



Efficacy of Herbicides for Weed Control in Cauliflower (*Brassica oleracea* var. *botrytis* L.)

K. Choube^{1*}, D. K. Raidas², M. L. Jadav³ and N. S. Kirar⁴

¹Department of Horticulture (Vegetable Science), RVSKVV-RAK College of Agriculture, Sehore, 466001, (M.P.), India.

²Department of Plant Physiology, RVSKVV- RAK College of Agriculture, Sehore, 466001, (M.P.), India.

³Department of Soil & Water Engineering, AICRP for Dry Land Agriculture, RVSKVV- College of Agriculture, Indore (M.P.), India.

⁴Department of Agronomy, SRF- NAHEP, RVSKVV- RAK College of Agriculture, Sehore, 466001, (M.P.), India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2021/v33i2030646

Editor(s):

(1) Prof. Al-Kazafy Hassan Sabry, National Research Centre, Egypt.

Reviewers:

(1) V. P. Karthika, Kerala Agricultural University, India.

(2) Gautam Saha, Bidhan Chandra Krishi Viswavidyalay, India.

Complete Peer review History: <https://www.sdiarticle4.com/review-history/74210>

Review Article

Received 16 July 2021
Accepted 26 September 2021
Published 05 October 2021

ABSTRACT

A field experiment was conducted during *Rabi*, 2018-19 at Horticulture farm, RAK College of Agriculture, Sehore (M.P.) to study the effect of different weed management practices on growth and yield of cauliflower. The treatments namely - T₁- Weedy check (control), T₂- Weed free (through hand weeding) at 30 & 60 DAT, T₃-Pendimethalin 30% EC (PE) + one hand weeding at 30 DAT, T₄ Oxyfluorfen 23.5% EC (PE) + one hand weeding at 30 DAT, T₅ - Propaquizafop 10% EC (POE) + one hand weeding at 60 DAT, T₆-Wheat straw mulch 5kg/plot, T₇- Black plastic mulch (150 mm) were evaluated in randomized block design with three replications. Results indicated that there was no weed under T₇-black plastic mulch (150 mm) at all the stages. The maximum weed control efficiency (98%) was found with the treatment T₇ - black plastic mulch (150 mm) at all the stages i.e. at 30, 60 and 90 DAT. The minimum weed index (0.00, 0.00 and 0.00%) was found with the treatment T₇ (Black plastic mulch (150 mm) at all the stages. The maximum curd length,

curd width, total curd weight (g) and curd yield ($q\ ha^{-1}$) was recorded T₇- black plastic mulch (150 mm) with the maximum net return (Rs. 75772.58 per ha). While the lowest net return was found under T₁ (Weedy check) (Rs. 21405.34 per ha) treatment. The maximum B: C ratio (1:4.0) was recorded in case of treatment T₃ [Pendimethalin 30% EC (PE) + 1HW at 30 DAT].

Keywords: Treatments; herbicides weed control efficiency; weed index; curd length; curd yield; economics.

ABBREVIATIONS

DAT : day after transplanting;
PE : pre emergence;
POE : post emergence;
Kg : Kilogram;
cm : centimetre;
Fig : Figures;
SE (m) : standard error of mean;
CD : critical difference;
% : percentage
EC : emulsifiable concentrate.

1. INTRODUCTION

Cauliflower (*Brassica oleracea* var. *botrytis* L.) is one of the most popular vegetable cole crops. It belongs to the family Brassicaceae and is mainly grown for its white tender curd, which is widely used as vegetable for curry, soup and pickle preparation. Beside, being a good source of proteins and carbohydrates, it is a rich source of vitamins and minerals. The curd extract is used as a traditional medicine in the treatment of scurvy, as a blood purifier and as an antacid. Its seed also have contraceptive properties. India ranks second in area and production of cauliflower in the world after China. In India major cauliflower growing states are west Bengal, Bihar, Maharashtra, Madhya Pradesh, Orissa, Gujarat and Haryana etc. It is grown in an area of 435.9 thousand hectares with production of 8573.3 thousand metric tons and productivity of 19.8 metric tons per hectare in India. In Madhya Pradesh, it is grown in an area of 25.1 thousand hectare with a production of 70.38 metric tons and highest productivity of 28.1 metric tons per hectare [1]. Cauliflower is a very sensitive crop and needs more care to grow successfully than most of other vegetables. In India annually undergoes considerable loss due to various production stresses and among these, weeds have been top the listed by contributing 33% total loss. Weeds remove the available nutrients from soil in large quantity ranging from 30 to 40 per cent. Weeds interfere with crop plants severely reduce crop growth and finally lower curd yield and quality [2]. Thus appropriate

