Int.J.Curr.Microbiol.App.Sci (2020) Special Issue-11: 2179-2185

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Special Issue-11 pp. 2179-2185**
Journal homepage: http://www.ijcmas.com

Original Research Article

Economic Analysis of Various Weed Management Strategies under High Density Apple (*Malus* × *domestica*) Orchard System

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A B S T R A C T

Weed management in high density orchards is a critical component for successful crop production. The present investigation was conducted in the Experimental fields of Division of Fruit Science, SKUAST, Kashmir during the year 2018 with the aim of calculating economics of different weed management strategies. One year old trees of exotic apple cv. "Elstar" grafted on M-9 T337 rootstock, introduced by SKUAST-Kashmir from Holland in March 2017, were selected for experimentation. The thirteen treatments used were replicated thrice in Factorial Randomized Complete Block Design. The benefit cost ratio (BCR)/per rupee return (PRR) for different herbicidal treatments, manual weeding and mulching was worked out by considering the rates of herbicides, quantity used and labour employed etc. The maximum net returns of Rs 20,03,881 was obtained from treatment T_{12} (Oxyfluorfen followed by Glufosinate ammonium) with benefit cost ratio of 4.57 followed by treatment T_5 (Paddy straw mulch) with net returns of Rs 19,02,121 and benefit cost ratio of 4.09. Lowest benefit cost ratio (2.82) was recorded in unweeded control (T_{13}). Higher benefit: cost ratio may be attributed to their being readily available, inexpensive on one hand and their beneficial effects on plant growth.

Keywords

Elstar, B:C ratio, Weed management

Introduction

Malus x domestica Borkh., the apple, is a perennial of the Rosaceae family. The apple is thought to have arisen in the Caucasus region of south-eastern Europe, and the tree is one of the hardiest temperate zone species. Considered as the king of temperate fruits, apple covers an area of 4933 thousand Ha with the production of 83139 thousand metric tonnes over the world (FAOSTAT., 2018). India with the area of 301 thousand Ha ranks second in the list after China, with the production of 2327 thousand metric tones (FAOSTAT., 2018). However in productivity, India lacks further apart. The productivity of apple in India is very low (7.73 MT/ Ha), compared to that of

developed countries like Switzerland (59.11 MT/ Ha), New Zealand (53.15 MT/ Ha), Italy (43.85 MT/ Ha), USA (39.48 MT/ Ha), China (18.93 MT/ Ha) etc. (FAOSTAT., 2018). The high-density planting system (HDP) is now being conceived as an alternative production system having a potential for improving productivity, increasing yield efficiency, reducing input cost, minimizing risks and maximizing returns. Weed management in high density orchards is a critical component for successful crop production (Atay *et al.*, 2017). The primary goal of weed management is to optimize yield by minimizing the weed competition (Merwin, 2003). Because of shallow root system in HDPs the weeds cause heavy losses by competing with the main crop for water, nutrients and also provide potential breeding niche for various insects/pests and diseases. 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 of calculating economics of different herbicidal treatments, manual weeding and mulching by taking into consideration, the rates of herbicides, quantity used and labour employed etc.

