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Economics of Chilli Production under Different Colour Shadenets with Varying Irrigation and Fertigation Regimes During Late *Rabi* Season

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Abstract

The experiment was conducted under five different colour shadenets *viz*., white shadenet, black shadenet, green+white shadenet, green+black shadenet and no shadenet (i.e. open field) with three irrigation regimes *viz*., 0.60, 0.80 and 1.0 ETc and three fertigation regimes *viz*., 100, 120 and 140% RDF to determine the suitable colour of shadenet, drip irrigation regime and fertigation regime for chilli crop under protected cultivation based on economics. The study revealed that the scheduling of drip irrigation daily at 1.0 ETc and alternate day fertigation at 140% RDF to chilli crop under white shadenet resulted into maximum net income of Rs. 54,820/- per 1000 m^2 area of shadenet house and maximum gross B:C ratio (1.52), followed by scheduling of drip irrigation daily at 1.0 ETc and fertigation at 120% RDF to chilli under white shadenet i.e. Rs. 53,012/-.

Key words : Chilli, shadenet colours, irrigation and fertigation regimes, yield, economics.

India has taken a bold step towards self sufficiency in food. However, self sufficiency in the true sense can be achieved only when each individual in the country is assured of balanced diet. Varied agro-climatic conditions in India make it possible to grow a wide variety of vegetable crops, all the year round, in one part of the country or another. India is the second largest producer of vegetables with 2.8 per cent of total cropped area under vegetables. An increase of 2.5 per cent per year in vegetable production is also necessary. Present production of 1.5 million tons of vegetable supply only 145 g per capita per day against recommended requirements of 300 g.

Chilli is a tropical and sub-tropical plant requiring a combination of warm, humid yet dry weather. During the growth stage, it needs a warm and humid weather. However, a dry weather is suitable for fruit maturity. Chilli is a warm season crop that dies when cold temperature threatens, unless a greenhouse or shadenet house is facilitated. Shade houses generally have shade cloths over it. They are mainly used to protect cultivated plants from excessive heat, light or dryness. Different shade cloths can be available in different colours and shading percentages to protect plants from sun, frost, etc. This shade net gardening technique is easy to install and give more productivity even in the adverse weather conditions. The range between 20-25°C is ideal temperature range for chilli growth. Chillies need regular moisture for growth. It has been found that black soil which retains moisture is ideal in case they are grown as rainfed crops. Under irrigated conditions, the crop needs well-drained sandy loam with rich organic content. They can also be grown in deltaic soil under irrigated conditions. The pH of soil should be in between 6.5 and 7.5 (neutral soil). The amount of water to be irrigated, number of irrigations and its frequency highly depends on the climatic conditions and the soil type. Therefore, the scare water is to be utilized

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efficiently and judiciously and for the same the solution is only to go for high-tech irrigation systems like micro irrigation. Drip irrigation is most suitable for row crops (vegetables and fruits), where one or more emitters can wet the complete row. Drip irrigation is suitable for most soils. The water savings that can be made using drip irrigation are the reductions in surface runoff and evaporation from the soil. It is best suited to areas where water quality is marginal, land is steeply sloping or undulating and of poor quality, where water or labour are expensive, or where high value crops require frequent water applications.

Fertigation is a method of fertilizer application in which fertilizer is incorporated within the irrigation water by the drip system. In this system fertilizer solution is distributed evenly in irrigation. In this method, liquid fertilizer as well as water soluble fertilizers are used. There are different water soluble fertilizers available in the market in different grades. Water soluble fertilizers helps in maintaining NPK nutrient balance in the plant and makes them easily and speedily available. Because they are easily broken down and fast-acting, the plants will have an immediate boost in nutrients. Rao *et al*. (2013) reported that the capsicum crop yield increased by 80 per cent under shadenets compared to open field cultivation, while approximately 40 per cent less water was used in covered cultivation. Meena *et al*. (2014) conducted a study on change in micro-environment under different colour shadenets and its impact on yield of spinach (*Spinacia oleracea* L.) at research farm of ICAR-Indian Agricultural Research Institute, New Delhi during summer and rainy seasons, 2012. The experiment showed that the light intensity, incoming radiation, canopy temperature, air temperature, soil temperature were found to be lower under different colour shadenets compared to control. However, the relative humidity and soil moisture was found to be higher under colour shadenets compared to control.

Firake *et al*. (2019) reported that the scheduling of drip irrigation daily at 0.90 ETc and fertigation at 80 % RDF to broccoli under white shadenet resulted into maximum yield. Wankhede *et al*. (2020) reported that the yield of tomato was enhanced when cultivated in shadenet houses of different shading percentages with drip irrigation was scheduled at 0.95 ETc as compared to open field condition. Rani *et al*. (2019) concluded that the drip irrigation at 100% pan evaporation with fertigation level of 150% RDF with P as water soluble fertilizer enhanced the productivity of bhendi. The experiment conducted by Nangare *et al*. (2015) showed that the growing of tomato, under shade house conditions will be more profitable irrespective of the seasons. The shadenet controls the plants from frost and cold waves during winter and from solar injury due to high intensity solar radiation during summer. It was concluded that the better growth, development and yield of tomato were achieved under shadenet due to optimum temperature and humidity.

