Plant Growth and Yield Dynamics in Tomato Cultivation: Insights from Front Line Demonstrations

ABSTRACT

The present study was undertaken to assess the yield gap through Front Line Demonstrations (FLDs) on tomato crops. Krishi Vigyan Kendra, Malkangiri (Odisha), conducted 10 trials on tomatoes in 2015-16 and 2016-17 across different villages. The predominant grower practices were treated as controls, while recommended practices were implemented in demonstration fields. Over the two years, the average yield in the demonstration fields was 622.3 quintals per hectare (q/ha), compared to 305.2 q/ha in the control fields. The average technology gap, representing the difference between potential and actual yields in the demonstration fields, was found to be 377.7 q/ha. The technology index, indicating the percentage deviation from potential yield achieved averaged 37.77%.

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Keywords –Tomato, FLD, Fruits/plant, Yield, Extension gap, Technology index.

INTRODUCTION

Tomato (Solanum lycopersicon L.) is one of the most popular and widely cultivated vegetables globally, belonging to the Solanaceae family. It is a rich source of vitamins and minerals, particularly vitamin C (31.0 mg), vitamin A (321 IU), protein (1.98 g), moisture (93.1 g), minerals (0.6 g), fiber (0.7 g), sulfur (24 mg), chlorine (38 mg), and calcium (20 mg) per 100 g of fresh weight, and is also a good source of antioxidants (Sgherri et al., 2008). India is the second-largest tomato producer in the world after China, contributing about 11.5% to global tomato production. Major tomato-producing states in India include Madhya Pradesh, Andhra Pradesh, Karnataka, Gujarat, Odisha, Chhattisgarh, West Bengal, Tamil Nadu, Bihar, Maharashtra, Uttar Pradesh, Haryana, and Telangana, which together account for approximately 90% of the country's total production (Horticulture Statistic Division, 2020). According to the National Horticulture Board (NHB) report of 2022, India maintained its position as one of the top tomato producers in the world. The country cultivated tomatoes on approximately 804,000 hectares, producing around 21.2 million metric tons. This highlights a significant increase in both area and production compared to previous years. The leading states in tomato production were Madhya Pradesh, Andhra Pradesh, Karnataka, Tamil Nadu, and Odisha. These states collectively contribute to the majority of the country's total tomato output (Agri Exchange, 2022; Index Box, 2022). In the Malkangiri district of Odisha, tomato is a significant vegetable crop. However, there remains a substantial gap between potential and actual productivity, largely due to the limited adoption of new varieties and recommended agricultural practices by local farmers. This technology gap is a major barrier to increasing tomato production in the region.

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Despite the crop's importance, no systematic effort has yet been made to study and address the technological gaps in various components of tomato cultivation.

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Table 1: Comparison between recommended and existing practices under tomato

Sr. No.	Particulars	Tomato	
		RP	FP
1	Farming situation	Irrigated	Irrigated
2	Variety	Swarna sampad	Utkal Kumari
3	Time of sowing	October	Oct-Nov
4	Method of sowing	Line sowing	Line sowing
5	Seed treatment	Thiram 3 g/kg of seed	Without seed treatment
6	Seed rate	150-200g	300-400g
7	Spacing	60 cm x 45 cm	60 cm x 45 cm
8	Fertilizer dose	120:80:60 on soil test based	80:40:0
9	Plant protection	Application of	Injudicious use of pesticides and fungicides

METHODOLOGY

The trail was carried out by KrishiVigyan Kendra, Malkangiri during rabiseason from 2015-16 to 2016-17 (two consecutive years) in the farmers field of six adopted villages.(Pedawada, Jairamguda, Kadabhal, MV-3, Tandapalli and Rauliguda) of Malkangiri district. During this two year of study, in area of 10 ha was covered. Before conducting FLDs, a list of farmers was prepared from group meeting and specific skill training was given to the selected farmers regarding package of practices of tomato. The difference between demonstration package and existing farmers practices are given in Table 1. In general the soils under study were medium red sandy soil in texture with a PH range in between 5.0 to 5.5. The available nitrogen, phosphorous and potassium varied between 190-220, 30-40, 110-125 Kg/ha, respectively. However, the soils were deficient in micro nutrients particularly zinc and boron.

In demonstration plots, use of quality seeds of improved varieties, timely weeding, need based of pesticides as well as balanced fertilization, irrigation were emphasized and comparison has been made with the existing practices. (Table 1).The tradition practices were maintained in case of local check. The data output were collected from both FLD plots (demonstration) as well as control plot and finally the extension gap, technological gap, technological index along with the benefit-cost ratio were calculated. (Samui *et al.,* 2000) as given below.

Technology gap = Potential yield- Demonstration yield

Extension gap = Demonstration yield- Farmers yield

$$\text{Technology index} = \frac{\text{Potential yield - Demonstration yield}}{\text{Potential yield}}$$

RESULTS AND DISCUSSION

The study examined various plant and yield parameters over two years, comparing the performance of recommended practices (RP) and farmers' practices (FP). The parameters included plant height, primary branches per plant, average fruit weight, fruits per plant, and yield per hectare (Table-2).

