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Impact of Front Line Demonstrations on Extent of Adoption and Horizontal Spread of Trellis Method of Cultivation in Tomato (*Solanum lycopercicum* Mill.) in Khammam District of Telangana

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study was conducted in Krishi Vigyan Kendra, Wyra adopted villages in Khammam District of Telangana. Tomato is an important vegetable crop in the district but the yields are not up to expectations due to poor quality, early decay, pests and disease incidence. An effort was made by KVK, Wyra to address the problem of reducing pests and disease incidence and improving the fruit quality by introduction of technology Trellis method of cultivation in tomato. This was tested on small scale for 3years with the help of On-farm trials with limited number of farmers. It was proved to be profitable hence this technology was up-scaled and disseminated on large scale with the help of front line demonstrations as the main thrust areas of KVKs are refinement and demonstration of novel technologies, training of farmers and extension functionaries. The front line demonstrations on trellising in tomato crop were conducted by Krishi Vigyan Kendra, Wyra, Khammam in its adopted

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villages from 2016-17 to 2018-19 with an objective of improving the yield and quality of tomato by adopting the technology trellising on tomato along with drip and mulching, use of indeterminate hybrid varieties, balanced use of fertilizers and integrated pest and disease management. Though trellising has been developed long back the knowledge and adoption rate was low with the tomato farmers of the district. The data from the study like cost of cultivation, production, productivity, gross returns and net returns were collected as per schedule and analyzed. The results from the study revealed that average highest yield recorded was 622.58 q/ha in demonstration plot compared to control plot yield 431.55 q/ha, an additional yield of 191.03 q/ha was recorded, 44.33 percent of average yield increase was recorded over control plot. The extension gap and technology gap enumerated from the study ranged from 183.45 q/ha to 201.80 q/ha and 11.40 to 41.25 q/ha respectively, with the technology index of 4.21 percent during the demonstration years. Besides this, the demonstrated plots gave higher gross return, net return with higher benefit cost ratio when compared to farmer's practice. In present study efforts were also made to study the impact of FLD on horizontal spread which has increased by 160.36 percent. Further the study was undertaken to do a formative and summative (outcome and impact) evaluation of the frontline demonstrations on trellising in Tomato.

Keywords: Frontline demonstrations; tomato; extension gap; technology gap; technology index; adoption and B: C ratio.

1. INTRODUCTION

Tomato (*Lycopersicon esculentum*) is an important vegetable crop in India. It is also popularly called 'love apple'. It is an herbaceous plant belonging to Nightshade family. India is the second largest producer of tomato in the world after China. In India total production of Tomato is 19759.32 thousand metric tons in an area of 789.15 thousand ha. (NHB 2017-18). Telangana state contributes to about 5.92 per cent of the total production of tomato in the country. The state produces about 1171.50 thousand metric tonnes of tomato from 41.48 thousand hectares having productivity of 28.24 metric ton/ha over the country's tomato productivity of 25.03 metric tonnes /ha. Tomatoes are a good source of vitamin C and the phytochemical lycopene. The fruits are commonly eaten raw as salads, served as a cooked vegetable, used as an ingredient of various prepared dishes and also in preparation of pickles. Additionally, a large percentage of the world's tomato crop is used for processing; products include canned tomatoes, tomato juice, ketchup, puree, paste and "sun-dried" tomatoes or dehydrated pulp. It is known as productive as well as protective food. Tomato is a warm season vegetable crop that is sensitive to frost and is killed by freezing temperatures. Previously tomatoes growth was confined to few seasons but the scenario has changed since last 10-12 years. Now a day's tomatoes are grown round the year [1]. Despite the economic importance of tomato, its production under small farm holdings is laced with following constraints in Khammam and is prone to many challenges like high incidence of pests and diseases, lack of technical knowhow, poor availability of hybrid seeds, shortage of water especially during the dry periods and excessive rains in the rainy season [2]. Seasonality is another barrier in tomato production especially during the rainy season in tropical countries. This is due to excessive rains which promote weed growth, pests and disease incidence. Excess rains also promote fruit rots thereby reducing the quality of fruits. Alternatively, trellising of tomatoes can address the problem of pest and disease incidence to a great extent. Trellising the plants is more practical and affordable even by the farmers having small farm holdings. According to Saunyama and Knapp [3], trellising controlled red spider mites in tomato. This was attributed to improved spray penetration upon lower leaf surfaces due to trellising. Trellising resulted in upright crop which improved air penetration reducing incidence of fungal disease attacks and easy maneuvering when carrying out operations like spraying, harvesting and others. Trellising in tomatoes also increased pollination, fruit set, fruit quality and reduced vine damages during harvesting.

