Original Research Article

Weed management practices affects vegetative growth and graft survival of apple cv. Silver Spur/M9-T339 nursery plants

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ABSTRACT

The present study aimed to evaluate the effect of different weed management practices on vegetative growth and graft survival of apple nursery. The experiment was laid out at the Experimental Farm, Division of Fruit Science, Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences and technology of Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir, India during the year 2020. Seven weed management practices i.e. T_1 (manual weeding), T_2 (pendimethalin @ 1 kg a.i. ha^{-1}), T_3 (pendimethalin @ 1 kg a.i. ha^{-1} + manual weeding), T_4 (paddy straw mulch - 6cm thick), T_5 (black polyethylene mulch - 200 micron), T_6 (weed free) and T_7 (weedy check) were tested in apple nursery (cv. Silver Spur grafted on M-9 T337). The experimental design used was Randomized Complete Block Design with three replicates. Observations on vegetative growth parameters of nursery stocks (plant height, number of branches & number of leaves per plant, leaf area, rootstock girth and scion girth) and graft survival was recorded. Plant growth and graft survival percentage of apple nursery plants was significantly affected by weed management practices. Black polyethylene and paddy straw mulches resulted superior plant growth and both the treatments were statistically at par for all the vegetative growth parameters. Plant height (87.81cm), number of branches (0.4) and number of leaves (45.04) per plant and leaf area (23.63 cm^{-2}) was maximum with black polyethylene much, while scion girth (3.26 cm) and rootstock girth (4.38 cm) was maximum with paddy straw mulch, Significantly maximum graft survival (90.60%) were recorded with black polyethylene. Hence, Black polyethylene (200 micron) found to be most effective weed management practice for obtaining higher graft survival of apple nursery plants with better plant growth characteristics.

Keywords: Apple nursery, weed management, vegetative growth, graft survival.

1. INTRODUCTION

Apple (*Malus* x *domestica* Borkh) is one of the most ubiquitous and well adapted species among temperate fruits in North-Western Himalayas at an elevation range of 1500-2700 m amsl. The primary centre of origin of apple is said to be south-western Asia, in the Caucasus region in Turkestan and domesticated by Greeks and Romans few centuries BC in Middle-East and South-eastern Europe as a result of their travel and invasions. It is known as the 'King of Temperate Fruits' and is fourth among the most widely produced fruits in the world after banana, oranges and grapes. It belongs to genus *Malus* of family Rosaceae and order Rosales. Globally, apple is grown over an area of 4.717 mha with annual production of 87.236 mMT [1]. Interestingly, commercial apple production is intensive in countries and in regions that have a strong comparative advantage in apple production and marketing. In India, it is grown over an area of about 0.31 mha with total production of 2.316 mMT predominantly in Jammu and Kashmir, Himachal Pradesh, Uttaranchal, Arunachal Pradesh and Nagaland [2]. Jammu & Kashmir is leading producer in India with an area of 0.165 mha and production of 1.882 mMT [3]. The two important states namely J&K and Himachal Pradesh accounts for 92 per cent of the total production and about 85 per cent of the total area under apple cultivation in India [2].

Apple production in most developed countries has risen primarily as a result of more intensive production systems, such as the adoption of high-density planting. High-density apple planting has received much attention recently in the Kashmir Valley, and farmers are increasingly establishing dwarf apple trees as a result of government initiatives and technological cooperation from state agriculture universities and research institutions. High density apple planting has a number of advantages, including a shorter time to full production, higher tree density and yields per unit area, higher quality, and less expensive pruning, thinning, and fruit harvesting. High density apple trees reach full productivity in three to four years, as opposed to conventional apple trees, which take seven to eight years. High density orchard performance is dependent on the utilization of quality planting materials. In the Kashmir valley, there is an increasing demand for high quality grafted plant materials of apple on clonal rootstocks such as M9 and MM-106 for establishing high density orchards. Plants at nurseries must be not just true to type, but also healthy, disease-free, and vigorous. Before being transplanted to orchard locations, grafted apple saplings must have been managed properly in the nursery for at least one year. Weed control is a serious issue for fruit nursery growers, because of losses from weed infestations frequently out numbers the losses from other types of agricultural pests.