Materials and Methods

The experiment was conducted in the Experimental fields of Division of Fruit Science, Sher-e-Kashmir University of Agricultural Science & Technology of Kashmir, Shalimar, Srinagar, Jammu & Kashmir during the year 2018. One year old trees of exotic apple cv. "Elstar" grafted on M-9 T337 rootstock, spaced at 1 x 3 m (3333 trees /Ha), introduced by SKUAST-Kashmir from Holland in March 2017 were selected for experimentation. The trees of uniform size, vigour and bearing capacity were selected for experiment. The experiment was laid out in Randomized complete block design (RCBD) comprising 13 treatments and 3 replications. The treatments included: T_1 - Farmer's Practice (Hoeing at 45 days interval, 3 hoeing's starting from last week of March), T_2 - Black polyethylene mulch (Punched) - 200µ, T_3 - Black polyethylene mulch (Unpunched) - 200 µ, T_4 - Bi-Colour polyethylene mulch - 200 µ, T_5- Paddy Straw mulch - 10cm thickness, T_6 - Forest Litter (Pine Needles) - 10cm thickness, T_7 - Chopped lawn grass - 5cm thickness, T_8 - Oxyfluorfen @ 0.5 L ha^{-1} (Pre-emergence herbicide), T_9- Glyphosate @ 2.0 L ha^{-1} (Post-emergence), T_{10} - Glufosinate ammonium @ 0.84 Kg ha^{-1} (Post-emergence), T_{11} - Oxyfluorfen @ 0.5 L ha^{-1} (Pre-emergence herbicide) followed by Glyphosate @ 2.0 L ha^{-1} (Post-emergence), T_{12} - Oxyfluorfen @ 0.5 L ha^{-1} (Pre-emergence herbicide) followed by Glufosinate ammonium @ 0.84 Kg ha^{-1} (Post-emergence) and T_{13} - No Weeding (Control). The application of organic as well as inorganic mulches were done during last week of March. Oxyflourfen was applied as pre-emergence herbicide during the first week of March, whereas, glyphosate and glufosinate ammonium were applied as post-emergent herbicide during mid of June. The economics of different herbicidal treatments, manual weeding and mulching was worked out by taking into consideration, the rates of herbicides, quantity used and labour employed etc. The benefit cost ratio (BCR)/per rupee return (PRR) was worked out by dividing gross return with total cost. The benefit cost ratio was worked out for each treatment on hectare basis.

$$\text{BCR/PRR} = \frac{\text{Gross return}}{\text{Total cost}}$$

The statistical analysis was carried out based on the procedure given by Gomez and Gomez

(1984). The treatment effects were tested at 5 percent level of significance.

Results and Discussion

The various variable and fixed costs incurred in apple production during the year of study under high density orchard system (3333 trees ha^{-1}) were computed (Table 1). Since different weed management strategies were adopted, thus treatment wise added cost (for weeding & hoeing) was calculated as shown in table 2. Comparative economics of cost of production of apple for different treatments under high density orchard system was computed (Table 3). Perusal of data presented in Table 3 revealed that total cost of production was highest under organic mulch treatments. Highest production cost of Rs 6,31,504 was under treatment T_6 (pine needles) which was followed by Rs 6,14,839 in treatments T_5 (Paddy straw mulch) and T_7 (chopped lawn grass). Lowest cost of production (Rs 5,47,279) was observed under control (T_{13}). Data pertaining to benefit:cost ratio of each treatment are presented in Table 4. It is evident from the data that different weed management strategies were beneficial.

Also the use of mulches and herbicides were highly beneficial as compared to hand weeding. The maximum net returns of Rs 20,03,881 was obtained from treatment T_{12} (Oxyfluorfen followed by Glufosinate ammonium) with benefit cost ratio of 4.57 followed by treatment T_5(Paddy straw mulch) with net returns of Rs 19,02,121 and benefit cost ratio of 4.09. Lowest benefit cost ratio (2.82) was recorded in unweeded control (T_{13}). Higher cost benefit ratio may be attributed to their being readily available, inexpensive on one hand and their beneficial effects on plant growth on the other hand and hence profitable benefit ratio can be recommended whereas low cost benefit ratio under hand weeding may be due to higher wages rate and low yield. The results are in agreement with Wibawa *et al.,* (2010) and Buskiene *et al.,* (2006) who recorded glyphosate and glufosinate ammonium as most cost-effective treatments for weed control.

Table.1 Cost incurred in production of apple under high density orchard system (3333 trees ha^{-1})

COST ITEMS	COST (Rs ha^{-1})
A. Variable Cost	
Labour cost (Pruning, training, thinning, harvesting, watch & ward)	43,636
Plant protection application	41,663
FYM, Fertilizer & Foliar nutrient spray	1,99,980
Total variable cost	2,85,279
B. Fixed cost	
Rental value of owned land (@Rs. 1100 /kanal)	22,000
Interest on capital investment	2,40,000
Total fixed cost	**2,62,000**

Table.2 Treatment-wise added cost (weeding & hoeing)

