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Bio-efficacy of herbicides on growth and yield of strawberry cv. Chandler

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ABSTRACT

A field trial was carried out on weed control in strawberry during 2007-08. Weed control treatments significantly reduced their population and dry matter as compared to weedy check. The lowest weed population and weed dry matter and highest weed control efficiency (WCE) was observed in weed-free check followed by herbicide treatment of oxyfluorfen + napropamide @ 0.60 + 5.00 kg a.i./ha. The strawberry plants attained maximum height (14.82 cm) with a spread (26.26 cm) under weed-free conditions followed by plants applied with oxyfluorfen @ 0.55 kg a.i./ha and polythene mulch treatment. Maximum yield (182 g/plant) was obtained under weed-free plots followed by(179.33 g/plant) under polythene mulch. The yield obtained under weedy check was (106.66 g /plant). Weed control efficiency and weed index was observed in the range (0-100%) and (0.00-41.39%).

Key words: Strawberry, oxyfluorfen, napropamide, weed control.

INTRODUCTION

Strawberry has recently been identified as one of the most favoured and profitable fruits to be grown in Jammu (Bhat *et al.*, 4) and its area is increasing further. The strawberry plant being herbaceous and shallow rooted is a poor competitor against weeds. Weeds compete with strawberry plants for water, minerals and sunlight; increase pressure from diseases, nematodes and insects; and reduce berry quality. The losses reported due to the presence of weeds have been estimated to be nearly 45 per cent (Bajwa *et al.*, 2).

Weed management refers to destroying or removal of weeds by any means. In most cases, prevention and eradication of weeds is not easy and feasible, and therefore their control becomes necessary. Control of weeds through mechanical means in strawberry is not feasible as it is quite laborious and cumbersome. However, chemical weed control on the other hand is a useful tool for reducing the cost of labour and number of cultivations required for mechanical means for weed control.

MATERIALS AND METHODS

The present investigation was conducted at Research Orchard of Division of Fruit Science, Faculty of Agriculture, SKUAST-Jammu during 2007-08. Nineteen treatments comprising weedy check, weed-free, polythene mulch, hand weeding at 15 day interval, oxyfluorfen @ 0.50, 0.55 and 0.60 kg a.i./ha (pre-planting), napropamide @ 4.00, 4.50 and 5.00 kg a.i./ha (post-planting), oxyfluorfen + napropamide @ 0.50 + 4.00, 0.50 + 4.50, 0.50 + 5.00, 0.55 + 4.00, 0.55 + 4.50, 0.55 + 5.00, 0.60 + 4.00, 0.60 + 4.50, 0.60 + 5.00 kg a.i./ha (pre-planting) were tested in randomized block design with three replications.

The soil of the experimental field was sandy loam and was neutral in reaction with pH of 7.09. Pre-plant herbicidal treatments were given three weeks before planting where as post-planting herbicidal treatments were carried out two weeks after planting of runners. Runners were planted on well prepared 2.0 m x 1.5 m raised beds after thorough ploughing, harrowing and leveling of land with spacing of 40 cm from row to row and 25 cm from plant to plant. Observations were recorded on weed, growth and yield attributes.

RESULTS AND DISCUSSION

The survey of weed flora in the experimental field was conducted. The category wise distribution, *viz.*, Broad leaved weeds, grassy weeds and sedges in unweeded check plots has been given in Table 1. All the weed control methods were significantly effective in reducing the weed population and dry matter accumulation of weeds at 30, 60, 90, 120 days after planting (DAP) and at harvest stage. The lowest weed population and dry matter was observed with oxyfluorfen + napropamide @ 0.60 + 5.00 kg a.i./ha (pre-plant).The reduction in weed population may be due to the inhibitory effect of these herbicides applied at pre-planting stage in one or more of the phases of seedlings growth. Both napropamide and oxyfluorfen exert an inhibitory effect on photochemical oxidative phosphorylation and respiration. These results are in conformity with the findings of Viljoen (15), and Sharma (12). On the other hand, use of polythene mulch has also considerably reduced the weed population. The

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Table 1. Weed flora associated with strawberry crop.

