1 ***Original Research Article***

2 Studies on Relative Economics of Apple 3 Nursery Production under Different Weed 4 Management Practices in Kashmir Valley, India

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28 **ABSTRACT**

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Aims: The purpose of this study was to assess the relative economics of various weed management approaches in apple nursery in Kashmir valley.

Study design: A Randomized Complete Block Design with seven treatments and three replications was employed as the experimental design.

Place and Duration of Study: 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.

Methodology: Seven weed management treatments i.e. manual weeding, pendimethalin @ 1 kg a.i. ha^{-1}, pendimethalin @ 1 kg a.i. ha^{-1} + manual weeding, paddy straw mulch-6 cm thick, black polyethylene mulch-200 micron, weed-free and weedy check were tested in apple nursery (cv. Silver Spur grafted on M-9 T337). The input costs and output in terms of monetary values were calculated under different treatments at prevailing market rates. The net return and benefit-cost (B:C) ratio was worked out based on input and output values under each treatment.

Results: The treatment paddy straw mulch incurred the highest input cost (₹9543725.90) while black polyethylene mulch resulted the maximum output (17113252.80). The maximum net returns of ₹78,02,726 from grafted apple nursery plants were recorded under black polyethylene mulch with a benefit-cost ratio of 1.83 followed by pendimethalin @ 1 kg a.i. ha^{-1} + manual weeding with net returns of ₹71,60,541 and benefit-cost ratio of 1.77.

Conclusion: Black polyethylene mulch resulted highest net return and B:C ratio, hence it

found to be most profitable weed management practice in apple nursery.

Keywords: Apple Nursery; Benefit-cost ratio; Relative economics; Weed management

1. INTRODUCTION

The cultivated apple (*Malus* x *domestica* Borkh.; Family Rosaceae) is world's leading temperate fruits. Globally, apple is grown over an area of 4.717 mha with annual production of 87.236 [1]. In India, it is predominantly cultivated in Jammu & Kashmir and Himachal Pradesh [2]. In Kashmir valley, most of the apple orchards are established in traditional system of planting with 5-6 m spacing. The high-density planting system (HDP) is increasingly being envisioned as an alternative production method with the potential to improve productivity, increase yield efficiency, reduce input costs, minimise hazards, and maximise returns. Although, apple trees are generally propagated through seeds or by vegetative means but commercial propagation for high density planting are carried out by vegetative means i.e. budding and grafting on clonal rootstocks viz. M-9 and MM-106. The ultimate success in apple cultivation depends on the quality of the nursery plants used for establishing the orchards, it is imperative that the nursery plants should not only be true-to-type, but they should also be healthy, disease free and of good quality. The nursery plants require adequate care and management for one or two years before their transplantation to permanent orchard sites.

Apple nursery plants are very often prone to weed infestation particularly in their early growth period. Weeds cause significant losses by competing with the primary crop for water and nutrients, as well as providing a possible breeding habitat for numerous insects, pests, and diseases due to the shallow root systems of nursery plants. Due to high competition for water, light, nutrients and interference with other operational factors among plants and weeds; inadequate weeds management lead to poor plant growth and development [3]. 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.

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 are particularly appealing because they provide a means of improving not only the physical properties of soil but also its nutrient content [8-10]. 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 [11]. Because of their operational benefits, inorganic plastic mulch films are commonly utilized in specialty crop production systems [12]. It also results in greater temperate regulation of soil [13].

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. Thus meaningful analysis of economics of various weed management strategies is essential so as to analyse whether the returns exceed the cost or not. Therefore

present study was carried out with the objective find out the relative economics of different weed management treatments in apple nursery production in Kashmir valley.

2. MATERIAL AND METHODS

2.1 Experimental site

The experiment was conducted in 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. The experimental site is located at 34.1^{o} North latitude and 74.9^{o} East longitude and 1587 m above the mean sea level.

