GROWTH AND YIELD OF CABBAGE *(BRASSICA OLERACEA VAR. CAPITATA L.)* UNDER MULCH WITH DRIP IRRIGATION IN RAICHUR CONDITION

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Abstract: An experiment was conducted to investigate the effect mulch and without mulch with three level of drip irrigation viz., 80% 100% and 120% ET and furrow irrigation on cabbage growth and yield under Raichur climate. The study showed that the drip irrigation saved water at the levels of 80, 100 and 120 per cent ET over furrow irrigation system was found to be 62.06, 54.50 and 46.94 per cent respectively. The better plant growth, more number of leaves per plant and higher leaf area were observed in under plastic mulch with drip irrigation. The highest yield was recorded in 100% ET with mulch plot ((92.95 t ha\(^{-1}\)) and lowest yield was observed in furrow irrigation without plastic mulch (50.64 t ha\(^{-1}\)). The plastic mulch increased the yield 8.82% more than the without plastic mulch field.

Keywords: Cabbage, Growth, *Brassica oleracea*

INTRODUCTION

Cabbage (*Brassica oleracea var. capitata* L.) is one of the most important vegetable under extensive cultivation in India and other countries. It can be grown in wide range of soils ranging from light sandy loams to heavy clay soils and requires moderate pH. India is the second largest cabbage growing country (after China) in the world. India is one of the most important cabbage growing countries in Asia with an area of 369 thousand ha and a production of 7,949 Mt with a productivity of 21.5 Mt ha\(^{-1}\) (Anonymous, 2011). West Bengal is the largest grower of cabbage followed by Orissa and Bihar occupying second and third position respectively. The other major growing states of cabbage are Assam, Karnataka, Maharashtra and Gujarat. Karnataka occupies an area of 7,967 ha with a production of 1,48,974 t and productivity of 25,025 kg ha\(^{-1}\) (Anonymous, 2005). In Karnataka, Belgaum district is having maximum area under cabbage cultivation and ranks first in area and production in the state. The area during the year 2007-08 was 1,021 ha which accounted for 14.10% of the total area under cabbage in the state with the production of 24,400 t, which is accounted for 16.18% of the total cabbage production of the state. Maximising of the yield is essential to serve the increasing population of our country. Adoption of recent agricultural techniques can also help to full fill the requirement. The use of both plastic mulch and drip irrigation system is the best method to improve the growth and yield of the crop (Jumah and Nassim, 2005). The mulching of soil reduces water loss through evaporation, and therefore increases the water available to plants (Langdale et al., 1992) this will leads to the better plant growth, higher yield of the crop (Andino and Motsenbocker, 2004). Adoption of surface drip irrigation system along with plastic mulch, save irrigation water by 15–51% with 11–80% more yield compare to the conventional irrigation system (Zotarelli et al., 2009).

The main objective of the study was to know the effects of mulch, without mulch, drip irrigation and furrow irrigation on cabbage growth and yield under Raichur condition.

MATERIAL AND METHOD

Field experiments were conducted during the year 2012-13 in rabi season. The experiments were located at New Orchard of Main Agricultural Research Station, University of Agricultural Sciences, Raichur. The soil of the experimental plot was sandy loam, having sand 74.62%, silt 11.35% and clay 14.03%. The pH of the soil was 7.70 and organic carbon 0.24%. The maximum temperature and ET during the cropping period was 35.4 “C and 5.8 mm day\(^{-1}\) and the minimum was 27.8 “C and 1.2 mm day\(^{-1}\) respectively. Shila F1 hybrid variety of cabbage was transplanted in the experimental plot at a spacing 0.5 x 0.45 m in a paired row. In the experiment 25μ thickness plastic mulch were used. The experiment was laid out in split plot design with two main treatments, four sub treatments and three replications. Design treatments are as follows.

