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

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ABSTRACT

A field experiment was conducted during Rabi, 2015-16 at College of Horticulture, Mandsaur (M.P.) to study the effect of different weed management practices on growth, yield and economics of cauliflower. The treatments namely T_1- Weedy check (control), T_2- Weed free, T_3 – Hand weeding at 25 & 45 DAT, T_4- Pendimethalin 30% EC (PE) + 1 HW at 30 DAT, T_5- Oxyfluorfen 23.5% EC (PE)+ 1 HW at 30 DAT, T_6- Propaquizafop 10% EC (POE) + 1 HW at 45 DAT, T_7- wheat straw mulch, T_8- black plastic mulch were evaluated in randomized block design with three replications. Results indicated that the T_2 (weed free) recorded maximum value of stalk length, number of leaves per plant, length of leaves, SPAD value, fresh weight of plant, dry weight of plant and earliest 50% curd initiation and curd maturity duration and yield attributing characteristics curd length, curd width, average curd weight, harvest index and curd yield. It was followed by T_5 {Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT}. Maximum weed population, weed dry weight and weed index was recorded with the treatment T_1 (weedy check). Highest weed control efficiency was recorded with T_2 (weed free). Maximum gross return (₹ 283493), net return (₹ 218793) was obtained with T_2 while maximum benefit: cost ratio (1:3.68) was obtained with T_5 {Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT}.

Keywords: Weed management practices, cauliflower, yield and economics.

INTRODUCTION

Cauliflower (*Brassica oleracea* var*. botrytis* L.) is one of the most popular vegetable crop among the cole crops. Cauliflower belongs to family Brassicaceae and is grown for its white tender curd which is used for vegetable, curry, soup and pickle preparations. Cauliflower fresh curd are highly nutritive and contain moisture 90.8 g, protein 2.6 g, fat 0.4 g, minerals 1.0 g, fiber 1.2 g, carbohydrates 4.0 g, calcium 33 mg, phosphorous 57 mg, iron 1.5 mg, carotene 30 mg, thiamine 0.04 mg, riboflavin 0.10 mg, niacin 1.0 mg vitamin-C 56 mg per 100 g of edible portion (Jood and Neelam, 2011). 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 hectare 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 tonnes per hectare (NHB, 2015).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 stresses of the agriculture and among these, weeds top the list by contributing 33% towards 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 lower yield and quality (Mal *et al.*, 2005). Although considerable research work has been carried out in India on various aspects of cauliflower cultivation, but the problem of weeds in this crop need special attention, as weeds when present in the field reduce the yield and impair the quality of the produce for vegetable purposes, the crop remain in the field for about four months and during its growth period, the crop faces competition due to presence of monocot and dicot weed. It is an established fact that weeds can be controlled effectively by manual hand weeding. But presently labour has become very costly and their non-availability at proper time makes the daunting task of weed control further challenging. Whereas, use of herbicides alone may not be the answer to the problem because an environmentalist claims them dangerous for sustainable agriculture. Thus appropriate choice for weed control in cauliflower would be an integration of cultural and herbicidal control for boosting the cauliflower production. Besides hand weeding and herbicidal control, mulching (particularly plastic mulch and rice straw mulch)

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has also been advocated by many researchers as an effective mean for reducing weed population (Bana *et al.*, 2012). 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 and availability of different herbicides, the present investigation was planned to assess the effect of weed management practices on growth and yield of cauliflower.

MATERIALS AND METHODS

The field experiment was conducted during Rabi season, 2015-16 at Research Field of the Department of Vegetable Science, College of Horticulture, Mandsaur (Madhya Pradesh). Soil of the experimental field was light alluvial having sandy loam texture with low (168 kg ha^{-1}) nitrogen, medium (16.80 kg ha^{-1}) phosphorus, medium (380 kg ha^{-1}) available potassium, 0.33 dSm^{-1} electrical conductivity and neutral (pH 7.5) in reaction. Eight treatment consisted T_1 (weedy check), T_2 (weed free), T_3 (HW at 25 & 45 DAT), T_4 [Pendimethalin 30% EC (PE) + 1 HW at 30 DAT], T_5 [Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT], T_6 [Propaquizafop 10% EC (POE) + 1 HW at 30 DAT], T_7 (Wheat straw mulch) T_8 (Black plastic mulch) were arranged in randomized block design with three replications. The land was prepared by deep ploughing, harrowing and leveling and thereafter plots were prepared. The calculated quantities of fertilizers were applied to the each plot. The source of nutrients were nitrogen (DAP, Urea), phosphorus (DAP), potash (MOP). Half of nitrogen and whole dose of phosphorus and potash were applied as basal dose before transplanting of cauliflower seedlings. While the remaining half dose of nitrogen was given in 2 equal split doses, at 30 and 45 days after transplanting. Pure and healthy forty two days old seedlings of uniform height were selected and transplanted in the field with the spacing of 50 x 45 cm. Irrigation was given immediately after transplanting and gap filling was done at 10 days after transplanting, to maintain the plant population in each plot and light irrigation was given just after gap filling of seedlings

