

Original Research Article

Effect of different weed management practices on growth and yield of cabbage (*Brassica oleracea* var. *capitata* L.)

Abstract

As cabbage is cultivated with wide spacing, it is prone to profuse weed infestations, resulting in reduced crop yields and subsequent significant economic losses. A field experiment comparing different weed management treatments namely T₁ (two hand weedings), T₂ (paddy straw mulch), T₃ (Pre-emergent application of oxyfluorfen @ 1 kg *a.i./ha*), T₄ (PE application of pendimethalin @ 1.5 kg *a.i./ha*), T₅ (PE application of pendimethalin @ 1 kg *a.i./ha* + HW at 35 days after transplanting), T₆ (PE application of oxyfluorfen @ 1 kg *a.i./ha* + HW at 35 DAT), T₇ (Weed-free) and T₈ (Weedy check) was conducted to evaluate their efficacy on growth, yield and economics of cabbage (*Brassica oleracea* var. *capitata* L.). The results revealed that the maximum value of plant height, number of unwrapped leaves, fresh weight of heads, dry weight of heads and yield per hectare was obtained in plots under treatment T₇ (weed free). Similarly, in terms of weed parameters minimum weed count, weed dry weight, weed index and maximum weed control efficiency were observed in treatment T₇ (weed free). Maximum net return and benefit: cost ratio was observed under the treatment T₅ (PE application of pendimethalin @ 1 kg *a.i./ha* + one HW at 35 DAT), making it an economically practical option for controlling weeds in cabbage.

Keywords: Cabbage, herbicides, pendimethalin, weed index, yield.

INTRODUCTION

Cabbage (*Brassica oleracea* var. *capitata* L.), is one of the most important members of the Cole group of vegetables belonging to the family Brassicaceae. In India, it was grown on 0.42 million hectares with a production of 9.825 million tonnes. Major cabbage-producing states in India include West Bengal, Odisha, Madhya Pradesh and Gujrat (Anonymous 2022).

Farmers can face a substantial yield and economic loss due to weeds in cabbage if not controlled in timely manner. Weeds can reduce cabbage yields by up to 94.59 percent (Akshatha *et al.* 2018). They not only reduce the yield by increasing crop competition but also by acting as a host for pathogens and insects. Farmers typically have multiple options for weed control and their decision on which method to use is heavily influenced by economic factors (Singh *et al.* 2019). Weeds can be controlled by traditional cultural practices like hand weeding and use of mulching. Hand weeding is an effective approach for maintaining weed population but it often becomes impractical and uneconomical due to high labour costs and availability in time. Herbicides provide good weed control in the early season by inhibiting and slowing down their

growth but due to the widespread use of herbicides, the ensuing environmental pollution and its damaging effects in soil, water and the environment have been on the rise (Ustuner *et al.* 2020). Herbicide reliance may be reduced by combining it with other approaches. Therefore, it becomes important to develop an integrated approach that not only effectively manages the weeds to reduce the yield and economic losses but also establishes a sustainable agriculture approach by mitigating environmental risks.

MATERIAL AND METHODS

A field experiment was conducted during *Rabi* 2021-22 at the agriculture research farm of Abhilashi University at Mandi (H.P.) to find the effect of various weed management treatments on growth and yield of cabbage. The soil of the experimental field was low in available nitrogen, medium in available phosphorus and potassium content. RBD design was laid out in 3 replications with the combination of 8 treatments namely, T₁ (HW respectively at 25 and 45 DAT), T₂ (paddy straw mulch), T₃ (PE application of oxyfluorfen @ 1 kg *a.i./ha*), T₄ (PE application of pendimethalin @ 1.5 kg *a.i./ha*), T₅ (PE application of pendimethalin @ 1 kg *a.i./ha* + HW at 35 DAT), T₆ (PE application of oxyfluorfen @ 1 kg *a.i./ha* + HW at 35 DAT), T₇ (Weed-free) and T₈ (Weedy check). Plot size was 3 m × 2 m. Fertilizers were applied as per recommended dose. Thirty days old seedlings were transplanted at a distance of 60 cm × 45 cm followed by irrigation. Gap filling was carried out ten days after transplantation in order to maintain the plant population. The required amount of herbicide treatment wise was applied using 750 litres volume of water per hectare with the help of a knapsack sprayer. The required chemical was calculated using the formula:

