Original Research Article

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

Abstract

Cabbage due to a wider-spacedcrop becomes susceptible to weed infestations, causing significant economic losses and reduced crop yields.Reducing these losses due to weeds in this crop becomes essential. To counter this problem a field experimenfoodt was conducted to find the efficacy of various weed management practices on growth, yield and economics of cabbage (*Brassica oleracea* var. *capitata*L.)**.** The field experiment was conducted in a randomized block design with tree replications and eight weed management treatments. The results revealed that under crop studiesthe maximum value of plant height, number of unwrapped leaves, fresh weight of heads, dry weight of heads and yield per hectare was obtained under treatment T_7 (weed free). Similarly, in terms of weed parameters minimum weed count, weed dry weight, weed control efficiency and maximum weed index were observed in treatment T_7 (weed free). Maximum net return and benefit: cost ratio was observed under the treatment T_5(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, scientifically known as *Brassicaoleracea* var *capitata* L., is one of the most important membersofthe Cole groupof vegetables belonging to the family Brassicaceae. It is a nutrient-rich versatile vegetable with distinct round or oval-shaped heads formed by tightly packed leaves. It has been cultivated as a staple in many cuisines worldwidefor centuries. It is highly regarded for its nutritional value, versatility in culinary applications, and ease of cultivation. The popularity of cabbage is not surprising, considering its impressive nutritional profile. Packed with essential vitamins, minerals and dietaryfibre, cabbage offers a range of health benefits. It is an essential source of vitamin C, vitamin K, vitamin B6, folate, calcium potassium and manganese. In India, it was grown on 0.42 m ha with a production of 9.825 mtones. 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 cabbageif not controlled timely. Weeds can reduce cabbage yields by up to 94.59 percent(Akshatha2018). They not only reduce the yield by increasing crop competition but alsoby acting as a host for pathogens and insects.Due to this

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problem, understanding the various weed management practices and their impact on cabbage growth and yield becomes very important.

Due to its popularity among farmers, cabbage requires cost-effective and efficient weed control methods to meet the high demand.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 approachformaintaining weed population but not very acceptable due to high labour costs and time factors. Herbicides provide good weed control in the early seasonby inhibiting and slowing down their growth but due to the widespread use of herbicides natural environments are getting polluted and its damaging effects have started to appear in soil, water and the environment (Ustuner et al. 2020).Herbicide reliance should be reduced by combining it with other approaches. Therefore, it becomes important to select an integrated approach that not only reduces the yield and economiclosses but also establishesa sustainable agriculture approach by reducing environmental risks. Thus, by keeping these points in view the present study was planned to determine the effect of different weed management practices on growth, yield and economicsof cabbage

Materials 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,T_1(HW respectively at 25 and 45 DAT), T_2(paddy straw mulch), T_3(PE application of oxyfluorfen @ 1 kg a.i./ha), T_4 (PE application of pendimethalin @ 1.5 kg a.i./ha), T_5(PE application of pendimethalin @ 1 kg a.i/ha + HW at 35 DAT), T_6(PE application of oxyfluorfen @ 1 kg a.i./ha + HW at 35 DAT), T_7(Weed-free) and T_8(Weedy check). To prepare the experimental field, two ploughings followed by planking was practiced. Layout was formed by making of plots of size 3 m × 2 m. Appropriate amounts of fertilizers were applied in the plots by calculating their respective doses. Nitrogen (120 kg/ha) in the form of urea in two equal splits i.e., half before transplanting and the remaining half after one month of transplantingwhile full dose of phosphorus (75 kg/ha) in the form of single super phosphate and potassium (85 kg/ha) in the form of muriate of potash was applied before transplanting. Thirty days old seedlings were transplanted at a distance of 60 cm × 45 cm followed by irrigating the seedlings. 10 days after transplanting gap filling was done in order to maintain the plant population.

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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 covering the soil properly by spreading a uniform layer of paddy straw. Hand weeding operations were carried out as per the treatment.

For taking observations five plants were selected from each plot and were tagged. The observations were recorded for growth and yield parameters *viz.*,plant height, number ofunwrapped 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 taking dry weight weeds within 0.25 cm^2 area were uprooted, cleaned and dried at a temperature of 80 °C until constant weight is achieved. Weed control efficiency was recorded by the formula suggested by Mani et al. (1973) and the formula suggested by Gill and Kumar (1996) was used to calculate the weed index (WI). 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 on growth parameters presented in Table 1 reveals thatat 30 DAT the plant height was not significantly affected by different weed control treatments. Whereas, significantly taller plants (22.36 cm on60 DAT and 27.34 cm at harvest) and maximum number of leaves (15.47)wererecorded in treatment T_7 (weed free) followed by treatment T_6(PE application of oxyfluorfen @ 1 kg a.i./ha + one HW at 35 DAT) while minimum values of these parameters were recorded under treatment T_8 (Weedy check). The increase in growth parameters in case of treatment T_7 (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 treatmentT_8 (Weedy check) due to the increase in crop weed competition for nutrients, sunlight exposer and water. Findings are in conformity with the results of Sen et al. (2018) and Patil et al. (2022)

In case of yield parameters (Table 1) like head fresh weight, head dry weight and yield per hectare different weed management treatments performed significantly better than treatment T_8 (weedy check). Highest values of head fresh weight (522.97 g), head dry weight (42.61 g) and yield/ha (188.63 q) were recorded under treatment T_7 (weed free) which was followed by treatment T_6 (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.