India faces the most challenging task of transferring the fast emerging agricultural technologies to sustain the increase in farm productivity and economic viability of farming. The FLDs is an important method of transfer of latest technology and package of practices in totality to farmers and main objective of this programme is demonstration of proven crop production, protection technologies and

management practices at the farmer's field in a large scale under real farming situations in the farmer's own field under different agro-climatic regions. Keeping in view, the present study has been undertaken to study the difference between demonstration package and farmer's practices in tomato cultivation and to assess the impact of the frontline demonstrations in tomato on increasing the productivity of tomato by adopting the trellis method of cultivation in Tomato.

2. MATERIALS AND METHODS

The present study was undertaken during 2018-19 in Khammam district of Telangana. This study is based on primary data collected from Tomato farmers. Multistage random sampling technique was adopted in designing sampling frame for the study. In the first stage, Telangana state is selected purposively. In the second stage, Khammam district was selected, in third stage six villages were selected randomly based on potentiality and highest area under tomato. The data was collected through pre-tested schedules by personal interviews. The primary data from sample farmers were collected by personal interview method by using pre-tested structured questionnaire. Farmers conducting front line demonstrations from 2016-17 to 2018-19 were selected and data was collected from them for the study. Total 30 demonstrations were conducted with Trellis method of cultivation in different villages for three continuous years. Each frontline demonstration was laid out on 0.4 ha area which was taken as demo while adjacent 0.4 ha was taken as control for comparison of farmer's practice. The farmers were selected randomly on the basis of survey conducted by KVK and trainings imparted on trellis method of tomato cultivation. For the demonstration plot trellising along with all the recommended package of practices like the application of farm yard manure, recommended dose of fertilizers, fertigation, mulching and integrated pest management practices and use of quality seeds of improved varieties or hybrids and others. The traditional practices were taken as a control. Field days were also conducted in each cluster to show the results of front line demonstration to the farmers of the same village and neighboring villages. In general, soils of the area under study were sandy to sandy loam with low to medium fertility status and the average annual rainfall of this area is 1036 mm and temperature varies from 24 to 43°C with average temperature of 30°C. In the present study, yield data, yield attributing characters, pest management, production cost and returns, data on gaps between the potential yield, demonstration yield, extension gap, technology index, quantity of insecticides used, and reduction in cost of plant protection were collected from demonstrated plots and local check plots of tomato for analysis and interpretation. The statistical tool to estimate the technology gap, extension gap and the technology index, the formulation as mentioned below were used as suggested by Samui et al. [4].

Per cent increase in yield = Demonstration yield - Farmers practice yield X 100 /Farmers practice yield

Technology gap = Potential yield - Demonstration yield

Extension gap = Demonstration yield - Yield under existing practice

Technology index = Potential yield - Demonstration yield X 100 /Potential yield

The data on adoption and horizontal spread of technologies were collected from the selected farmers with the help of schedule. Data were subjected to suitable statistical methods. The following formulae were used to assess the impact on different parameters of tomato crop on trellising method.

Impact of yield = Yield of demonstration plot- Yield of control plot/Yield of control plot X 100

Impact on adoption (% change) = No. of adopters after demonstration - No. of adopters before demonstration /No. of adopters before demonstration X 100

Impact on horizontal Spread (% change) = After area (ha) - Before area (ha)/ Before area ×100

3. RESULTS AND DISCUSSION

The data were pooled on different parameters and the results obtained are discussed accordingly. Adoption of improved practices in tomato crop from Table 1 shows that all the FLD farmers fully adopted the recommended package of practices with slight modifications.

3.1 Yield Parameters

The perusal of data (Table 2) indicate that due to initiation of front line demonstrations the tomato yield ranged from 608.75 q/ ha to 638.60 q/ha in demonstration plots and from 418.60 q/ ha to 450.75q / ha in farmer's practice plot in three years of demonstrations conducted. An average yield of 622.58 q/ ha was obtained under demonstration plots as compared to farmer's practice plots 431.55 q/ha in consecutively. The average yield of tomato is increased by 44.33 per cent over the yield obtained under farmer's practices of tomato cultivation. The above findings are in similarity with the findings of Singh et al. [5] and Balai et al. [6]. Similarly yield enhancement in different crops in frontline demonstrations were documented by Hiremath et al. [7], Mishra et al. [8], Kumar et al. [9], Surywanshi and Prakash [10], Dhaka et al. [11] and Mishra et al. [2].

The increment in yield ranged between 41.67 to 48.20 per cent. The per cent increase in yield over farmer's practice was highest (48.20) during 2016-17. However variations in the yield of tomato in different years might be due to the variations in soil moisture availability, rainfall, and change in the location of demonstrations every year.

