Effect of mulching and pre-emergence herbicides on production of kiwifruit cuttings

AARUSHI[1], CL SHARMA[2], REVA JARYAL[1*], BS DILTA[3] and VISHAL S RANA[2]

[1]Department of Seed Science and Technology, [2]Department of Fruit Science
[3]Department of Floriculture and Landscape Architecture, College of Horticulture
Dr YS Parmar University of Horticulture and Forestry
Nauni, Solan 173230 Himachal Pradesh, India
[*]Email for correspondence: revajaryal01@gmail.com

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ABSTRACT

A field experiment was conducted at the experimental farm of Department of Seed Science and Technology, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during 2019-20 to see the effect of mulching and pre-emergence herbicides on production of kiwifruit cuttings laid out in randomised block design. Three mulching treatments viz black polythene mulch, grass mulch and crop residue; four pre-emergence herbicides treatments viz oxyfluorfen (1.0 and 0.5 ai kg/ha), pendimethalin (1.0 and 0.5 0.5 ai kg/ha) and control (hand weeding – once a month) were used as soil treatments. Black polythene mulch significantly increased the sprouting (83.67%), shoot length (123.03 cm), shoot diameter (5.29 mm), number of leaves per cutting (20.17), leaf area (86.60 cm^2), fresh and dry weight of shoots (24.71 and 14.47 g respectively), rooting (47.96%), number of roots per cutting (29.17), fresh and dry weight of roots (25.23 and 12.13 g respectively), total biomass (26.59 g), survival rate (54.47%) and saleable plants (39.27%) in hardwood cuttings of kiwifruit. At the same time, minimum number of weeds at 30, 60, 90 and 120 days after treatment was also observed under black polythene mulch. Hence the black polythene mulch was proved best among all the treatments for production of kiwifruit cuttings.

Keywords: Black polythene mulch; cuttings; kiwifruit; mulching; pre-emergence herbicides

INTRODUCTION

Kiwifruit or Chinese gooseberry [*Actinidia deliciosa* (Chev) CF Liang and AR Ferguson] has gained the enormous popularity among the fruit crops in India and emerged as a success story after apple in temperate fruit production. This fruit holds a great promise for commercial cultivation in low and mid-hills of entire Himalayan region having sub-temperate to sub-tropical climatic conditions, due to high economic return per unit area. In India, kiwifruit has also shown potential for cultivation in mid-hills of Himachal Pradesh, Uttarakhand, Jammu and Kashmir and northeastern states. It was first introduced at Lalbagh garden, Bangalore in early 1960s as an ornamental as well as a fruit plant, where it did not fruit due to lack of chilling. Later, it was introduced at Regional Station, Phagli, Shimla, Himachal Pradesh, where it gave successful crop in 1969 (Dadlani et al 1971). In India, it occupies an area of 5 thousand hectares with an annual production of 16 thousand MT (Anon 2023).

Various methods of propagation such as grafting, budding, cutting and tissue culture technique have been employed for the multiplication of nursery plants of kiwifruit, but raising of plants by cuttings is quick and less expensive and requires less space and skill. In general, both hardwood and semi-hardwood cuttings are employed for the multiplication of nursery plants, but rooting success varies depending upon the variety and growing conditions. Multiplication of planting material through hardwood cuttings requires a suitable environment for the development of proper root and shoot growth of cuttings in the nursery.

Hand weeding is an effective method of controlling weeds within plants and rows of nursery stock, yet can result in mechanical damage to crop. In

addition to hand weeding and sanitation/preventive measures, several non-chemical methods of weed control have been developed and employed with varying levels of success (Stewart et al 2017). One method of non-chemical weed control, that has received some attention and adoption, is the use of various types of mulches (Wilen et al 1999). Inorganic mulch, like black polythene, also provides the benefits of weed control, moisture conservation and soil thermal regulation, which can improve the rooting of cuttings.

Herbicide use is also an important component of weed management in field nursery crops. No single herbicide controls all weed species. Oxyfluorfen, simazine and isobaxen are pre-emergence herbicides effective against broadleaf weeds. Pendimethalin, oryzalin and prodiamine are effective for pre-emergence control of grasses and small-seeded broadleaf weeds (Altland et al 2003).