The nursery plants are delicate and vulnerable to weed evasion, especially in their early stages of development, presence of those unsown plant species interferes with the growth of nursery saplings. Between weed and nursery plants, competition for water, light, nutrients, and interference with other operational factors are significant. Weeds can also impede cultural practices in the nursery, such as budding, grafting, thinning, and other operations. Inadequate weed control in young nursery plants causes poor plant growth and development, resulting in inferior planting materials. Weed infestation has an indirect effect on the occurrence of insect pests and diseases, the growth and development of young seedlings is disrupted, and the planting material. The critical weed-free period for temperate fruit nursery of Kashmir valley is the spring-summer during May, June and July. Weed management in fruit nurseries is normally achieved by a variety of methods around the world, either mechanically through specific cultivation practices or with the application of herbicides; however, the traditional hand weeding approach is the most common in India, particularly in the Kashmir. Nevertheless, manual weed control is not only laborious but is also highly expensive. Thus, of late, manual and mechanical weed control methods are gradually being replaced by other alternatives such as the use of mulches and herbicides as these are easier, cheaper and less time consuming. Mulching is an old age practice of applying a covering of external material to the ground all around plants for suppressing weed infestation and improving crop performance in terms of economic yield. In crop production systems, mulching plays an important role in the conservation of soil moisture during dry periods [4] in addition to providing benefits such as weed suppression [5], reducing water runoff and soil erosion, improving water and fertilizer use efficiency [6] and improve the aesthetic value of landscapes and economic value of crops [7] . Organic mulches include straw, coconut coir, grasses, and cover crop cuttings, all of which provide nutrients to the soil as they decompose. Organic mulches are environmentally friendly and that can be easily applied to orchards and nurseries. Among inorganic mulches, black polyethylene mulch is widely used in various crop production systems as is has greater efficiency in weed control and [8]. Because of their operational benefits, inorganic plastic mulch films are commonly utilized in specialty crop production systems [9]. It also results in greater temperate regulation of soil [10]. Herbicide use is an important component of weed management particularly in commercial crop production as well as nursery production systems. Aside from providing satisfactory weed control, chemical weed control also provides several other benefits such as ease of herbicidal application, longevity of treatment effect. In the Kashmir valley, manual weeding is general practice to minimize weed infestation in fruit nursery

including in clonally propagated apple nursery. Keeping in view the above facts, present study was carried out with the objective of study the effect of different weed management practices on vegetative growth and graft survival of apple nursery.

2. MATERIAL AND METHODS

2.1 Experimental site

The experiment was conducted at the Experimental Field of the Division of Fruit Science, Sher-e-Kashmir University of Agricultural Science & Technology of Kashmir (SKUAST-K), Shalimar Campus, Srinagar, Jammu and Kashmir (India) during the year 2020.

2.2 Pant material

Apple cv. Silver Spur grafted on M-9 T337 rootstock was used as plant materials for experimentation. In India, the cultivar is recommended for cultivation in Jammu & Kashmir, Himachal Pradesh, Arunachal Pradesh and Uttarakhand. The characteristic features of this cultivar are compact to medium tree vigour with excellent spur density, medium and large size conical fruits with pronounced lobes, deep red skin with stripes, mature in the middle of the season [11].

2.3 Weed management treatments

The treatments included: T_1 (manual weeding), T_2 (pendimethalin @ 1 kg a.i. ha^{-1}), T_3 (pendimethalin @ 1 kg a.i. ha^{-1} + manual weeding), T_4 (paddy straw mulch-6cm thick), T_5 (black polyethylene mulch-200 micron), T_6 (weed free) and T_7 (weedy check). The application of paddy straw mulch as well as black polyethylene mulch was carried out during on 15th March, 2020. The paddy straw mulch of about 6 cm thickness and the black polyethylene mulch of 200 micron were applied in the respective treatment plots all around the plants so as to complete covering the ground with mulches. Pendimethalin (1 kg a.i ha^{-1}) was applied as pre-emergence herbicide on 15th March.