choice for weed control in cauliflower would be needed an integration of cultural and herbicidal control together for boosting the cauliflower production. Besides hand weeding and herbicidal control, mulching (particularly plastic mulch and rice straw mulch) has also been advocated by many researchers as an effective mean for reducing weed population [3]. Thus, it is of utmost importance advisable and beneficial to go in for integrated approach or combinations of more than one method to achieve the desired results. Keeping in view the seriousness of weed problems, high cost of manual labour now and availability of different herbicides, the present investigation was planned to assess the effect of weed management practices on growth and yield of cauliflower.

2. MATERIALS AND METHODS

A field experiment was conducted at Research farm Department of Horticulture, RAK College of Agriculture, Sehore (M.P) during the *Rabi* season, 2018-19 on medium black soil. The experiment was laid out using seven different treatments in randomized block design, viz., T₁- Weedy check (control), T₂- Weed free (through hand weeding) at 30 & 60 DAT, T₃- Pendimethalin 30% EC (PE) + 1 HW at 30 DAT, T₄ Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT, T₅- Propaquizafop 10% EC (POE) + 1 HW at 60 DAT, T₆-Wheat straw mulch 5kg/plot, T₇- Black plastic mulch (150 mm) with three replications. All other crop production practices was adopted during growing season. The observations were recorded on weeds population (m^{-2}), weed control efficiency (%) and weed index (%) at 30, 60 and 90 days after transplanting of different treatments. The weed control efficiency (%) was calculated by using the formula given by Bangi et al. [4].

$$WCE (\%) = \frac{\text{Weed dry weight in weedy check} - \text{Weed dry weight in treatment}}{\text{Weed dry weight of weedy check}} \times 100$$

The weed index (%) was calculated by using the formula given by Gill and Vijay kumar [5]

Weed index (%)

$$= \frac{\text{Curd yield from the weed free check (A)} - \text{curd yield from the treatment (B)}}{\text{Curd yield from the weed free check (A)}} \times 100$$

The yield attributing characteristics viz. curd length (cm), curd width (cm), total curd weight (g) and curd yield (qha⁻¹) at the harvest. The benefit cost ratio was worked out by considering the cost of cultivation and gross monetary returns. The benefit cost ratio (B: C) was calculated for each treatment combination. Benefit cost ratio was worked out as follows.

$$B: C \text{ Ratio} = \frac{\text{Gross return (Rs per ha)}}{\text{Cost of cultivation (Rs per ha)}}$$

The mean data obtained on various treatments were statistically analyzed for all characters as per standard procedure given by Panse and Sukhtme, [6].

3. RESULTS AND DISCUSSION

3.1 Effect of Different Weed Management Practices on Weed Population (m⁻²), Weed Control Efficiency (%) and Weed Index (%)

The effect of different weed management practices on the weed population was noticed significant at 30, 60 and 90 DAT is presented in (Table 1). There was no weed under T₇ -black plastic mulch (150 mm) at all the stages i.e. at 30, 60 and 90 DAT. It was followed by T₂ -weed free (through hand weeding) at 30, 60 and 90 DAT (6.11, 9.91 and 14.77) and T₄ -Oxyfluorfen 23.5% EC (PE) + 1HW at 30 DAT at all stages (15.53, 17.98 and 24.38). The maximum weed population of 82.95, 118.49 and 181.46 weed population (m⁻²) was recorded under T₁ (weedy check) at 30, 60 and 90 DAT, respectively. All the weed management practices had significantly higher number of weeds as compared to T₇ (Black plastic mulch (150 mm)). Similar results were also reported by Mal et al. [2], Bana et al. [3], Kumar et al. [7] and Kumar et al. [8] in cauliflower and Nandal et al. [9] in cabbage.

Similarly the data presented in (Table 1) revealed remarkable effect of weed management practices on weed control efficiency were significant. The maximum weed control efficiency (98%) was found with the treatment T₇ - black plastic mulch (150 mm) at all the stages i.e. at

30, 60 and 90 DAT. It was followed by T₂ -weed free (through hand weeding) at 30, 60 and 90 DAT (68.95, 92.67 and 94.67) and T₄-Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT at all the stage i.e. 30 60 and 90 days after transplanting (60.66, 76.6) and 82.67). The minimum weed control efficiency (1.00 %) was recorded under the treatment T₁ (weedy check). It is apparent from the findings that those treatments which checked weed population and had lesser weed dry matter consequently resulted in higher weed control efficiency. These results are in conformity with those of Bana et al. [3] and Kumar et al. [8] in cauliflower.