Extension gap: Extension gap of 201.80, 183.45 and 187.85 q/ha was observed during 2016-17, 2017-18 and 2018-19 respectively. On an average extension gap under three year FLD programme was 191.03 q/ha. This emphasized the need to educate the farmers through various techniques for the adoption of improved agricultural production technologies to reverse this trend of wide extension gap. More and more use of latest production technologies like trellising in tomato with high yielding variety/hybrid will subsequently change this alarming trend of galloping extension gap.

Technology gap: The technology gap, the differences between potential yield and yield of demonstration plots was 29.60, 41.25 and 11.40 q /ha during 2016-17, 2017-18 and 2018-19, respectively. On an average technology gap under three year FLD programme was 27.41 q/ha. This may be due to the soil fertility, managerial skills of individual farmer's and climatic conditions of the selected area. Hence, location specific recommendations are necessary to bridge these gaps. These findings are similar to Singh et al. [5], Sharma and Prakash [12] and Mishra et al. [2].

Technology Index: The technology index shows the feasibility of the demonstrated technology at the farmer's field. The technology index varied from 1.75 to 4.55 (Table 2). On an average technology index of 4.21 per cent was observed during the three years of FLD programme, which shows the effectiveness of technical interventions. This accelerates the adoption of demonstrated technical interventions to increase the yield performance of tomato.

Economic returns: In order to find the economic feasibility of the demonstration technologies over and above the control, some economic indicators like cost of cultivation, net return and B: C ratio was worked out. The economic viability of improved demonstrated technology over farmer's practice was calculated depending on prevailing price of inputs and outputs cost and represented in terms of B: C ratio (Table 3). It was found that the cost of production of tomato under demonstration varied from Rs. 1, 86,500 to 2, 06, 250 / ha with an average of Rs. 1,95,916 as against 98,650 to 1,15,625 with an average Rs. 1,08,841 under control. The additional cost increased in demonstration was mainly due to more cost involved in balanced fertilizer, procurement of improved hybrid seed and IPM practices.

The cultivation of tomato under improved technologies gave higher net return of Rs. 2,31,500/ha, Rs. 2,68,750 /ha and Rs. 2,15,440 / ha in the year 2016-17, 2017-18 and 2018-19 respectively with an average net return of Rs. 2,38,563 /ha which was lower 1,05,785 in farmer's practices. The benefit cost ratio of tomato ranged from 2.19 to 2.38 in demonstration plots and from 1.94 to 2.03 in farmer's practice plots during three years of demonstration with an average of 2.27 in demonstration and 1.98 under farmer's practices. This may be due to higher yield obtained and lower cost of cultivation under improved technologies compared to local check (farmers practice). This finding is similar with the findings of Singh et al. [5] and Mishra et al. [13]. Similar findings are also reported by Morwal et al. (2018) in case of cumin.

Table 1. Level of use and gap in adoption of tomato technologies in the study area

Crop operations	Improved package of practices	Level of adoption	
		FLD farmers	Non-FLD farmers
Soil testing	Have done in all locations	Not in practice	Not adopted
Seed priming	Seed priming was performed for better germination. Seeds were soaked during night for 8-10 hours with natural water, drained out excess water and dried in shade before sowing.	Not in practice	Not adopted
Seed treatment	Seed was treated by carbendazim @ 1gm/ kg of seed	Not in practice	Not adopted
Transplanting method	Transplanting in raised bed distance Row to Row 90 cm & Plant to Plant 60 cm	Flat bed transplanting Row to Row 60 cm & Plant to Plant 30 cm	Partially adopted
Nursery time	June	First week of July	Partially adopted
Transplanting time	July	August	Partially adopted
Trellising	2nd week after transplanting, every 10-15 days weave the plants with string	No trellising	
Fertilizer dose	Fertilizer @ 200 Kg N, 120Kg P2O5 and 120 Kg K2O/ha	Without recommendation	Partially adopted
Weeding	Mulching, Using of power weeder between the rows	Hand weeding/rarely used	Partially adopted
Multiplex nutrient spry	@ 2.5 g/ lit water and spray on both the surface of leaves. First spray just before flowering, second spray during flowering or 25 days after first spray and third spray when fruits are bean size.	No application	Fully adopted
Plant protection measures	Need based application of chemicals in case of severe infestations of TLCV. Imidaclroprid 17.8% SL. or dimethoate 30 EC @ 2ml/lit and other systematic chemicals	Use chemicals with recommendations	Partially adopted
Crop duration	7-8 months	5 months	Partially adopted

