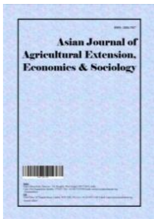

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Extent of Adoption of Tomato Cultivation Practices among Farmers under Shade Nets in Kolar District of Karnataka

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Authors' contributions

This work was carried out in collaboration among all authors. Author NH involved in selection of research topic, schedule preparation and thesis writing. Authors JT, DMC and SKM involved in preparation of programme of research, selection of research design, objectives formulation. Author ATJ involved in statistical analysis and helped use of project appraisal techniques. All authors read and approved the manuscript.

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ABSTRACT

Indian agriculture is severely affected from climate change, fragmentation of cultivable land, water scarcity, rapid urbanization, declining crop production and productivity, crash in market price, declining biodiversity and ever-increasing population, demand for food, especially vegetables has increased manifold. Protected cultivation has offered a new dimension to produce more in a limited area. The study was undertaken during the year 2016-17 in the Kolar, Malur and Mulbagal taluks of Kolar district based on the maximum number of shade net structures growing tomato. From each taluk, respondents were selected by using purposive sampling procedure to constitute a

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sample size of 80 for the study. The study found that no one respondent raised nursery for seedlings. The probable reason might be lack of extension functionaries' effort from respective departments. In the case of cultural practices, concerning ploughing, nearly two-thirds (62.50%) of the respondents partially adopted the recommended number of ploughings (2-3times). On the other hand, 100 per cent of the respondents didn't adoptthe digging practice, whereas more than half (53.75%) of the respondents had partially adopted the recommended size of the bed (1-meter width, 15 cm height and 0.5 meters between the rows) and nearly half (48.75%) of the respondents belonged to partial adoption category of bed treatment @ 4% formalin for tomato cultivation. The findings of Karl Pearson correlation coefficient showed that variables such as annual income, extension participation, exhibited a positive and significant relationship with the adoption behaviour of respondents at 1 per cent level of significance. Concerning the relationship of independent variables with the adoption of tomato, variables like annual income, extension participation, exhibited a positive and significant relationship with the adoption behaviour of respondents at 1 per cent level of significance.

Keywords: Adoption; tomato; correlation; shade net.

1. INTRODUCTION

Agriculture is highly dependent on the environment and it is very difficult to get favourable climatic conditions for crop growth and development as per crop need. Agriculture is climate/season based. Hot and humid climatic conditions characterized in rainy and post rainy season is most favourable for both crop and crop enemies [1,2]. To raise a healthy disease-freecrop, spring-summer seasons are considered as most suitable. But, fast climatic changes happening across the globe has changed climatic characteristics of a season, which has resulted in untimely rains and other fluctuations in the spring-summer season, throwing the challenge to develop climate-resilient technologies [3,4]. Not even that, with time extreme hot and cold temperature stresses, have been noticed in geographically varied locations where it was not supposed to be earlier based on various geographical factors deciding the climatic conditions of that area. Therefore, there is a need to develop suitable varieties and technologies to sustain these challenges which may come up in the form of various biotic and abiotic factors (Singh, 2014).

How to address these issues, can we manipulate the climatic conditions or can we protect the crops against climatic fluctuations and various other related stresses? Yes, protected cultivation technology has the answer to this but, it's a tricky technology highly depending upon the intelligent implementation of protected structures for vegetable cultivation by having knowhow on "*What, When, Where and Why*" *to* implement. Every protected structure has its limitations and advantages (Singh and Kalia, 2005), but the basic benefit is its extra protective shelter restricting or minimizing the exposure of the crops to various adverse factors, which are high in open conditions. Even though the application of chemicals for controlling biotic stresses is also low under protected structures which give high-quality safe vegetables for human consumption. By using protected structures, it is also possible to raise an offseason and long duration vegetables of high quality (Sabir and Singh, 2013).

Vegetable farming in agri-entrepreneurial models targeting various niche markets of the big cities is inviting regular attention of the vegetable growers for diversification from traditional ways of vegetable cultivation to the modern methods. Under the new era of Foreign Direct Investment (FDI) in retail, these kinds of models possess high potential for enhancing the income of farmers opting for quality and offseason vegetable cultivation through protected cultivation [5].

1.1 The Genesis of Protected Cultivation

A playhouse/greenhouse is a framed or an inflated structure covered with a transparent or translucent material in which crops could be grown under the conditions of at least partially controlled environment and which is large enough to permit supervisors and labour to work in carrying out cultural operations.