The data recorded for weed index are presented in (Table 1) revealed remarkable effect of weed management practices. The minimum weed index (0.00, 0.00 and 0.00%) was found with the treatment T₇ (Black plastic mulch (150 mm) at all the stages i.e. at 30, 60 and 90 DAT. It was followed by T₂ -weed free (through hand weeding) at 30 & 60 DAT, at all stages i.e. is (17.30, 35.73, 42.66) and T₄- Oxyfluorfen 23.5% EC (PE) +1 HW at 30 DAT at all stage i.e. is (32.73, 36.70, 44.68). The maximum weed index (29.60, 34.90 and 51.50) was recorded under the treatment T₁ (weedy check) at all the stages i.e. at 30, 60 and 90 DAT. This could be described to the lower impact of weeds on yield under these treatments. These results are in line with those reported by Bana et al. [3], Kumar et al. [8] in cauliflower and Gandolkar et al. [10] in onion.

3.2 Effect of Weed Management Practices on Economics of Cauliflower

3.2.1 Curd length and curd width (cm)

The curd length and curd width at harvest of the crop is presented in (Table 2). The data indicated significant effect of weed management practices on curd length and curd width at harvest. The maximum value of curd length (9.79cm) and curd width (21.12cm) was found under the treatment T₇ -black plastic mulch (150 mm) followed by T₂ [Weed free (Through hand weeding) at 30 & 60 DAT] > T₃ [Pendimethalin 30% EC (PE) + 1 HW at 30 DAT] > T₄ (Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT). While the minimum value of curd length and curd width was found under T₁ - weedy check (7.08, 16.44) at harvesting stage. Similar finding were also reported by Bana et al. [3] in Cauliflower and Bakht and Khan [11] in tomato.

Table 1. Effect of weed management practices on weed population (m⁻²), WCE (%) and weed index (%) in cauliflower

Treatment	Weeds population (m ⁻²)			Weed control efficiency (%)			Weed index (%)		
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
T ₁	9.13 (82.95)	10.91 (118.49)	13.49 (181.46)	1.22 (1.00)	1.22 (1.00)	1.22 (1.00)	5.48 (29.60)	5.92 (34.90)	7.20 (51.50)
T ₂	2.56 (6.11)	3.23 (9.91)	3.91 (14.77)	8.33 (68.95)	9.65 (92.67)	9.76 (94.67)	5.22 (17.30)	6.02 (35.73)	6.57 (42.66)
T ₃	4.00 (15.55)	4.99 (24.39)	5.37 (28.33)	8.03 (63.98)	8.72 (75.67)	8.93 (79.33)	5.70 (32.00)	6.06 (36.27)	6.62 (43.33)
T ₄	4.00 (15.53)	4.30 (17.98)	4.99 (24.38)	7.82 (60.66)	8.78 (76.67)	9.12 (82.67)	5.76 (32.73)	6.10 (36.70)	6.72 (44.68)
T ₅	6.15 (37.30)	3.23 (9.92)	8.99 (80.33)	7.82 (60.73)	8.82 (77.33)	9.15 (83.33)	5.84 (33.57)	6.12 (36.97)	6.82 (45.98)
T ₆	8.73 (75.67)	8.25 (67.62)	11.04 (121.44)	7.76 (59.80)	8.69 (75.00)	9.17 (83.67)	5.90 (34.30)	6.21 (38.07)	6.87 (46.85)
T ₇	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	9.92 (98.00)	9.92 (98.00)	9.92 (98.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
SE (m) ±	0.064	0.038	0.035	0.13	0.13	0.14	0.11	0.08	0.15
CD at 5%	0.186	0.112	0.101	0.38	0.38	0.43	0.33	0.25	0.45

DAT- Day After Transplanting, T₁- Weedy check (control), T₂- Weed free (through hand weeding) at 30 & 60 DAT, T₃-Pendimethalin 30% EC (PE) + 1 HW at 30 DAT, T₄ Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT, T₅- Propaquizafop 10% EC (POE) + 1 HW at 60 DAT, T₆-Wheat straw mulch 5kg/plot, T₇- Black plastic mulch (150 mm)