$$\text{Chemical required} = \frac{\text{a.i./ha}}{\text{EC\%}} \times 100$$

Pre-emergence herbicides oxyfluorfen and pendimethalin were sprayed uniformly one day after transplanting the cabbage seedlings. Mulching was done by spreading a uniform layer of paddy straw. Hand weeding operations were carried out as per the treatment. Observations were made on five pre-tagged plants from each plot. The observations were recorded for growth and yield parameters *viz.*, plant height, number of unwrapped leaves per plant, fresh weight of heads, dry weight of heads and yield per plot. Weed parameters recorded were weed count, weed dry weight, weed control efficiency and weed index. For the assessment of dry weight, weeds within 0.25 m² area were uprooted, cleaned and dried at a temperature of 80 °C until constant weight is achieved. Weed control efficiency was recorded as per the formula suggested by Mani *et al.* (1973) and weed index (WI) was derived using the formula suggested by Gill and Kumar (1969). Prior to performing statistical analysis, the density of weeds and dry weight data underwent a square root ($\sqrt{x+0.5}$) transformation to enhance the homogeneity of variance for ANOVA. The economics was worked out on the basis of prevailing market prices.

RESULTS AND DISCUSSION

Growth and yield parameters

The data presented in Table 1 reveals that except for plant height at 30 DAT all the growth parameters were significantly affected by different weed control treatments. Significantly taller plants and the maximum number of leaves were recorded in treatment T₇ (weed free) followed by treatment T₆ (PE application of oxyfluorfen @ 1 kg *a.i./ha* + one HW at 35 DAT) while minimum values of these parameters were recorded under treatment T₈ (Weedy check). The increase in growth parameters in case of treatment T₇ (weed free) could be due to the absence of weeds during the crop growth period while on the other hand weeds reduced the plant growth in treatment T₈ (Weedy check) due to the increase in crop weed competition for nutrients, sunlight exposure and water. The findings are in conformity with the results of Sen *et al.* (2018) and Patil *et al.* (2022).

In case of yield parameters (Table 1) such as head fresh weight, head dry weight and yield per hectare different weed management treatments performed significantly better than treatment T₈ (weedy check). Highest values of head fresh weight, head dry weight and yield/ha were recorded under treatment T₇ (weed free) which was followed by treatment T₆ (PE application of oxyfluorfen @ 1 kg *a.i./ha* + one HW at 35 DAT). The high value of these parameters in these treatments might be due to the maximum availability of assimilates (light, moisture, nutrients and space) to the crop because of less crop weed competition. This resulted in an increase in the dry matter of crop and ultimately the yield. Sen *et al.* (2018), Atal *et al.* (2021) and Patil *et al.* (2022) observed similar results.

Weed studies

Remarkable influence of different weed control treatments could be observed on weed count and weed dry weight (Table 2). Treatment T₇ (weed free) recorded the minimum number of weeds and dry weight of weeds, followed by treatment T₆ (PE application of oxyfluorfen @ 1 kg *a.i./ha* + one HW at 35 DAT). This might be due to the fact that in weedy check plots, weeds were present throughout the crop growing season and also dry weight of weeds was taken at the end, which let weeds to occupy a good amount of space and obtain good growth, ultimately leading to increased dry matter accumulation. Previous workers, Kumar *et al.* (2015), Sen *et al.* (2018), Kaur *et al.* (2021) and Patil *et al.* (2022) reported similar results. Maximum weed control efficiency was recorded in treatment T₇ (weed free) followed by treatment T₆ (PE application of oxyfluorfen @ 1 kg *a.i./ha* + one HW at 35 DAT). Minimum value of this parameter was recorded under treatment T₈ (weedy check). From the results, it is evident that treatments that control weeds effectively consequently resulted in a higher percentage of weed control efficiency. Findings are in similarity to the results of Kumar *et al.* (2014), Sen *et al.* (2018) and Patil *et al.* (2022). In terms of weed index lowest values were obtained under treatment T₇ (weed free) followed by treatment T₆ (PE application of oxyfluorfen @ 1 kg *a.i./ha* + one HW at 35 DAT). The minimum weed index was recorded under treatment T₇ (weed free) followed by treatment T₆ (PE application of oxyfluorfen @ 1 kg *a.i./ha* + one HW at 35 DAT). Reason for the low weed index in these treatments might be due to the lower impact of weeds on yields. Similar results have been reported by Sen *et al.* (2018) and Patil *et al.* (2022).

