MAHARANA PRATAP UNIVERSITY OF AGRICULTURE & TECHNOLOGY, UDAIPUR

RAJASTHAN COLLEGE OF AGRICULTURE, UDAIPUR

CERTIFICATE-I

Dated / /2009

This is to certify that **Mr. Mohan Lal Bana** has successfully completed the comprehensive examination held on April 05, 2010 as required by the regulation for degree of **Master of Science in Agriculture (Horticulture).**

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CERTIFICATE-II

Dated: / / 2009

This is to certify that the thesis entitled "**Integrated Weed Management in Cauliflower (*Brassica oleracea* var. *botrytis* L.)**" submitted for the degree of **Master of Science in Agriculture** in the subject of **Horticulture,** embodies bonafied research work carried out by **Mr. Mohan Lal Bana** under my guidance and supervision and that no part of this thesis has been submitted for any other degree. The assistance and help received during the course of investigation have been fully acknowledged. The draft of this thesis was also approved by the advisory committee on 06/05/2010.

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CERTIFICATE-III

Dated: / / 2009

This is to certify that the thesis entitled "**Integrated Weed Management in Cauliflower (*Brassica oleracea* var. *botrytis* L.)**" submitted by **Mr. Mohan Lal Bana** to the Maharana Pratap University of Agriculture and Technology, Udaipur in partial fulfillment of the requirements for the degree of **Master of Science in Agriculture** in the subject of **Horticulture** after recommendation by the external examiner was defended by the candidate before the following members of the examination committee. The performance of the candidate in the oral examination on his thesis has been found satisfactory; we therefore, recommended that the thesis should be approved.

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CERTIFICATE-IV

Dated: / /2009

This is to certify that **Mr. Mohan Lal Bana** of the Department of **Horticulture,** Rajasthan College of Agriculture, Udaipur has made all corrections and modifications in the thesis entitled "**Integrated Weed Management in Cauliflower (*Brassica oleracea* var. *botrytis* L.)**" which were suggested by the external examiner and the advisory committee in the oral examination held on / /2009. The final copies of the thesis duly bound and corrected were submitted on / /2009 are enclosed here with for approval.

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Enclosed one original and two copies of bound thesis forwarded to the Director, Resident Instruction, MPUAT, Udaipur, through the Dean, Rajasthan College of Agriculture, Udaipur.

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Integrated Weed Management in Cauliflower (*Brassica oleracea* var. *botrytis* L.)

Mohan Lal Bana * **Dr R.A. Kaushik****

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ABSTRACT

A field experiment was undertaken at Hi-Tech unit, Department of Horticulture, Rajasthan College of Agriculture, Udaipur to evaluate the effect of different weed management practices on weeds and cauliflower (*Brassica oleracea* var. *botrytis* L.) cv. Pusa Snowball K-1 during the year 2009-10.

The treatments comprising ten weed control methods were weedy check, two hand weedings (35 and 60 days after transplanting), black plastic mulch (400 gauge), rice straw mulch and three herbicides (fluchloralin at 1.5 kg/ha, pendimethalin at 1.5 kg/ha and alachlor at 2 kg/ha) alone and in combination with one hand weeding at 35 days after transplanting (DAT). Among the herbicides fluchloralin was applied as pre plant incorporation (incorporated into soil 2 days before transplanting) while pendimethalin and alachlor were applied 7 hours before transplanting. These were tested in a Randomized Block Design and replicated three times.

Results showed that all the treatments significantly reduced the weed population and biomass over weedy check. However, among the different treatments the black plastic mulch treated plot showed excellent weed control. The growth (plant height, spread and number of leaves), quality (compactness, color and per cent protein content of curd) and yield were also higher under black plastic mulch but it was not significantly different with rice straw mulch. Among the herbicides pendimethalin in combination with one hand weeding was found most effective.

The results further revealed that the rice straw mulch was economically best treatment as it gave highest benefit cost ratio of 3.48: 1. Thus, rice straw mulch was the most remunerative for weed control in cauliflower crop.

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1. Introduction

Vegetables are being considered as cash crops as these provide a good source of income to the growers and form a vital part of human diet. India is the second largest producer of vegetable crops in the world. However, its vegetable production is much less than the requirement if balanced diet is being provided to every individual. The present production of 125887 thousand MT (Anon., 2008a) is to be raised to 250000 MT by 2024-2025 (Singh, 1998). There are different ways and means to achieve this target, viz., bringing additional area under vegetable crops, using hybrid seeds, use of improved agro-techniques. Another potential approach is perfection and promotion of protected cultivation of vegetables (Singh *et al*., 1999).

Cauliflower (*Brassica oleracea* var. *botrytis* L.) is one of the most popular vegetable crop among the cole crops. It is native of Southern Europe (Chatterjee and Swarup, 1972). Cauliflower was introduced in India from England by Britishers in 1822 and in such a short period of its introduction, it has gained a lot of importance among the researchers, farmers and consumers. It is grown for its white tender curd formed by shortened floral parts which is used for vegetable, curry, soup and pickle preparation. Besides being good source of protein and carbohydrate, cauliflower is a rich source of vitamin A (70 IU) and vitamin C (75 IU) and affluent in riboflavin, thiamin, nicotinic acid, calcium, magnesium, phosphorus, iron etc. The peculiar flavour in cauliflower curd is due to sinigrin (Singh, 2007).

In India, cauliflower is cultivated on an area about 321 thousand ha with an annual production of about 5797 thousand MT (Anon., 2008a). Indo-Gangetic Plain is the major cauliflower growing area of India having a share of around 24.8% of the global production (Anon., 2008b). As far as area and production of cauliflower in Rajasthan is concerned, it is 8.5 thousand ha and 40.9 thousand MT, respectively (Anon., 2007). Cauliflower is grown extensively in Shri Ganganagar, Udaipur, Jaipur, Ajmer, Tonk, Kota, Bundi, Chittorgarh, Jodhpur and Alwar districts of Rajasthan.

The immense importance of cauliflower makes it imperative for the horticulturists to overcome major constraints in its cultivation. Although a lot of

research work has been done in India on various aspects of cultivation of cauliflower, but some important problems have not been investigated thoroughly and weed problem is one of them.

For profitable cultivation of cauliflower, control of weeds is necessary. Weeds compete with crop for nutrients, water, light and space and cause tremendous reduction in growth, yield and quality of cauliflower. It has been reported that longer period of weed-cauliflower competition greatly reduce crop growth and curd yield. Average reduction in shoot dry weight and curd yield were 81 per cent and 89 per cent, respectively (Qasem, 2009). Indian agriculture annually undergoes considerable loss due to various stresses and among them, weeds top the list by contributing 33 per cent towards total loss (Mani, 1977). Besides direct losses, weeds also harbour or attract insect-pest which may later attack the crop and may also serve as disease reservoirs.

In Udaipur region, the problem of weeds are particularly severe because of comparatively high soil fertility level accompanied with high atmospheric humidity, even then there is no definite recommendation for control of weeds. It is established fact that weeds can be controlled effectively by manual hand weeding. To keep weeds under control, two to three hand weedings are required. But now a days 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 though many selective herbicides viz., fluchloralin, pendimethalin and alachlor have been widely used. Singh *et al.* (1983) reported that application of alachlor in combination with one hand weeding gave most effective control of weeds and curd yield similar to those of under weed free conditions. Thus appropriate choice for weed control in cauliflower would be a combination of cultural and herbicidal control for boosting the sustained cauliflower production. Integrated approach of weed control offers great possibility of crop production in weed free environment by accommodating more number of crop plants per unit area and simultaneously save time and labour, and above all help to save depletion of soil nutrients through weeds (Joshi, 1989).

Besides hand weeding and herbicidal control, mulching has also been advocated by many researchers as an effective mean for keeping the weed population under control. Among the mulches, plastic mulch and rice straw mulch

are found effective. These may also be helpful in weed management. Most studies aiming at reducing herbicide reliance have focused on combining herbicides with cultivation and weed-suppressive cover crops, residues or living mulches and in existing tillage systems (Brandsaeter and Netland, 1999).

Therefore, the present investigation has been planned to explore herbicides and other options of weed control with following objectives:

1. To study the effect of weed management on weed dynamics
2. To assess the effect of weed management on growth, yield and quality of cauliflower
3. To work out economics of different treatments

2. Review of Literature

The literature relevant to integrated weed management in cauliflower is presented in this chapter. Due to paucity of the adequate experimental evidences on this aspect, the similar work done on other crops has also been reviewed to understand the effect of different treatments.

2.1 Effect of chemicals

Leela (1982) reported that pre-planting application of basalin at 2.5 l/ha has controlled both monocot and dicot weeds and significantly increased the cabbage head yield.

Sandhu *et al.* (1982) reported that fluchloralin at 1.2 kg, alachlor at 1.5-2.5 kg and chloroxuron at 1.5 kg/ha incorporated 1-4 days before transplanting of cauliflower seedings gave effective control of weeds and showed no toxic effect on the crop. Whereas, methabenzthiazuron at 1.4-2.1 kg and metribuzin at 0.52-0.7 kg/ha were toxic to the crop.

Khurana *et al.* (1986) advocated that fluchloralin at 1 kg/ha metribuzin at 0.250 kg/ha registered satisfactory weed control and higher seedling fresh weight of cauliflower. However simazine at 0.15 kg/ha, oxadiazon at 1.0 kg/ha and methabenzthiazuron at 1.5 kg/ha had adverse effects on cauliflower crop.