Common name/Group	Botanical name
Broad leaved weeds	
Bathua	*Chenopodium album*
Krishna neel	*Anagalis arvensis*
Maina	*Medicago denticulata*
Filarees	*Erodium* spp.
Matri	*Vicia sativa*
Gajri	*Fumaria parviflora*
Jungli palak	*Rumex* spp.
Bhang	*Cannabis sativa*
Congress grass	*Parthenium hysterophorus*
Grassy weeds	
Johnson grass	*Sorghum halpense*
Doob grass	*Cynodon dactylon*
Sedge	*Cyperus rotundus*

subtraction of weeds with black polythene mulch is attributed to the lack of sunlight and to their smothering, delayed emergence and reduced population (Kundu *et al.,* 8; Chatha and Chanana, 5). The highest weed population and dry matter was noted in unweeded control (Tables 2&3) because weeds were allowed to grow throughout the growing season.

Weed control efficiency and weed index was observed in the range of 0-100% and 0.00-41.39% ,respectively (Table 4). The highest weed control efficiency (100%) was observed in weed-free treatment followed by oxyfluorfen + napropamide @ 0.60 + 5.00 kg a.i./ha (96.28%). Weed index significantly influenced by all weed control treatments. The lowest weed index (1.46%) was obtained under polythene mulch and highest (41.39%) under weedy check. Similar results have been reported by Bhargava *et al.* (3).

The data presented in Table 5 reveal that all the growth parameters were significantly influenced by various weed control treatments as compared to weedy check. Maximum plant height (14.82 cm) was recorded in weed-free plots where as minimum plant height was obtained in plots applied with oxyfluorfen in combination with napropamide @ 0.60 + 5.00 kg a.i./ha. The plants in weed-free plots reached to the maximum spread of (26.26 cm) which was followed by the plants in the plots covered with polythene mulch (25.97 cm) and plots applied with oxyfluorfen @ 0.55 kg a.i./ha. Maximum number of leaves (16.00) and crowns per plant (2.35) was noted in weed-free plots followed by black polythene mulch treatment and minimum number of leaves and crowns per plant was observed with oxyfluorfen in combination with napropamide @ 0.60 + 5.00 kg a.i./ha. The results are in conformity with the findings of Stinchcombe and Stott (13). Application of napropamide @ 4.00, 4.50 and 5.00 kg a.i./ha as well as in combination with higher dose of oxyfluorfen @ 0.60 kg a.i./ha adversely affected the growth of strawberry plants. This may be because of the fact that the concentration at which both these herbicides were applied might have acted synergistically and resulted into toxicity effects on strawberry plants which resulted reduction in plant growth. These results are in contradiction with the observations made by Ghanta *et al.* (6). The use of black polythene mulch also improved the growth parameters of strawberry plant, which may be simply because the mulch helped in conserving the moisture in the root zone and also helped in the build up of organic matter, besides provided a ground cover and restricts the weed growth. Similar results were obtained by Rao and Pathak (10).

The results depicted in Table 5 reveal that yield per plant was significantly influenced by different weed control treatments and it ranged from 106.66 to 182 g /plant. The plants in weed free plots resulted in maximum yield of 182 g/plant followed by the plants covered with polythene mulch (179.33 g /plant) and were at par with each other. Minimum yield (106.66 g/ plant) was obtained under unweeded control. Among herbicidal treatments significant increase in the yield per plant (172.66 g/plant) was recorded in plants applied with oxyfluorfen @ 0.55 kg a.i./ha followed by the plants applied with oxyfluorfen @ 0.50 kg a.i./ ha (169.00 g /plant) as compared to other herbicide treatments applied singly or in combination with each other. These treatments might have enabled the roots to exploit greater surface thus leading to higher uptake of nutrients and water and results obtained in the present study are in agreement with Ri (11), Prakash *et al.* (9), and Akasaka and Imai (1).

Weed-free treatment gave highest cost of cultivation (Rs. 3,92,390/ha) (Table 6). Gross returns (Rs. 9,10,000/ha) were highest in weed free treatments but highest net returns per hectare (Rs. 5,46,760/ ha) were obtained under black polythene mulch treated plots with benefit-cost ratio of 1.56 followed by herbicidal treatment of oxyfluorfen @ 0.55 kg a.i./ ha (Rs. 5,19,810/ha) with benefit-cost ratio of 1.51 and lowest (Rs.1,93,410/ha) with benefit-cost ratio of 0.56 was obtained under control. This is due to the involvement of more labour under weed-free treatment as compared to use of polythene mulch for controlling of weeds. Similar estimates for gross income were reported by Kotze and Joubert (7) who observed an increase in the net returns with the use of mulch treatments as compared to hand weeding as standard practice. The estimates derived in the present investigation are in close conformity with the estimates of Sharma (12).