Kadam *et al*. (2015) reported that the higher levels of irrigation and fertigation boosted the yield of colour capsicum under shade net house and interaction effect of treatment I_3F_3 (1.0 PE, 120% RD) resulted into maximum gross monetary returns (Rs. 239.50 m^{-2}) and B:C ratio (8.60). Kakade *et al*. (2016) reported that the fruit yield of okra was significantly higher under shadenet house (237.55 q ha^{-1}). They further added that, it is economically viable for the farmers to adopt shadenet house with mulching for okra as the benefit : cost ratio was 1.98.

Material and Methods

The present investigation was carried out at the Institutional Farm of Precision Farming

Development Centre, Department of Irrigation and Drainage Engineering, Dr. A. S. College of Agril. Engineering and Technology, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra. The experiment was carried out in split-split plot design with three main factors as shadenet colours, irrigation regimes and fertigation regimes with three replications. The healthy chilli seedlings of 45 days old were transplanted on 3rd January, 2022. All shadenets used were having 50% shading. The soil media used in shade net houses was made up of red soil (30%), FYM (30%), sand (30%) and rice husk (10%) as per recommendation. In open field condition (control), the soil media was not used. The pH and EC of soil media used in shadenet house was 6.77 and 0.10 dS m^{-1}, respectively and pH and EC of soil in open field was 7.20 and 0.27 dS m^{-1}, respectively.

The forty-five treatments were the combination of five colours of shadenet i.e. white shadenet (S_1), black shadenet (S_2), Green+white shadenet (S_3), Green+Black shadenet (S_4) and No shadenet (S_5) (i.e. open field) with three irrigation regimes i.e. 0.60 (I_1), 0.80 (I_2) and 1.0 (I_3) of ETc and three fertigation regimes i.e. 100 (F_1), 120 (F_2) and 140 (F_3) % of RDF (recommended dose of fertilizers). Water soluble fertilizers were scheduled at alternate day through drip irrigation as per recommended dose of fertilizers (i.e. 150:75:75 NPK kg ha^{-1}). The irrigation water was applied daily to the crop through drip irrigation system and soluble fertilizers were applied at alternate days by using venturi tube assembly. The irrigation scheduling was done as per the treatment on the basis of ETc. The crop evapo-transpirtation was calculated based on FAO Penman-Monteith formula computed with MPKV recommaned Phule Jal software. The volume of water to be applied for each treatment plot was computed by the equation V= d x A, where V is volume of water, lit; d is depth of water, mm; and A is area of plot, m^2. The time of operation (hr) of drip irrigation system for each treatment was calculated by equation To = V/ q.n.EU, where To is time of operation of drip irrigation unit for respective treatment (hr); V is volume of water to be applied per irrigation, lit; q is average discharge of emitter in respective treatments (lph); EU is emission uniformity of drip irrigation unit (0.95) and n is number of emitters per plot.

The detailed economic analysis of experiment was calculated and the investment in shadenet structure was studied by calculating benefit:cost ratio. The cost of shadenet house structure, cost of drip irrigation unit, cost of inputs, maintenance cost of system and cost of labour, etc. were considered for shadenet cultivation. The depreciation was considered as per the life span of material for shadenet structure and drip irrigation system components.

Result and Discussion

Total cost of cultivation: The cost of cultivation per 1000 m^2 shadenet area was highest (Rs.57,037/-) in treatment I_3 F_3 S_1 (i.e. 1.0 ETc x 140 % RDF x White shadenet), I_3 F_3 S_2 (i.e. 1.0 ETc x 140 % RDF x Black shadenet) and I_3 F_3 S_3 (i.e. 1.0 ETc x 140 % RDF x Green + White shadenet) and I_3 F_3 S_4 (i.e. 1.0 ETc x 140% RDF x Green+Black shadenet). The lowest cost of cultivation per 1000 m^2 (Rs. 34,614/-) was found in I1 F1 S5 (i.e. 0.6 ETc x 100% RDF x Open field). Malik and Kumar (2020) reported that higher initial investment, lack of skilled labour and less durability of cladding material were the major problems related to production.

Gross monetary return: The gross income obtained under different treatments varied from Rs.11,520/- to Rs. 1,60,900/-. The maximum gross monetary returns per 1000 m^2 (Rs. 1,60,900/-) were obtained under treatment of I_3 F_3 S_1 (i.e. 1.0 ETc x 140% RDF x White shadenet) and the minimum net income of (Rs. 11,520/-) was observed under I_1 F_1 S_5

Table 1. Cost of cultivation, gross income, net income and benefit cost ratio as influenced by treatments, calculated for 1000 sq. m area of shadenet house

