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Economics of Cocoon Production as influenced by Methods of Irrigation and Organic Mulches

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ABSTRACT: Water is undoubtedly elixir of life. Whether it be for irrigation, drinking and sanitation or for the protection of natural ecosystems and providing goods and services for growing populations, without water life on earth is just impossible and hence it is "lifeline". Mulberry is cultivated in about 2.42 lakh ha area in India of the total mulberry area above 80 per cent is under irrigation conditions. In this context research was conducted at Department of Sericulture, College of Agriculture, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka during 2021 - 2022 to study Effect of different methods of irrigation and organic mulching in mulberry during Kharif and Rabi seasons. The experiment was laid out in Factorial Randomized Complete Block Design (FRCBD) with fourteen treatment combinations and three replications. Main plots include two different methods of irrigation *viz.*, Surface drip irrigation- I_1 and Subsurface drip irrigation- I_2 at 15-20 cm depth both at 0.75 Cumulative Pan Evaporation (CPE) and with treatments of organic mulches (Mulching with glyricidia leaves, Mulching with pongamia leaves, Mulching with neem leaves, Live mulching with cowpea, Live mulching with horsegram, Live mulching with *dhaincha* and control without mulch). The results revealed that subsurface drip irrigation @ 0.75 CPE and among organic mulches cowpea live mulching enhanced the growth and yield of mulberry, further the economics was estimated for different treatment combinations. The economics of Cross Breed cocoon production revealed that total cost of cultivation was more (Rs. 2,07,310 ha^{-1} $crop^{-1}$) in combination with subsurface drip irrigation and living mulch with dhaincha, maximum net returns (Rs. 2,46,981.47 ha^{-1} $year^{-1}$) and highest B:C ratio of 2.21 was reported in subsurface drip irrigation + live mulching with cowpea treated mulberry plots. In double hybrid cocoon production total cost of cultivation was more in combination of subsurface drip irrigation and live mulching with dhaincha (Rs. 2,12,315 ha^{-1} $crop^{-1}$), subsurface drip irrigation and live mulching with cowpea treated mulberry leaves fed with double hybrid silkworms yielded maximum net returns (Rs. 4,56,829.40 $ha^{-1}year^{-1}$) and highest B:C ratio of 3.18.

Keywords: Methods of irrigation and organic mulching, Cost of production, Gross returns, Net returns, B:C ratio.

INTRODUCTION

Water demand and supply gap is increasing year after year and shrinkage in availability is posing major threat globally in near future. Water Resources Consortium in its recent report (2009) stated that globally, current withdrawals of about 4500 km^3 exceeds the availability of about 4200 km^3; by 2030, the demand is expected to increase to 6900 km^3; with a slight drop in availability to 4100 km^3 result with a deficit of 40 per cent and in India, the annual demand is expected to increase to almost 1500 km^3, as against a projected availability of 744 km^3; a deficit of 50 per cent of water (Narasimhan, 2010).

Thus, water is likely to become critically scarce in coming decades, continuous increase in its demands due to rapid increase in population and expanding economy in India (Ramasamyiyer, 2010). Globally agriculture is the single biggest drain on water supplies, accounting for about 69 per cent of all use, about 23 per cent of water meets the demands of industry and energy and just 8 per cent goes for domestic and commercial use (Anonymous, 2002). In India, agriculture sector uses about 93 per cent of water whereas industry and domestic and commercial sectors use 3 and 4 per cent respectively (Kumar *et al.*, 2005). As agriculture is the major area of water consumption in our country, any one speaks of water management; the focus is only on agriculture, even if 10 per cent of water is saved, 14 M ha will benefit additionally.

Existence of vast scope for saving water in irrigation, recycling of water for domestic uses and awareness among people on water conservation are the key for water management (Palanisami, 2010). In order to achieve maximum Water Use Efficiency (WUE) in mulberry cultivation without compromise on the quality and productivity of leaf and raw silk with the policy of "More Crop and Income for Drop of Water" this study was carried out to find way for sustainable sericulture.

Works carried out by Seenappa and Devakumar (2015), who reported that number of shoots plant^{-1}increased in subsurface drip irrigation with higher level at 1.0 CPE about 26.42 during harvest and Seenappa (2015), the maximum gross, net profit and B:C ratio (Rs. 943740, Rs. 516984 and 2.21) were recorded with subsurface drip irrigation and similarly, Kombali *et al.* (2016) reported that subsurface drip irrigation at 100 per cent pan evaporation recorded significantly higher cane length (226.6 cm) and cane girth (0.91 cm) shows that subsurface drip irrigation played vital role in growth and yield of crops.