Nepalia and Jain (2000) reported that application of different herbicides (oxadiazon 0.5 kg/ha, oxyfluorfen 0.125 kg/ha, pendimethalin 0.75 kg/ha and isoproturon 0.5 kg/ha) significantly reduce density as well as dry matter of weeds, resulted high yield of Indian mustard (*Brassica juncea*).

Anyszka and Dobrzanski (2003) assessed the efficacy of herbicides like oxyfluorfen, pendimethalin and trifluralin applied before transplanting of cauliflower and found that these herbicides were more effective in non-covered cauliflower than that of covered with non-woven polypropylene.

Miller *et al.* (2003) carried out an experiment in Freeville, New York, USA to determine response of cabbage to post-transplant application of pendimethalin and revealed that this application reduce the head yield by 23 to 87% depending upon the stage of transplant.

Arora and Gopal (2004) conducted an experiment to determine whether the herbicide pendimethalin (and its metabolite) translocated in the edible portion

of cabbage cv. Golden Acre after its application and how long it remained in the soil. The result indicated that the herbicide and its metabolite did not translocate in the edible portion of cabbage. At the same time, the data on weed population and cabbage yield indicated that the herbicide was highly effective for weed control in cabbage.

Ahuja and Sandhu (2004) carried out an experiment in Punjab with six herbicides (pendimethalin; oxyfluorfen; metribuzin; trifluralin; linuron and glyphosate) in cabbage-onion relay system indicated that pendimethalin and oxyfluorfen decrease the weed population and dry weight accumulation by weeds after 45 days of transplanting. Significant increase in cabbage yield was also recorded.

Dixit *et al.* (2005) assessed the efficacy of herbicides against weed infesting cabbage. The treatments consisted of weedy control, two hand weedings (at 20 and 40 days after planting), paddy straw mulch, fluchloralin at 0.20 and 0.10 kg/ha, pendimethalin at 0.75 and 0.50 kg/ha, oxadiazon at 0.40 and 0.20 kg/ha, and oxyfluorfen at 0.20 and 0.12 kg/ha. They found that pendimethalin at 0.75 kg/ha gave the lowest weed dry weight while pendimethalin at 0.50 kg/ha was at par in terms of both net income as well as benefit: cost ratio.

Mal *et al.* (2005) studied effect of chemical weed control and nitrogen levels on cauliflower var. Snowball-16. The treatments consisted of six levels of weed control measures (weedy check, hand weeding, pendimethalin and oxadiazon each at 1.0 and 1.5 kg/ha). All the herbicidal treatments reduced weed population and weed dry matter significantly and increased plant height, average weight of curd, total curd yield per bed, total curd yield per hectare and protein content in curd over control. However, the maximum value of these parameters were recorded in pendimethalin at 1.5 kg/ha.

Nandal *et al.* (2005) advocated oxadiazon at 1.0 kg/ha and oxadiazon at 0.75 kg/ha+pendimethalin at 0.75 kg/ha as most effective in terms of weed control and enhancing yield in cabbage.

Studies to investigate the effect of herbicides on uptake of NPK by weed plants showed minimized uptake of NPK and S by oxadiazon, oxyfluorofen, pendimethalin and isoproturon (Nepalia and Jain, 1998); NPK by alachlor pendimethalin and oxadiazon (Nandal *et al.*, 2006)

Norsworthy and Smith (2007) suggested that application of herbicides (pendimethalin, thiobencarb, quinclorac and prodiamine) prior to crop emergence caused less than 10% injury to crops and did't reduce density, height and fresh weight of crop plants of brassicaceae family.

Rathi *et al.*, (2007) carried out an experiment on integrated weed management technique in chickpea-mustard intercropping system and revealed that pendimethalin and fluchloralin had higher weed control efficiency but pre-emergence application of pendimethalin was better over fluchloralin applied as PPI in terms of weed population control.

Sikkema *et al.* (2007) studied response of cole crops with pre transplant herbicide application. They concluded that herbicides like oxyfluorfen (560 and 1120 g/ha), dimethenamid-p (750 and 1500 g/ha), sulfentrazone (100 and 200 g/ha) and a tank-mix of dimethenamid-p plus sulfentrazone (750 + 100 and 1500 + 200 g/ha) applied pre transplant at the relevant dose did not cause any visual injury and did not reduce number of heads, head weight and yield. Based on these results all the above herbicides were found acceptable for use at the proposed dose in broccoli, cabbage and cauliflower.

2.2 Effects of hand weeding

Singh and Tripathi (1982) reported that increase in yield of cauliflower was the highest with one hand weeding at 30 days after transplanting, intermediate with one hand weeding at 15 or 45 days after transplanting and the lowest with one hand weeding at 60 days after transplanting.

Singh *et al.* (2001) studied the effect of different weed management techniques on nutrient uptake in *Brassica species* and found that highest uptake of N, P, K and S from weed free treatment followed by two hand weeding at 25 and 45 days after sowing. Significantly increase in the yield of crop with all weed management techniques had also been recorded. Similarly, Kumawat *et al.* (2002) investigated the effects of different weed management techniques on NPK uptake by *Plantago ovata* and observed the similar results.

Sharma *et al.* (2001) recommended hand weeding twice, instead of herbicide application in the areas where, there is excessive rainfall during crop season.

Sonnenberg and Silva (2005) investigated the effect of weed control on the productive performance of cabbage hybrid Fuyotoyo in Goiania, Brazil. The treatments were: no weeding after transplanting, weeding once (one month or two months after transplanting) and weeding twice (one and two months after transplanting). With respect to yield and number of marketable heads as well as average head weight, the weeding treatments were similar to each other but significantly superior over control. The plants of plots which weeded once (one month after transplanting) and twice (one and two months after transplanting) were significantly earlier than those weeded only once (two months after transplanting) or not weeded. The ratio between head width and height and the harvesting rate were not influenced by the treatments.

Rathi *et al.* (2007) conducted an experiment at Kanpur to determine the most suitable weed management technique for chick pea-mustard intercropping system. The pre-dominant weeds observed by them were *Phalaris minor, Chenopodium album, Anagallis arvensis, Phyllanthus niruri, Cynodon dactylon, Cyperus rotundus* and *Spergula arvensis*. The maximum weed control efficiency viz., 89.99% compared to weedy control recorded by them was with two hand weedings at 25 and 45 days after sowing.

2.3 Effect of mulches

Campiglia *et al.* (2000) evaluated the ability of soil solarization to control annual weeds and its effects on the productivity of cauliflower cv. Artemis grown in an open field in central Italy. The soil was covered with different flexible plastic polyethylene mulches (0.05 mm thick). They advocated that the mulching with polyethylene increased the soil temperature at all depths compared with unmulched soil and reduced weeds (decreased both the total biomass and weed density), resulted into increase in the crop yield.

Changani (2001) conducted an experiment to evaluate effect of mulches on water conservation, weed population, yield and monetary value of lettuce. All seven mulch treatments (soybean shell, cowpea shell, groundnut shell, millet chaff, sawdust, black polyethylene and clear polyethylene) significantly controlled weed population and improved yield in comparison to non-mulch control except saw dust mulch treatment.

Riley and Brandsaeter (2001) found that besides supplying nutrients the clover/grass material as surface mulch gave a good weed control as well as saleable yield of white cabbage.

Jedrszczyk *et al.* (2005) carried out an experiment to determine the effect of living mulches on white cabbage yield, soil aggregates water-resistance and weed infestation. They found that besides beneficial effect on water-resistance of soil aggregates, mulches also limited weeding by controlling weeds to great extent.

Singh *et al.* (2005) studied effect of different plastic film mulches (light blue color and black plastic mulch) on growth and yield of tomato crop. They observed maximum plant height with blue color mulch.

Singh and Mir (2005) investigated the effects of different types of mulches on yield and yield-attributing traits of cabbage cv. Pride of India. The treatments were no mulch, alfalfa straw mulch, wheat straw mulch, clear polyethylene mulch, white polyethylene mulch, black polyethylene mulch, red polyethylene mulch, blue polyethylene mulch and green polyethylene mulch. The polyethylene mulches, irrespective of colour, were superior to wheat straw and alfalfa straw mulches in improving the growth and head yield of cabbage and suppressed the weed growth significantly. The black polyethylene suppressed drastically the weed growth by 96.82%; the other colours also controlled the weed growth by 91.05% (red), 89.41% (blue), 85.65% (green) and 73.04% (white). The clear polyethylene and natural mulches (wheat straw and alfalfa straw) were markedly less efficient. The black polyethylene mulch recorded the highest net return of Rs 119 380.00/ha, followed by the red polyethylene mulch (Rs 115 992.00/ha).

Moniruzzaman *et al.* (2007) conducted an experiment at the Agricultural Research Station, Raikhali, Rangamati Hill District (Bangladesh) to observe the effect of irrigation and mulch materials on its yield attributes, yield and profitability. For this trial five materials of mulching (viz. no mulch, black polyethylene mulch, rice straw mulch, sun grass mulch and mango leaves mulch) were used and results revealed that black polythene was most effective mulch in terms of yield attributes and marketable yield of cauliflower. However, the B: C ratio was higher in case of organic mulches (mango leaves mulch, rice straw mulch and sun grass mulch).

Abouziena *et al.* (2008) studied the effects of rice straw mulch, cattail mulch, black plastic mulch, hand hoeing, cultivation, glyphosate, and unweeded control treatments on weed control, fruit yield, and fruit quality of mandarin crop. Results showed that the greatest control of weeds occurred with the plastic mulch (94%–100%) followed by rice straw mulch. Both the treatments significantly increased the fruit yield/tree. Whereas, uncontrolled weeds in the weedy control caused significant reduction in yield and fruit quality. Soil mulching with three layers of rice straw, cultivation, glyphosate, and hand hoeing treatments caused a significant reduction in weed density and weed biomass, but gave lower yield than plastic mulch treatment. These results finally demonstrate that rice straw mulch could be used effectively for controlling weeds in citrus groves because it has a higher B: C ratio.