Treatments	Cost of cultivation per 1000 sq. m	Gross income per 1000 sq. m	Net income per 1000 sq. m	Gross B:C ratio
$I_1 F_1 S_1$	54,654	1,11,400	7,703	1.07
$I_1 F_2 S_1$	55,845	1,12,500	7,612	1.07
$I_1 F_3 S_1$	57,037	1,31,700	25,620	1.24
$I_2 F_1 S_1$	54,654	1,41,200	37,503	1.36
$I_2 F_2 S_1$	55,845	1,43,900	39,012	1.37
$I_2 F_3 S_1$	57,037	1,47,300	41,220	1.39
$I_3 F_1 S_1$	54,654	1,49,500	45,803	1.44
$I_3 F_2 S_1$	55,845	1,57,900	53,012	1.51
$I_3 F_3 S_1$	57,037	1,60,900	54,820	1.52
$I_1 F_1 S_2$	49,614	55,500	(-) 42,257	0.57
$I_1 F_2 S_2$	50,805	61,200	(-) 37,748	0.62
$I_1 F_3 S_2$	51,997	65,600	(-) 34,540	0.66
$I_2 F_1 S_2$	49,614	65,800	(-) 31,957	0.67
$I_2 F_2 S_2$	50,805	67,900	(-) 31,048	0.69
$I_2 F_3 S_2$	51,997	69,000	(-) 31,140	0.69
$I_3 F_1 S_2$	49,614	69,800	(-) 27,957	0.71
$I_3 F_2 S_2$	50,805	73,700	(-) 25,248	0.74
$I_3 F_3 S_2$	51,997	81,400	(-) 18,740	0.81
$I_1 F_1 S_3$	47,022	1,05,600	10,435	1.11
$I_1 F_2 S_3$	48,213	1,10,100	13,744	1.14
$I_1 F_3 S_3$	49,405	1,13,400	15,852	1.16
$I_2 F_1 S_3$	47,022	1,21,300	26,135	1.27
$I_2 F_2 S_3$	48,213	1,26,000	29,644	1.31
$I_2 F_3 S_3$	49,405	1,29,100	31,552	1.32
$I_3 F_1 S_3$	47,022	1,23,600	28,435	1.30
$I_3 F_2 S_3$	48,213	1,30,900	34,544	1.36
$I_3 F_3 S_3$	49,405	1,32,900	35,352	1.36
$I_1 F_1 S_4$	49,614	71,900	(-) 25,857	0.74
$I_1 F_2 S_4$	50,805	74,200	(-) 24,748	0.75
$I_1 F_3 S_4$	51,997	78,800	(-) 21,340	0.79
$I_2 F_1 S_4$	49,614	83,100	(-) 14,657	0.85
$I_2 F_2 S_4$	50,805	86,500	(-) 12,448	0.87
$I_2 F_3 S_4$	51,997	97,500	(-) 2,640	0.97
$I_3 F_1 S_4$	49,614	99,450	1,693	1.02
$I_3 F_2 S_4$	50,805	1,03,200	4,252	1.04
$I_3 F_3 S_4$	51,997	1,09,500	9,360	1.09
$I_1 F_1 S_5$	34,614	11,520	(-) 28,881	0.29
$I_1 F_2 S_5$	35,805	12,540	(-) 29,052	0.30
$I_1 F_3 S_5$	36,997	17,340	(-) 25,444	0.41
$I_2 F_1 S_5$	34,614	20,880	(-) 19,521	0.52
$I_2 F_2 S_5$	35,805	24,300	(-) 17,292	0.58
$I_2 F_3 S_5$	36,997	28,860	(-) 13,924	0.67
$I_3 F_1 S_5$	34,614	30,960	(-) 9,441	0.77
$I_3 F_2 S_5$	35,805	34,740	(-) 6,852	0.84
$I_3 F_3 S_5$	36,997	35,700	(-) 7,084	0.83

(i.e. 0.6 ETc x 100 % RDF x Open field). Patil *et al.* (2017) also reported that the maximum gross monetary returns and net returns were reported under application of higher per cent of NPK.

Net income: The net income obtained under different treatments varied from Rs. (-) 42,257/- to Rs. 54,820/-. The maximum net income of (Rs. 54,820/-) was obtained under treatment of I_3 F_3 S_1 (i.e.1.0 ETc x 140% RDF x White shadenet) and the minimum net income (Rs. (-) 42,257/-) was under I_1 F_1 S_2 (i.e. 0.6 ETc x 100 % RDF x Black shadenet).

Gross Benefit : Cost ratio: The B:C ratio obtained under different treatments varied from 0.35 to 1.52. The maximum B:C ratio of 1.52 was obtained under treatment of I_3 F_3 S_1 (i.e. 1.0 ETc x 140% RDF x White shadenet) which was at par with I_3 F_2 S_1 and the minimum B:C ratio of (0.29) was observed under I_1 F_1 S_5 (i.e. 0.6 ETc x 100 % RDF x Open field) due to adverse climatic conditions in the season. Patil *et al.* (2017) also reported that the economic analysis of cucumber production under open field with different fertigation levels revealed that the production was not economically viable as the B: C was less than 1.0.

Conclusions

The study revealed that the treatment I_3 F_3 S_1 (0.60 ETc x 140 % RDF x White shadenet) was the best as there was maximum net income (Rs. 54,820/- per 1000 m^2) and benefit : cost ratio (1.52), indicating the additional net extra income of Rs. 47,968/- over control.

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