MATERIAL and METHODS

The present investigations were carried out at the experimental farm and laboratory of the Department of Seed Science and Technology, Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during 2019-20. The experiment was laid out in randomized block design with 8 treatments viz black polythene mulch (T_1), grass mulch (T_2), crop residue mulch (T_3), oxyfluorfen 1.0 kg per ha (T_4), oxyfluorfen 0.5 kg per ha (T_5), pendimethalin 1.0 kg per ha (T_6), pendimethalin 0.5 kg per ha (T_7) and control (hand weeding once in a month) (T_8). The experiment was laid out in randomized block design and each treatment was replicated thrice. The nursery was raised following the standard procedure and the observations were recorded for sprouting, shoot length, shoot diameter, number of leaves, leaf area, fresh and dry weight of shoots and roots, rooting, number of roots, total biomass of rooted plants, survival rate, saleable plants and weed count.

Hardwood cuttings were prepared from one-year-old well mature dormant shoots in the month of February and stored in moist gunny bags in cool and shady place. While preparing the cuttings, a round cut near bud at the basal end and slanting cut at the top of the cuttings were given. The prepared cuttings were first wounded by removing small portion of bark from the basal end, so that absorption of solution was increased. After that, cuttings were treated with IBA 6,000 ppm solution by dipping the basal end of cuttings in solution up to the depth of 2 cm for 5 seconds, which were then taken out of the solution and kept in the shade for few minutes to allow the ethanol to evaporate.

Commercial formulations of pre-emergence herbicides were applied as directed spray in the beds as per the treatments with foot sprayer 48 hours before planting of cuttings. Manual application of fertilizers was done to meet out the nutritional requirement of rooted cuttings. Required complex water soluble fertilizer having NPK in the ratio of 19:19:19 dissolved in water at the rate of 5 g per litre was prepared. The application of fertilizer solution was done at fortnightly interval as the sprouting of buds started.

Parameters like sprouting percentage was calculated by counting the number of cuttings sprouted out of the total number of cuttings planted in each replication using the following formula:

$$\text{Sprouting (\%)} = \frac{\text{Number of sprouted cuttings}}{\text{Total number of cuttings}} \times 100$$

The statistical analysis of the data was done as per the procedure suggested by Panse and Sukhatme (1985).

RESULTS and DISCUSSSION

Growth characters (Table 1)

Shoot length: Maximum shoot length was recorded in T_1 (Black polythene mulch) (123.03 cm) and T_2 (Grass mulch) (102.20 cm), which were at par and minimum in T_4 (Oxyfluorfen 1.0 kg/ha) (69.03 cm), T_6 (Pendimethalin 1.0 kg/ha) (72.33 cm), T_7 (Pendimethalin 0.5 kg/ha) (79.90 cm) and T_5 (Oxyfluorfen 0.5 kg/ha) (81.90 cm), which were statistically at par.

Thakur et al (2013) studied the effect of mulching, herbicides and hand hoeing on seedling growth and weed population in jujube nursery and reported highest plant height and girth with black polythene mulch.

Higher shoot length with the use of black polythene mulch might be due to adequate moisture conservation in the soil, which is essential for plant growth and in turn helps to enhance the metabolic processes inside the plant system, better nutrient

uptake and translocation of nutrients. Pratima and Sharma (2014) also reported the higher shoot growth with black polythene mulch in kiwifruit.

Shoot diameter: Higher shoot diameter was recorded in T_1 (5.29 mm) and T_3 (Crop residue mulch) (5.13 mm), the two being at par and lower in T_4 (4.89 mm), T_6 (4.96 mm), T_7 (4.98 mm), T_5 (5.04 mm), T_2 (5.06 mm) and T_8 (Control) (5.08 mm), all being at par.

Larger shoot diameter under black polythene mulch might be attributed to the fact that mulching created the favourable conditions in the soil by conservation of soil moisture, regulation of temperature and inhibition of weeds.

Fresh shoot weight: Maximum fresh shoot weight of 24.71 and 23.63 g was recorded in treatments T_1 and T_2 respectively, which were at par and minimum 18.61, 19.63 and 20.33 g in T_4, T_6 and T_5 respectively, which were also at par.