The growing of off-season cucumbers under a transparent stone for Emperor Tiberius in the first century is the earliest reported protected agriculture. In the 16th century, glass lanterns, bell jars and hotbeds covered with glass were used to protect horticultural crops against cold. In the 17th century, low portable wooden frames covered with an oiled translucent paper were used to warm the plant environment.

In Japan, straw mats were used in combination with oil paper to protect crops from severe environmental conditions. Greenhouses in France and England during the same century were heated by manure and covered with glass panes. The first greenhouse in the 1700s used glass on one side only as a sloping roof. Later in the century, glass was used on both sides. Protected agriculture was fully established with the introduction of polyethene after World War II. The first use of polyethene as a greenhouse cover was in 1948, when Professor Emry Myes Emmert, at the University of Kentucky, used the less expensive material in place of more expensive glass. At present, nearly 90 per cent of the new greenhouses are being constructed by utilizing ultraviolet (UV) stabilized polythene sheets as the glazing material. (Manohar and Igathinathane, 2000)

In1965, Indo-American Hybrid Seeds (Pvt) Ltd., Bangalore was first introducing greenhouse technology in India in commercial production of seeds, ornamental plants and cut flowers. In1990, with support of Agricultural and Processed Food Products Exports Development Authority (APEDA), Ministry of Commerce, Govt. of India, and several poly houses are established by private entrepreneurs at Bangalore, Pune, Hyderabad and New Delhi. Defence Agricultural Research Laboratory (DARL), DRDO, at Pithoragarh and Chamoli districts successfully developed poly house vegetable production technology for capsicum, tomato, pea, brinjal etc in the winter season.

In recent years constraints in agriculture like fragmentation of cultivable land, water scarcity, rapid urbanization, declining crop production and productivity, crash in market price, declining biodiversity and ever-increasing population, demand for food, especially vegetables has increased manifold. Protected cultivation has offered a new dimension to produce more in a limited area in Kolar district. An attempt would be made through this study to analyse the adoption behaviour of farmers about tomato cultivation practices. This study will be of greater importance for officials and administrators of government to formulate suitable training programmes and give suggestions for farmers in future and extension of such facilities to the non-traditional region of the state.

2. METHODOLOGY

The study was undertaken during the year 2016-17 in the selected three taluks of Kolar district of Karnataka state. Based on the maximum number of shade net structures under protected cultivation, Kolar, Malur and Mulbagal taluks were selected for the study. From each taluk respondents were 32, 28 and 20 selected by using purposive sampling procedure to constitute a sample size of 80 for the study. Majority of the farmers are growing capsicum and tomato under protected cultivation(Shade net). The extent of adoption was the dependent variable selected for the study.

In the present study, adoption referred to the acceptance and practice of some or all the recommended protected cultivation practices of capsicum and tomato crops by the respondent. The scores for each one of the individual practices adopted were arrived at considering the relative importance of the items in consultation with a specialist of Indian Institutes of Horticultural Research, Bangalore. The answers elicited from the farmers were compared and quantified by giving a score of 2, 1 and 0 for full adoption, partial adoption and non-adoption respectively. The full adoption is completely adopting recommended practices in their protected cultivation structure (Shade net) and partial adoption is the slight deviation from the recommended practices/dosage. The non-adoption is adopting the cultivation practices other than recommended practices/dosage. Based on the total scores, the respondents were grouped into three categories as low, medium and high by using mean and standard deviation as a measure of the check. The scale developed by Sengupta [6] and followed by Singh et al. [7].

2.1 Correlation Analysis

The correlation coefficient is used to determine the nature of the relationship between variables. The significance of calculated 'r' values was tested at 5 and 1 per cent level of significance to draw an inference.

$$r = \frac{\sum xy - \frac{(\sum x)(\sum y)}{n}}{\sqrt{\left(\sum x^2 - \frac{(\sum x)^2}{n}\right)\times\left(\sum y^2 - \frac{(\sum y)^2}{n}\right)}}$$

Where,

r= Karl Pearson correlation coefficient

n= Sample size

xy-(x) (y)/n=Sum of product of x and y
x2-(x)2/n=Sum of square of x
y2-(y)2 / n =Sum of square of y

3. RESULTS AND DISCUSSION

3.1 Adoption Behaviour of Farmers about Tomato Crop Cultivation Practices under Shade Nets

About nursery management, no one respondent raised nursery for seedlings. The probable reason might be lack of extension functionaries' effort from respective departments. Most of the farmers are using 'Abhinava' as a tomato hybrid from Syngenta private seed company which ishigh yielding, resistance to leaf curl disease and nematode infestation (Table 1).