2.2 Plant Materials

Apple cv. Silver Spur grafted on M-9 T337 rootstock was used as plant materials for assessing the weed management trial in apple nursery in present study. Apple cv. Silver Spur is a 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 recommended for cultivation in Jammu & Kashmir, Himachal Pradesh, Arunachal Pradesh, Uttarakhand [14]. The M-9 T337 is a dwarfing type clonal rootstock introduced in Kashmir from Holland and being used for production of grafted planting materials of apple for high density planting. Morphologically M9 T337 rootstock is of weak vigour with short internodes, reddish brown in colour (sunny side), strong undulated leaf margin, weak prudence on lower side of leaf, long petiole length with small stipule [15].

2.3 Weed control treatments

The treatments included: manual weeding (T_1), pendimethalin (T_2), pendimethalin + manual weeding (T_3), paddy straw mulch - 6cm thick (T_4), black polyethylene mulch (T_5), weed free (T_6) and weedy check (T_7). The paddy straw mulch (6 cm thick) and black polyethylene mulch (200 micron) were applied around the plants in each treatment plot to completely cover the soil with the mulch. On March 15, pendimethalin @ 1 kg a.i. Ha^{1}) was applied as a pre-emergence herbicide in respective treatment plots.

2.4 Experimental Design

The experiment was laid out with seven weed management treatments in Randomized complete block design where each treatment was replicated thrice.

2.5 Data collection

The Cost concepts used to work out the nursery production economics were the variable cost, fixed cost ant total cost of cultivation. Cost ‘A’ includes the costs on account of hired human labour, manures and fertilizers, rootstock, scion wood, machinery charges, irrigation charges, plant protection charges, land revenue, depreciation and repairs, interest on working capital etc. Cost ‘B’ includes rental value of land and interest on fixed capital cost which is added to the Cost ‘A’. Cost ‘C’ is the total cost of production, which included all the item’s costs.

2.5.1 Cost of production

Cost of production was computed on the basis of costs of all inputs for production of grafted apple nursery under different treatments. It includes fixed cost, variable costs, depreciations, rental value of land, interest on working capital.

2.5.2 Gross return

Gross return from survived grafted plant materials was estimated on the basis of the sale price of grafted plant materials (₹200 per plant). For estimating net return, total cost of production was subtracted from gross return as follows:

$$\text{Net return} = \text{Gross return} - \text{Cost of production}$$

2.5.3 Benefit Cost Ratio:

Benefit: cost ratio (B:C) is defined as the amount received in the shape of profit on the costs of one rupee.

The BCR was computed by using following formula:

$$\text{Benefit: cost (B: C) ratio} = \frac{\text{Gross return}}{\text{Cost of production}}$$

2.6 Data analysis

The data recorded on various parameters were statistically analyzed at a 5% significance level according to Panse and Sukhatme's standard method [16].

3. RESULTS AND DISCUSSION

The fixed input cost irrespective of the treatments incurred presented in Table 1. It was ₹ 56307.20 on account of rental value of land, depreciation on implements, and interests on fixed capital.

Table 1: Fixed cost for production of grafted apple nursery for all the weed management treatments (per ha basis)

S.No.	Particulars	Cost (₹)
1.	Rental value of land	50000
2.	Depreciation on implements	3120
	Sub-total	53120
3.	Interest on fixed capital (6 %)	3187.20
	Total	56307.20

Common variable cost irrespective (other than treatment and its application costs) of treatments was calculated ₹8645895 (Table 2). It includes hired human labour, machinery charges, manures and fertilizers, rootstock, scion wood, irrigation charges, plant protection charges, land revenue, depreciation and repairs, interest on working capital etc. Input cost due to treatments varied from highest in weed free conditions to the lowest in weedy check (Table 2).