Dry shoot weight: T_1 (14.47 g) resulted in maximum dry shoot weight as compared to all other treatments. In other treatments, it ranged from 10.86 g (T_4) to 12.25 g (T_2) and all these treatments were statistically at par.

Maximum fresh weight of shoots in black polythene mulch might be attributed to more number of leaves, leaf area and number of shoots per cutting in this treatment, whereas, the higher dry weight of shoots might be due to more synthesis and accumulation of photo-assimilates and nutrient content in the cuttings. Minimum fresh weight of shoots by the higher dose of oxyfluorfen might be due to the lesser root development, whereas, the lowest dry weight of shoots found in oxyfluorfen 1.0 kg per ha might be due to less vegetative growth and, hence, less accumulation of assimilates and nutrients.

Earlier, Pandey et al (2015) recorded highest fresh weight and dry weight of strawberry plants in black polythene mulch and attributed it to the vigorous growth of plants under this mulch.

Number of leaves per cutting: T_1 and T_2 with 20.17 and 18.70 leaves per cutting respectively exhibited highest number of leaves per cutting and were at par. Lowest number was found in T_4 (12.53) and T_6 (14.30), the two being at par.

The higher number of leaves per cutting under black polythene mulch might be due to well developed root system leading to modified hydrothermal regime. Bakshi et al (2014) also obtained the increased number of leaves in strawberry under black polythene mulch.

Leaf area: T_1 (86.60 cm^2) resulted in maximum leaf area, whereas, minimum was found in T_4 (67.47 cm^2), T_6 (70.65 cm^2) and T_8 (71.27 cm^2), all being at par.

The maximum leaf area under black polythene mulch might be due to well developed root system and suppression of weed growth, which resulted in more absorption and translocation of nutrients to the vegetative parts of the cuttings. These findings are in agreement with the study of Singh et al (2007) who recorded significantly more leaf area in strawberry plants mulched with black polythene as compared to those mulched with clear polythene or paddy straw. Similarly, Kumar et al (2012) reported higher leaf area in strawberry plants mulched with black polythene, paddy straw and pine mulch.

Rooting: Maximum rooting was observed in T_1 (47.96%), whereas, minimum was observed in T_4 (38.90%), T_8 (39.18%), T_6 (40.69%),, T_5 (40.83%) and T_7 (41.72%), all being at par.

The higher rooting in cuttings might be due to the fact that black polythne mulching regulated the hydrothermal regime of soil and improved the physical properties of soil also, which was helpful in initiation of root formation. These results are in agreement with the findings of Dolkar et al (2018) who recorded significantly higher rooting (10% higher) in seabuckthorn cuttings propagated under black polythene mulch as compared to non-mulched in open condition.

Number of roots per cutting: Maximum number of roots per cutting (29.17 and 27.60) was noticed in T_1 and T_2 respectively, which were statistically at par. The number of roots per cutting (23.37, 24.80, 25.19 and 25.29) was found to be minimum in treatments T_4, T_6, T_8 and T_7 respectively, which were at par.

This could be due to the reason that mulching affects the plant microclimate by modifying the soil energy balance and restricting the soil water evaporation (Tarara 2000). These findings are in accordance with the results of Kumar et al (2012) who

Table 1. Effect of mulching and pre-emergence herbicides on growth characters of kiwifruit cuttings

Treatment	Shoot length (cm)	Shoot diameter (mm)	Fresh shoot weight (g)	Dry shoot weight (g)	Number of leaves/cutting	Leaf area (cm^2)	Rooting (%)
T_1	123.03	5.29	24.71	14.47	20.17	86.60	47.96
T_2	102.20	5.06	23.63	12.25	18.70	80.50	43.84
T_3	98.85	5.13	22.47	11.94	17.60	79.20	43.02
T_4	69.03	4.89	18.61	10.86	12.53	67.47	38.90
T_5	81.90	5.04	20.33	11.04	15.67	72.23	40.83
T_6	72.33	4.96	19.63	11.24	14.30	70.65	40.69
T_7	79.90	4.98	21.57	11.35	16.77	76.71	41.72
T_8	93.63	5.08	21.95	12.13	15.61	71.27	39.18
$CD_{0.05}$	23.87	0.19	1.92	1.72	1.85	4.75	3.67

Table 1. Contd…..

