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Study of irrigation regimes and nutrient management practices on economics of mulberry silkworm cocoon production

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Abstract
Field experiments were conducted at field No. 68 of Eastern Block, Department of Sericulture, Tamil Nadu Agricultural University, Coimbatore during 2015-2016. Investigations were undertaken on mulberry variety Victory-1(V1) to evaluate "Study of irrigation regimes and nutrient management practices on economics of silkworm cocoon production". The experiments were laid out in split plot design in three replications. Four irrigation regimes *viz.*, irrigation of 5 cm depth at 1.20 IW/CPE ratio, irrigation of 5 cm depth at 0.90 IW/CPE ratio, irrigation of 5 cm depth at 0.60 IW/CPE ratio and irrigation of 5 cm depth at 1.0 IW/CPE (control) with four levels in main plots and four nutrient management practices *viz.*, absolute control (no organic & inorganic), 100 per cent inorganic fertilizers (NPK 375:140:140 kg/ha/year), 50 per cent inorganic fertilizers + 50 per cent organic manures (25 per cent vermin compost + 25 per cent bio fertilizer) and 100 per cent organic manures (50 per cent vermin compost + 50 per cent bio fertilizer) treatment in the subplots were studied. Irrigation was given based on the IW/CPE (Irrigation Water / Cumulative Pan Evaporation) ratio as per the treatment schedule and nutrients management practices also as per the treatment schedule. Mulberry leaves were collected from each treatment and fed to silkworm to study the response of irrigation regimes and nutrient management practices on growth and economic characteristics of double hybrid silkworm (CSR 6 X CSR26) X (CSR 2 X CSR 27) and cross breed (PM X CSR 2). The results of the experiment revealed that irrigation of 5 cm depth at 0.9 IW/CPE ratio and 50 per cent inorganic and 50 per cent organic manures application registered more gross income, net income and B: C ratio.

Keywords: Mulberry, Silkworm, Irrigation, Nutrients Management and Economics

Introduction
India is the second largest producer of mulberry raw silk, next only to China, accounting more than 15 per cent of the global raw silk production. The total annual production of raw silk in India was 30348 MT, of which mulberry raw silk output aggregated to about 21273 MT during 2016-17. However, the productivity and quality of the silk produced in India is comparatively lower than that of advanced silk producing countries such as China and Japan. Further, the cost of production of the silk is also higher than that in many other countries. One of the major reasons attributable for lower productivity and quality is small-scale operations by the farmers and reelers and the adoption of traditional technologies for the production of cocoons and raw silk. Sericultural operations are mostly confined to small or medium scale mostly with the mulberry holdings ranging from 0.5 acre to 2 acres in India due to the labour intensive nature and the personal care required for silkworm rearing operations. As the improved technologies evolved by the research institutes of the country have increased the crop stability and considerably reduced the labour dependence for silkworm rearing operations, large-scale or commercial farming has now become economically viable and is becoming popular especially among progressive farmers and educated persons. It is hypothesized that high production and cost efficiency and quality are characteristic of large-scale sericultural farming. In this context, this study has been taken up to examine the performance of different irrigation regimes and nutrient management practices on economics of silkworm cocoon production. In India there is an urgent need to boost the economic status of poor farmers through adoption of new technologies to increase crop production through the optimal use of scarce resources, such as land, water and fertilizers. Major reasons for low productivity levels in India are lack of adequate irrigation facilities and unbalanced fertilizer scheduling.

Lakshmanan, *et al*. (2000) [5] compared economic benefits over investment in rearing bivoltine and crossbred cocoons in their study one economics of bivoltine versus cross breed cocoon production in K.R. Nagar taluk of Mysore district. The study revealed that bivoltine rearing

earns higher net returns than crossbred production, owing to climatic suitability, skilled man power and technical guidance received from developmental agencies. Hajare *et al*. (2008) [3] observed that the contribution from sericulture enterprise was found to be highest at 52 percent (Rs. 82315/ha/yr) followed by paddy–sun flower (20 percent).