2.4 Experimental design

The experiment was laid out in Randomized complete block design (RCBD) comprising of seven treatments and three replications.

2.5 Data collection

2.5.1 Plant height

The height of 10 grafted plants in each treatment was recorded at the end of growing season on 30 November, 2020. The plant height was measured from the marked point on rootstock at ground level to the growing tip of the plant with the help of meaning scale and the averaged plant height is expressed in cm.

2.5.2 Scion girth

The Scion girth of 10 grafted plants in each treatment was recorded at the end of growing season on 30 November, 2020. The Scion girth was taken 5 cm above marked point on rootstock at ground level with the help of Vernier calliper and the averaged Scion diameter is expressed in cm.

2.5.3 Rootstock girth

The rootstock girth of 10 grafted plants in each treatment was recorded at the end of growing season on 30 November, 2020. The Scion diameter was measured 10 cm above marked point on rootstock at ground level with the help of Vernier calliper and the averaged rootstock girth is expressed in cm.

2.5.4 Number of branches per plant

Number of branches produced on 10 grafted plants in each treatment was recorded at the end of growing season on 30 November, 2020 and thus data were averaged to find out the mean number of branches per plant.

2.5.5 Number of leaves per plant

Number of leaves produced on 10 grafted plants during growing period was counted in each treatment and thus data were averaged to find out the mean number of leaves per plant.

2.5.6 Leaf area

Leaf area of twenty leaves of grafted plants in each treatment was recorded in middle of July, August and September months. The leaf area of sampled leaves was measured with the help of Leaf Area Meter (Systronics, India) and average value was expressed as leaf area cm^2.

2.5.7 Graft survival

Graft survival (%) in each treatment was calculated by dividing the total survived grafts at the end of growing season by total number of grafts transplanted and multiplied by 100.

$$\text{Graft Survival (\%)} = \frac{\text{Number of grafts survived at the end of the season}}{\text{Total number of grafted plants}} \times 100$$

2.6 Data analysis

Data recorded on various parameters were subjected to statistical analysis using least significant difference (LSD $p \leq 0.05$) test for mean comparison to identify the significant components of the treatment means as per standard procedures given by Panse and Sukhatme [12].

3. RESULTS AND DISCUSSION

3.1 Plant height

The effect of weed control measures on plant height was significant (Fig. 1). The maximum plant height (87.81cm) was observed in T_5 (black polyethylene mulch), however, it was at par T_4 (paddy straw mulch) (86.24 cm) and significantly superior over rest of the treatment. Plant height under T_3 (pendimethalin @1 kg a.i. ha^{-1} + manual weeding), T_2 (pendimethalin @ 1 kg a.i. ha^{-1}), T_1 (Manual weeding) was and 82.48, 57.21 and 77.18 cm, respectively. Plant height in weed free plots was 80.81 cm while weedy check resulted in lowest plant height (53.78 cm). The increase in plant height of nursery plants is attributed to the suppression of weed growth and increased availability of nutrients and moisture as mulches conserve moisture, suppress weed growth and improve soil fertility [13-15], while herbicides, in addition to inhibiting weed development, are said to improve root density and activity, resulting in increased nutrition and moisture intake, resulting in strong growth [16].

Srivastava *et al.* [17] also found an increase in plant height with the application of weed control through mulching in apple nursery plants. The current findings are consistent with Rana's [18] findings, which showed that black polyethylene mulch increased plant height. Srivastava *et al.* [17] found that black polyethylene mulch generated the tallest grafts, while Dalal *et al*. [19] found that black polyethylene mulch created the highest incremental height.