In the case of cultural practices, concerning ploughing, nearly two-thirds (62.50%) of the respondents partially adopted the recommended number of ploughings (2-3times). On the other hand, 100 per cent of the respondents didn't adoptthe digging practice, whereas more than half (53.75%) of the respondents had partially adopted the recommended size of the bed (1 meter width, 15 cm height and 0.5 meter between the rows) and nearly half (48.75%) of the respondents belonged to partial adoption category of bed treatment @ 4% formalin for tomato cultivation. The majority (70.00%) of the respondents partially adopted the recommended FYM application (80 tons). In case of mulching, more than three fourth (96.25%) of the respondents did not use crop residues as a mulching and more than half (56.25%) of the respondents partially adopted the recommended plastic mulching (400 gauge of 100 micron and 5cm diameter of holes). The probable reason might be that low education leads to less knowledge and high cost involved in cultural practices of tomato under shade net.

In the case of transplanting, cent (100%) per cent of the respondents did not cultivate any recommended tomato cultivars (Sun 7611 and Naveen) under shade net. Whereas majority (71.25%, 76.25%, 56.25% and 61.25%) of the respondents partially followed the recommended age of the seedlings (35-40 days), seeding rate (18000-20000), seedling treatment (Imidachlopride @ 0.1 ml/L), spacing (60X45 cm) respectively. Whereas, nearly three fourth (70.00%) of the respondents partially followed the drenching of seedlings at one day after transplanting (Copper oxy chloride @ 0.3%). The possible reason for this might be that, lack of knowledge about recommended practices.

The outcomes obtained from the Table 1 show that majority (67.50% and 50.00%) of the respondents partially adopted the recommended dosage of inorganic fertilizers (60:60:60) and organic fertilizers (200 Kg Neem Cake) respectively. In case of biofertilizers, 47.50 per cent and 57.50 per cent of the respondents partially adopted the recommended dosage of biofertilizers viz, *Trichoderma viridae* (2 Kg), *Pseudomonas* (2 Kg) respectively. The probable reason might be that, lack of knowledge about fertilizer management and high cost.

Regarding training and pruning, more than half (46.50%) of the respondents were fully adopted the recommended days for pruning (28 DAP @ interval of 3-4 days) and more than half (52.50%) of the respondents partially adopted the recommended days of pruning (30DAP @ interval of 8-10 days). Whereas, three fourth (75.00%) of the respondents did not adopt the de-leafing practice. The lack of information and technical knowledge regarding the pruning besides higher labour cost, complexity in practice and lack of skill to practice might have favoured the situation.

Concerning irrigation and fertigation, nearly three fourth (70.00%) of the respondents partial adopted the recommended duration for irrigation (Half an hour a day). On the other hand, nearly two-thirds (58.75%) of the respondents partially adopted the recommended time for fertigation (3^{rd} week after planting and twice in a week) and 57.50 per cent of the respondents partially adopted the recommended dosage of water-soluble fertilizers (19:19:19 @ 4 kg). The lack of technical information about irrigation, fertigation and high cost is the reason for the above research findings.

The results of Integrated Pest Management(IPM) as evident from the Table 1 that, in case of cultural method, the majority (85.00%) of the respondents had full adoption of summer ploughing practice. On the other hand, nearly three fourth (71.25%) of the respondents adopted the recommended burning of previous crop plant debris, whereas, cent (100%) per cent of the respondents adopted the recommended crops for rotation like marigold, cauliflower etc and more than half (57.50%) of the respondents fully adopted the recommended trap crops like marigold, sweet corn, bendi etc., The past farming experience and lower cost is the probable reason for above findings.