Materials and Methods

Field Location

Field experiments were conducted in a five years old, established mulberry garden with Victory.1 variety in field No. 68 of Eastern Block, Department of Sericulture, Tamil Nadu Agricultural University, Coimbatore which is located at 11° North Latitude, 77° East Longitude and at an altitude of 426.7 m above mean sea level (MSL). Field experiments and laboratory studies (silkworm rearing) were carried after successive prunings of mulberry as per the schedule given below.

Crops after	Experiment	
	Field study	Silkworm Rearing
I pruning	10.06.2015 - 11.08.2015	22.07.2015 - 16.08.2015
II pruning	14.08.2015 - 17.10.2015	21.09.2015 - 17.10.2015
III pruning	19.10.2015 - 21.12.2015	01.12.2015 - 26.12.2015
IV pruning	14.01.2016 - 16.03.2016	16.02.2016 - 20.03.2016

Crop and Variety

It is essential to select mulberry variety according to agro climatic conditions of the area. The variety selected should have good agro-economic efficiency in terms of their response to applied fertilizer or fertilizer use efficiency (FUE), disease resistance and drought tolerance. The leaves of a selected variety should have good succulence, shelf life, palatability and nutritive value. The test mulberry crop variety is V1 (Victory-1) evolved by Central Sericultural Research and Training Institute, Mysore, holds high potentials under irrigated conditions in South India. This superior mulberry variety is suitable to different agro climatic conditions that not only yield better, but also will be of high quality to support the growth of silkworm and resistant to climatic hazards, diseases and insects which is also suited for semi arid regions.

Silkworm egg

Disease Free Laying's (DFL's) of the cross breed (PM X CSR 2) and double hybrid (DH1) {(CSR2 X CSR 27) X (CSR 6 X CSR 26)} were obtained from the Silkworm Seed Production Centre, Coimbatore under the control of Central Silk Board. The selected breed was suitable for all seasons in Tamil Nadu.

Experimental details

The experiments were laid out in split plot design in three replications. The selected crop is mulberry, Victory 1 (V1) variety and four times pruning's were done.

The treatment details are as follows:

I. Main plot (Irrigation Regimes)		
I_1	:	Irrigation at 5 cm depth - 1.2 IW/ CPE Ratio
I_2	:	Irrigation at 5 cm depth - 0.9 IW/ CPE Ratio
I_3	:	Irrigation at 5 cm depth - 0.6 IW/ CPE Ratio
I_4	:	Control (IW/ CPE Ratio 1.0)
II. Sub plot (Integrated Nutrient Management (INM)		
N_1	:	Absolute control (No organic & Inorganic).
N_2	:	100 per cent Inorganic fertilizers (NPK 375:140:140 Kg/ha/year)
N_3	:	50 per cent Inorganic fertilizers + 50 per cent Organic manures (25 per cent Vermicompost* + 25 per cent Biofertilizer**)
N_4	:	100 per cent Organic manures (50 per cent Vermicompost* + 50 per cent Biofertilizer**)

*Vermicompost @ 8 MT/ha/yr.

**Biofertilizer (Potash Solubilizing bacteria - *Bacillus mucilaginosus*) @ 12.5 Kg/ha/year.

Economics

The net income and expenditure right from the start of the experiment for all the seasons were pooled and economics were worked out and expressed in rupees per hectare. Total incomes obtained from cocoon yield of all seasons were calculated for individual treatments. Gross returns, net returns and cost / benefit ratio were worked out based on total variable cost and returns.

Gross return

Gross return was calculated using cocoon yield of all the seasons based on market price and expressed as Rs. $dfl^{-1}$of cocoon.

Net return

Net return was calculated by deducting the variable cost of cultivation from gross return and expressed as Rs. ha^{-1}.

Net return (Rs. ha^{-1}) = Gross return (Rs. ha^{-1}) – Variable cost of cultivation (Rs. ha^{-1}).

Benefit: cost ratio

Data on mulberry leaf yield from the experiments of all the seasons were pooled. The cost benefit ratio was worked out from the pooled data. The cost of imposing treatments was added to the cost of cultivation in the respective treatments and benefit cost ratio was worked out.