Subrahmaniyan and Zhou (2008) carried out an experiment to determine the effect of different type of mulches on biomass production, enzyme activities, growth, and yield of winter rapeseed. The mulches used were black polyethylene, transparent polyethylene, herbicidal polyethylene film (herbicide coated), degradable polypropylene, straw mulch, and non-mulched control. The results indicated that higher soil temperature under plastic mulches markedly shortened the days to 50% flowering and maturity. The increased number of pods per plant, number of seeds per pod, and seed yield observed with plastic mulches due to increased soil temperature indicates that modification of field soil temperature through management practices could improve rapeseed production by achieving an optimal balance between vegetative and reproductive growth.

Juan (2009) made a comprehensive study at Georgia, USA to determine the effects of different mulches on root zone temperature, plant growth and yield of broccoli (*Brassica oleracea* var. *italica*). They suggested that the plastic film mulches, particularly of dark colored mulch provide most favorable conditions for plant growth and yield of the crop.

2.4 Effect of integrated weed management

Singh *et al.* (1983) observed that the major weeds of cauliflower were *Chenopodium album, Anagallis arvensis, Fumaria parviflora, Cyperus rotundus, Portulaca quadrifida* and *Melilotus alba*. Uncontrolled weeds reduced the curd yield of cauliflower by 36.6-59.1 per cent and found that alachlor at 3 kg/ha alone

or at 2 kg/ha + 1 hand weeding at 60 days after transplanting (DAT) gave acceptable weed control and curd yield which was similar to a weed free control. They also observed that alachlor was more effective than nitrofen. Similarly, due to weed competition for the first 15 days and after 60 DAT significantly reduction and no adverse effect on the yield, respectively.

Bhayan *et al.* (1985) conducted an experiment during the winter season on a sandy loam soil. Six herbicides were tested at two concentrations and compared with plots hand-weeded four times during the season, plots kept weed-free and a non-weeded control. The yields were highest (217.97 q/ha) on weed-free plots followed by those weeded 4 times (186.78 q/ha) and on plots treated with pendimethalin at 1.5 kg/ha one day before transplanting (181 q/ha).

Randhawa *et al.* (1987) observed that annual weed infestation in cauliflower transplanted on sandy loam soil was selectively controlled by fluchloralin incorporated pre-plant at 1.2 kg/ha without a supplementary hoeing or at 0.84 kg/ha with hoeing or by nitrofen at 2 kg/ha (pre-emergence). These treatments significantly increased curd yield.

Leela (1993) made a comprehensive study at Banglore on herbicides for vegetables and recommended that one spray with herbicide plus earthing up to 40 days later provided good weed control in cabbage and cauliflower.

Mahmood *et al.* (2003) studied integrated weed management by using pre-transplant oxadiazon alone or with manual hoeing (one to two) in cabbage crop. The formation of cabbage heads in weedy control was significantly lower compared to the weed free control, oxadiazon alone or oxadiazon with hoeings.

Mal *et al.* (2003) studied the effects of weed control treatments (hand weeding at 30 DAT, 1.00 or 1.50 kg pendimethalin/ha and 1.00 or 1.50 kg oxadiazon/ha) on the performance of cauliflower cv. Snowball-16 at Jobner, Rajasthan. Pendimethalin and oxadiazon were applied before transplanting. Application of 1.50 kg pendimethalin/ha resulted in the greatest plant height at 60 DAT (49.2 cm) and harvest (53.1 cm) and total yield of marketable curd (212.3 q/ha).

Anyszka (2004) conducted an experiment to determine the effect of weed control management systems including the use of herbicides (trifluralin, metazachlor and oxyflourfen+metazachlor) alone and with inter-tillage and hand hoeing, on the growth and yield of white head cabbage. He observed that the use

of hand and mechanical methods of weed control in cabbage is necessary in case of poor effect of herbicides results better yield as compared to those not treated mechanically and by hand at all.

Dillard *et al.* (2004) observed that generally herbicides provide the best weed control in cabbage and similarly, non-chemical practices were also as effective as herbicides in controlling some noxious weeds. For an effective control, it is desirable to conjugate both the practices.

Dobrzanski (2004) observed that weeds are still one of the most harmful reasons that lead to yield and quality losses of head cabbage even after availability of many herbicides. Therefore, it is necessary to dedicate a great attention to weed control using integrated chemical and agro-technical measures.

Nandanwar *et al.* (2006) carried out an experiment to evaluate the effect of 5 herbicides (fluchloralin at 1.0 kg/ha, alachlor at 2.0 kg/ha, pendimethalin at 1.0 kg/ha, oxyfluorfen at 0.2 kg/ha and isoproturon at 1.0 kg/ha) applied alone and in combination with one hand weeding at 30 days after transplanting, on the growth and yield of cabbage cv. Pride of India. Results revealed that combinations of herbicides with one hand weeding were more effective in controlling weed than herbicides applied alone.

Arora *et al.* (2006) evaluated the efficacy of hoeing, pendimethalin (1.0 or 2.0 kg a.i./ha), and pendimethalin (1.0 kg a.i./ha) + hoeing for the control of weeds infesting cabbage cv. Golden Acre at IARI, New Delhi. They found that combination of pendimethalin with hoeing gave the highest reduction in number of weed plants. The treatments were also effective in the reduction of the population of diamond back moth (*Plutella xylostella*).

Sharma *et al.* (2007) conducted an experiment on effect of clodinafop and row spacing on weed management and productivity of gobhi sarson (*Brassica napus var. oleracea*). They found that herbicides application significantly reduced the total weed dry matter as well as number of weeds and were statistically at par with hand weeding twice and resulted in yield comparable to hand weeding twice. The per cent increase in the yield due to hand weeding, clodinafop 75 g/ha (post-transplant), sequential application of pendimethalin at 0.75 kg/ha (pre-transplant) followed by 0.45 g/ha (post-transplant) and pendimethalin at 1.5 kg/ha (pre-transplant) was 130.4, 125.4, 127.9 and 119.4, respectively over weedy check.

3. Materials and Methods

The field experiment entitled **"Integrated weed management in cauliflower (*Brassica oleracea* var. *botrytis* L.)"** was conducted during rabi season from October, 2009 to February, 2010. The details of materials used, experimental procedure employed and methodology adopted for evaluation of treatment effects during the entire course of investigation are described in this chapter.

3.1 EXPERIMENTAL SITE

The field experiment was conducted at Hi-Tech unit, Department of Horticulture, Rajasthan College of Agriculture, Udaipur, which is situated at 24°35 N latitude and 24° 42 E longitudes at an elevation of 579.5 meters above mean sea level. The region falls under agro climatic Zone IV A (Sub-humid Southern Plain and Aravali Hills) of Rajasthan. The field had fairly leveled topography and clay loam texture.

3.2 CLIMATE AND WEATHER CONDITIONS

The climate of this zone is typically semi-arid and subtropical, characterized by mild winter and moderate summers associated with high relative humidity during the month of July to September. The average rainfall of this tract ranges from 650 mm to 750 mm, out of which 90 per cent is received during July to September and sometimes scanty showers during winter months.

Weather, the non-monetary input influences the growth, yield and quality of crops as well as biotic phase of soil during the growing season; hence, it is important to present climatic variables in this context. The weather parameters were weekly recorded during the crop period at the meteorological observatory presented in Table 3.1. The maximum temperature ranged between 24.3°C to 34.3°C while minimum temperature ranged between 5.9°C to 22.0°C during crop season (October to February).

FIG. 3.1 PLAN OF LAYOUT

N ⟶ E

MAIN IRRIGATION CHANNEL										
	R_3T_7	R_3T_9	R_3T_8	R_3T_7	R_3T_6	R_3T_0	R_3T_2	R_3T_3	R_3T_4	R_3T_1
	SUB-IRRIGATION CHANNEL									
	R_2T_3	R_2T_5	R_2T_4	R_2T_7	R_2T_2	R_2T_8	R_2T_9	R_2T_1	R_2T_0	R_2T_6
	SUB-IRRIGATION CHANNEL									
	R_1T_0	R_1T_1	R_1T_2	R_1T_3	R_1T_4	R_1T_5	R_1T_6	R_1T_7	R_1T_8	R_1T_9

25.75 m

R_1 = First Replication
R_2 = Second Replication
R_3 = Third Replication

Bed size = 2.5 m X 1.5 m
Size of main irrigation channel = 0.75 m
Size of sub-irrigation channels = 0.50 m

T_0 = Weedy check

T_1 = Fluchloralin at 1.5 kg/ha PPI

T_2 = Pendimethalin at 1.5 kg/ha PE

T_3 = Alachlor at 2 kg/ha PE

T_4 = T_1 + one hand weeding 35 DAT

T_5 = T_2 + one hand weeding 35 DAT

T_6 = T_3 + one hand weeding 35 DAT

T_7 = Black plastic mulch (400 gauge)

T_8 = Rice straw mulch (3 cm thick)

T_9 = Two hand weeding (35 and 60 DAT

3.3 SOIL CHARACTERISTICS OF THE EXPERIMENTAL FIELD

To know the physico-chemical properties and fertility status of the experimental soil, the soil samples were taken randomly from different spots in the field at the depth of 0-30 cm before experimentation. A representative soil sample was prepared and subjected to mechanical, physical and chemical analysis. The results of soil analysis along with methods used for determination are presented in Table 3.2.