Table 1. Distribution of respondents according to adoption behaviour of farmers about tomato crop cultivation practices under protected cultivation n=80

Sl. No.	Package of practices	Recommended dosage/acre	FA		PA		NA	
			F	%	F	%	F	%
I	**Nursery Raising**							
1.	Seed rate	200 gm	0	0	0	0	80	100
2.	Growing media	Cocopeat	0	0	0	0	80	100
3.	Depth of sowing	0.5 cm	0	0	0	0	80	100
II	**Cultural practices**							
1.	Ploughing	2-3 times	30	37.50	50	62.50	0	00.00
2.	Digging		0	0	0	0	80	100
3.	Bed preparation	1 meter width and 15 cm height and 0.5 meter between the rows	25	31.25	43	53.75	12	15.00
4.	Bed treatment	Formaldehyde@ 4%	29	36.25	39	48.75	12	15.00
5.	FYM application	80 tons	24	30.00	56	70.00	0	0
6.	**Mulching**							
a.	Residue mulching		3	3.75	0	0	77	96.25
b.	Plastic mulching	400 gauge of 100 micron and 5cm diameter of holes	19	23.75	45	56.25	16	20.00
III	**Transplanting**							
1.	Selection of cultivars	Naveen and Sun 7611	0	0	0	0	80	100
2.	Age of Seedlings	35-40 days	23	28.75	57	71.25	0	0
3.	Seedling rate	18000-20000	19	23.75	61	76.25	0	0
4.	Seedling treatment	Imidachlopride @ 0.1ml/ltr	21	26.25	45	56.25	14	17.50
5.	Spacing	60X45cm	31	38.75	49	61.25	0	0.00
6.	Seedling treatment one day after transplanting	Copperoxychloride @0.3%	11	13.75	56	70	13	16.25
IV	**Fertilizer management**							
1.	Inorganic Fertilizers	60:60:60	13	16.25	54	67.50	13	16.25
2.	Organic fertilizers	200 kg(Neem Cake)	26	32.5	40	50.00	14	17.50
3.	**Biofertilizers**							
3.1	*Tricoderma viridae*	2kg	6	7.5	38	47.50	36	45.00
3.2	*Psuedomonas*	2kg	4	5.00	46	57.50	30	37.50
V	**Pruning**	28 DAP @ interval of 3-4 days	37	46.25	29	36.25	14	17.5
VI	**Training**	30 DAP	22	27.5	42	52.50	16	20.00

Sl. No.	Package of practices	Recommended dosage/acre	FA		PA		NA	
			F	%	F	%	F	%
VII	**Deleafing**	70DAP	3	3.75	17	21.25	60	75.00
VIII	**Drip irrigation and Fertigation**							
1.	Irrigation	Halften hour per day	24	30.00	56	70.00	0	00.00
2.	Fertigation	3rd week after transplanting and twice in a week	21	26.25	47	58.75	12	15.00
3.	**Recommended fertilisers**							
a.	19:19:19	15 kg	18	22.50	46	57.50	16	20.00
IX	**Integrated Pest Management**							
1.		Summer ploughing/soil solarisation	68	85.00	0	0	12	15.00
		Burning of previous crop plant residues	57	71.25	0	0	23	28.75
		Crop rotation	80	100	0	0	0	0
	Cultural method	Growing of trap crops like Marigold, Bendi etc.,	46	57.50	0	0	34	42.50
2.		Nylon mesh	75	93.75	0	0	5	6.25
		Removal of infested parts of the plants(viral diseases)	74	92.50	0	0	6	7.50
	Mechanical method	Light traps (6 traps/acre)	26	32.50	40	50.00	14	17.50
		Pheromone Traps(4-5)	10	12.50	60	75	10	12.50
3.	**Chemical methods**							
a.	Mites	Dicofol @ 2 ml/litre	21	26.25	33	41.25	26	32.50
b.	Thrips	Acephate @ 1.5 gm/litre	23	28.75	45	56.25	12	15.00
c.	Fruit borer	Corboryl @ 0.1%	21	26.25	46	57.50	13	16.25
d.	White flies	Imidacloprid @ 0.4%	17	21.25	49	61.25	14	17.50
e.	Root knot nematode	Corbofuran @ 20 kg/acre	22	27.50	45	56.25	13	16.25
4.	**Biological method**							
a.	Nematodes	Neem cake @ 800 kg/acre 4-5 days before transplanting to the beds	35	43.75	32	40.00	13	16.25
b.	Aphids and mites	Pongamia oil @5-8 ml/L	19	23.75	48	60.00	13	16.25
X	**Harvesting**	75-85 DAP	29	36.25	38	47.50	13	16.25

FA=Full Adoption, PA=Partial Adoption, NA=Non Adoption, F=Frequency, %=Percent

Regarding mechanical method, three fourth (75.00%) of the respondents had partially adopted the recommended pheromone traps(4-5 traps) for pest control, whereas nearly cent (93.75%) per cent of the respondents fully adopted the recommended nylon mesh for pest control. In case of the removal of infected parts of the plants, nearly cent (92.50%) per cent of the respondents were in full adoption category and nearly half (50.00%) of the respondents partially adopted the recommended light traps (6 light traps/acre). The possible reason might be the lack of scientific information and skill training about IPM practices.