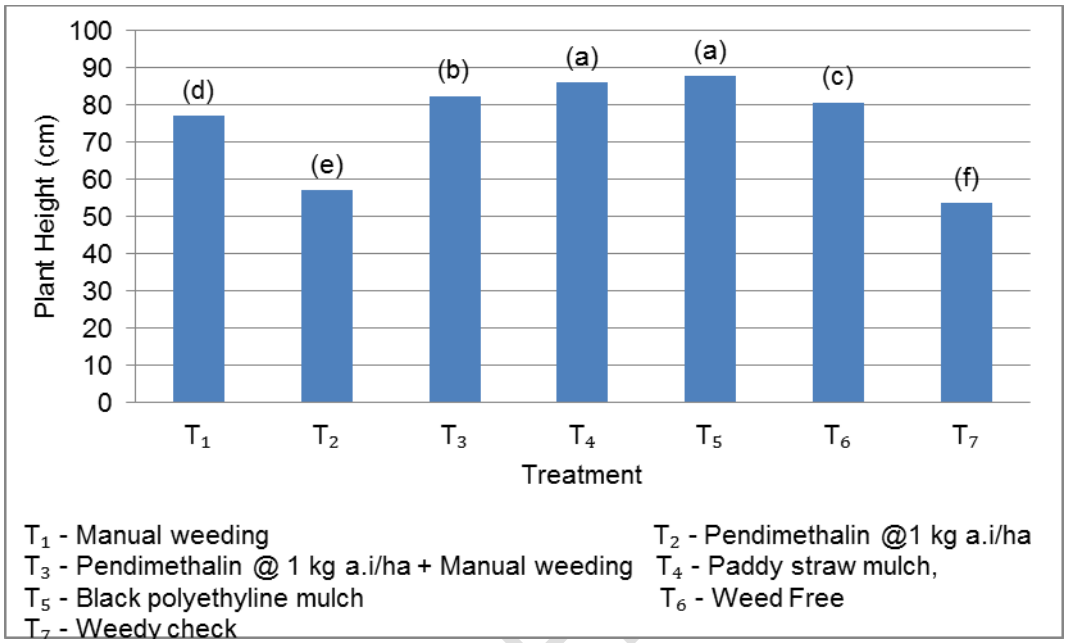

Fig. 1. Effect of weed management practices on plant height of apple cv. Silver Spur/M9-T339 in nursery

3.2 Scion girth

The highest scion girth was recorded under treatment T_4 (paddy straw mulch) with a value of 3.26 cm, followed by treatment T_5 (black polyethylene mulch) i.e. (3.23 cm), both of which were at par with each other (Table 1). The treatment T_6 (weed free) also recorded high values of scion girth (3.19cm) which was statistically at par with treatment T_5 (black polyethylene mulch) with a value of 3.23 cm. The treatment T_7 (weedy check) recorded lowest scion girth of 2.36 cm, however the treatment T_2 (pendimethalin @ 1kg a.i. ha^{-1}) also recorded low scion girth of 2.85 cm. Mulches save moisture, restrict weed development, and enhance soil fertility; hence the increased scion and rootstock girth of nursery plants may be linked to the suppression of weed growth and improved availability of nutrients and moisture. The results of present study are in close conformity to the findings of Chand [20] who found that hay and black plastic mulch increased trunk girth and overall shoot length more than clean cultivation and un-weeded control in apple.

3.3 Rootstock girth

The maximum rootstock girth (4.38 cm) was recorded with treatment T_4 (Paddy straw mulch), followed by treatment T_5 (Black polyethylene mulch) and T_6 (Weed free) to the values of 4.36cm and 4.32cm, respectively and the results of these three treatment were statistically at par (Table 2). Rootstock girth (4.21cm) was measured due to T_3 (Pendimethalin + manual weeding) treatment which was significant over T_2 (pendimethalin @ 1kg a.i. ha^{-1}), and T_1 (manual weeding) with rootstock girth of 3.89 and 4.09 cm,

respectively. The lowest rootstock girth (3.45cm) was recorded in T_7 (weedy check) while rootstock girth (4.32 cm) was measured in the plants under weed free plots. The results of present study are in close conformity to the findings of Das *et al.* [21] who found that guava orchard beneath the paddy straw mulch showed the greatest growth in plant stem diameter.