The soil of experimental site was clay loam in texture, slightly alkaline in reaction, low in available nitrogen and medium in available phosphorus and potassium (Table 3.2).

3.4 EXPERIMENTAL DESIGN AND LAYOUT

The experiment was laid out in a "Randomized Block Design" with three replications. Randomization of the treatment was done with the help of random number table as advocated by Fisher (1950). The layout plan of the experiment is given in Fig. 3.1

Test crop	:	Cauliflower
Variety	:	Pusa Snowball K-1
Total number of treatments	:	10
Replications	:	3
Total number of plots	:	30
Plot size	:	2.50 m × 1.5 m
Number of plants per plot	:	15
Transplanting Distance		
(a) Plant to plant	:	50 cm
(b) Row to row	:	50 cm
Experimental Design	:	RBD

Table: 3.1 Mean weekly weather parameters during crop season October, 2009 to February, 2010

Standard week	Weeks	Temprature (^{0}C)		Relative humidity (%)		Rainfall (mm)
		Max.	Min.	Max.	Min.	
40	1 Oct – 7 Oct	33.3	22.0	79.1	45.0	4.0
41	8 Oct-14 Oct	33.1	19.1	84.3	36.7	0.8
42	15 Oct-21 Oct	33.8	15.4	73.1	25.4	0.0
43	22 Oct- 28 Oct	33.5	11.7	62.6	12.9	0.0
44	29 Oct- 4 Nov	34.3	13.6	59.6	12.7	0.0
45	5 Nov-11 Nov	31.8	14.6	65.6	26.0	0.0
46	12 Nov-18 Nov	25.7	14.0	88.4	48.9	4.5
47	19 Nov-25 Nov	27.8	8.7	77.3	23.3	0.0
48	26 Nov-2 Dec	29.2	9.7	76.9	24.0	0.0
49	3 Dec-9 Dec	28.4	10.6	81.4	29.8	0.0
50	10 Dec-16 Dec	29.3	11.7	83.3	33.0	0.0
51	17 Dec-23 Dec	25.7	11.0	88.6	42.6	0.0
52	24 Dec-31Dec	25.8	8.4	74.5	32.0	0.0
1	1 Jan.- 7Jan	24.6	7.8	83	30	1.6
2	8 Jan.-14 Jan	24.3	6.5	86	35	0.0
3	15 Jan - 21 Jan	25.1	5.9	82	24	0.0
4	22 Jan - 28 Jan	28.5	8.6	78	20	0.0
5	29 Jan - 4 Feb	28.0	9.8	73	24	0.0
6	5 Feb -11 Feb	28.2	11.4	68	24	0.6
7	12 Feb - 18 Feb	27.0	9.9	73	26	0.0
8	19 Feb -25 Feb	30.7	10.4	67	20	0.0

Source: AGROMET Observatory, RCA, Udaipur

Table: 3.2 Physico-chemical properties of the experimental soil

	Characteristics	Values	References of method
A.	Mechanical analysis (%):		
	Sand	32.40	International pipette method
	Silt	28.65	Piper (1950)
	Clay	38.95	Piper (1950)
B.	Physical analysis:		
	Bulk density (g cm^{-3})	1.35	Piper (1950)
	Particle density (g cm^{-3})	2.64	Black (1965)
	Porosity (%)	28.18	Black (1965)
C.	Chemical parameters:		
	Organic carbon (%)	0.47	Walkely & Black (1947)
	Available N (kg ha^{-1})	186.5	Alkaline $KMnO_4$ method Subbiah and Asija (1956)
	Available P_2O_5 (kg ha^{-1})	26.5	Olsen's method Olsen *et al.* (1954)
	Available K_2O (kg ha^{-1})	252.5	Flame photometer method Jackson (1973)
	EC of saturated extract (dSm^{-1} at 25°C)	0.54	Using solubridge Jackson (1973)
	pH (1:2.5:: soil: water suspension)	7.34	Blackman's pH meter and glass electrode Jackson (1973)

Table: 3.3 Treatments detail with their notation.

Treatments	Notation

1.	Weedy check	T_0
2.	Fluchloralin at 1.5 kg/ha PPI	T_1
3.	Pendimethalin at 1.5 kg/ha PE	T_2
4.	Alachlor at 2 kg/ha PE	T_3
5.	T_1 + one hand weeding 35 DAT	T_4
6.	T_2 + one hand weeding 35 DAT	T_5
7.	T_3 + one hand weeding 35 DAT	T_6
8.	Black plastic mulch (400 gauge)	T_7
9.	Rice straw mulch (3 cm thick)	T_8
10.	Two hand weeding (35 and 60 DAT)	T_9

PPI: Pre-plant incorporation; PE: Pre-emergence;
DAT: Days after transplanting

3.5 NURSERY RAISING IN POLYHOUSE

The seeds of cauliflower cv. Pusa Snowball K-1 were procured from National Seed Corporation, regional office, Udaipur. Seed were sown singly in portray using cocopit media under the polyhouse conditions. The seed were sown in the second week of October, 2009. Water was sprinkled over the portray with the help of watering cane. To maintain proper moisture, timely irrigations were provided.

3.6 FIELD PREPARATION

The experimental field was thoroughly and cross ploughed with the help of mould board plough and cross harrowing was done with tractor. This was followed by planking and soil was brought to a good tilth. Beds of 1.5 X 2.5 m size were prepared. Path and channels were also prepared according to layout.

3.7 APPLICATION OF MANURES AND FERTILIZERS

A basal dose of FYM (farm yard manure) at the rate of 25 tonnes/ha was applied and thoroughly mixed in the soil at the time of transplanting. Nitrogen, phosphorus and potash were applied as per recommendations.

3.8 TRANSPLANTING

About five week old seedling having height of 13-15 cm were transplanting at 50 X 50 cm spacing. The transplanting was done on 10 Nov., 2009 in the evening and watering was done thereafter.

3.9 IRRIGATION

The crop was irrigated immediately after transplanting. Further, irrigation given at an interval of 4-5 days upto the establishment of seedlings and thereafter, at an interval of 10 days upto curd formation. In the period of curd formation irrigation was given at closer intervals (after every 5th day).

3.10 GAP FILLING

Gap filling was done by transplanting, where seedling were not establishment in early period, to maintain plant population in field, from the same portray.

3.11 PLANT PROTECTION MEASURES

To prevent the plant from termite attack chloropyriphos 20 EC was applied to entire field immediately after transplanting with irrigation water and same was also repeated after a month.

To check the attack of cabbage butterfly, lopper and aphids prophylactic measure were taken, i.e. the cauliflower plants were sprayed with imidacloprid 17.8 SL at an interval of 14 days from 40 days after transplanting up to the maturity of crop.

3.12 HARVESTING OF CURD:

Mature plants along with curd were harvested with the help of sharp sickle and observations of tagged plants were recorded. Harvesting of crop started from 9th February to 20th February, 2010.

3.13 TREATMENT EVALUATION

3.13.1 Growth parameters

3.13.1.1 Plant height (cm)

Five plants were selected randomly from each plot and tagged permanently, height of individual plant was measured and recorded at 60 DAT and at harvest, from the ground level to apex of the longest leaf with the help of meter scale and average height was calculated.

3.13.1.2 Plant spread (m^2)

Spread of plant was measured in two opposite direction (NS-EW) with the help of meter scale (and multiplied) at 60 DAT and harvesting stage on five tagged plants and average spread of plant was calculated**.**

3.13.1.3 Number of leaves per plant (60 days after transplanting & at harvest)

The number of leaves of five tagged plants were counted at 60 DAT and at harvest from each plot and average number of leaves per plant was calculated.

3.13.1.4 Days taken to curd initiation

The number of days were counted from the date of transplanting to the initiation of curd formation. The average was calculated.

3.13.1.5 Days taken to curd maturity (at harvest)

The number of days were counted from the date of transplanting to stage when curd was ready to sale in market. The average was calculated.

3.13.2 Yield attributes

3.13.2.1 Weight of curd (kg/plant)

Curd weight of tagged plants were taken after removing stem and leaves from each plot and average weight of curd per plant was calculated.

3.13.2.2 Yield per plot (kg)

It was recorded by weighing the curds from each plot separately.

3.13.2.3 Yield per hectare (t)

It was calculated by the formula

$$\frac{\text{Yield per plot X (10000 – area consumed by beds)}}{\text{Net area of plot (m}^2\text{)}}$$

3.13.2.4 Harvest index (%)

It was calculated by using the formula

$$\frac{\text{Weight of curd X 100}}{\text{Weight of whole plant}}$$

3.13.3 Quality characters

3.13.3.1 Diameter of curd (cm)

Diameter of curd was measured by dividing the circumference(2Лr) by 3.14(Л). The circumference of curd was measured with a synthetic fibre.

3.13.3.2 Compactness of curd (out of 10 points)

A panel made to testing compactness of curd, rank marks were given out of ten. The compactness of curd may be determined by pressing the curd with fingers. The basis of above system curds were sorted into four group categories most compact (7.5 to 10), medium compact (5 to 7.5) and poor curd (<5).

3.13.3.3 Color of curd (out of 10 points)

A panel made to observe color of curd, rank marks were given out of ten. These wee sorted into four group categories white (7.5 to 10), milky white (5 to 7.5), off white (2.5 to 5) and yellow (<2.5).

3.13.3.4 Protein content (%)

Samples of curd were taken from each plot at harvest after grinding, these samples were chemically analyzed for the estimation nitrogen content. The content was estimated by colorimetric method (Snell and Snell, 1939). The grinded samples were digested in sulphuric acid and treated with hydrogen peroxide to remove brown whitish color. Nessler's reagent was obtained by multiplying the per cent nitrogen content by 6.25 (A.O.A.C., 1960).