Table 2. Productivity, technology gap, technology index and extension gap in trellis method of cultivation in tomato under FLD

Year	Area (ha)	No. of farmers	Yield (q/ha)			% increase in yield	Extension gap (q/ha)	Technology gap (q/ha)	Technology index (%)
			Potential	Demonstration	Control				
2016-17	4.0	10	650	620.40	418.60	48.20	201.80	29.60	4.55
2017-18	4.0	10	650	608.75	425.30	43.13	183.45	41.25	6.34
2018-19	4.0	10	650	638.60	450.75	41.67	187.85	11.40	1.75
Pooled data	-	-	650	622.58	431.55	44.33	191.03	27.41	4.21

Table 3. Comparative B: C analysis of tomato under FLD and farmers practice

Year	Cost of cultivation		Gross return (Rs./ha)		Net returns (Rs./ha)		B:C Ratio	
	Demo	Control	Demo	Control	Demo	Control	Demo	Control
2016-17	1,95,000	98,650	4,26,500	2,00,500	2,31,500	1,01,850	2.19	2.03
2017-18	2,06,250	1,15,625	4,75,000	2,28,000	2,68,750	1,12,375	2.38	1.97
2018-19	1,86,500	1,12,250	4,21,940	2,18,380	2,15,440	96,130	2.26	1.94
Average	1,95,916	1,08,841.66	4,41,146	2,15,626	2,38,563	1,05,785	2.27	1.98

Table 4. Impact of Front Line Demonstration (FLDs) on adoption of trellising in tomato

Technology	Number of adopters		Change in no. of adopters	Impact (%change)
	Before demonstration	After demonstration		
Land preparation and FYM applications	18	37	19	105.55
Use of recommended hybrids	15	36	21	140
Transplanting in raised bed along with mulching	13	42	16	223.07
Trellising in tomato	10	35	25	250.00
Balance fertilizer application	9	23	21	155.55
Weed management	15	32	17	113.33
Spacing & plant populations	08	23	15	187.50
Foliar nutrition	08	19	11	137.50
Recommended insect pest management	13	30	17	130.76

Table 5. Impact of Front Line Demonstration (FLDs) on horizontal spread of trellising in tomato

Name of the technology	Area (ha)		Change in area	Impact (% change)
	Before demonstration	After demonstration		
Trellies method of cultivation in tomato	56	131	75	133.9

The B: C ratio was recorded to be higher under demonstration against control during all the years of study. Trellies method of tomato cultivation can reduce the technology gap to a considerable extent, thus leading to increased productivity of tomato in the district which in term will improve the economic condition of the growers. Moreover, extension agencies in the district need to provide proper technical support to the farmers through different extension methods to reduce the extension gap for better tomato production in the Khammam district of Telangana.

The result of improved technology intervention brought out that adoption of recommended technology trellising in tomato by farmers before demonstration was negligible, which increased by 250% after demonstration. Transplanting in raised bed technique was increased by 223.07% due to intervention through FLD. The overall adoption level of trellising method of tomato cultivation was increased by about 160.36 percent due to FLD conducted by KVK, Wyra (Table 4).

In present study efforts were made to study the impact of FLD on horizontal spread of trellis method of tomato cultivation.

Data in Table 5 showed that FLD organized on tomato crop helped to increase area under trellis method of cultivation in tomato. There was significant area increase horizontally from 56 to 131 ha under trellis method of cultivation in tomato.

4. CONCLUSION

The results clearly indicated that the higher average yield was obtained in demonstration plots over the years compared to farmer's practice due to high knowledge and adoption of full package of practices i.e. use of trellis method of training to tomato plants, application of farm yard manure, recommended dose of fertilizers, fertigation, mulching, preparation of raised beds, pheromone traps and timely application of plant protection chemicals whereas due to lack of knowledge on use of bio fertilizers, balanced dose of fertilizer, IPM practices yields were low in farmer's practice.

The FLD produced a significant positive result and provided an opportunity to demonstrate the productivity potential and profitability of the latest technology (intervention) under real farming situation. Therefore the study concludes that FLDs conducted by KVK, Wyra in Tomato crop made significant impact on horizontal spread of the technology. Therefore, target oriented training programmes on improved vegetable production technology along with multiple demonstration is required to enhance the level of knowledge and skills of growers which help in

adoption of technology. This could circumvent some of the constraints in the existing transfer of technology system in the Khammam district of Telangana. The productivity gain under FLD over existing practices of tomato cultivation has created greater awareness and motivated other farmers to adopt the demonstrated technologies for tomato production in the district which helps to enhance the vegetable production, consumption, nutritional security and overall livelihood security of the farmers in Khammam district of Telangana.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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