- **Main treatments**
  - M\(_1\) - Cabbage with mulch condition
  - M\(_2\) - Cabbage without mulch condition

- **Sub-treatments**
  - T\(_1\) - Water application at 80% ET using drip irrigation
  - T\(_2\) - Water application at 100% ET using drip irrigation
  - T\(_3\) - Water application at 120% ET using drip irrigation
  - T\(_4\) - Water application at 100% ET using surface irrigation

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In each treatment the length of bed was 10 m long, 0.8 m width and 0.4 m spacing was given between the beds. In furrow irrigation 1.0 m spacing was given to avoid the moisture movement from one plot to another plot. Dippers at 2 litres per hour (l h⁻¹) capacity of inline drip were used at a spacing of 40 cm for in drip irrigation treatments. Amount of irrigation water applied to drip treatments were based on daily pan evaporation readings. The water requirement of the crop was calculated based on the following equation.

\[ WR = \frac{A \times B \times C \times D}{E} \]

WR = Water requirement of a plant, (l day⁻¹ plant⁻¹)

A = Pan Evaporation, (mm).

B = Amount of area covered with foliage (canopy factor), fraction

C = Crop co-efficient, fraction

D = spacing of the crop (0.5 x 0.45 m)

E = efficiency of drip irrigation, (considered as 90 per cent)

The plant height and leaf area was calculated using scale. Leaf area was calculated by following formula suggested by Rao (1978), expressed as cm² per plant.

\[ A = 0.9817 \times B^{1.1270} \times L^{0.7503} \]

Where,

A = actual area, (cm²)

B = Maximum breadth, (cm)

L = Length of leaf, (cm)

RESULT AND DISCUSSION

Before start of the experiment both drip and furrow irrigation moisture content was brought to the level of field capacity so as to monitor the moisture depletion critically in all the treatments. Subsequently the irrigation water was delivered under drip irrigation as per treatments and in furrow irrigation the crop was irrigated at variable frequency (100% ET) and depth of irrigation was calculated. The amount of water delivered per month from October to January to cabbage under different levels of drip irrigation and furrow irrigation are presented in Table 1.

<table>
<thead>
<tr>
<th>Month</th>
<th>Amount water applied through drip irrigation at different irrigation levels, (l)</th>
<th>T4 (Water Applied in furrow irrigation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15th October</td>
<td>T1 (80% ET)</td>
<td>T2 (100% ET)</td>
</tr>
<tr>
<td>October (16 days)</td>
<td>9.38</td>
<td>9.38</td>
</tr>
<tr>
<td>November</td>
<td>8.88</td>
<td>11.10</td>
</tr>
<tr>
<td>December</td>
<td>16.45</td>
<td>20.56</td>
</tr>
<tr>
<td>January (16 days)</td>
<td>7.36</td>
<td>9.20</td>
</tr>
<tr>
<td>Total</td>
<td>43.88</td>
<td>52.51</td>
</tr>
<tr>
<td>% saving water over furrow</td>
<td>48.01</td>
<td>37.80</td>
</tr>
</tbody>
</table>

For drip irrigation at 80% ET in both mulch and without mulch, the monthly water requirement varied from 18.81 l in October to 16.45 l in December. Similarly, the amount of water required for 80, 100 and 120% ET as given in table. For furrow irrigation in both mulch and without mulch, the water requirement varied from 10.95 l in October to 29.10 l December in December. The water saving under drip irrigation system at the levels of 80%, 100% and 120% ET over furrow irrigation system was found to be 48.01%, 37.80% and 27.58% respectively. From the experimental results it was observed that there is considerable amount of water saving by drip irrigation system as compared to furrow irrigation system. This was be due to the fact that maximum amount of water will be stored in the root zone and deep percolation losses will be minimum at lower irrigation levels. These results are agreement with the findings of Tagar et al. (2012).
Table 2. Irrigation capacity (duty) of 1 m$^3$ of water and delta of water for different treatments for the crop period

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Water applied in (l plot$^{-1}$)</th>
<th>Water applied in (m$^3$ ha$^{-1}$)</th>
<th>Irrigation capacity (ha m$^{-3}$)</th>
<th>Delta (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T$_1$</td>
<td>1930.73</td>
<td>2413.41</td>
<td>0.0004</td>
<td>24.13</td>
</tr>
<tr>
<td>T$_2$</td>
<td>2310.23</td>
<td>2887.79</td>
<td>0.0003</td>
<td>28.88</td>
</tr>
<tr>
<td>T$_3$</td>
<td>2689.73</td>
<td>3362.17</td>
<td>0.0003</td>
<td>33.62</td>
</tr>
<tr>
<td>T$_4$</td>
<td>3714.04</td>
<td>4642.55</td>
<td>0.0002</td>
<td>46.43</td>
</tr>
</tbody>
</table>

**Growth Parameters**

The effects of mulch and without mulch with different levels of drip irrigation were compared with furrow irrigation treatment on the basis of vegetative parameters of cabbage crop. The results of the same are presented below.