Table 1. Effect of weed management practices on scion and rootstock girth of apple cv. Silver Spur/M9-T339 nursery plants

Treatment	Scion girth (cm)	Rootstock girth (cm)
T_1: Manual weeding	2.99	4.09
T_2: Pendimethalin @1 kg a.i. ha^{-1}	2.85	3.89
T_3: Pendimethalin @1 kg a.i. ha^{-1}+ manual weeding	3.10	4.21
T_4: Paddy straw mulch (6 cm thick)	3.26	4.38
T_5: Black polyethylene mulch (200 micron)	3.23	4.36
T_6: Weed free	3.19	4.32
T_7: Weedy check	2.36	3.45
SEm±	0.02	0.03
C.D(P≤0.05)	0.06	0.09

3.4 Number of branches per plant

Number of branches per plant was recorded maximum (0.4) with T_5 (black polyethylene mulch), however there was no significant difference in the number of branches observed in T_5 (black polyethylene mulch), T_4 (paddy straw mulch), T_3 (pendimethalin + manual weeding) and T_6-weed free (Table 1). There was no branching in treatment T_2 (pendimethalin @1 kg a.i. ha^{-1}) and (T_7) weedy checks.

3.5 Number of leaves per plant

The highest number of leaves per plant (45.04) was counted in the plants raised with T_5 (black polyethylene mulch), followed T_4 (Paddy straw mulch) with leaf count per plant of 42.85 (Table 2). There was no significant difference in the number of leaves observed in T_5 (black polyethylene mulch) and T_4 (paddy straw mulch). Number of leaves per plant counted due to T_3 (pendimethalin + manual weeding) treatment was 39.20 which was significantly higher compared with the number of leaves observed in T_2 (pendimethalin 1kg a.i. ha^{-1}), and T_1 (manual weeding). The number of leave per plant in T_1 (manual weeding) and T_2 (pendimethalin 1kg a.i. ha^{-1}) was noted 36.69 and 25.17, respectively. The number of leaves per plant under weed free (T_6) was 42.28 while the weedy check (T_7) exhibited the lowest leaf area (22.80).

3.6 Leaf area

The maximum leaf area (23.63 cm^{-2}) was measured in T_5 (black polyethylene mulch), followed T_4 (paddy straw mulch) with 23.20 cm^{-2} leaf area (Table 2). There was no significant difference in the leaf area observed in T_5 (Black polyethylene mulch) and T_4 (Paddy straw mulch). Leaf area recorded due to T_3 (pendimethalin + manual weeding) treatment was 18.71 cm^{-2} which was significantly higher compared with the leaf area observed in T_1 (manual weeding) and T_2 (pendimethalin 1kg a.i. ha^{-1}). The leaf area in T_2 (pendimethalin 1kg a.i. ha^{-1}), and T_1 (manual weeding) was noted 14.92 and 17.10 cm^{-2}, respectively. The leaf area under weed free (T_6) was 21.40 cm^{-2} while the weedy check (T_7) exhibited the lowest leaf area (11.99 cm^{-2}).

Table 2. Effect of weed management practices on number of branches, number of leaves and leaf area of apple cv. Silver Spur/M9-T339 nursery plants

Treatment	Number of branches per plant	Number of leaves per plant	Leaf area (cm^2)
T_1: Manual weeding	0.1	36.69	17.10
T_2: Pendimethalin @1 kg a.i. ha^{-1}	0.0	25.17	14.92
T_3: Pendimethalin @1 kg a.i. ha^{-1}+ manual weeding	0.3	39.20	18.71
T_4: Paddy straw mulch (6 cm thick)	0.3	43.85	23.20
T_5: Black polyethylene mulch (200 micron)	0.4	45.04	23.63
T_6: Weed free	0.3	42.28	21.40
T_7: Weedy check	0.0	22.80	11.99
SEm±	0.03	0.70	0.61
C.D(P≤0.05)	0.1	2.13	1.81

3.7 Graft survival

Weed management practices exerted a significant effect on graft survival percentage (Fig. 2). The highest graft survival (90.60%) was recorded under T_5 (black polyethylene mulch) and it was at par with T_4 (paddy straw mulch) and T_6 (weed free). The graft survival under paddy straw mulch (T_4) was 88.09% and it statistically at par with T_3 (pendimethalin + manual weeding) and T_1 (manual weeding) and T_6 (weed free). Graft survival under pendimethalin + manual weeding) was 86.94 while it was 85.17 in case due to manual weeding. The