Table 2. Effect of control treatments on population of weeds (No. m^{-2}) at different stages of crop growth in strawberry cv. Chandler.

Treatment	Dose (kg ai/ha)	30 DAP	60 DAP	90 DAP	120 DAP	Harvest
T_1 Oxyfluorfen	0.50	5.88 (33.66)	7.27 (52.00)	8.62 (73.33)	8.36 (69.00)	6.53 (41.66)
T_2 Oxyfluorfen	0.55	5.22 (26.33)	6.10 (36.33)	7.81 (60.00)	6.92 (47.00)	5.59 (30.33)
T_3 Oxyfluorfen	0.60	4.39 (18.33)	5.16 (25.66)	6.40 (40.00)	5.77 (32.33)	4.82 (22.33)
T_4 Napropamide	4.00	10.56 (110.66)	12.70 (160.33)	15.58 (242.00)	14.31 (204.00)	11.51 (131.66)
T_5 Napropamide	4.50	9.39 (87.33)	11.48 (131.00)	13.92 (193.00)	13.24 (174.33)	10.39 (107.00)
T_6 Napropamide	5.00	8.58 (72.66)	10.24 (104.00)	12.57 (157.00)	11.22 (125.00)	9.09 (81.66)
T_7 Oxyfluorfen + Napropamide	0.50 + 4.00	5.31 (27.33)	6.63 (43.00)	7.95 (62.33)	7.50 (55.33)	5.91 (34.00)
T_8 Oxyfluorfen + Napropamide	0.50 + 4.50	5.02 (24.33)	5.97 (34.66)	7.74 (59.00)	7.14 (50.00)	5.28 (27.00)
T_9 Oxyfluorfen + Napropamide	0.50 + 5.00	4.89 (23.00)	5.71 (31.66)	7.04 (48.66)	6.55 (42.00)	5.19 (26.00)
T_{10} Oxyfluorfen + Napropamide	0.55 + 4.00	4.79 (22.00)	5.85 (33.33)	7.28 (52.00)	7.16 (50.33)	5.37 (28.00)
T_{11} Oxyfluorfen + Napropamide	0.55 + 4.50	4.61 (20.33)	5.56 (30.00)	6.92 (47.00)	6.63 (43.00)	5.31 (27.33)
T_{12} Oxyfluorfen + Napropamide	0.55 + 5.00	4.27 (17.33)	5.38 (28.00)	6.58 (42.33)	6.21 (37.66)	4.75 (21.66)
T_{13} Oxyfluorfen + Napropamide	0.60 + 4.00	4.79 (22.00)	5.56 (30.00)	6.68 (43.66)	6.63 (43.00)	5.16 (25.66)
T_{14} Oxyfluorfen + Napropamide	0.60 + 4.50	4.31 (17.66)	5.06 (24.66)	6.40 (40.00)	6.10 (36.33)	4.75 (21.66)
T_{15} Oxyfluorfen + Napropamide	0.60 + 5.00	4.16 (16.33)	4.93 (23.33)	5.83 (33.00)	4.99 (24.00)	3.99 (15.00)
T_{16} Hand weeding	At 15-day interval	6.73 (44.33)	7.93 (62.00)	9.72 (93.66)	5.65 (31.00)	4.72 (21.33)
T_{17} Weed-free	-	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
T_{18} Polythene mulch	-	5.16 (25.66)	5.56 (30.00)	5.88 (33.66)	5.59 (30.33)	4.82 (22.33)
T_{19} Weedy check	-	14.00 (220.66)	17.62 (309.66)	20.33 (412.66)	20.23 (408.33)	20.10 (403.33)
CD at 5%		0.317	0.173	0.171	0.230	0.272

DAP = Days after planting

Data subjected to sq-rt ($\sqrt{x}+0.5$) transformation. Figures in parentheses are original values

Table 3. Effect of control treatments on total dry weight (g m^{-2}) of weeds at different stages of crop growth in strawberry.