The required amount of herbicides for the experimentation was calculated by using the following formula.

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

Thus, spray of calculated amount of herbicide was done to each treatment plot using knapsack sprayer with a spray volume of 750 liters of water per hectare. The pre-emergence herbicides Pendimethalin and Oxyfluorfen were applied as spray uniformly two days before transplanting of cauliflower seedlings. The post emergence herbicide Propaquizafop was applied uniformly 25 days after transplanting as per treatment.

After transplanting, the cauliflower seedlings were protected from insect-pests and diseases by spray of insecticide (Imidachlopride @ 0.3 ml/l of water) and fungicide (Carbandazime @ 2 gm/l of water) at an interval of 15 days. After complete development, the curds were harvested and observations were recorded on growth and yield parameters, marketable curd yield and harvest index. Weed population, weed control efficiency, weed index was determined. The data obtained from the investigation were subjected to statistical analysis as advocated by Panse and Sukhatme (1984). The economics of different treatments was worked out on the basis of prices prevailing in the market for various inputs and produce.

RESULTS AND DISCUSSION

Growth parameters

There was significant effect of weed management practices on all the growth parameters (Table 1). Among the weed management practices, treatment T_2 (weed free) recorded maximum stalk length, leaves per plant, leaf length, SPAD value, fresh weight and dry weight of plant followed by treatment T_5 [Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT] while the minimum value of all the growth parameters were recorded under treatment T_1 (weedy check). This increase in growth parameters could be due to no weed competition and lower in case of T_1 (weedy check) due to continuous competition of weeds which reduced the growth of plants due to poor exposure to sunlight and competition for nutrient and water. Similar results were reported by Mal *et al.* (2005), Qasem (2009) and Bana *et al.* (2012) in cauliflower.

Table 1: Effect of different weed management practices on growth parameters of cauliflower

Treatments	Stalk length (cm)			No. of leaves/plant			Leaf length (cm)			SPAD Value		
	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT	30 DAT	45 DAT	60 DAT
T_1	4.1	7.0	9.3	6.9	9.9	13.5	20.2	32.9	44.0	47.7	55.4	59.0
T_2	7.2	10.2	12.4	9.9	13.9	17.8	28.4	43.0	56.3	58.4	62.6	66.9
T_3	5.6	8.6	10.2	8.4	11.5	15.3	23.9	36.4	46.7	52.5	57.2	59.6
T_4	5.9	8.7	10.3	8.4	11.6	15.3	24.1	36.5	46.8	52.6	57.3	60.1
T_5	6.7	9.5	11.3	9.2	12.8	16.4	26.2	39.7	51.3	55.5	59.9	63.9
T_6	4.8	8.3	9.9	7.9	11.2	15.0	22.7	35.9	45.9	51.6	56.6	58.4
T_7	4.6	8.0	9.6	7.5	11.0	14.6	22.5	35.6	45.6	51.4	56.5	58.1
T_8	5.5	8.4	10.1	8.3	11.5	15.2	23.7	36.2	46.6	52.2	57.1	59.9
S.Em ±	0.25	0.26	0.33	0.25	0.39	0.45	0.71	1.08	1.40	0.91	0.88	0.89
C.D. (P=0.05)	0.75	0.77	0.99	0.74	1.17	1.36	2.13	3.27	4.25	2.75	2.64	2.72

**DAT- Days after transplantin, ** T_1: weedy check, T_2: weed free, T_3: HW at 25 & 45 DAT, T_4: Pendimethalin 30% EC (PE) + 1 HW at 30 DAT, T_5 : Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT, T_6 : Propaquizafop 10% EC (POE) + 1 HW at 30 DAT, T_7 : Wheat straw mulch, T_8 : Black plastic mulch*

