

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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ABSTRACT

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.

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

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1. INTRODUCTION

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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 it 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

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

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84 **2. MATERIAL AND METHODS**

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86 **2.1 Experimental site**

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88 The experiment was conducted in the Experimental Field of the Division of Fruit Science,
89 Sher-e-Kashmir University of Agricultural Science & Technology of Kashmir (SKUAST-K),
90 Shalimar Campus, Srinagar, Jammu and Kashmir (India) during the year 2020. The
91 experimental site is located at 34.1° North latitude and 74.9° East longitude and 1587 m
92 above the mean sea level.

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94 **2.2 Plant Materials**

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96 Apple cv. Silver Spur grafted on M-9 T337 rootstock was used as plant materials for
97 assessing the weed management trial in apple nursery in present study. Apple cv. Silver
98 Spur is a compact to medium tree vigour with excellent spur density, medium and large
99 size conical fruits with pronounced lobes, deep red skin with stripes, mature in the middle of
100 the season recommended for cultivation in Jammu & Kashmir, Himachal Pradesh, Arunachal
101 Pradesh, Uttarakhand [14]. The M-9 T337 is a dwarfing type clonal rootstock introduced in
102 Kashmir from Holland and being used for production of grafted planting materials of apple for
103 high density planting. Morphologically M9 T337 rootstock is of weak vigour with short
104 internodes, reddish brown in colour (sunny side), strong undulated leaf margin, weak
105 prudence on lower side of leaf, long petiole length with small stipule [15].

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107 **2.3 Weed control treatments**

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109 The treatments included: manual weeding (T₁), pendimethalin (T₂), pendimethalin + manual
110 weeding (T₃), paddy straw mulch - 6cm thick (T₄), black polyethylene mulch (T₅), weed free
111 (T₆) and weedy check (T₇). The paddy straw mulch (6 cm thick) and black polyethylene
112 mulch (200 micron) were applied around the plants in each treatment plot to completely
113 cover the soil with the mulch. On March 15, pendimethalin @ 1 kg a.i. Ha⁻¹) was applied as a
114 pre-emergence herbicide in respective treatment plots.

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116 **2.4 Experimental Design**

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

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121 **2.5 Data collection**

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

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131 **2.5.1 Cost of production**

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

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137 **2.5.2 Gross return**

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

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$$143 \quad \text{Net return} = \text{Gross return} - \text{Cost of production}$$

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145 **2.5.3 Benefit Cost Ratio:**

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

149

150 The BCR was computed by using following formula:

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

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154 **2.6 Data analysis**

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

157

158 **3. RESULTS AND DISCUSSION**

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160 The fixed input cost irrespective of the treatments incurred presented in Table 1. It was ₹
 161 56307.20 on account of rental value of land, depreciation on implements, and interests on
 162 fixed capital.

163

164 **Table 1: Fixed cost for production of grafted apple nursery for all the weed**
 165 **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

166

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

173

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

177 higher cost of cultivation (₹9261381.64) compared to manual weeding and pendimethalin @
 178 1 kg a.i. ha⁻¹ as the cost of production estimated under manual weeding and pendimethalin
 179 @ 1 kg a.i. ha⁻¹ was ₹9259115.90 and ₹9223221.64, respectively. The lowest cost of
 180 production (₹9220955.90) was estimated in weedy check.

181

182 **Table 2: Variable cost for production of grafted apple nursery under different weed**
 183 **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	Herbicide	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

184

185 The highest gross return (₹17113252.80) was estimated under black polyethylene mulch,
 186 followed by paddy straw mulch (₹16639143.92), weed free (₹16591921.92). Pendimethalin
 187 @ 1 kg a.i. ha⁻¹ + manual weeding treatment exhibited higher gross return (₹16421922.72)
 188 compared to manual weeding and pendimethalin @ 1 kg a.i. ha⁻¹ as the gross return
 189 estimated under manual weeding and pendimethalin @1 kg a.i. ha⁻¹ was ₹15898702.96 and
 190 ₹11112281.04, respectively (Table 3). The lowest cost of production (₹9051512.96) was
 191 estimated in weedy check.

192

193 Black polyethylene mulch resulted the highest net return (₹7802726.90) was estimated
 194 under followed by weed free (₹7199246.02) and pendimethalin @ 1 kg a.i. ha⁻¹ + manual
 195 weeding (₹7160541.08) (Table 3). Treatment paddy straw mulch exhibited higher net return
 196 (₹7199246.02) compared to manual weeding and pendimethalin @1 kg a.i. ha⁻¹ as the net
 197 return estimated under manual weeding and pendimethalin @1 kg a.i. ha⁻¹ was ₹6639587.06
 198 and ₹ 1889059.40, respectively. There was loss of ₹169442.94 under weedy check as net
 199 return was less than the total cost of production.

200

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

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

207

208 **Table 3: Economics of grafted apple nursery cv. Silver Spur on M9-T339 rootstock**
 209 **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

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211 The components of relative economics under different weed control treatments varied
 212 greatly due to the variable inputs incurred and outputs under different weed management
 213 treatments. Among different weed control treatments (manual weeding, herbicide and
 214 mulches); the highest cost of production of grafted apple nursery plants was incurred in
 215 paddy straw mulch, followed by black polyethylene mulch, pendimethalin @ 1 kg a.i. ha⁻¹ +
 216 manual weeding, manual weeding and pendimethalin @ 1 kg a.i. ha⁻¹ with corresponding
 217 amount of ₹9543725.90, ₹9310525.90, ₹9261381.64, ₹9259115.90 and ₹9223221.64,
 218 respectively. The higher production cost under paddy straw mulch was mainly due to the
 219 facts that the paddy straw used as was made available at costlier rates. The highest gross
 220 return from grafted apple nursery plants was recorded in black polyethylene mulch, followed
 221 by paddy straw mulch, pendimethalin @ 1 kg a.i. ha⁻¹ + manual weeding, manual weeding
 222 and pendimethalin @ 1 kg a.i. ha⁻¹ with corresponding monetary value of ₹17113252.80,
 223 ₹16639143.92, ₹16421922.72, ₹15898702.96 and ₹11112281.04, respectively. The highest
 224 gross return under black polyethylene mulch was attributed to the higher graft survival and
 225 thus realizing greater total outcome in terms of monetary value under this treatment.

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

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

249

250 **4. CONCLUSION**

251

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

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280 **CONSENT**

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282 Not Applicable.

283

284 **ETHICAL APPROVAL**

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286 Not Applicable.

287

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