3.13.4 Weed studies

3.13.4.1 Weed density (weed/m^2)

Grassy (monocot), broad leaved weeds (dicot) and total weed species were counted with the help of a quadrant measuring 0.5 X 0.5 m^2 by placing randomly at two places in each plot. The weed species were counted at 35 DAT, 60 DAT and at the time of harvesting of the crop. Important weed species of field were listed in Table 3.4.

3.13.4.2 Total weed biomass (kg/ha)

Biomass of weeds at 35 DAT, 60 DAT was recorded from 0.25 sq. m. area with the help of an iron quadrant placed randomly in each plot. But at harvested stage weeds from whole plot were harvested and their fresh weight was recorded. Fresh sample weight 100 g. from each plot was collected for computing biomass of weeds. Weed sample were oven dried at 70^0C for 24 hours to a constant weight. Then dried weed sample were weighted and dry matter yield was computed for each plot.

3.13.5 Weed control efficiency (WCE)

Weed control efficiency was calculated at harvest by using the formula by Umani and Boi (1982) as,

$$WCE(\%)= (DMC-DMT)/DMC \times 100$$

Where,

DMC= Dry weed production of weeds in weedy check plot

DMT= Dry weed production of weeds in treated plot

3.14 ECONOMICS DIFFERENT TREATMENTS

The economics of different treatments was estimated in terms of net profit /ha. The cost of cultivation for each treatment was substrated from gross returns and net profit was worked out. Further, to ascertain profitability on per rupee investment, benefit cost ratio was also calculated.

3.15 STATISTICAL ANALYSIS

The experimental data were statistically analyzed for analysis of variance and test at significance through the procedure described by Fisher (1950).the critical difference for treatment comparison worked out where the “F” test was used to found significant at 5% level of significance. Summary table along with S.Em. and C.D. were prepared and presented in the text at the chapter entitled “Experimental Results” and analysis of variance for different parameters are presented in Appendices.

4. Experimental Results

The results of the field experiment entitled **"Integrated weed management in cauliflower (*Brassica oleracea* var. *botrytis* L.)"** conducted in rabi season 2009-2010 at Hi-Tech unit, Department of Horticulture, Rajasthan College of Agriculture, Udaipur are presented in this chapter. The data pertaining to the effect of different treatments on weed management and simultaneously on growth, yield and quality attributes of cauliflower were statistically analyzed for test of significance of the results. In addition to tabular presentation of data, depicting through graphs has also been done for better understanding. The results of various treatments for different characters are presented in relevant tables.

The analysis of variance for different characters is given in the Appendices (I to XV).

4.1 GROWTH PARAMETERS

4.1.1 Plant height (cm)

The data regarding height of plant at 60 days after transplanting (DAT) and at harvest have been presented in the table 4.1. The analysis of variance has been given in Appendix I and graphically represented in Fig. 4.1.

4.1.1.1 Plant height at 60 days after transplanting (DAT)

A perusal of data (Table-4.1) revealed that the average plant height was significantly affected due to the weed management treatments. Maximum plant height (52.53 cm) was recorded under T_7 (black plastic mulch) non-significantly followed by T_8 (rice straw mulch) and T_5 (pendimethalin at 1.5 kg/ha + one hand weeding at 35 DAT). Significantly lowest plant height (43.50 cm) was recorded under the T_0 treatment where no weed control method was adopted.

4.1.1.2 Plant height at harvest

The data (Table 4.1) revealed that the average plant height of cauliflower crop at harvest was significantly affected due to different weed management treatments.

Here the highest plant height (56.23 cm) was recorded under T_7 (black plastic mulch) which was at par with T_8 (rice straw mulch) 54.87 cm and T_5 (pendimethalin at 1.5 kg/ha + one hand weeding at 35 DAT) 54.33 cm. Significantly, the lowest plant height (46.43 cm) was recorded under the T_0 treatment where no weed control method was adopted.

4.1.2 Plant spread (cm^2)

The data pertaining to effect of different treatments on spread of plant at 60 DAT and at harvest have been presented in the Table 4.1. The analysis of variance has been given in Appendix II and depicted graphically in Fig. 4.2.

4.1.2.1 Plant spread at 60 DAT

An examination of data presented in Table 4.1 clearly established that significant difference was derived in terms of spread of plant due to different weed management treatments. The maximum plant spread (2445.76 cm^2) was recorded under T_7 (black plastic mulch). However, it was statistically at par with T_8 (rice straw mulch) and T_5 (pendimethalin at 1.5 kg/ha + one hand weeding at 35 DAT) which was 2383.82 cm^2 and 2330.55 cm^2 respectively. Significantly minimum plant spread (1781.21 cm^2) was recorded under weedy check treatment.

4.1.2.2 Plant spread at harvest

The data (Table-1) indicated that the minimum plant spread was observed under T_0 (weedy check) while the maximum plant spread (3469.38 cm^2) was recorded from the treatment T_7 (black plastic mulch), which was at par with T_8 (rice straw mulch) where the plant spread was 3396.30 cm^2.

4.1.3 Number of leaves per plant

The data regarding the effect of different treatments on number of leaves per plant at 60 DAT and at harvest have been presented in the table 4.2. The analysis of variance has been given in Appendix III.

4.1.3.1 Number of leaves per plant at 60 DAT

As the data from Table 4.2 revealed that there was non-significant difference between different treatments in experiment in respect of number of leaves at 60 DAT.

4.1.3.2 Number of leaves per plant at harvest

A comparison of weed control treatment (Table 4.2) revealed that non-significantly difference between treatments in respect of number of leaves at harvest.

4.1.4 Days taken to curd initiation

It is explicit from the data (Table 4.3 and Fig. 4.3) that application of different weed control methods significantly reduced the time taken for the initiation of curd as compared to check plot. The treatment T_0 (weedy check) took maximum (74.93) days for curd initiation whereas the minimum time taken for the initiation of curd after transplanting (68.00 days) was recoded in T_7 (black plastic mulch) which was at par with T_8 (rice straw mulch).

4.1.5 Days taken to curd maturity

As evident from data presented in Table 4.3 and depicted Fig 4.3 that the maximum time (99.70 days) for curd maturity was under T_0 (weedy check). The minimum time taken to curd maturity (92.80 days) was recorded in T_7 (black plastic mulch). However, it was statistically at par (93.70 days) with T_8 (rice straw mulch).

4.2 YIELD ATTRIBUTES

4.2.1 Weight of curd (kg)

A comparison of data regarding different treatments (Table 4.4) revealed that lowest average curd weight (545 g) was recorded under weedy check treatment. Significantly, the highest curd weight (675 g) was under T_7 (black plastic mulch) closely followed by T_8 (rice straw mulch).

4.2.2 Yield per plot (kg)

The data on yield per plot as affected by different treatments of weed control are presented in Table 4.4. It is evident from the data that all the weed control measures significantly increase the yield per plot over the weedy check plot. The maximum yield 11.82 kg recorded from the plot T_7 (black plastic mulch) which did not influenced significantly 11.06 kg with T_8 (rice straw mulch). The minimum yield per plot 5.12 kg was observed under T_0 (weedy check).

4.2.3 Total yield (t/ha)

The data regarding effect of different treatments of weed control measures on yield of marketable curd/ha have been presented in Table 4.4. The analysis of variance has been given in Appendix VI and graphically represent in Fig 4.4.

. The most important inference drawn from the results (Table 4.4) is that all methods employed for control of weeds, significantly enhanced the yield over weedy check but the degree of variation noticed depended upon the effectiveness of the treatment. Here the maximum yield (26.30 t/ha) was obtained from T_7 (black plastic mulch) which was statistically at par with T_8 (rice straw mulch) 24.60 t/ha. Significantly, lowest curd yield (11.39 t/ha) was recorded under the T_0 treatment where no weed control method had been adopted.

4.2.4 Harvest index (%) (HI)

A comparison of weed control treatments (Table 4.4) revealed that all weed treatments caused significant per cent increase in harvest index over control (weedy check). But the maximum harvest index (59.97 %) was obtained from T_7 (black plastic mulch) which was closely followed by T_8 (rice straw mulch) 59.88 %.

4.3 QUALITY CHARACTERS

4.3.1 Diameter of curd (cm)

The data on curd diameter is presented in Table 4.5 and its analysis of variance is given in Appendix VII. These data reveals that the lowest curd diameter (11.10 cm) was recorded under the T_0 treatment where no weed control method was adopted. Significantly the highest curd diameter (17.20 cm) was obtained under T_7 (black plastic mulch). Which was statistically at par 16.83 cm with T_8 (rice straw mulch) and 16.27 cm with T_5 (pendimethalin at 1.5 kg/ha + one hand weeding at 35 DAT).

4.3.2 Compactness of curd (out of 10 points)

The effect of different weed control treatments on compactness of curd was found to be significant, A perusal of data (Tables 4.5 and Fig 4.5) shows that compactness of curd was maximum (9.31) in T_7 (black plastic mulch) and minimum (6.23) in T_0 (weedy check). However, there was not significant difference between T_7 and T_8 (rice straw mulch).

4.3.2 Color of curd (out of 10 points)

The effect of various treatments on color of curd was found to be significant. A perusal of data (Tables 4.5 and Fig 4.5) shows that color of curd rank marks were given minimum in T_0 (weedy check) 6.56. The maximum colour score (9.38) was obtained from black plastic mulch which was non-significantly followed by rice straw mulch.