Phenological parameters

There was significant effect of weed management methods on days to 50% curd initiation. Minimum days to 50% curd initiation was taken in trearment T_2 (weed free) followed by T_5 [Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT]. While the treatment T_1 (weedy check) had delayed 50% curd initiation (Table 2). This might be due to the control of weed infestation at early stage and less crop weed competition during the critical growth stage of the crop. These findings are in agreement with the result obtained by Bana *et al.* (2012) in cauliflower and Kumar *et al.* (2014) in cabbage. Findings revealed significant effect of weed management practices on days to 50% maturity of curd in cauliflower. Minimum days to 50% curd maturity was taken by T_2 (weed free) followed by T_5 [Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT], T_4 [Pendimethalin 30% EC (PE) + 1 HW at 30 DAT], T_3 (HW at 25 & 45 DAT), T_8 (Black plastic mulch), T_6 [Propaquizafop 10% EC (POE) + 1 HW at 30 DAT], T_7 (wheat straw mulch). While the T_1 (weedy check) had taken maximum days to attain 50% maturity of curd. Similar finding have been reported by Bana *et al.* (2012) in cauliflower and Kumar *et al.* (2014) in cabbage. Curd maturity duration of cauliflower significantly affected by weed management practices. The minimum curd maturity duration recorded under the treatment T_2 and it was followed by T_5 [Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT] while maximum curd maturity duration was observed under the treatment T_1 (weedy check). This might be due to the excellent control of weed infestation at early stage and less crop weed competition during the critical growth stage of the crop. These results are in agreement with Bana *et al.* (2012) in cauliflower.

Yield parameters

Maximum curd length, curd width, average curd weight were recorded under the treatment T_2 (weed free) followed by T_5 [Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT]. While the T_1 (weedy check) recorded minimum curd length, curd width and average curd weight. Highest marketable curd yield, total curd yield and harvest index were recorded under the treatment T_2 (weed free) followed by T_5 [Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT], While the treatment T_1 (weedy check) recorded lowest marketable curd yield, total curd yield and harvest index (Table 2). This can be attributed to increase in plant growth and ultimately yield attributing character with reduced crop weed competition. The increased stalk length, number of leaves, leaf length, SPAD value, fresh weight of plant and dry weight of plant are directly responsible for increasing dry matter production. Higher synthesis and accumulation of photosynthates in the plant resulted in increasing the dry matter of crop and ultimately yield. Similar finding were also reported by Mal *et al.* (2005), Qasem (2007) and Bana *et al.* (2012) in cauliflower, Nandal *et al.* (2005) and Kumar *et al.* (2014) in cabbage.

Table 2: Effect of different weed management practices on growth and yield parameters of cauliflower

Treatment	Fresh weight of plant at harvesting stage (g)	Dry weight of plant at harvesting stage(g)	Days to 50% curd initiation	Days to 50% curd maturity	Curd maturity duration (Days)	Curd length (cm)	Curd width (cm)	Average curd weight (g)	Marketable curd yield (q/ha)	Total curd yield (q/ha)	Harvest index (%)
T_1	735.0	71.8	59.6	74.3	14.6	7.2	15.7	268.6	118.7	124.8	36.5
T_2	1291.6	129.1	45.0	53.3	8.3	9.8	21.8	650.2	283.4	293.7	50.8
T_3	972.4	96.5	55.3	66.3	11.3	8.1	18.1	402.6	175.7	190.9	41.4
T_4	1000.4	99.8	55.0	66.0	11.0	8.2	18.2	425.2	184.7	197.4	42.5
T_5	1165.8	110.9	50.0	59.6	9.6	9.0	19.9	545.9	232.5	244.9	46.7
T_6	854.1	84.7	57.0	68.6	11.6	7.7	16.8	327.2	143.6	162.1	38.3
T_7	805.3	79.1	57.6	70.6	13.0	7.3	16.5	308.3	133.7	150.3	38.3
T_8	922.5	91.6	56.6	68.6	12.0	8.0	17.8	375.7	166.6	181.1	40.7
S.Em ±	41.20	3.54	1.63	1.99	0.40	0.25	0.56	22.66	5.48	8.20	1.29
C.D. (P=0.05)	124.97	10.76	4.93	6.02	1.21	0.74	1.69	68.72	16.64	24.89	3.91