TREATMENT CODE	TREATMENT COST (Rs ha^{-1})	LABOUR COST (Rs ha^{-1}) (@Rs 225/ day)	TOTAL ADDED COST (Rs ha^{-1})
T_1	-	13,500	13,500
T_2	40,755	2,700	43,455
T_3	40,755	2,250	43,005
T_4	41,990	2,250	44,240
T_5	66,660	900	67,560
T_6	83,325	900	84,225
T_7	66,660	900	67,560
T_8	9,797	450	10,247
T_9	5,598	450	6,048
T_{10}	2,683	450	3,133
T_{11}	15,395	900	16,295
T_{12}	12,480	900	13,380
T_{13}	0	0	0

Table.3 Treatment-wise comparative economics of cost of production of apple under high density orchard system (3333 trees ha^{-1})

TREATMENT CODE	FIXED COST (Rs. ha^{-1}) (A)	VARIABLE COST (Rs. ha^{-1})	TOTAL ADDED COST (Rs. ha^{-1})	TOTAL VARIABLE COST (Rs ha^{-1}) (B)	TOTAL COST OF PRODUCTION (Rs ha^{-1}) (A+B)
T_1	2,62,000	2,85,279	13,500	2,98,779	5,60,779
T_2	2,62,000	2,85,279	43,455	3,28,734	5,90,734
T_3	2,62,000	2,85,279	43,005	3,28,284	5,90,284
T_4	2,62,000	2,85,279	44,240	3,29,519	5,91,519
T_5	2,62,000	2,85,279	67,560	3,52,839	6,14,839
T_6	2,62,000	2,85,279	84,225	3,69,504	6,31,504
T_7	2,62,000	2,85,279	67,560	3,52,839	6,14,839
T_8	2,62,000	2,85,279	10,247	2,95,526	5,57,526
T_9	2,62,000	2,85,279	6,048	2,91,327	5,53,327
T_{10}	2,62,000	2,85,279	3,133	2,88,412	5,50,412
T_{11}	2,62,000	2,85,279	16,295	3,01,574	5,63,574
T_{12}	2,62,000	2,85,279	13,380	2,98,659	5,60,659
T_{13}	2,62,000	2,85,279	0	2,85,279	5,47,279

Total variable cost (Rs. ha^{-1}) = Variable cost (Rs. ha^{-1}) + Added cost (Rs. ha^{-1})

Total cost of cultivation (Rs. ha^{-1}) = Fixed cost (Rs. ha^{-1}) + Total variable cost (Rs. ha^{-1})

Table.4 Benefit: cost ratio of different weed management strategies in apple cv. 'Elstar' under high density orchard system (3333 tree ha^{-1})

TREATMENT CODE	TOTAL COST OF PRODUCTION (Rs ha^{-1})	YIELD (Kg ha^{-1})	GROSS RETURNS (Rs ha^{-1})	NET RETURNS (Rs ha^{-1})	B:C RATIO
T_1	5,60,779	22,175.56	18,62,760	13,01,981	3.32
T_2	5,90,734	27,197.28	22,84,570	16,93,836	3.87
T_3	5,90,284	27,652.79	23,22,850	17,32,566	3.94
T_4	5,91,519	26,952.86	22,64,050	16,72,531	3.83
T_5	6,14,839	29,963.67	25,16,960	19,02,121	4.09
T_6	6,31,504	26,664.00	22,39,760	16,08,256	3.55
T_7	6,14,839	26,608.45	22,35,080	16,20,241	3.64
T_8	5,57,526	24,686.42	20,73,660	15,16,134	3.72
T_9	5,53,327	22,297.77	18,73,047	13,19,720	3.39
T_{10}	5,50,412	23,275.45	19,55,110	14,04,698	3.55
T_{11}	5,63,574	28,163.85	23,65,760	18,02,186	4.19
T_{12}	5,60,659	30,530.28	25,64,540	20,03,881	4.57
T_{13}	5,47,279	18,387.05	15,44,510	9,97,231	2.82

Gross return (Rs ha^{-1}) = yield (Kg ha^{-1}) x cost of apple per Kg.
Selling price of apple = Rs. 90 per Kg for A grade apple and Rs.50 for remaining (considering 85% of the apples produced where of A grade quality).
Net return (Rs ha^{-1}) = Gross return (Rs ha^{-1}) – Total cost of cultivation (Rs ha^{-1})
Benefit cost ratio = Gross return (Rs ha^{-1}) / Total cost of production (Rs ha^{-1})

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