Treatment	Dose (kg ai/ ha)	30 DAP	60 DAP	90 DAP	120 DAP	Harvest
T_1 Oxyfluorfen	0.50	1.73 (2.02)	3.60 (11.99)	5.96 (34.61)	6.11 (36.37)	4.76 (21.74)
T_2 Oxyfluorfen	0.55	1.67 (1.82)	3.09 (8.55)	5.46 (28.85)	5.63 (30.73)	4.19 (16.64)
T_3 Oxyfluorfen	0.60	1.42 (1.04)	2.71 (6.41)	4.65 (20.68)	4.85 (22.56)	3.68 (12.58)
T_4 Napropamide	4.00	2.70 (6.32)	6.22 (37.70)	10.72 (113.99)	10.87 (117.24)	8.51 (71.44)
T_5 Napropamide	4.50	2.46 (5.07)	5.44 (28.68)	9.70 (93.21)	10.18 (102.83)	7.58 (56.56)
T_6 Napropamide	5.00	2.41 (4.80)	4.92 (23.27)	8.58 (72.74)	8.71 (74.90)	6.68 (43.71)
T_7 Oxyfluorfen + Napropamide	0.50 + 4.00	1.54 (1.40)	3.16 (9.05)	5.64 (30.86)	5.98 (34.80)	4.43 (18.64)
T_8 Oxyfluorfen + Napropamide	0.50 + 4.50	1.54 (1.40)	2.97 (7.84)	5.36 (27.80)	5.43 (28.52)	4.05 (15.45)
T_9 Oxyfluorfen + Napropamide	0.50 + 5.00	1.49 (1.23)	2.91 (7.47)	5.07 (24.77)	4.83 (22.43)	3.80 (13.48)
T_{10} Oxyfluorfen + Napropamide	0.55 + 4.00	1.52 (1.32)	2.89 (7.40)	5.06 (24.67)	5.42 (28.47)	4.04 (15.34)
T_{11} Oxyfluorfen + Napropamide	0.55 + 4.50	1.56 (1.45)	2.82 (7.00)	4.86 (22.71)	5.14 (25.47)	3.91 (14.30)
T_{12} Oxyfluorfen + Napropamide	0.55 + 5.00	1.49 (1.23)	2.75 (6.57)	4.65 (20.66)	4.74 (21.51)	3.56 (11.70)
T_{13} Oxyfluorfen + Napropamide	0.60 + 4.00	1.50 (1.25)	2.78 (6.78)	4.64 (20.54)	5.08 (24.69)	3.80 (13.45)
T_{14} Oxyfluorfen + Napropamide	0.60 + 4.50	1.42 (1.03)	2.65 (6.06)	4.32 (17.68)	4.56 (19.88)	3.46 (11. 01)
T_{15} Oxyfluorfen + Napropamide	0.60 + 5.00	1.37 (0.89)	2.37 (4.66)	4.07 (15.66)	4.29 (17.45)	3.05 (8.36)
T_{16} Hand weeding	At 15-day interval	1.92 (2.71)	3.95 (14.64)	6.77 (44.96)	6.91 (46.82)	3.43 (10.78)
T_{17} Weed-free	-	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
T_{18} Polythene mulch	-	1.57 (1.49)	2.95 (7.77)	4.36 (18.09)	4.35 (18.00)	3.49 (11.23)
T_{19} Weedy check	-	3.81 (13.53)	6.87 (46.32)	14.27 (202.72)	15.23 (231.08)	15.00 (223.99)
CD at 5%		0.052	0.232	0.213	0.226	0.190

DAP = Days after planting

Data subjected to sq-rt ($\sqrt{x}$ + 0.5) transformation. Figures in parentheses are original values

Table 4. Effect of weedicides on weed control efficiency and weed index in strawberry.

Treatment	Dose (kg ai/ha)	At harvest (WCE)	Weed index (%)
T_1 Oxyfluorfen	0.50	89.67	7.14
T_2 Oxyfluorfen	0.55	92.48	5.13
T_3 Oxyfluorfen	0.60	94.46	10.62
T_4 Napropamide	4.00	67.35	27.47
T_5 Napropamide	4.50	73.47	24.54
T_6 Napropamide	5.00	79.75	21.79
T_7 Oxyfluorfen + Napropamide	0.50 + 4.00	91.57	16.48
T_8 Oxyfluorfen + Napropamide	0.50 + 4.50	93.30	10.62
T_9 Oxyfluorfen + Napropamide	0.50 + 5.00	93.55	8.60
T_{10} Oxyfluorfen + Napropamide	0.55 + 4.00	93.05	13.37
T_{11} Oxyfluorfen + Napropamide	0.55 + 4.50	93.22	15.57
T_{12} Oxyfluorfen + Napropamide	0.55 + 5.00	94.62	21.42
T_{13} Oxyfluorfen + Napropamide	0.60 + 4.00	93.63	17.58
T_{14} Oxyfluorfen + Napropamide	0.60 + 4.50	94.62	18.50
T_{15} Oxyfluorfen + Napropamide	0.60 + 5.00	96.28	24.72
T_{16} Hand weeding	At 15-day interval	94.71	5.49
T_{17} Weed-free	-	100.00	0.00
T_{18} Polythene mulch	-	94.46	1.46
T_{19} Weedy check	-	0.0	41.39

Table 5. Effect of weed control treatments on plant height, spread, number of leaves and number of crowns per plant and yield of strawberry.