Benefit cost ratio was worked out by using the formula.

$$\text{Returns per rupee invested (B/C ratio)} = \frac{\text{Total return}}{\text{Total cost}}$$

Statistical analysis

The data collected during the experimental period were analyzed statistically by analysis of variance method with respective design as suggested by Gomez and Gomez (1976).

Result

Effect of irrigation regimes and nutrients management practices on economics of Double hybrid Cocoon production

Both irrigation regimes and nutrient management practices had significant influence on economics of double hybrid

cocoon production, which is conspicuous from the results presented in the Table 1. Among the treatments, 0.9 IW/CPE ratio with 50 per cent organic and 50 per cent inorganic fertilizers application (I_2N_3) gave higher gross return (Rs.190853.60) compared to other treatments.

Table 1: Effects of irrigation regimes and nutrient management practices on economics of double hybrid cocoon production (ha^{-1} harvest^{-1})

Treatments	Total Expenditure	Gross Return	Net Return	B:C ratio
I_1N_1	77280.00	89157.23	11877.23	1.15
I_1N_2	85823.75	164467.40	78643.65	1.92
I_1N_3	86927.00	176517.30	89590.30	2.03
I_1N_4	88030.00	155950.30	67920.33	1.77
I_2N_1	76780.00	97793.20	21013.20	1.28
I_2N_2	85323.75	186555.50	101231.72	2.19
I_2N_3	86427.00	190853.60	104426.63	2.21
I_2N_4	87530.00	172042.80	84512.83	1.97
I_3N_1	76280.00	85329.20	9049.20	1.12
I_3N_2	84823.75	154690.30	69866.51	1.83
I_3N_3	85927.00	163018.70	77091.73	1.90
I_3N_4	87030.00	140785.80	53755.80	1.62
I_4N_1	76280.00	92023.13	15743.13	1.21
I_4N_2	84823.75	181133.90	96310.15	2.14
I_4N_3	85927.00	183756.50	97829.53	2.14
I_4N_4	87030.00	163812.80	76782.77	1.88

This is 55.29 per cent higher than irrigation at 0.6 IW/ CPE ratio along with absolute control (I_3N_1), which recorded the lowest gross return value Rs. 85329.20. The higher net return value 104426.63 and B: C ratio value 2.21 was observed in the treatment of 0.9 IW/CPE ratio with 50 per cent organic and 50 per cent inorganic fertilizers application (I_2N_3). This is 91.33 (net return) and 49.32 (B:C ratio) per cent higher than irrigation at 0.6 IW/ CPE ratio along with absolute control (I_3N_1), which recorded the lower net return value 9049.20 and B: C ratio value 1.12 recorded.

Economics of cross breed cocoon production

Both irrigation regimes and nutrient management practices had significant influence on economics of cross breed cocoon production, which is conspicuous from the results presented in the Table 2. Among the treatments, 0.9 IW/CPE ratio with 50 per cent organic and 50 per cent inorganic fertilizers application (I_2N_3) gave higher gross return (Rs.104426.63) compared to other treatments. This is 51.86 per cent higher than irrigation at 0.6 IW/ CPE ratio along with absolute control (I_3N_1), which recorded the lowest gross return value Rs. 62209.33. The higher net return value Rs.53352.27 and B: C ratio value 1.62 was observed in the treatment of 0.9 IW/CPE ratio with 50 per cent organic and 50 per cent inorganic fertilizers application (I_2N_3). This is 116.85 (net return) and 45.68 (B:C ratio) per cent higher than irrigation at 0.6 IW/ CPE ratio along with absolute control (I_3N_1), which recorded the lower net return value Rs. -14070.67 and B: C ratio value 0.82.