4.3.3 Protein content (%)

The data regarding effect of different weed control treatments on per cent protein content in curd of cauliflower have been presented in Table 4.5. The analysis of variance has been given in Appendix VIII.

The perusal of data revealed that application of some treatments significantly increase the per cent protein content in curd as compared to controls. The per cent protein content of curd was highest (2.78) in T_7 (black plastic mulch) closely followed by T_8 (rice straw mulch) 2.70 per cent.

4.4 WEED STUDIES

4.4.1 Weed Density (weeds/m^2)

4.4.1.1 Weed Density 35 DAT

An examination of data (Table 4.6) revealed that all the weed control treatments significantly reduced density of grassy (monocot), broad leaved (dicot) and total weeds over weedy check. Further, treatment T_7 (black plastic mulch) showed no weed/m^2.

4.4.1.2 Weed density 60 DAT

A perusal of data (Table 4.7) indicated that all the weed control practices significantly reduced density of grassy, broad leaved and total weeds at 60 DAT. The lowest density of grassy weeds (1.19/m^2), broad leaved weeds (1.67/m^2) and total weeds (2.86/m^2) was observed under the treatment T_7 (black plastic mulch). When compared to T_0 (weedy check) wherein density of grassy weeds, broad leaved weeds and total weeds were recorded highest.

4.4.1.2 Weed density at harvest

A comparison of weed control treatment (Table 4.8 and Fig 4.6) revealed that at the harvesting stage all weed control treatments reduce the weed density. However, the treatment T_7 (black plastic mulch) was most effective as it has the lowest weed

density of grassy (2.22/m^2), Broad leaved (2.22/m^2) and total weeds (4.45/m^2) whereas the highest weed population was recorded from weedy check plot which was 55.00, 173.30 and 228.30 of grassy, Broad leaved and total weeds/m^2, respectively.

4.4.2 Total weed biomass (kg/ha)

4.4.2.1 Total weed biomass at 35 DAT

An appraisal of data presented in Table 4.9 explicit that all the weed control treatments significantly reduced weed biomass (dry matter) over T_0 (weedy check). The data further revealed that the treatment T_7 (black plastic mulch) has the nil weed biomass as the plot was totally free from weeds. The maximum total weed biomass (740 kg/ha) was recorded from the field where no weed control measure has been adopted.

4.4.2.2 Total weed biomass at 60 DAT

An assessment of data (Table 4.9) indicated that all the weed control practices significantly reduced the total weed biomass over the control. However, the minimum of weed biomass at 60 DAT (60 kg/ha) was recorded under the treatment T_7 (black plastic mulch).

4.4.2.3 Total weed biomass at harvest

A critical examination of data presented in Table 4.9 explicit that all the weed control practices significantly reduced the total weed biomass over the control. The minimum weed biomass (120 kg/ha) was recorded under the treatment T_7 (black plastic mulch). The plot treated with rice straw mulch (T_8) showed the second lowest total weed biomass (210 kg/ha) after T_7.

4.4.3 Weed control efficiency (%) (WCE)

4.4.3.1 Weed control efficiency at 35 DAT

An examination of data presented in Table 4.10 revealed that weed control efficiency at 35 DAT based on weed dry weight fluctuated to a great extent under the influence of various weed control treatments. It is obvious from data that in general all weed control treatments efficiently controlled grassy as well as broad leaved weeds.

The data further indicated that 100 per cent weed control efficiency was recorded under T_7 (black plastic mulch). This was followed by T_8 (rice straw mulch) where WCE was 89.19 per cent.

4.4.3.2 Weed control efficiency at 60 DAT

The data presented in Table 4.10 indicated that highest weed control efficiency at 60 DAT (97.44 %) was under T_7 (black plastic mulch) followed by T_8 (rice straw mulch) where WCE was 94.00 per cent.

4.4.3.3 Weed control efficiency at harvest

A thorough examination of data (Table 4.10) unveiled the fact that weed control efficiency at harvest fluctuated under the influence of different weed control treatments. However, the highest WCE (96.35 %) was recorded under T_7 (black plastic mulch) followed by T_8 (rice straw mulch) where WCE was 93.44 per cent.

4.5 ECONOMICS OF DIFFERENT TREATMENTS

The data presented in Appendix XIV and XV indicated that cost of cultivation of cauliflower crop was Rs. 39495 per hectare including labour cost, tractor charges, manures and fertilizers cost, ploughing, sowing, irrigation and plant protection measures. Treatment wise additional cost is also given.

The economics of various treatments with B: C ratios are given in Table 4.11. The gross return from sale of cauliflower curd was calculated at an average price of Rs 10 per kg (Table 4.11). The net profit from cultivation under different treatments were worked out after subtracting cost of cultivation from gross returns. The net profit inclusive land rent and management.

It may be inferred from B: C ratio that the rice straw mulch increased the production of cauliflower. As far as net profit is concerned it was maximum (Rs. 200091.70) from black plastic mulch followed by rice straw much (Rs. 191071.70). But the plastic mulch was found costly so the benefit cost ratio was lesser than rice straw mulch. Minimum cost benefit ratio of 1.88: 1 and net profit (Rs. 74385) was obtained from plot where no weeding had been done.

5. Discussion

During the course of presenting results of the field experiment entitled **"Integrated weed management in cauliflower (*Brassica oleracea* var. *botrytis* L.)"**, significant variations in the criteria used for evaluation of treatments was observed due to different treatments. In the ensuing pages it is endeavored to discuss the significant events and those assuming a definite pattern in respect of various parameters studied so as to establish cause and affect relationship in the light of available evidences and literature.

The effects of integrated weed management on different attribute have been discussed in this chapter under the following heads:

5.1 Growth parameters

Height of plant was superior in plots where number of weed were low since there was lesser crop-weed competition for light, nutrients, moisture and space resulting into increasing availability of assimilates for growth and developments of plants (Mal *et al.*, 2005). The maximum plant height was obtained with black plastic mulch followed by rice straw mulch. Similar results were reported by Juan (2009) and Moniruzzaman *et al.* (2007). Significant increase in plant height in plot treated with pendimethalin at 1.5 kg/ha in combination with one hand weeding (35 DAT) was also statistically at par with plastic mulch (Nandawar *et al.*, 2006).

The results for plant spread unveiled the fact that the maximum plant spread was obtained from black plastic mulch which was statistically at par with rice straw mulch and pendimethalin at 1.5 kg/ha + one hand weeding at 35 DAT. The reason is again less crop-weed competition.

Number of leaves were lowest in weedy check since it has highest weed intensity which might have altered the spectral photon distribution within the canopy (Mal, 2005) thus affected the plant development. However, the weed control treatments black plastic mulch, rice straw mulch and pendimethalin at 1.5 kg/ha + one hand weeding at 35 DAT showed maximum number of leaves. Bhayan *et al.* (1985) reported that some weed control treatments increased availability of light, nutrients, moisture and space to crop which results into more biomass accumulation ultimately

increased number of leaves. The difference depends upon effectiveness of different treatments in controlling weed population.

As far as days taken to curd initiation and maturity are concerned it was lowest under black plastic mulch closely followed by rice straw mulch. The possible reason may be due to rise in temperature under mulch conditions which markedly shortened the maturity days (Juan, 2009; Subrahmaniyan and Zhou, 2008)

5.2 Yield attributes

The application of weed control treatments significantly increased the average weight of curd, yield per plot, total yield per hectare and harvest index. As stated earlier that increase in availability of light, nutrients, moisture and space to the crop was responsible for increased yield. These findings are in close conformity with that of Mani (1977) and Mal (2003). Lower biological yield per plant as observed in weedy check plot might be due to more competition for light and space which resulted in small and slender plant. Whereas, higher values of different yield attributes viz. average weight of curd per plant, yield per plot, total yield and harvest index as observed in black plastic mulch Subrahmaniyan and Zhou (2008) than rice straw mulch and pendimethalin at 1.5 kg/ha + one hand weeding at 35 DAT might be attributed to better weed control under these treatments. In fact increasing assimilates available to plant vegetative phase directly responsible in these treatments for the better growth of curd and ultimately yield (Bhayan *et al.*, 1985). Contrary to this, poor value of these yield parameters recorded in weedy check plot may be ascribed to more crop-weed competition.

5.3 Quality parameters

In the present investigation the black plastic mulch resulted into better quality parameters viz. diameter, compactness, color and protein content. Whereas the curds from the weedy check plot were poor in quality. Similar results were observed by Moniruzzaman *et al.* (2007). This might be due adequate and balanced availability of nutrients and simultaneously better use of natural resources such as solar radiation and atmospheric nitrogen.

5.4 Weed attributes

Among weeds the broad leaved weeds like *Chenopodium album, Chenopodium murale, Anagelis arvensis* and *Asphodelus tenuifolius* mainly invaded

the crop field. Both density and biomass of weeds at different stages were maximum in weedy check whereas, minimum under black plastic mulch. However, all the treatments proved effective in minimizing the weed density and weed biomass production. The greatest control of weeds (grassy, broad leaved and total number of weeds) occurred with the black plastic mulch followed by rice straw mulch. Similar results have been found by Abouziena *et al.* (2008). Campiglia *et al.* (2000) revealed the reason that it might be due to rise in soil temperature under mulch conditions at all depths which reduced weed density as well as weed biomass production.

The maximum biomass of weed was found in weedy check because weeds were allowed to grow throughout the growing season and removed appreciable amount of nutrients from the soil. Whereas, the minimum weed biomass was under black plastic mulch because it suppressed the weed growth to a great extent. Although, all the weed control treatments gave sufficient control of weeds over weedy check. The results are in agreement with Bhayan (1983).