Table 2. Effect of weed management practices on economics of cauliflower

Treatments	Curd length (cm)	Curd width (cm)	Total curd weight (g)	Curd yield (qha ⁻¹)	Gross return (₹/ha)	Cost of cultivation (₹/ha)	Net Income (₹/ha)	B:C Ratio
T ₁	7.08	16.44	251.56	107.03	107026.67	85621.33	21405.34	1:25
T ₂	9.27	20.32	563.67	241.14	241136.67	176012.16	65124.51	1:37
T ₃	8.47	19.29	435.25	201.09	201090.00	143635.71	57454.24	1:40
T ₄	8.18	18.62	380.48	167.60	167596.67	126012.53	41584.14	1:33
T ₅	7.65	18.14	330.36	150.39	150393.33	115687.17	34706.16	1:30
T ₆	7.23	17.50	313.45	125.61	125606.67	101295.70	24310.97	1:24
T ₇	9.79	21.12	659.41	280.56	280563.33	204790.75	75772.58	1:37
SEm±	0.32	0.60	21.06	7.03	-	-	-	-
CD 5%	0.99	1.85	64.90	21.67	-	-	-	-

3.2.2 Total curd weight (g) and curd yield (qha⁻¹)

The total curd weight (g) and curd yield (q ha⁻¹) at harvest of the crop is presented in (Table 2). The data indicated significant effect of weed management practices on total curd weight (g) and curd yield (q ha⁻¹) at harvest. The maximum total curd weight (659.41) and curd yield (280.56) was recorded under the treatment T₇ -(black plastic mulch (150 mm) followed by T₂ [Weed free (Through hand weeding) at 30 & 60 DAT] > T₃ [Pendimethalin 30% EC (PE) + 1HW at 30 DAT] > T₄ (Oxyfluorfen 23.5% EC (PE) + 1HW at 30 DAT), while the minimum curd weight and curd yield was recorded under T₁ (weedy check) at harvest. This can be attributed to increase in plant growth and ultimately yield attributing character which reduced crop weed competition. The increased stalk length, number of leaves, leaf length, fresh weight of plant and dry weight of plant are directly responsible for increasing dry matter production. Higher synthesis and accumulation of chlorophyll content in the plant part resulted in increasing the dry matter of crop and ultimately curd yield. Similar finding were also reported by Mal et al. [2], Qasem [12], Bana et al. [3] Sen et al. [13] in cauliflower and in cauliflower and Bakht and Khan [10] in tomato.

3.2.3 Economic of the different treatments

The data presented in (Table 2) revealed significant effect of weed management practices on economics of different treatments. The viability of any practice is evolved on the basis of experimentation and depends upon its economic feasibility. A best treatment, if not fetching appropriate monetary returns, may not be acceptable to farmers. With a view to evaluate various treatments in terms of their economic return, the marketable yield of the crop converted into monetary returns. The highest net return (Rs. 75772.58 per ha) was realized in case of treatment T₇ -black plastic mulch (150mm) while the lowest net return was found under T₁ (weedy check) (Rs. 21405.34 per ha) treatment. The maximum B:C ratio (1:4.0) was found in case of treatment T₃ [Pendimethalin 30% EC (PE) + 1HW at 30 DAT] followed by T₇ black plastic mulch (150mm), T₂ [Weed free (Through hand weeding) at 30 & 60 DAT], T₄ (Oxyfluorfen 23.5% EC (PE) + 1HW at 30 DAT), T₅ (Propaquizafop 10% EC (PoE) + 1HW at 60 DAT), and T₆ (Wheat straw mulch). T₁ (Weedy check) in descending order. While lowest net return (Rs.

21405.34 per ha) and B: C ratio (1:2.5) was found in case of treatment T₁ (Weedy check). The similar results are agreement with Nandal et al. [9] in cabbage, Bana et al. [3] and Kumar et al. [8] in cauliflower and Mohite et al. [14] in Garlic.

4. CONCLUSION

On the basis of present experiment, it may be conducted that maximum curd yield and lesser weed as well as maximum gross and net return was recorded by weed management practices T₇-black plastic mulch (150mm) followed by treatment T₂[Weed free (Through hand weeding) at 30 & 60 DAT]. But the highest B: C ratio (1:4.0) was obtained with weed management practices T₃ [Pendimethalin 30% EC (PE) + 1HW at 30 DAT]. Thus appropriate choice for weed control in cauliflower would be an integration of cultural and herbicidal combination for boosting the cauliflower production. Besides hand weeding and mulching (particularly plastic mulch) has also been advocated by many researchers as an effective mean for reducing weed population.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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