Data in Table 3 reveals that the highest cost of production (₹ 9543725.90) was incurred under paddy straw mulch, followed by weed free (₹9392675.90), and black polyethylene mulch (₹9310525.90). Treatment pendimethalin @ 1 kg a.i. ha^{-1} + manual weeding exhibited

higher cost of cultivation (₹9261381.64) compared to manual weeding and pendimethalin @ 1 kg a.i. ha^{-1} as the cost of production estimated under manual weeding and pendimethalin @ 1 kg a.i. ha^{-1} was ₹9259115.90 and ₹9223221.64, respectively. The lowest cost of production (₹9220955.90) was estimated in weedy check.

Table 2: Variable cost for production of grafted apple nursery under different weed management treatments (per ha basis)

Treatment	Common variable input cost (₹)	Cost due to weed management treatments (₹)			Interest on working capital (6%) (₹)	Total variable cost (₹)
		Labour	Herbic-ide	Mulch		
T_1: Manual weeding	8645895	36000	-	-	520913.70	9202808.70
T_2: Pendimethalin @ 1 kg a.i. ha^{-1}	8645895	-	2137.49	-	518881.95	9166914.44
T_3: Pendimethalin @ 1 kg a.i. ha^{-1} + manual weeding	8645895	36000	2137.49	-	521041.95	9205074.44
T_4: Paddy straw mulch (6 cm thick)	8645895	4500	-	300000	537023.70	9487418.70
T_5: Black polyethylene mulch (200 micron)	8645895	4500	-	80000	523823.70	9254218.70
T_6: Weed free	8645895	162000	-	-	528473.70	9336368.70
T_7: Weedy check	8645895	-	-	-	518753.70	9164648.70

The highest gross return (₹17113252.80) was estimated under black polyethylene mulch, followed by paddy straw mulch (₹16639143.92), weed free (₹16591921.92). Pendimethalin @ 1 kg a.i. ha^{-1} + manual weeding treatment exhibited higher gross return (₹16421922.72) compared to manual weeding and pendimethalin @ 1 kg a.i. ha^{-1} as the gross return estimated under manual weeding and pendimethalin @1 kg a.i. ha^{-1} was ₹15898702.96 and ₹11112281.04, respectively (Table 3). The lowest cost of production (₹9051512.96) was estimated in weedy check.

Black polyethylene mulch resulted the highest net return (₹7802726.90) was estimated under followed by weed free (₹7199246.02) and pendimethalin @ 1 kg a.i. ha^{-1} + manual weeding (₹7160541.08) (Table 3). Treatment paddy straw mulch exhibited higher net return (₹7199246.02) compared to manual weeding and pendimethalin @1 kg a.i. ha^{-1} as the net return estimated under manual weeding and pendimethalin @1 kg a.i. ha^{-1} was ₹6639587.06 and ₹ 1889059.40, respectively. There was loss of ₹169442.94 under weedy check as net return was less than the total cost of production.

It is evident from data in Table 3, that the highest B:C ratio (1.83) was recorded under black polyethylene mulch, by weed free (1.77) and Pendimethalin @ 1 kg a.i. ha^{-1} + manual

weeding (1.77). Treatment paddy straw mulch exhibited higher B:C ratio (1.74) compared to manual weeding and pendimethalin @ 1 kg a.i. ha^{-1} as the gross return estimated under manual weeding and pendimethalin @ 1 kg a.i. ha^{-1} was 1.72 and 1.20, respectively. The lowest B:C ratio (0.98) was estimated in weedy check.

Table 3: Economics of grafted apple nursery cv. Silver Spur on M9-T339 rootstock under different weed management practices (per ha basis)

Treatment	Cost of cultivation (₹)	Gross return(₹)	Net return (₹)	B:C ratio
T_1: Manual weeding	9259115.90	15898702.96	6639587.06	1.72
T_2: Pendimethalin @ 1 kg a.i. ha^{-1}	9223221.64	11112281.04	1889059.40	1.20
T_3: Pendimethalin @ 1 kg a.i. ha^{-1} + manual weeding	9261381.64	16421922.72	7160541.08	1.77
T_4: Paddy straw mulch (6 cm thick)	9543725.90	16639143.92	7095418.02	1.74
T_5: Black polyethylene mulch (200 micron)	9310525.90	17113252.80	7802726.90	1.83
T_6: Weed free	9392675.90	16591921.92	7199246.02	1.77
T_7: Weedy check	9220955.90	9051512.96	(-)169442.94	0.98