Weed

Weed population, weed dry weight, weed control efficiency and weed index indicated remarkable influence of weed management practices (Table 3). Among the weed management practice, treatment T_2 (weed free) was infested with minimum weed population followed by T_5 [Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT]. Maximum weed population was recorded in case of T_1 (weedy check) at all stages of crop growth. Similar results were also reported by Mal *et al.* (2005), Bana *et al.* (2012) and Kumar *et al.* (2015) in cauliflower and Nandal *et al.* (2005) in cabbage. Minimum weed dry weight was recorded by T_2 (weed free) which was followed by T_5 [Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT]. Maximum weed dry weight was found in case of T_1 (weedy check). This might be due attributed to the fact that the data for dry weight of weeds were taken at the end of the season, where almost all of the weeds were present. By this time the persistence effect of pre-emergence herbicides has finished, while the post-emergence herbicides were selective and only controlled either grassy or broad leaf weeds. As a result the tolerant or resistant species flourished well. So at the end of the season weeds were present in all the treatments though there was significant difference between them in terms of weed dry weight. These results are in line with Mal *et al.* (2005) and Kumar *et al.* (2015) in cauliflower and Kumar *et al.* (2014) in cabbage. Among the weed management practices, treatment T_2 (weed free) recorded maximum weed control efficiency. It was followed by T_5 [Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT], while the minimum value of weed control efficiency was recorded under the treatment T_1 (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.* (2012), Kumar *et al.* (2014) and Kumar *et al.* (2015) in cauliflower. Among the weed management practices T_2 (weed free) had lowest weed index which was followed by T_5 [Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT] while the maximum weed index was recorded with T_1 (weedy check). This could be described to the lower impact of weeds on yield under these treatments. These results are in line with those reported by Rathod *et al.* (2014) and Gandolkar *et al.* (2015) in onion.

Table 3: Effect of different weed management practices on weed parameters and economics of cauliflower

Treatment	Weed studies						Economics		
	Weed population per m^2			Weed dry weight (g/m^2)	Weed control efficiency (%)	Weed index (%)	Gross income (₹ ha^{-1})	Net income (₹ ha^{-1})	B:C ratio
	30 DAT	45 DAT	60 DAT						
T_1	9.1 (82.3)*	10.9 (118.6)	13.5 (181.6	14.7 (217.7)*	1.0 (0.0)*	7.4 (55.3)	118726	76326	1.8
T_2	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	10.0 (100.0)	1.0 (0.0)	283493	218793	3.3
T_3	4.0 (15.3)	5.0 (24.6)	5.4 (29.0)	5.1 (26.1)	9.4 (87.9)	6.0 (36.0)	175776	125376	2.4
T_4	3.5 (11.6)	4.2 (17.6)	4.9 (23.2)	4.9 (23.4)	9.5 (89.9)	5.8 (32.9)	184766	135566	2.7
T_5	2.4 (5.0)	3.2 (9.6)	3.8 (14.0)	3.5 (11.3)	9.7 (94.7)	4.0 (15.3)	232563	182863	3.6
T_6	6.1 (37.0)	8.3 (68.6)	9.0 (81.0)	6.0 (35.8)	9.1 (83.5)	6.9 (46.7)	143686	94786	1.9
T_7	8.6 (74.0)	10.1 (101.3)	11.0 (121.3)	10.3 (106.3)	7.2 (51.1)	7.0 (49.3)	133780	81380	1.5
T_8	4.3 (18.0)	5.4 (28.3)	5.8 (33.3)	5.8 (32.8)	9.2 (84.9)	6.3 (38.8)	166630	92230	1.2
S.Em ±	0.33	0.30	0.33	0.42	0.07	0.29	-	-	-
C.D. (P=0.05)	1.02	0.93	1.01	1.28	0.22	0.89	-	-	-

Economics

The viability of any practices 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 economic return, the marketable yield of the crop converted in to monetary returns. Highest gross income and net income was found with weed management practices T_2 (weed free) followed by T_5 [Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT] but the highest B:C ratio was found under treatment T_5 [Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT] followed by treatment T_2 (weed free). The results are in agreement with Bana *et al.* (2012) and Kumar *et al.* (2015) in cauliflower and Nandal *et al.* (2005) in cabbage.

On the basis of present experiment, it may be concluded that the maximum values growth, yield attributes, yield of cauliflower and lower weed population as well as maximum gross and net returns were recorded with treatment T_2 (weed free) followed by treatment T_5 (Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT). But highest B:C ratio(1:3.68) was obtained with treatment T_5 [Oxyfluorfen 23.5% EC (PE) + 1 HW at 30 DAT] under climatic conditions of Mandsaur (Madhya Pradesh).

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