1). Plant height: The effect of mulch, without mulch and irrigation at different level on plant height at 30, 60 days after transplanting and at the time of harvest are presented in Fig. 1. The results indicated that the maximum height of the plant was recorded in mulch with drip irrigation in different periods of the crop as compare to the without mulch treatments with drip irrigation.

![Plant height in different stage of cabbage](image1.png)

**Fig. 1.** Effect of mulch, without mulch, irrigation methods and irrigation level on plant height in cabbage

2). Number of leaves: The data pertaining to number of leaves 30, 60 days after transplanting, and at the time harvest are presented in Fig. 2. It can be seen from the Fig. that the treatment with 100% ET with plastic mulch showed the highest number of leaves in all stages if the crop as compare to furrow irrigation without mulch.

3). Leaf area: The effect of mulch, without mulch and irrigation at different level on leaf area at 30, 60 days after transplanting and at the time of harvest are presented in Fig. 3. The maximum leaf area was observed in plastic mulch with drip irrigation as compare to mulch with furrow irrigation.

![Number of leaves at different stage of cabbage](image2.png)

**Fig. 2** Effect of mulch, without mulch, irrigation methods and irrigation level on Number of leaves on cabbage
Yield of the crop
The total marketable yield per hectare as influenced by mulch and without mulch, irrigation methods and levels of drip irrigation are presented in Table 3. Significant differences were noticed in yield due to irrigation methods as well as drip irrigation levels. In the main plot the plant under mulch recorded the maximum yield (81.24 t ha$^{-1}$) and the without mulch recorded the minimum yield (74.08 t ha$^{-1}$). A similar result has been reported in Mukherjee et al. (2010). Among the different irrigation level the plants receiving water at 100 per cent ET recorded significantly maximum yield (88.57 t ha$^{-1}$). The lowest yield was noticed in furrow irrigation treatment (52.93 t ha$^{-1}$). This was due to less percolation of water in the drip compare to furrow irrigation. The complimentary soil moisture which was easily available through drip directly to the root zone, will improve the yield of the cabbage. The present results are in line with the findings of Jinhui et al. (1999). The interaction effects treatment mulch with 100 per cent ET was recorded the maximum yield (92.95 t ha$^{-1}$) followed by 80 per cent ET with mulch (89.17 t ha$^{-1}$) which was on par with mulch and 120 per cent ET (89.63 t ha$^{-1}$). The minimum yield was noticed in without mulched with control treatment (50.64 t ha$^{-1}$). This was due to higher transpiration rate from the broader leaf even though plastic mulch reduces the evaporation from the soil. The present results obtained are in line with the findings of Tiwari et al. (2003) and Vijay Kumar et al. (2012).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Yield (t ha$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T1</td>
</tr>
<tr>
<td>M1</td>
<td>89.17</td>
</tr>
<tr>
<td>M2</td>
<td>81.69</td>
</tr>
<tr>
<td>Mean</td>
<td>85.43</td>
</tr>
</tbody>
</table>

**Table 3.** Effect of mulch, without mulch, irrigation methods and irrigation levels on yield for Cabbage

**CONCLUSION**

The water saved due to different drip irrigation treatments over furrow irrigation was 48.01 per cent under 80 per cent ET, 37.80 per cent under 100 per cent ET and 27.58 per cent under 120 per cent ET. So there was a considerable amount of water can save by using drip irrigation. The growth components like plant height, number of leaves per plant and leaf area were significantly influenced by irrigation. The maximum plant height, number of leaves per plant and leaf area was recorded under drip irrigation at mulch with 100 per cent ET when compared to others treatments throughout the growing period. The highest yield of 92.95 t ha$^{-1}$ was obtained for the treatment mulch with drip irrigation at 100 per cent ET but in same level of irrigation in without mulch treatment yield was 84.14 t ha$^{-1}$. So the use of mulch increases the yield of the crop.
REFERENCES