Superiority of weed control methods was estimated in terms of weed control efficiency. The maximum weed control efficiency was found in black plastic mulch which might be due to the lowest weed biomass recorded under this treatment as compared to biomass of weedy check. Singh and Mir (2005) also obtained the highest weed control efficiency with black polythene mulch in cabbage cv. Pride of India.

5.4 Cost benefit ratio

As the benefit depends upon yield and the maximum yield and net profit per unit investment. Although the yield recorded was highest from black plastic mulch yet per unit profit (cost benefit ratio) was highest (1: 3.48) from the rice straw mulch treated plot because this is far cheaper than the plastic mulch. Similar results were reported by Moniruzzaman *et al.* (2007) and Abouziena *et al.* (2008).

6. Summary

The results of the field experiment entitled **"Integrated weed management in cauliflower (*Brassica oleracea* var. *botrytis* L.)"** conducted at Hi-Tech unit, Department of Horticulture, Rajasthan College of Agriculture, Udaipur during the rabi season of 2009-10 which presented and discussed in preceding chapters are summarized in this chapter:

1. The maximum height of cauliflower plant 52.53 cm at 60 days after transplanting (DAT) and 56.23 cm at harvest was recorded under black plastic mulch an it was closely followed by rice straw mulch (51.83 cm at 60 DAT and 54.87 cm at harvest) and pendimethalin at 1.5 kg/ha + one hand weeding at 35 DAT (50.63 cm at 60 DAT and 54.63 cm at harvest).
2. Plant spread was significantly affected by different treatments of weed management. Maximum plant spread at 60 DAT (2445.76 cm^2) was recorded under black plastic mulch which was statistically at par 2383.82 cm^2 with rice straw mulch and 2330.55 cm^2 with pendimethalin at 1.5 kg/ha + one hand weeding at 35 DAT. Similarly the maximum plant spread at harvest (3469.38 cm^2) was recorded under black plastic mulch. However, it was statistically at par with rice straw mulch 3396.30 cm^2.
3. Minimum days (68.00) taken for curd initiation were under black plastic mulch which was closely followed by rice straw mulch (69.03 days). Whereas, the maximum days (74.93) taken for curd initiation were recorded under weedy check.
4. The maximum days taken to maturity (99.70) was recorded under weedy check plot while the black plastic mulch treated plot had taken the minimum days (92.80). However, the treatments rice straw mulch and pendimethalin at 1.5 kg/ha + one hand weeding at 35 DAT were not significantly different with black plastic mulch.
5. The application of black plastic mulch significantly increased the average weight of marketable curd per plant and per plot and total yield (26.30 t/ha) which was non-significantly followed by rice straw mulch wherein total yield was 24.60 t/ha.

6. As far as quality characters (diameter, compactness, color and protein content of curd) were concerned the treatment black plastic mulch was found most superior followed by rice straw mulch.
7. The highest number of weeds/m^2 were recorded in weedy check plots and lowest numbers of weeds in plots treated with black plastic mulch and this proved most effective method in controlling weed population.
8. The maximum weed biomass 3200 kg/ha (at harvest) was recorded from weedy check plots against the minimum (120 kg/ha) from plots of black plastic mulch followed by rice straw mulch (210 kg/ha).
10. Among the different treatments the highest WCE (96.35 %) was recorded under T_7 (black plastic mulch) followed by T_8 (rice straw mulch) where WCE was 93.44 per cent.
11. Rice straw mulch was found economically most superior as it gave highest B: C ratio of 3.48: 1 followed by Pendimethalin + 1 hand weeding (3.34: 1) and black plastic mulch (3.18: 1).

7. Conclusion

It is inferred that significantly higher weed control efficiency was achieved by using black plastic mulch followed by rice straw mulch. Amongst different weed management practices, use of black plastic mulch registered highest curd yield but it was at par with rice straw mulch. Though the net returns were little higher by use of black plastic mulch, however on account of low cost the use of rice straw mulch resulted in higher B: C ratio than black plastic mulch. Also the quality parameters (viz. diameter, compactness, color and protein content of curd) were at par between these two treatments.

Hence, rice straw mulch is recommended for weed control in cauliflower.

Table 4.1. Effect of weed management on plant height (cm) and plant spread (cm^2) at 60 days after transplanting (DAT) and at harvest.

Treatments	Plant height (cm)		Plant spread (cm^2)	
	60 DAT	At harvest	60 DAT	At harvest
T_0- Weedy check	43.50	46.43	1781.21	2772.95
T_1- Fluchloralin at 1.5 kg/ha	47.07	49.47	2080.90	3015.88
T_2- Pendimethalin at 1.5 kg/ha	48.43	51.07	2218.43	3192.04
T_3- Alachlor at 2 kg/ha	46.33	48.80	2019.35	2948.16
T_4- Fluchloralin + 1 hand weeding	49.07	52.43	2276.76	3233.64
T_5- Pendimethalin + 1 hand weeding	50.63	54.33	2330.55	3297.54
T_6- Alachlor + 1 hand weeding	47.91	50.50	2174.43	3101.76
T_7- Black plastic mulch	52.53	56.23	2445.76	3469.38
T_8- Rice straw mulch	51.83	54.87	2383.82	3396.30
T_9- Two hand weedings	48.33	51.07	2228.44	3174.39
SEm.±	0.97	0.73	44.55	51.29
CD at 5%	2.87	2.18	132.35	152.40

Table 4.2. Effect of weed management on number of leaves per plant 60 DAT and at harvest.

Treatments	Number of leaves per plant	
	60 DAT	At harvest
T_0- Weedy check	18.27	21.37
T_1- Fluchloralin at 1.5 kg/ha	18.37	21.64
T_2- Pendimethalin at 1.5 kg/ha	18.33	21.73
T_3- Alachlor at 2 kg/ha	18.73	22.10
T_4- Fluchloralin + 1 hand weeding	19.27	22.97
T_5- Pendimethalin + 1 hand weeding	19.90	23.53
T_6- Alachlor + 1 hand weeding	19.23	21.73
T_7- Black plastic mulch	20.24	23.23
T_8- Rice straw mulch	20.13	23.20
T_9- Two hand weedings	18.33	21.83
SEm. ±	0.70	0.79
CD at 5%	2.08	2.33

Table 4.3. Effect of weed management on days taken to curd initiation and curd maturity (number of days).

Treatments	Days taken to curd initiation	Days taken to curd maturity
T_0- Weedy check	74.93	99.70
T_1- Fluchloralin at 1.5 kg/ha	73.43	97.40
T_2- Pendimethalin at 1.5 kg/ha	72.27	96.27
T_3- Alachlor at 2 kg/ha	73.83	97.70
T_4- Fluchloralin + 1 hand weeding	71.70	95.77
T_5- Pendimethalin + 1 hand weeding	71.17	95.33
T_6- Alachlor + 1 hand weeding	72.10	96.17
T_7- Black plastic mulch	68.00	92.80
T_8- Rice straw mulch	69.03	93.70
T_9- Two hand weedings	72.20	96.23
SEm. ±	0.58	0.98
CD at 5%	1.71	2.90

Table 4.4. Effect of weed management on weight of curd (g), yield per plot (kg), total yield (t/ha) and harvest index (%).

Treatments	Weight of curd (g)	Yield per plot (kg)	Total yield (t/ha)	Harvest index (%)
T_0- Weedy check	545.00	5.12	11.39	50.29
T_1- Fluchloralin at 1.5 kg/ha	595.00	7.48	16.64	54.21
T_2- Pendimethalin at 1.5 kg/ha	616.67	7.88	17.54	56.01
T_3- Alachlor at 2 kg/ha	586.67	7.10	15.79	52.84
T_4- Fluchloralin + 1 hand weeding	623.00	8.63	19.21	56.79
T_5- Pendimethalin + 1 hand weeding	628.67	9.08	20.21	57.96
T_6- Alachlor + 1 hand weeding	601.67	7.96	17.71	55.72
T_7- Black plastic mulch	674.67	11.82	26.30	59.97
T_8- Rice straw mulch	653.67	11.06	24.60	59.88
T_9- Two hand weedings	619.00	8.22	18.29	55.85
SEm. ±	14.90	0.39	0.61	0.35
CD at 5%	44.28	1.15	1.82	1.04

Table 4.5. Effect of weed management on diameter of curd (cm), compactness of curd (out of 10 points), color of curd (out of 10 points) and protein content (%).

Treatments	Diameter of curd (cm)	Compactness of curd (out of 10 points)	Color of curd (out of 10 points)	Protein content (%)
T_0- Weedy check	11.10	6.23	6.56	2.41
T_1- Fluchloralin at 1.5 kg/ha	14.27	7.83	7.95	2.45
T_2- Pendimethalin at 1.5 kg/ha	15.07	8.47	8.11	2.48
T_3- Alachlor at 2 kg/ha	13.87	7.66	7.49	2.45
T_4- Fluchloralin + 1 hand weeding	15.80	7.99	8.02	2.58
T_5- Pendimethalin + 1 hand weeding	16.27	8.52	8.11	2.51
T_6- Alachlor + 1 hand weeding	15.07	7.57	7.97	2.46
T_7- Black plastic mulch	17.20	9.31	9.38	2.78
T_8- Rice straw mulch	16.83	9.28	9.33	2.70
T_9- Two hand weedings	14.83	8.72	8.70	2.63
SEm. ±	0.58	0.12	0.11	0.04
CD at 5%	1.71	0.36	0.33	0.12

Table 4.6. Effect of weed management on weed density (weed/m^2) at 35 DAT.