Treatment	Number of roots/cutting	Fresh root weight (g)	Dry root weight (g)	Total rooted plants biomass (g)	Sprouting (%)	Survival rate (%)	Saleable plants (%)
T_1	29.17	25.23	12.13	26.59	83.67 (9.20)	54.47	39.27
T_2	27.60	24.10	11.24	23.49	79.03 (8.95)	51.20	37.68
T_3	26.90	23.41	10.32	22.26	78.23 (8.90)	52.11	38.17
T_4	23.37	12.43	6.68	17.54	75.17 (8.72)	41.32	32.85
T_5	26.70	16.73	8.22	19.26	76.60 (8.81)	46.07	37.14
T_6	24.80	13.47	7.68	18.92	72.20 (8.56)	42.31	35.30
T_7	25.29	18.70	9.22	20.57	77.47 (8.86)	44.20	37.24
T_8	25.19	20.03	10.74	22.87	71.90 (8.54)	43.17	37.96
$CD_{0.05}$	2.22	2.71	2.16	3.03	0.08	3.35	1.42

T_1: Black polythene mulch, T_2: Grass mulch, T_3: Crop residue mulch, T_4: Oxyfluorfen 1.0 kg/ha, T_5: Oxyfluorfen 0.5 kg/ha, T_6: Pendimethalin 1.0 kg/ha, T_7: Pendimethalin 0.5 kg/ha, T_8: Control (hand weeding); Figures in parentheses are square root transformed values

Table 2. Effect of mulching and pre-emergence herbicides on weed count at different intervals in kiwifruit cuttings

Treatment	Weed count/m^2 after (days)			
	30	60	90	120
T_1: Black polythene mulch	0.00 (1.00)	0.00 (1.00)	1.33 (1.52)	2.67 (1.91)
T_2: Grass mulch	1.33 (1.52)	11.00 (3.45)	12.67 (3.69)	16.67 (4.19)
T_3: Crop residue mulch	1.67 (1.63)	13.00 (3.72)	16.00 (4.12)	20.00 (4.58)
T_4: Oxyfluorfen (1.0 kg/ha)	4.67 (2.36)	13.67 (3.81)	17.67 (4.32)	23.33 (4.93)
T_5: Oxyfluorfen (0.5 kg/ha)	7.00 (2.81)	16.67 (4.19)	23.00 (4.90)	26.00 (5.20)
T_6: Pendimethalin (1.0 kg/ha)	6.33 (2.71)	16.00 (4.12)	21.00 (4.68)	28.67 (5.45)
T_7: Pendimethalin (0.5 kg/ha)	6.33 (2.69)	17.67 (4.32)	22.67 (4.86)	32.00 (5.74)
T_8: Control (hand weeding)	8.67 (3.10)	21.67 (4.74)	28.33 (5.42)	32.33 (5.77)
$CD_{0.05}$	0.50	0.64	0.43	0.37

Figures in parenthesis are square root transformed values

observed higher number of roots in plants mulched with black polythene mulch (50 micron) compared to transparent polythene, paddy straw and pine mulch in case of strawberry. Sharma (2004) recorded increased number of roots in strawberry cv Chandler under black polythene mulch as compared to other mulches.

Fresh root weight: Fresh root weight (25.23, 24.10 and 23.41 g) was recorded in T_1, T_2 and T_3 respectively, all being at par and minimum in T_4 (12.43 g).

Dry root weight: Dry root weight (12.13, 11.24, 10.74 and 10.32 g) was recorded in T_1, T_2, T_8

and T_3 respectively, all being at par and minimum (6.68, 7.68 and 8.22 g) in T_4, T_6 and T_5 respectively, all the three being at par. The findings are in line with the observations made by Pandey et al (2015) who observed that the fresh and dry weight of roots of strawberry plants was highest under black polythene mulch and attributed it to the induction of improved root zone temperature, better moisture conservation and suppression of weeds.

