 79.80          |
| **Total**                 | **110.94**     | **147.92**     | **185.10**     | **222.09**     |
| **Per cent saving over $I_3$** | 40.06          | 20.08          | 0.00           | -19.98         |

**Table 2** Water requirement, water saving and water use efficiency of French bean crop during 2016-17

| Sl. No. | Treatment                                                   | Quantity of water applied, cm | Water saving, % | Yield, q ha<sup>-1</sup> | WUE, q ha<sup>-1</sup> cm<sup>-1</sup> |
|--------|------------------------------------------------------------|-------------------------------|----------------|--------------------------|------------------------------------------|
| 1      | Drip irrigation at 60% ET+ white on black plastic mulch    | 12.75                         | 40.06          | 100.00                   | 7.84                                     |
| 2      | Drip irrigation at 60% ET + silver on black plastic mulch | 12.75                         | 40.06          | 86.10                    | 6.75                                     |
| 3      | Drip irrigation at 60% ET + black plastic mulch           | 12.75                         | 40.06          | 97.50                    | 7.64                                     |
| 4      | Drip irrigation at 60% ET + without mulch                 | 12.75                         | 40.06          | 98.90                    | 7.75                                     |
| 5      | Drip irrigation at 80% ET + white on black plastic mulch  | 16.89                         | 20.08          | 157.40                   | 9.31                                     |
| 6      | Drip irrigation at 80% ET + silver on black plastic mulch| 16.89                         | 20.08          | 149.90                   | 8.87                                     |
| 7      | Drip irrigation at 80% ET + black plastic mulch           | 16.89                         | 20.08          | 135.20                   | 8.00                                     |
| 8      | Drip irrigation at 80% ET + without mulch                 | 16.89                         | 20.08          | 120.00                   | 7.10                                     |
| 9      | Drip irrigation at 100% ET + white on black plastic mulch | 21.11                         | 0.00           | 114.90                   | 5.44                                     |
| 10     | Drip irrigation at 100% ET + silver on black plastic mulch| 21.11                         | 0.00           | 104.60                   | 4.95                                     |
| 11     | Drip irrigation at 100% ET + black plastic mulch          | 21.11                         | 0.00           | 100.30                   | 4.75                                     |
| 12     | Drip irrigation at 100% ET + without mulch                | 21.11                         | 0.00           | 116.60                   | 5.52                                     |
| 13     | Drip irrigation at 120% ET + white on black plastic mulch | 25.34                         | -19.98         | 73.40                    | 2.89                                     |
| 14     | Drip irrigation at 120% ET + silver on black plastic mulch| 25.34                         | -19.98         | 88.50                    | 3.49                                     |
| 15     | Drip irrigation at 120% ET + black plastic mulch          | 25.34                         | -19.98         | 68.20                    | 2.69                                     |
| 16     | Drip irrigation at 120% ET + without mulch                | 25.34                         | -19.98         | 57.80                    | 2.28                                     |
The depth of water applied for 60, 80, 100 and 120 per cent of ET was 110.94 mm, 147.92 mm, 185.10 mm and 222.09 mm, respectively. The per cent of water saving over 100 per cent ET was 40.06, 20.08 and -19.98 for 60, 80 and 120 per cent ET, respectively represented in Table 1. This might be due to the fact that maximum amount of water would be stored in the root zone and deep percolation losses would be minimum at lower irrigation levels (Tagar et al., 2012 and Gupta et al., 2010).

**Economics**

The results on the economics of the French bean cultivation are presented in Table 3. Scrutiny of the same showed that highest cost of cultivation per hectare Rs. 96,678 was incurred with the treatment of colour plastic mulches. Whereas the lowest cost of cultivation Rs. 75,958 was noticed in the treatment without plastic mulch. The maximum net returns per hectare Rs. 3,75,522 were obtained under white on black plastic mulch with 80 per cent ET. The results showed that the highest benefit-cost (BC) ratio of 3.88 was obtained under drip irrigation (Tiwari et al., 1998, Bhatt et al., 2011 and Reddy et al., 2012) at 80 per cent ET with white on black plastic mulch while the lowest

| Treatment | Crop yield, t ha^{-1} | Cultivation cost, Rs ha^{-1} | Total returns, Rs ha^{-1} | Net returns, Rs ha^{-1} | Benefit cost ratio |
|-----------|------------------------|-----------------------------|---------------------------|-------------------------|-------------------|
| I_{1}M_{0} | 9.89                   | 75,958                      | 2,96,700                  | 2,20,742                | 2.90              |
| I_{1}M_{1} | 10.00                  | 96,678                      | 3,00,000                  | 2,03,322                | 2.10              |
| I_{1}M_{2} | 8.61                   | 96,678                      | 2,58,300                  | 1,61,622                | 1.67              |
| I_{1}M_{3} | 9.75                   | 96,678                      | 2,92,500                  | 2,20,742                | 2.02              |
| I_{2}M_{0} | 12.00                  | 75,958                      | 3,00,000                  | 2,84,042                | 3.73              |
| I_{2}M_{1} | 15.74                  | 96,678                      | 4,72,200                  | 3,75,522                | 3.88              |
| I_{2}M_{2} | 14.99                  | 96,678                      | 4,49,700                  | 3,53,022                | 3.75              |
| I_{2}M_{3} | 13.52                  | 96,678                      | 4,05,600                  | 3,08,922                | 3.19              |
| I_{3}M_{0} | 11.66                  | 75,958                      | 3,49,800                  | 2,73,842                | 2.83              |
| I_{3}M_{1} | 11.49                  | 96,678                      | 3,447,00                  | 2,48,022                | 2.65              |
| I_{3}M_{2} | 10.46                  | 96,678                      | 3,13,800                  | 2,17,122                | 2.24              |
| I_{3}M_{3} | 10.03                  | 96,678                      | 3,00,900                  | 2,04,222                | 2.11              |
| I_{4}M_{0} | 5.78                   | 75,958                      | 1,73,400                  | 97,442                  | 1.28              |
| I_{4}M_{1} | 7.34                   | 96,678                      | 2,20,200                  | 1,23,522                | 1.27              |
| I_{4}M_{2} | 8.85                   | 96,678                      | 2,65,500                  | 1,68,822                | 1.74              |
| I_{4}M_{3} | 6.82                   | 96,678                      | 2,04,600                  | 1,07,922                | 1.11              |
BC ratio of 1.11 was recorded in treatment drip irrigation at 120 per cent ET with black plastic mulch. It is concluded that drip irrigation at 80% ET with white on black plastic mulch resulted in significantly high yield, water use efficiency and maximum benefit cost ratio. The drip irrigation system giving a saving of 40 per cent of water and the economic analysis of all the treatments revealed that the ideal combination of highest net returns and benefit cost (BC) ratio was drip irrigation at 80 per cent ET with white on black plastic mulch.

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