The components of relative economics under different weed control treatments varied greatly due to the variable inputs incurred and outputs under different weed management treatments. Among different weed control treatments (manual weeding, herbicide and mulches); the highest cost of production of grafted apple nursery plants was incurred in paddy straw mulch, followed by black polyethylene mulch, pendimethalin @ 1 kg a.i. ha^{-1} + manual weeding, manual weeding and pendimethalin @ 1 kg a.i. ha^{-1} with corresponding amount of ₹9543725.90, ₹9310525.90, ₹9261381.64, ₹9259115.90 and ₹9223221.64, respectively. The higher production cost under paddy straw mulch was mainly due to the facts that the paddy straw used as was made available at costlier rates. The highest gross return from grafted apple nursery plants was recorded in black polyethylene mulch, followed by paddy straw mulch, pendimethalin @ 1 kg a.i. ha^{-1} + manual weeding, manual weeding and pendimethalin @ 1 kg a.i. ha^{-1} with corresponding monetary value of ₹17113252.80, ₹16639143.92, ₹16421922.72, ₹15898702.96 and ₹11112281.04, respectively. The highest gross return under black polyethylene mulch was attributed to the higher graft survival and thus realizing greater total outcome in terms of monetary value under this treatment.

Among different weed control treatments (manual weeding, herbicide and mulches); the highest benefit: cost ratio (1.83) was noted in black polyethylene mulch. Weed free and pendimethalin @ 1 kg a.i. ha^{-1} + manual weeding resulted in similar B:C ratio of 1.77 in case of both the treatments. The B: C ratio of 1.72 was observed in manual weeding, while pendimethalin @ 1 kg a.i. ha^{-1} resulted the benefit: cost ratio of 1.20 only. In present study, black polyethylene mulch emerged the most beneficial treatment in terms of monetary benefits as it yielded highest gross return because of higher graft survival that exerted to highest net return and thus constituted the highest Benefit: cost ratio compared to other treatments. Meena [17] advocated the use grass mulch followed by glyphosate sprays at 0.8 kg ha^{-1} to be cost-effective strategy for weed management in peach. Hegazi [18] advocated that plastic mulching control of weeds and most importantly to save water and increase the net income from grapevines in comparison of mulching, straw mulching, and herbicides. Sharma and Kathiravan [19] recorded pine needle as the best mulch material for plum as it provided maximum income compared to others mulches viz. transparent polythene, black

polythene, bicoloured polythene, field grass, pine needles and un-mulched control. In Aonla (*Emblica officinalis* Gaertn.), Iqbal *et al.* [20] while studying the economics of different mulching materials viz., black polythene, white polythene, paddy straw, saw dust, sarkanda, dry grass and control (unmulched) on aonla, they recorded higher cost of cultivation due to black polythene mulch but net return and B:C ratio found to be maximum in black polythene mulch (2.04:1) and minimum in control (1.69:1). Rakesh *et al*. [21] recorded grass mulching as most cost-effective treatment in plum (cv. Red Beut) in comparison of herbicides, mulching and hand weeding treatments.

4. CONCLUSION

The treatment paddy straw mulch incurred the highest input cost (₹ 9543725.90) while black polyethylene mulch resulted in maximum output (₹17113252.80). The maximum net returns of ₹78,02,726 from grafted apple nursery plants was recorded under black polyethylene mulch with a benefit: cost ratio of 1.83; followed by pendimethalin @ 1 kg a.i. ha^{-1} + manual weeding with net returns of ₹71,60,541 and benefit cost ratio of 1.77. Hence, black polyethylene mulch found to be most profitable weed management practice in apple nursery in Kashmir valley.

CONSENT

Not Applicable.

ETHICAL APPROVAL

Not Applicable.

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Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.