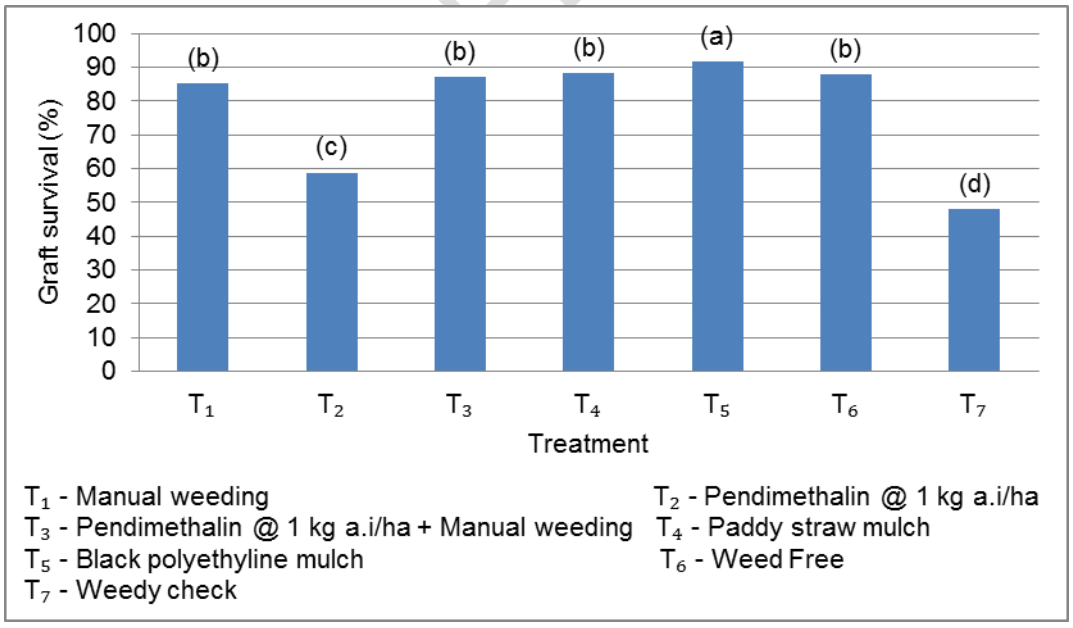

Fig. 2. Effect of weed management practices on graft survival of apple cv. Silver Spur/M9-T339 nursery plant

treatment T_2 pendimethalin @1 kg a.i. ha^{-1}) exhibited graft survival of 58.83 %. The graft survival under weed free (T_6) was 87.84 and weedy checks (T_7) recorded the lowest graft survival (47.92%).

Increased vegetative growth in terms of number of branches, number of leaves and leaf area under the mulching treatments might be attributed to appropriate soil moisture and the lack of weeds, both of which are essential for plant development and aid in nutrient absorption, nutrient translocation, and intense metabolic activities The findings for leaf number and leaf area are consistent with those of Srivastava *et al*. [17], who found that black polythene mulch produced the greatest quantity and size of leaves in apples. Similar results concerning to the role of weed control measure on number of leaves per plant/leaf area were also reported by Aly *et al.* [22], Kaur and Kaur [23], Yograj *et al.* [24], Eid and El-Kholy [25] and Rannu *et al.* [26]. The results on graft survival in our study are consistent with those of Srivastava *et al.* [17], who found that mulches had a substantial impact on the survival of apple nursery grafts. *Kour et al.* [27] also found that black polyethylene mulch significantly increased the proportion of guava seedlings that survived.

4. CONCLUSION

Weed management practices significantly influenced the plant growth and graft survival percentage of apple nursery plants. Black polyethylene (200 micron) and paddy straw (6 cm thick) mulches resulted in superior plant growth and both the treatments were statistically at par for all the vegetative growth parameters (plant height, number of branches, number of leaves and leaf area, scion girth and rootstock girth); however, black polyethylene found to be most effective weed management practice for obtaining significantly higher graft survival of apple nursery plants.

CONSENT

Not Applicable

ETHICAL APPROVAL

Not applicable

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