Treatments	35 DAT		
	Grassy weeds	BLW	Total
T_0- Weedy check	3.58 (12.33)	7.91 (62.00)	8.65(74.33)
T_1- Fluchloralin at 1.5 kg/ha	3.54 (12.00)	4.14(16.66)	5.40 (28.66)
T_2- Pendimethalin at 1.5 kg/ha	1.96 (3.33)	4.18(17.00)	4.56 (20.33)
T_3- Alachlor at 2 kg/ha	2.48 (5.66)	5.34(28.00)	5.84(33.66)
T_4- Fluchloralin + 1 hand weeding	2.41 (5.33)	5.11(25.66)	5.61 (30.99)
T_5- Pendimethalin + 1 hand weeding	2.55 (6.00)	3.85(14.33)	4.56 (20.33)
T_6- Alachlor + 1 hand weeding	2.92 (8.00)	4.85(23.00)	5.61 (31.00)
T_7- Black plastic mulch	0.71 (0.00)	0.71(0.00)	0.71(0.00)
T_8- Rice straw mulch	1.87 (3.00)	1.08(0.66)	2.04(3.66)
T_9- Two hand weedings	3.85 (14.33)	8.32(68.66)	9.14(82.99)
SEm. ±	0.02	0.03	0.04
CD at 5%	0.05	0.10	0.11

Table 4.7. Effect of weed management on weed density (weed/m^2) at 60 DAT.

Treatments	60 DAT		
	Grassy weeds	BLW	Total
T_0- Weedy check	7.40 (54.33)	13.06(170.00)	14.99 (224.33)
T_1- Fluchloralin at 1.5 kg/ha	4.67 (21.33)	8.20(66.66)	9.41(87.99)
T_2- Pendimethalin at 1.5 kg/ha	4.14 (16.66)	7.25 (52.00)	8.32(68.66)
T_3- Alachlor at 2 kg/ha	5.01 (24.66)	8.28(68.00)	9.65 (92.66)
T_4- Fluchloralin + 1 hand weeding	3.19 (9.66)	5.31 (27.66)	6.15(37.32)
T_5- Pendimethalin + 1 hand weeding	2.80(7.33)	4.71(21.66)	5.43(28.99)
T_6- Alachlor + 1 hand weeding	3.34 (10.66)	5.58(30.66)	6.47(41.32)
T_7- Black plastic mulch	1.28 (1.19)	1.47 (1.67)	1.83(2.86)
T_8- Rice straw mulch	2.41(5.33)	2.20 (4.33)	3.19(9.66)
T_9- Two hand weedings	4.34(18.33)	7.56(56.66)	8.69(74.99)
SEm. ±	0.07	0.04	0.06
CD at 5%	0.21	0.12	0.19

Table 4.8. Effect of weed management on weed density (weed/m^2) at harvest.

Treatments	At harvest		
	Grassy weeds	BLW	Total
T_0- Weedy check	7.45 (55.00)	13.18(173.30)	15.13 (228.30)
T_1- Fluchloralin at 1.5 kg/ha	5.02 (24.66)	8.09(65.00)	9.50 (89.66)
T_2- Pendimethalin at 1.5 kg/ha	3.54 (12.00)	7.40(54.33)	8.17 (66.33)
T_3- Alachlor at 2 kg/ha	4.53(20.00)	8.43(70.60)	9.54 (90.60)
T_4- Fluchloralin + 1 hand weeding	2.68 (6.66)	5.21(26.66)	5.82 (33.32)
T_5- Pendimethalin + 1 hand weeding	2.80 (7.33)	4.18 (16.99)	4.98 (24.32)
T_6- Alachlor + 1 hand weeding	2.80 (7.33)	5.37 (28.33)	6.01 (35.66)
T_7- Black plastic mulch	1.65 (2.22)	1.65 (2.22)	2.22 (4.45)
T_8- Rice straw mulch	2.55 (5.99)	2.55 (5.99)	3.53 (11.98)
T_9- Two hand weedings	3.94 (15.00)	7.60 (57.34)	8.53 (72.34)
SEm. ±	0.04	0.05	0.05
CD at 5%	0.11	0.16	0.16

Table 4.9. Effect of weed management on weed biomass (kg/ha) at harvest.

Treatments	Weed biomass		
	35 DAT	60 DAT	At harvest
T_0- Weedy check	740	2500	3200
T_1- Fluchloralin at 1.5 kg/ha	480	870	1150
T_2- Pendimethalin at 1.5 kg/ha	310	530	770
T_3- Alachlor at 2 kg/ha	500	990	1230
T_4- Fluchloralin + 1 hand weeding	490	440	560
T_5- Pendimethalin + 1 hand weeding	290	340	430
T_6- Alachlor + 1 hand weeding	520	510	700
T_7- Black plastic mulch	0.00	60	120
T_8- Rice straw mulch	80	150	210
T_9- Two hand weedings	750	530	780
SEm. ±	6.34	11.70	15.50
CD at 5%	18.84	34.80	46.20

Table 4.10. Effect of weed management on weed control efficiency (%) of different treatments over weedy check.

Treatments	Weed control efficiency		
	35 DAT	60 DAT	At harvest
T_0- Weedy check	-	-	-
T_1- Fluchloralin at 1.5 kg/ha	35.11	65.19	64.05
T_2- Pendimethalin at 1.5 kg/ha	58.10	78.80	75.93
T_3- Alachlor at 2 kg/ha	32.43	60.40	61.56
T_4- Fluchloralin + 1 hand weeding	33.75	82.39	82.49
T_5- Pendimethalin + 1 hand weeding	60.81	86.40	86.56
T_6- Alachlor + 1 hand weeding	29.69	79.59	78.11
T_7- Black plastic mulch	100.00	97.44	96.35
T_8- Rice straw mulch	89.19	94.00	93.44
T_9- Two hand weedings	-*	78.79	75.61
SEm.±	0.97	0.27	0.29
CD at 5%	2.87	0.81	0.87

* Hand weeding- done after taking observation

Table 4.11. Economics of different treatments with B: C ratio.

Treatments	Total cost of cultivation	Gross return Rs./ha	Net profit	B: C ratio
T_0- Weedy check	39495	113880.00	74385.00	1.88: 1
T_1- Fluchloralin at 1.5 kg/ha	41660.8	166394.30	124733.30	2.99: 1
T_2- Pendimethalin at 1.5 kg/ha	42095	175400.00	133305.00	3.17: 1
T_3- Alachlor at 2 kg/ha	41415	157900.00	116485.00	2.81: 1
T_4- Fluchloralin + 1 hand weeding	46160	192113.3	145953.30	3.16: 1
T_5- Pendimethalin + 1 hand weeding	46595	202095.80	155500.80	3.34: 1
T_6- Alachlor + 1 hand weeding	45915	177086.70	131171.70	2.86: 1
T_7- Black plastic mulch	62875	262966.70	200091.70	3.18: 1
T_8- Rice straw mulch	54895	245966.70	191071.70	3.48: 1
T_9- Two hand weedings	48495	182901.70	134406.70	2.77: 1

APPENDIX-XIV

General cost of cultivation per hectare of experimental crop (excluding cost of treatment input)

Particulars	Units	Rate per unit (Rs.)	cost per ha (Rs.)
A. Labour charges			
1. Raising of nursery	5 Mandays	100.00/Mandays	500.00
2. Care of nursery	4 Mandays	100.00/Mandays	400.00
3. Application of FYM and fertilizers	18 Mandays	100.00/Mandays	1800.00
4. Layout of experiment	6 Mandays	100.00/Mandays	600.00
5. Transplanting of seedlings	30 Mandays	100.00/Mandays	3000.00
6. Gap filling	5 Mandays	100.00/Mandays	500.00
7. Irrigation labour	28 Mandays	100.00/Mandays	2800.00
8. Spraying of insecticides	10 Mandays	100.00/Mandays	1000.00
9. Harvesting and selling of curds	55 Mandays	100.00/Mandays	5500.00
10. Miscellaneous			750.00
B. Service charges of land preparation by tractor	10 Hours	400.00/hr	4000.00
C. Material inputs			
1. Seeds	500 Grams	800/Kg	400.00
2. FYM	25 Tonnes	300/T	7500.00
3. Irrigation cost (in terms of electricity and others)	18 Irrigations	300	5400.00
4. Nitrogen (Urea)	217 Kg/ha	5/Kg	1085.00
5. Phosphorus (SSP)	375 kg/ha	4.7/ Kg	1762.50
6. Potash (MOP)	100 kg/ha	6/Kg	600.00
7. Chloropyriphos (20EC)	4.5 l/ha	294/L	1323.00
8. Imidacloprid (17.8 SL)	600 ml /ha	1291/l	774.60
Total			39495.40

*

APPENDIX-XV

Cost of different treatments

	Cost of Flocloralin 45 EC @ Rs 530/ l	Cost of Pendimethalin 30 EC@ Rs 420/ l	cost of Alachlor 50EC @ Rs 380/ l	cost of hand weeding @ Rs.100/labour	Cost of plastic mulch @ Rs. 14 m^2	cost of straw mulch @ Rs. 2500/t	cost of application Rs.100/labour	Total cost under treatment (Rs./ha)	Total cost of cultivation (Rs./ha)
T_0	-	-	-	-	-	-	-	-	39495.00
T_1	1765						400	2165	41660.80
T_2		2200					400	2600	42095.00
T_3			1520				400	1920	41415.00
T_4	1765			4500			400	6465	46160.00
T_5		2200		4500			400	6900	46595.00
T_6			1520	4500			400	6220	45915.00
T_7					23380		300	23380	62875.00
T_8						15000	400	9400	54895.00
T_9				9000				8600	48495.00