Paul *et al.* (2013) stated that drip irrigation system is observed to be economical and cost effective as compared with conventional surface irrigation. As a result, the use of drip irrigation system either alone or in combination with mulching, could increase the capsicum yield up to an extent of 57 per cent over surface irrigation method with the same quantity of water. The net profit could be increased by 54 per cent over the normal surface method by adopting drip irrigation system with mulch.

Kumaresan and Geetha Devi (2014) reported that the drip irrigation system was economically viable with B:C ratio of 1.74 even without subsidy in addition to improvement of productivity (19.40 %) and quality and proper input use.

A study conducted by Biswas *et al.* (2015) on combined effects of drip irrigation and mulches on yield, water-use efficiency and economic return of tomato. The treatments of the study comprised different combinations of three drip irrigation levels (100, 75 and 50 % of crop water requirement, ETc) and two mulches (black polyethylene sheet and paddy straw). The highest net return (US$ 7098/ha), incremental net return (US$ 1556 ha^{-1}), and incremental benefit-cost ratio (7.03) were found for 50 per cent water application with straw mulch. The study thus reveals that drip irrigation with mulch has an explicit role in increasing the land and water productivity of tomato.

Live mulches are cover crops planted either before, after or with a main crop and maintained as a living ground cover throughout the growing season or longer (Hartwig and Ammon 2002). The main task of live mulches in crop production systems is to enhance soil properties as well as to improve the growing conditions for the main crop (Brainard and Bellinder 2004). Leguminous live mulches offer the greatest potential for fertility improvement and weed management (Silva *et al.*, 2008).

Improvement in soil organic carbon content (Groody, 1990), soil macro aggregation stability (Shennan, 1992), soil moisture, total porosity, lower soil bulk density has also been found by many authors when using legumes (Borowy, 2012; Boyd *et al.*, 2001; Jedrszczyk *et al.*, 2005). In addition to improving soil properties, reductions in weed diversity have been widely reported in studies of hairy vetch (*Viciavillos*) as a live mulch in corn (Mohammadi, 2012), subterranean clover (*Trifolium subterranean* L.) in soybean (Enache and IInicki 1990) and cowpea as a live mulch in maize (Talebbeigi and Ghadiri 2012).

Incorporating leguminous live mulching can significantly improve yield of main crop (Decker *et al.*, 1994). Yield advantages have been recorded in many main-crop live mulching systems, including maize - cowpea and pepper - cowpea (Talebbeigi and Ghadiri 2012).

MATERIALS AND METHODS

A field experiment was conducted at Department of Sericulture, UAS, GKVK, Bengaluru-65 during 2021-2022 in established mulberry garden with Victory 1 variety planted at a spacing of (90 +150) × 60 cm (paired row system). The experiment was laid out in Factorial Randomized Complete Block Design (FRCBD) with fourteen treatment combinations and three replications.

Cost of cultivation (Rs. ha^{-1} year^{-1}). The cost of cultivation was worked out treatment wise. The prices of the inputs that at the time of their use and selling prices of the cocoons on the basis of prevailing market rates were taken into account.

Net returns (Rs. ha^{-1} year^{-1}). The net returns ha^{-1} was calculated by deducting the cost of cultivation per hectare from gross returns per hectare.

Benefit: Cost ratio. Benefit cost ratio was worked out by using following formula

$$\text{Benefit : Cost ratio} = \frac{\text{Gross returns (Rs./ha)}}{\text{Cost of cultivation (Rs./ha)}}$$

RESULT AND DISCUSSIONS

A. Total cost of cultivation (Rs. ha^{-1}crop^{-1}) of cross breed cocoon production

Total cost of cultivation was more (Rs. 2,07,310 ha^{-1} crop^{-1}) in treatment T_{13} which received subsurface drip irrigation and living mulch with dhaincha followed by T_8 and T_{10}(Rs. 2,07,260 ha^{-1} crop^{-1}). The cost of cultivation was least (Rs. 1,95,410 ha^{-1} crop^{-1}) in T_7 which is surface drip irrigation without mulching is presented in Table 1 and cocoons produced by different treatment combinations are depicted in Plate 1.

The net returns earned was ranged from 2,46,981.47. Rs. ha^{-1} year^{-1} in T_{11} treated mulberry to T_7 (Rs. 1,94,305.69ha^{-1} year^{-1}). Among the different treatment combinations subsurface drip irrigation and live mulching with cowpea treated mulberry yielded maximum net returns (Rs. 2,46,981.47 ha^{-1}year^{-1}) followed by surface drip irrigation and live mulching with cowpea (Rs. 2,36, 866.27 ha^{-1} year^{-1}), subsurface drip irrigation and live mulching with horsegram (Rs. 2,36,857.03 ha^{-1}year^{-1}) and least was recorded in surface drip irrigation without mulching (Rs. 1,94,305.69 ha^{-1}year^{-1}).