The majority (41.25%) of the respondents had partially adopted the recommended plant protection chemicals such as Dicofol @2 ml/L for mites management, whereas more than half (56.25%) of the respondents partially adopted the recommended plant protection chemicals such as Acephate @ 1.5 gm/L for thrips control. On the other hand, more than half (57.50%) of the respondents adopted the recommended chemicals such as Carboryl @ 0.1% for fruit borer management and nearly twothird (61.25%) of the respondents partially adopted the recommended chemicals such as Imidacloprid @ 0.4%, meanwhile, more than half of the (56.25%) of the respondents partially adopted the recommended chemical such as Carbofuran (20 kg) for nematode management. The possible reason might be lack of scientific information and higher plant protection chemicals and labour cost.

In case of biological method, nearly half (43.75%) of the respondents had fully adopted the recommended bio pesticide such as neem cake (800 kg) for nematode control, whereas nearly two third (60.00%) of the respondents partially adopted the recommended bio pesticide such as Pongamia oil (5-8 ml/L) for aphids and mites control. Above all, non availability of biocontrol agents as expressed by respondents might be the possible reason for lesser adoption. The similar findings found in Rebek et al. (2013).

Nearly half (47.50%) of the respondents partially adopted the recommended days for harvesting of capsicum (75-80 DAP) .The probable reason might be that, the majority of the farmers established shade nets under Krish Bhagya Scheme (68.75%), it is implemented in the 2014 and farmers will become expert in vegetable production under shade net as experience increase and lack of information about recommended practices of tomato under shade net

3.2 Relationship between Socio-economic Profile of Respondents with Their Adoption Behaviour of Capsicum and Tomato Crops Cultivation Practices under Protected Cultivation

A cursory look at Table 2 showed that, variables such as annual income, extension participation,

Table 2. Relationship between socio-economic profile of respondents with their adoption behaviour of capsicum and tomato crops cultivation practices under protected cultivation n=80

Sl. No.	Independent variable	Karl Pearson's 'r' value	
		Adoption of capsicum cultivation practices under shade net	Adoption of tomato cultivation practices under shade net
1.	Age	0.328*	0.428*
2.	Education	0.227*	0.316*
3.	Farming experience	0.308*	0.472*
4.	Size of Land holdings	0.377*	0.325*
5.	Annual income	0.421**	0.259**
6.	Social participation	0.165*	0.229*
7.	Extension Participation	0.281**	0.245**
8.	Mass media utilization	0.220*	0.216*
9.	Information seeking behaviour	0.120*	0.138*
10.	Risk orientation	0.563*	0.407*
11.	Management orientation	0.458*	0.585*
12.	Scientific orientation	0.310*	0.452*
13.	Source of finance	0.125*	0.258*

exhibited positive and significant relationship with adoption behaviour of respondents at 1 per cent level of significance. Whereas, age, education, farming experience, size of land holding, social participation, mass media utilization, information seeking behaviour, risk orientation, management orientation, scientific orientation and source of finance were exhibited positive and significant relationship with this adoption behaviour of capsicum cultivation practices at 5 per cent level of significance.

With respect to relationship of independent variables with adoption of tomato, variables like annual income, extension participation, exhibited positive and significant relationship with adoption behaviour of respondents at 1 per cent level of significance. On the other hand, age, education, farming experience, size of land holding, social participation, mass media utilization, information seeking behaviour, risk orientation, management orientation, scientific orientation and source of finance were exhibited positive and significant relationship with this adoption behaviour of capsicum cultivation practices at 5 per cent level of significance.

4. CONCLUSION

The protected cultivation is one of the interventions for climate smart agriculture. The study found that majority of the respondents belonged to partial adoption category with respect to adoption behaviour of tomato crop cultivation practices under shade net and no one farmer adopted the recommended tomato cultivar under shade net. This bring to focus that it is of utmost importance to design more number of extension activities like demonstrations, study tours, exposure visits by the development departments, convince the farmers about cultivation practices of tomato for full adoption under shade net technology.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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