Table 2: Effects of irrigation regimes and nutrient management practices on economics of cross breed cocoon production (ha^{-1}harvest^{-1})

Treatments	Total Expenditure	Gross Return	Net Return	B:C ratio
I_1N_1	77280.00	64774.67	-12505.33	0.84
I_1N_2	85823.75	119091.90	33268.18	1.39
I_1N_3	86927.00	127748.80	40821.83	1.47
I_1N_4	88030.00	111830.40	23800.37	1.27
I_2N_1	76780.00	72178.20	-4601.80	0.94
I_2N_2	85323.75	132333.50	47009.78	1.55
I_2N_3	86427.00	139779.30	53352.27	1.62
I_2N_4	87530.00	124117.50	36587.50	1.42
I_3N_1	76280.00	62209.33	-14070.67	0.82
I_3N_2	84823.75	109456.80	24633.01	1.29
I_3N_3	85927.00	119522.00	33595.03	1.39
I_3N_4	87030.00	102955.70	15925.70	1.18
I_4N_1	76280.00	67291.27	-8988.73	0.88
I_4N_2	84823.75	128923.20	44099.45	1.52
I_4N_3	85927.00	132631.50	46704.46	1.54
I_4N_4	87030.00	120865.40	33835.37	1.39

Discussion

Effect of irrigation regimes and nutrient management practices on economics of silkworm

Higher gross return, net income and B:C ratio were obtained in treatments where irrigation of 5cm depth at 0.9 IW/CPE ratio with 50 per cent organic manures and 50 per cent inorganic fertilizers application (I_2 N_3) was carried out. In treatments where application of irrigation at 0.9 IW/CPE ratio was practiced, mulberry plant canopy grew faster and covered the soil surface and arrest the weed growth for want of light and nutrient competition. This might be due to the nutrient management practices followed with combination of organic and inorganic sources. It is also confirmed that chemical fertilizers can be supplemented with the addition of vermin compost and bio fertilizer to some extent and these organic manures cannot replace completely the chemical fertilizers. Further, it is concluded from the experiment that organic manures, a cheaper supplement to the expensive chemical fertilizers and can be used in mulberry cultivation to reduce the use of chemical fertilizers and thus saving50 per cent cost of chemical fertilizers.

The above study confirmed that about 50 per cent inorganic fertilizers could be saved by using nitro and phopho biofertilizers without any adverse effect on leaf yield and quality (Purohit *et al*., 2011). Das *et al*. (1993) [6, 1] observed that the silkworms reared on mulberry leaves obtained by the application of different levels of nitrogen *viz*., 50 to150 kg N ha^{-1} yr^{-1} along with organic and bio fertilizer combination had no significant difference with respect to larval weight, shell weight, single cocoon weight, shell ratio, denier, filament length and absolute silk content. Jaishankar and Dandin (2009) [4] studied the effect of beneficial microflora in soil after application of all the organic and biological inputs in conjunction with reduced doses (50%) of inorganic fertilizers *i.e*. under integrated nutrient management condition in mulberry and found no reduction in soil fertility. The present studies were undertaken to investigate the influence of irrigation regimes and nutrient management practices for obtaining good quality mulberry leaf production and good cocoon production. In the current studies, the mulberry plant growth parameters such as shoot length, number of leaves per branch, specific leaf area and leaf fresh weight, leaf yield per hectare per harvest and quality parameters *viz*., leaf

chlorophyll, carotenoid, carbohydrate, total sugar, protein, moisture content and macro nutrients has been gathered and analysed. Also silkworm rearing parameters such as silkworm larval weight, cocoon weight, shell weight, shell ratio, filament length, silk denier, renditta and disease incidence were also studied. Based on these parameters, irrigation of 5 cm depth at 0.9 IW/CPE ratio with 50 per cent inorganic fertilizer and 50 per cent organic manures application is found to be the best treatment for earning more profitability.

Conclusion

In the present investigation on "Study of irrigation regimes and nutrient management practices on economics of silkworm" applying irrigation water 5 cm depth at 0.90 IW/CPE ratio with 50% inorganic fertilizers and 50% organic manures registered higher gross return (Rs. 190853.60 and 139779.30), net return (Rs.104426.63 and 53352.27) and B:C ratio (2.21 and 1.62) performed better than all other treatment combinations.

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