The highest B:C ratio of 2.21was recorded in subsurface drip irrigation and live mulching with cowpea (T_{11}), surface drip irrigation and live mulching with cowpea (T_4), followed by surface drip irrigation and live mulch with cowpea (2.20), T_5- Subsurface drip irrigation+ live mulching with horsegram (2.17) and among mulches lowest was recorded in surface drip irrigation and mulching with neem leaves and surface drip irrigation without mulching (1.99) is presented in Table 1.

B. Total cost of cultivation (Rs. $ha^{-1}crop^{-1}$) od double hybrid cocoon production

Total cost of cultivation was more (Rs. 2,12,315 ha^{-1} $crop^{-1}$) in treatment T_{13} which received subsurface drip irrigation and live mulching with dhaincha followed by T_8 and T_{10} (Rs. 2,12,265 ha^{-1} $crop^{-1}$). The cost of cultivation was least (Rs. 2,00,415 ha^{-1} $crop^{-1}$) in T_7 which is surface drip irrigation without mulching is presented in Table 2 and cocoons produced by different treatment combinations are depicted in Plate 1.

The net returns earned was ranged from 4,56,829.40 Rs. ha^{-1} $year^{-1}$ in treatment T_{11} to 3,21,868.50 Rs. ha^{-1} $year^{-1}$ in T_7. Among the different treatment combinations subsurface drip irrigation and live mulching with cowpea (T_{11}) treated mulberry leaves fed double hybrid silkworms yielded maximum net returns (Rs. 4,56,829.40 $ha^{-1}year^{-1}$) followed by T_{12}-subsurface drip irrigation and live mulching with horsegram (Rs. 4,41,333.88 × ha^{-1} $year^{-1}$), T_4-surface drip irrigation and live mulching with cowpea (Rs. 4,39,534.45 ha^{-1} $year^{-1}$) and least was recorded in T_7-surface drip irrigation without mulching (Rs. 3,21,868.50 $ha^{-1}year^{-1}$).

The highest B:C ratio of 3.18 was recorded in combination of subsurface drip irrigation and live mulching with cowpea (T_{11}), surface drip irrigation and live mulch with cowpea (T_4), followed by T_5-surface drip irrigation and live mulching with horsegram (3.11), T_{12} - Subsurface drip irrigation and live mulching with horsegram (3.10), among mulches lowest was recorded in T_3-surface drip irrigation and mulching with neem leaves (2.72) but least was recorded in T_7-surface drip irrigation without mulches (2.61) is presented in Table 2.

Table 1: Economics of cross breed cocoon production as influenced by methods of irrigation and organic mulches.

Treatments	Cost of cultivation (Rs. ha^{-1} $year^{-1}$)		Total cost of production (Rs.)	Returns Rs. (750 DFLs)		
	Total cost of leaf production (Rs.ha^{-1} yr^{-1})	Total cost of cocoon production (Rs.ha^{-1} yr^{-1})		Gross profit	Net Profit	B:C ratio
T1 -I1 M1	166070	33790	199860	420015.02	220155.02	2.10
T2 -I1 M2	163400	33790	197190	405308.48	208118.48	2.06
T3 -I1 M3	166070	33790	199860	398303.26	198443.26	1.99
T4 -I1 M4	163020	33790	196810	433676.27	236866.27	2.20
T5 -I1 M5	163620	33790	197410	428569.64	231159.64	2.17
T6 -I1 M6	166120	33790	199910	416483.14	216573.14	2.08
T7 -I1 M7	161620	33790	195410	389715.69	194305.69	1.99
T8 -I2 M1	173470	33790	207260	434430.17	227170.17	2.10
T9 -I2 M2	170800	33790	204590	417373.81	212783.81	2.04
T10 -I2 M3	173470	33790	207260	413720.68	206460.68	2.00
T11 -I2 M4	170420	33790	204210	451191.47	246981.47	2.21
T12 -I2 M5	171020	33790	204810	441667.03	236857.03	2.16
T13 -I2 M6	173520	33790	207310	420696.24	213386.24	2.03
T14 -I2 M7	169020	33790	202810	406230.58	203420.58	2.00