Economics

The success of any practice hinges on its financial viability. To assess the economic benefits of different treatments, the marketable yield of the crop was converted as monetary returns. The highest net income and benefit: cost ratio (Table 2) was obtained under treatment T₅ (PE application of pendimethalin @ 1 kg a.i./ha + one HW at 35 DAT). Lowest net income and B: C ratio was obtained from treatment T₈ (weedy check). Though the weed free treatment resulted in better weed control and higher head yield, the net return and B: C ratio were still low due to the higher cost involved for human labour and the high cost of cultivation. Several workers have reported similar findings (Sen *et al.* 2018; Gupta *et al.* 2020; Patil *et al.* 2022).

CONCLUSION

From the study it may be concluded that keeping field weed free was effective for controlling weeds and getting higher yields but due to higher labour requirements and higher costs involved this method could not be considered. As the benefit: cost ratio was recorded higher under treatment T₅ (pendimethalin 1 kg a.i./ha + one HW at 35 DAT) it can be considered for controlling weeds in cabbage.

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Table 1. Effect of different weed management practices on growth and yield parameters in cabbage

| Treatments | Plant height (cm) | | | Number of unwrapped leaves | Fresh weight of heads (g) | Dry weight of unwrapped leaves (g) | Yield per hectare (q) |
|----------------------|-------------------|--------|------------|----------------------------|---------------------------|------------------------------------|-----------------------|
| | 30 DAT | 60 DAT | At harvest | | | | |
| T₁ | 11.60 | 18.78 | 22.08 | 12.60 | 429.87 | 19.29 | 136.19 |
| T₂ | 11.03 | 18.38 | 21.79 | 12.27 | 376.62 | 18.93 | 117.17 |
| T₃ | 12.43 | 20.14 | 24.82 | 13.93 | 484.66 | 23.36 | 155.73 |
| T₄ | 12.90 | 19.86 | 24.41 | 13.40 | 470.06 | 22.74 | 148.84 |
| T₅ | 12.86 | 20.95 | 25.57 | 14.20 | 491.98 | 23.85 | 172.18 |
| T₆ | 13.16 | 21.92 | 26.23 | 14.87 | 499.34 | 24.82 | 174.73 |
| T₇ | 13.22 | 22.36 | 27.34 | 15.47 | 522.97 | 25.72 | 188.63 |
| T₈ | 10.58 | 16.75 | 18.82 | 10.27 | 287.55 | 15.76 | 71.23 |
| SE(m) ± | 0.71 | 0.85 | 0.89 | 0.66 | 18.03 | 0.90 | 5.51 |
| CD at 5% | NS | 2.62 | 2.81 | 2.02 | 55.22 | 2.76 | 16.88 |

Table 2. Effect of different weed management practices on weed parameters and economics in cabbage

| Treatments | Weed count/0.25 m ² | | | Dry weight of weeds (g/0.25 m ²) | WCE (%) | WI (%) | Net return (₹ /ha) | B: C ratio |
|----------------|--------------------------------|-----------------|-----------------|--|---------|--------|--------------------|------------|
| | 25 DAT | 60 DAT | At harvest | | | | | |
| T ₁ | 3.25 (9.66) | 3.59 (12.00) | 4.78 (22.00) | 8.81 (76.72) | 56.14 | 27.94 | 108375 | 1.13 |
| T ₂ | 1.98 (3.00) | 3.44 (11.00) | 5.19 (26.00) | 9.25 (84.75) | 51.56 | 37.95 | 81229 | 0.86 |
| T ₃ | 1.71 (2.00) | 2.88 (7.33) | 3.95 (14.66) | 5.12 (25.27) | 85.64 | 17.37 | 137625 | 1.43 |
| T ₄ | 1.82 (2.33) | 2.99 (8.00) | 4.35 (18.00) | 6.06 (35.90) | 79.61 | 21.03 | 139310 | 1.66 |
| T ₅ | 1.82 (2.33) | 2.06 (3.33) | 3.55 (11.66) | 4.53 (19.62) | 88.83 | 8.73 | 167197 | 1.84 |
| T ₆ | 1.60 (1.66) | 1.90 (2.66) | 3.20 (9.33) | 3.84 (13.92) | 92.15 | 7.06 | 157986 | 1.52 |
| T ₇ | 1.00 (0.00) | 1.00 (0.00) | 1.00 (0.00) | 1.00 (0.00) | 100 | 0.00 | 154538 | 1.20 |
| T ₈ | 3.64 (12.33) | 5.16 (25.66) | 6.80 (45.33) | 13.29 (175.86) | 0.00 | 62.48 | 27190 | 0.34 |
| SE(m) ± | 0.15 | 0.15 | 0.11 | 0.20 | - | - | - | - |
| CD at 5% | 0.46 | 0.48 | 0.34 | 0.63 | - | - | - | - |

Data in parentheses was subjected to square root transformation