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Weed studies

Table 2 reveals a remarkable influence of different weed control treatmentson data related to weed count and weed dry weight. Treatment T_7(weed free) recorded the minimum number of weeds(0.00/0.25 m^2at 25, 60 DAT and at harvest) and dry weight of weeds (0.0/0.25 m^2), it was followed by treatment T_6(PE application of oxyfluorfen @ 1 kg a.i./ha + one HW at 35 DAT). Whereas, maximum values of these parameters were obtained under treatment T_8 (Weedy check). This might be due to the fact thatin 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 (2015), Sen et al. (2018), Kaur et al. (2021) andPatil et al. (2022) reported similar results. Maximum weed control efficiency (100 %) was recorded in treatment T_7 (weed free)followed by treatment T_6 (PE application of oxyfluorfen @ 1 kg a.i./ha + one HW at 35 DAT). Minimum valueof this parameter was recorded under treatment T_8 (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 (2014), Sen et al.

(2018) and Patil et al. (2022). In terms of weed index lowest values were obtained under treatmentT_7 (weed free) followed by treatment T_6 (PE application of oxyfluorfen @ 1 kg a.i./ha + one HW at 35 DAT).The maximum weed index was recorded under the treatment T_8 (weedy check). Reason for the low weed index in these treatments could be due to the lower impact of weeds on yields. Findings are comparable to the results of Sen et at. (2018) and Patil et al. (2022).

Economics

The success of anypractice hinges on experimentation and its financial viability. Even if a treatment is deemed superior, farmers may reject it if it doesn't yield satisfactory financial gains.To assess the economic benefits of different treatments, the marketable yield of the crop is converted into monetary returns. Data in Table 2 indicates that the highest net income (₹ 167197) and benefit: cost ratio (1.84) was obtained under treatment T_5(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 T_8 (weedy check). Though the weedfree treatment resulted in better weed control and higher head yield, the net return and B:C ratio were still low due to the increased need for human labour and the high cost of cultivation. Sen et al. (2018), Gupta et al. (2020) and Patil et al.(2022) reported similar results.

Conclusion

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From the study it may be concluded that keeping field weed free was effective for controlling weeds and get 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 T_5 (pendimethalin 1 kg a.i. /ha + one HW at 35 DAT) it can be considered for controlling weeds in cabbage.

References

1. Anonymous. Department of Agriculture and Farmers Welfare, horticulture statistics. 2022. https://agricoop.nic.in/en/StatHortEst.
2. Atal MK, Verma RB, Singh VK, Haque MM, Kumar A, Singh SN. Effect of intercropping and weed management practices on growth and yield of cabbage (*Brassica oleracea* var. *capitata*).The Pharma Innovation Journal. 2021;10(8): 1719-1724.
3. Akshatha V, Prameela KP, Narayankutty C, Menon MV. Weed management in cabbage (*Brassica oleraceae* var. *capitata* L.). Journal of Tropical Agriculture. 2018;56(2):187-190.
4. Gill GS, Kumar V. Weed index, a new method for reporting weed control trials. Indian Journal of Agronomy.1969;4: 96-98.
5. Gupta RK, Bharti R, Shah MH, Pramanik K. Weed management in transplanted onion (*Allium cepa* L.) through early post-emergence herbicides. Plant Archives. 2020;20(2):6919-6924.
6. Kumar A, Manuja S, Singh J, Chaudhary DR. Integrated weed management in cauliflower (*Brassica oleracea* var. *botrytis*) under dry temperate climate of western Himalayas. Journal of Crop and Weed. 2015;11(2):168-171.
7. Kumar JS, Reddy KC, Rajkumar BV, Rao AM. Integrated weed management in cabbage. Annals of Plant and Soil Research. 2014;16(2):175-176.
8. Mani VS, Mala ML, Gautam KC, Bhagavandas. 1973. Weed Killing Chemicals in Potato Cultivation. Indian Farming. 23: 17-18.
9. Patil AG, Patil SV, Farooq Md, Singh VP, Mangesh. Evaluation of different weed management practices on growth and yield of cabbage (*Brassica oleracea* var. *capitata*.). The Pharma Innovation Journal. 2022;11(9): 2718-2722.
10. Sen S, Sharma RK, Kushwah SS, Dubey R. Effect of different weed management practices on growth and yield of cauliflower (*Brassica oleracea* var. *botrytis* L.). Ann. Plant Soil Res. 2018;20:63-68.
11. Singh M, Kaul A, Pandey V, Bimbraw AS. Weed Management in Vegetable Crops to Reduce the Yield Losses. International Journal of Current Microbiology and Applied Sciences. 2019;8(7):1241-1258.
12. Ustuner T, Sakran A, Almhemed K. Effect of herbicides on living organisms in the ecosystem and available alternative control methods. Int. J. Sci. Res. Publ. 2020;10:633-641.

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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				
T_1	11.60	18.78	22.08	12.60	429.87	19.29	136.19
T_2	11.03	18.38	21.79	12.27	376.62	18.93	117.17
T_3	12.43	20.14	24.82	13.93	484.66	23.36	155.73
T_4	12.90	19.86	24.41	13.40	470.06	22.74	148.84
T_5	12.86	20.95	25.57	14.20	491.98	23.85	172.18
T_6	13.16	21.92	26.23	14.87	499.34	24.82	174.73
T_7	13.22	22.36	27.34	15.47	522.97	25.72	188.63
T_8	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 1. Effect of different weed management practices on growth and yield parameters in cabbage

Treatments	Weed count/0.25 m^2	Dry weight of	WCE (%)	WI (%)	Net return	B: C ratio

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

	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	1.16
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 indicatesoriginal values

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