The results are in agreement with Senn and Cornish (2000) who reported that Surface drip is the high cost associated with frequent removal and replacement, whereas subsurface drip irrigation system lasts long enough to offset the high initial setup cost and subsurface drip irrigation avoids interference with cultural practices also in conformity with Thayalaseelan *et al.* (2017) who studied the effect of growth and yield performances of mungbean (*vigna radiata* L.) under different mulching practices. Three different mulching treatments such as live mulch with sun hemp (T1), dry mulch *i.e.*, paddy straw mulch (T2) and No mulch(T3). Economics was worked out and profit from live mulched treatment also had highest than other treatments. Where net profit from live mulch was 3,15,800.00 and from straw mulch plot was 2,77,400.00. The results are also in conformity with Patel *et al.*, (2003) who conducted experiment at fixed site on loamy sand soil of Sardar Krushinagar to study the effect of fertilizer N and *Gliricidia* leaves on the yield of cluster bean during *kharif* Seasons. The data revealed that the highest gross income of Rs. 23812 ha^{-1} was recorded by treatment 100 per cent RDN + Gliricidia, closely followed by 100 per cent RDN fertilizer (Rs. 23,538 ha^{-1}), thus, in cluster bean-pearl millet crop rotation full amount of fertilizer N can be substituted by Gliricidia leaves without hampering the crop yield and net profit under dryland conditions of North Gujarat. Delaune *et al.* (2012) revealed irrigating cotton at 100 per cent ETc in subsurface drip irrigation resulted in significantly higher lint yield 1,138 kg ha^{-1} and net return of 67,737 ha^{-1} compared with all other irrigation levels and lowest lint yield and net return were resulted in 0 per cent Etc *i.e.*, dryland.

Table 2: Economics of double hybrid cocoon production as influenced by methods of irrigation and organic mulches.

Treatments	Cost of cultivation (Rs. ha^{-1}year^{-1})		Total cost of production (Rs.)	Returns Rs. (750 DFLs)		
	Total cost of leaf production (Rs.ha^{-1} yr^{-1})	Total cost of cocoon production (Rs.ha^{-1} yr^{-1})		Gross profit	Net Profit	B:C ratio
T_1 -I_1 M_1	166070	38795	204865	607537.73	402672.73	2.97
T_2 -I_1 M_2	163400	38795	202195	580254.60	378059.60	2.87
T_3 -I_1 M_3	166070	38795	204865	556645.35	351780.35	2.72
T_4 -I_1 M_4	163020	38795	201815	641349.45	439534.45	3.18
T_5 -I_1 M_5	163620	38795	202415	629532.00	427117.00	3.11
T_6 -I_1 M_6	166120	38795	204915	600667.50	395752.50	2.93
T_7 -I_1 M_7	161620	38795	200415	522283.50	321868.50	2.61
T_8 -I_2 M_1	173470	38795	212265	644856.30	432591.30	3.04
T_9 -I_2 M_2	170800	38795	209595	620823.15	411228.15	2.96
T_{10} -I_2 M_3	173470	38795	212265	594567.00	382302.00	2.80
T_{11} -I_2 M_4	170420	38795	209215	666044.40	456829.40	3.18
T_{12} -I_2 M_5	171020	38795	209815	651148.88	441333.88	3.10
T_{13} -I_2 M_6	173520	38795	212315	625449.60	413134.60	2.95
T_{14} -I_2 M_7	169020	38795	207815	552080.70	344265.70	2.66

Plate 1: Cocoons obtained from silkworm hybrids PM × CSR2 and FC1× FC2 fed with mulberry leaves obtained from gardens treated with methods of irrigation and organic mulches.

CONCLUSIONS

Economics of Cross Breed cocoon production revealed that **s**ubsurface drip irrigation and live mulching with cowpea yielded maximum gross returns (Rs. 4,51,191.47 ha^{-1} $year^{-1}$) and lowest gross returns was noticed in surface drip irrigation without mulching (Rs. 3,89,715.69 ha-^{1} $year^{-1}$) and maximum net returns of (Rs. 2,46,981.47 ha^{-1} $year^{-1}$) with the B:C ratio (2.21) was recorded in subsurface drip irrigation and live mulching with cowpea, least net returns was recorded in surface drip irrigation without mulching (Rs. 1,94,305.69$ha^{-1}year^{-1}$) and B:C ratio (1.99). Similarly, same trend has been followed with economics of FC1 × FC2 cocoon production where mulberry garden with subsurface drip irrigation in combination with live mulching with cowpea plots yielded maximum gross returns (Rs. 6,66,044.40 ha^{-1} $year^{-1}$) where lowest gross returns was noticed in surface drip irrigation without mulching (Rs. 5,22,283.50 ha^{-1} $year^{-1}$) and maximum net returns (Rs. 4,56,829.40 ha^{-1} $year^{-1}$) with higher B:C ratio (3.18) was recorded in subsurface drip irrigation and live mulching with cowpea and least net returns was recorded in surface drip irrigation without mulching (Rs. 3,21,868.50 ha^{-1} $year^{-1}$) and B:C ratio (2.61).

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Conflict of Interest. None.

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