Treatment	Dose (kg ai/ha)	Plant height (cm)	Plant spread (cm)	No. of leaves/plant	No. of crowns/plant	Yield/plant (g)
T_1 Oxyfluorfen	0.50	13.24	24.45	14.00	2.17	169.00
T_2 Oxyfluorfen	0.55	14.74	25.93	15.66	2.31	172.66
T_3 Oxyfluorfen	0.60	12.83	22.76	13.00	2.03	162.66
T_4 Napropamide	4.00	9.60	20.31	11.00	1.48	132.00
T_5 Napropamide	4.50	9.21	18.09	12.00	1.66	137.33
T_6 Napropamide	5.00	8.46	17.07	13.00	1.80	142.33
T_7 Oxyfluorfen + Napropamide	0.50 + 4.00	12.88	21.60	14.00	2.10	152.00
T_8 Oxyfluorfen + Napropamide	0.50 + 4.50	12.57	23.98	13.00	2.12	162.66
T_9 Oxyfluorfen + Napropamide	0.50 + 5.00	11.88	23.67	14.00	1.92	166.33
T_{10} Oxyfluorfen + Napropamide	0.55 + 4.00	11.50	20.65	12.00	1.83	157.66
T_{11} Oxyfluorfen + Napropamide	0.55 + 4.50	10.77	19.92	11.66	1.77	153.66
T_{12} Oxyfluorfen + Napropamide	0.55 + 5.00	10.71	18.51	11.00	1.62	143.00
T_{13} Oxyfluorfen + Napropamide	0.60 + 4.00	9.80	19.81	11.66	1.77	150.00
T_{14} Oxyfluorfen + Napropamide	0.60 + 4.50	9.54	16.77	11.00	1.51	148.33
T_{15} Oxyfluorfen + Napropamide	0.60 + 5.00	8.44	15.88	9.30	1.41	137.00
T_{16} Hand weeding	At 15-day interval	13.27	25.01	15.00	2.21	172.00
T_{17} Weed-free		14.82	26.26	16.00	2.35	182.00
T_{18} Polythene mulch	-	13.82	25.97	16.00	2.33	179.33
T_{19} Weedy check	-	9.21	16.34	9.00	1.51	106.66
CD at 5%		1.003	1.090	1.706	0.037	4.137

Table 6. Economic returns as influenced by weed control treatments in strawberry.

Treatment	Cost of weed control treatment (Rs.)	Cost of cultivation + cost of weed control treatment (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	B:C ratio
T_1	3,225	3,43,115	8,45,000	5,01,885	1.46
T_2	3,600	3,43,490	8,63,300	5,19,810	1.51
T_3	3,900	3,43,790	8,13,300	4,69,510	1.36
T_4	2,650	3,42,540	6,60,000	3,17,460	0.92
T_5	3,000	3,42,890	6,86,650	3,43,760	1.01
T_6	3,325	3,43,215	7,11,650	3,68,435	1.07
T_7	5,875	3,45,765	7,60,000	4,14,235	1.19
T_8	6,225	3,46,115	8,13,300	4,67,185	1.34
T_9	6,550	3,40,545	8,31,650	4,91,105	1.44
T_{10}	6,250	3,46,140	7,88,300	4,42,160	1.27
T_{11}	6,600	3,46,490	7,68,300	4,21,810	1.21
T_{12}	6,925	3,46,815	7,15,000	3,68,185	1.06
T_{13}	6,550	3,40,545	7,50,000	4,09,455	1.20
T_{14}	6,900	3,46,790	7,41,650	3,94,860	1.13
T_{15}	7,225	3,47,115	6,85,000	3,37,885	0.97
T_{16}	28,000	3,67,890	8,60,000	4,92,110	1.33
T_{17}	52,500	3,92,390	9,10,000	5,17,610	1.31
T_{18}	10,000	3,49,890	896650	5,46,760	1.56
T_{19}	-	3,39,890	533300	1,93,410	0.56

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