Total biomass of rooted plants: The total biomass of rooted cuttings (26.59 g) was significantly highest in treatment T_1 which might be attributed to the fact that mulching had produced a healthy root system encouraging vigorous vegetative growth as compared to rest of the treatments, including control. Minimum biomass of rooted plants (17.54, 18.92, 19.26 and 20.57 g) was recorded in the treatments T_4, T_6, T_5 and T_7 respectively, all the four being at par.

Sprouting: T_1 recorded significantly highest sprouting (83.67%) among all the treatments including control. Among the herbicidal treatments, the treatment T_7 recorded significantly highest sprouting of cuttings (77.47%). The treatments T_8 and T_6 recorded the lowest sprouting of 71.90 and 72.20 per cent respectively, which were statistically at par.

The higher sprouting under black polythene mulch might be due to the congenial soil environmental conditions as the mulches are well known to conserve soil moisture and regulate soil temperature. Pratima and Sharma (2014) found that black polythene mulching + irrigation at 60 per cent field capacity increased the shoot growth, inter-nodal length, leaf area and leaf thickness in kiwifruit.

Among pre-emergence herbicides oxyfluorfen and pendimethalin at lower concentration was found to be effective over control. It could be due to the fact that the early germination of weeds was suppressed by the herbicidal application thus reducing the competition with the cuttings to be sprouted. Sharma et al (2009) also reported the higher seedling production in onion with the application of pendimethalin 0.5 kg per ha and oxyfluorfen 0.125 kg per ha.

Survival rate: The survival rate of cuttings 54.47, 52.11 and 51.20 per cent was maximum in treatments T_1, T_3 and T_2 respectively, the three being at par, while, the minimum survival rate of 41.32, 42.31, 43.17 and 44.20 per cent was recorded in T_4, T_6, T_8 and T_7 respectively, all the four being statistically at par.

The maximum survival rate under mulching treatments might be due to the synergistic effect of mulches by their corresponding merit in root and shoot growth and sustenance over a period of time. Barajas-Guzman et al (2006) reported that plant survival increased by 30 to 65 per cent when soil was mulched as compared to bare soil plots. Higher survival and growth were observed in polythene mulch than organic mulches. Hjelm et al (2018) also reported that plant survival of short cuttings, long cuttings and rooted plants of poplars was improved when soil was mulched.

Saleable plants: The maximum saleable plants were found in the treatments T_1, T_3 and T_8 (39.27, 38.17 and 37.96% respectively). However, the minimum saleable plants (32.85%) were recorded in treatment T_4. The higher proportion of saleable plants under treatment black polythene mulch might be due to the production of healthy cuttings with vigorous growth. This treatment might have created a congenial environment for proper root growth and, hence, shoot growth of cuttings. Thakur et al (2013) reported the highest proportion of buddable plants with straw mulch, which was at par with the weed mulch, black polythene mulch and weed free check.

Weed count

The data presented in Table 2 indicate that the treatment T_1 recorded no weeds after 30 and 60 days of treatment and was significantly superior over rest of the treatments. After 90 and 120 days of treatment also, significantly lowest weed count was observed in the same treatment as compared to rest of the treatments including control (hand weeding).

The less number of weeds under black polythene mulch might be attributed to the fact that mulching has smothering effect on weed population by putting a physical barrier to imparting photosynthetic activity and thus inhibiting their top growth. The findings are in agreement with those of Thakur et al (2013) who studied the effect of mulching, herbicides and hand hoeing on seedling growth and weed population in jujube nursery and recorded the highest weed control efficiency with mulching treatments. Hegazi (2000) elucidated that black polythene mulching efficiently controlled weeds in vineyard followed by dry banana

leaves. Similarly, Kaur and Kaundal (2009) also found black polythene mulch more effective in controlling many weed species in Japanese plum orchard.

CONCLUSION

Among different mulches and pre-emergence herbicides, black polythene mulch was found best for production of kiwifruit cuttings in terms of various quality parameters such as sprouting, shoot length, shoot diameter, number of leaves per cutting, leaf area, fresh and dry weight of shoots, per cent rooting, number of roots per cutting, fresh and dry weight of roots, total biomass of rooted plant, per cent survival rate and saleable plants. At the same time, minimum number of weeds was also recorded under black polythene mulch.

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