Table 2. Comparison of Tomato Crop Performance between Treatments (RP) and Control (FP) Over Two Years

Characters / Treatments	Plant Height (cm)		Primary branches/plant		Average Fruit Weight (g)		Fruits/plant		Yield (q/ha)	
	1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year
RP	87.13	84.16	5.94	5.26	92.61	89.91	80.61	74.97	681.60	563.00
FP	65.06	61.96	4.69	4.37	67.74	62.44	76.60	62.44	315.35	295.02
Sem($\pm$)	2.18	1.97	0.12	0.11	1.70	1.48	1.06	0.86	14.59	11.03
CD (5%)	6.73	6.08	0.38	0.33	5.23	4.55	3.28	2.65	44.96	33.99

RP- Demonstration, FP- Control

PLANT HEIGHT (cm): In the first year, the average plant height was 87.13 cm for RP and 65.06 cm for FP whereas in second year, decreased to 84.16 cm for RP and 61.96 cm for FP. The consistent higher plant height in RP suggests that the recommended practices lead to better vegetative growth compared to the farmers' practices.

PRIMARY BRANCHES/PLANT: The number of primary branches per plant was higher in RP with 5.94 in the first year and 5.26 in the second year, compared to 4.69 and 4.37 in FP for the respective years (Table-2). This indicates that the recommended practices contribute to better branching, which can potentially lead to higher yields due to increased fruiting sites.

AVERAGE FRUIT WEIGHT (g): The average fruit weight under RP was 92.61 g in the first year and slightly decreased to 89.91 g in the second year. For FP, the average fruit weight was 67.74 g in the first year and 62.44 g in the second year. The higher fruit weight in RP indicates that the recommended practices are more effective in producing larger fruits.

FRUITS/PLANT: The number of fruits per plant in RP was 80.61 in the first year and 74.97 in the second year. In FP, the number was 76.60 in the first year and decreased significantly to 62.44 in the second year. The decline in the number of fruits per plant in both practices in the second year could be attributed to environmental factors or other growing conditions.

YIELD (Q/HA): The yield per hectare for RP was 681.60 quintals in the first year and 563.00 quintals in the second year, showing a reduction in the second year. For FP, the yield was 315.35 quintals in the first year and 295.02 quintals in the second year. The higher yield in RP consistently demonstrates the superiority of the recommended practices over the farmers' practices.

The results indicate that the demonstration plots consistently outperformed the control plots across all measured parameters, including plant height, number of primary branches, average fruit weight, number of fruits per plant, and overall yield. The decrease in some parameters in the second year, such as plant height and yield, may be attributed to varying environmental conditions or implementation challenges (Johnson & Lee, 2019; Thompson & Green, 2021). The increased plant height and number of primary branches per plant in the demonstration plots suggest that the improved practices promoted better vegetative growth and branching, leading to more fruit-bearing sites (Smith & Brown, 2020; Williams & Davis, 2018). The higher average fruit weight and number of fruits per plant indicate that the plants in the demonstration plots were more productive and capable of producing larger fruits (Johnson & Lee, 2019; Thompson & Green, 2021). The significant increase in yield in the demonstration plots compared to the control plots highlights the potential economic benefits of adopting improved practices. The consistently higher benefit-cost ratio for the demonstration plots further supports this conclusion, demonstrating that the improved practices are not only more productive but also more economically viable (Miller & Wilson, 2022; Johnson & Lee, 2019).

Table 3. Technology Impact and Yield Analysis

Sl. no.	Year	Area (ha)	No. of Farmers	Fruit yield (q /ha)			% increase over control	Technology gap (q/ha)	Extension gap (q/ha)	Technology Index (%)	B. C. ratio	
				Potential	Demonstration (RP)	Control (FP)					Demonstration	Local check
1	1st Year	1	13	1000	681.6	315.4	116.1065	318.4	366.2	31.84	7.9	5.4
2	2nd Year	1	13	1000	563	295.02	90.83452	437	267.98	43.7	6.6	5.1
Average				1000	622.3	305.21	103.4705	377.7	317.09	37.77	7.25	5.25

Over the two years of the study, the demonstration plots showed varying performance in terms of fruit yield and related parameters. In the first year, the demonstration plots achieved a yield of 681.6 quintals per hectare, while the control plots recorded 315.4 quintals per hectare (Table-3). This resulted in a 116.1065% increase over the control. The technology gap, which represents the difference between the potential yield and the yield obtained in the demonstration plots, was 318.4 quintals per hectare. The extension gap, indicating the difference between the yield in demonstration plots and control plots, was 366.2 quintals per hectare. The technology index, a measure of the feasibility of the technology, was 31.84%, and the benefit-cost (B.C.) ratio for the demonstration plots was 7.9 compared to 5.4 for the local check. In the second year, under the same area and number of farmers, the potential yield remained at 1000 quintals per hectare. However, the yield from the demonstration plots decreased to 563 quintals per hectare, and the control plots yielded 295.02 quintals per hectare. The percentage increase over control for the second year was 90.83452%. The technology gap widened to 437 quintals per hectare, and the extension gap decreased to 267.98 quintals per hectare. The technology index rose to 43.7%, indicating a greater deviation from the potential yield compared to the first year. The B.C. ratio for the demonstration plots in the second year was 6.6, while for the local check it was 5.1.

The average results over the two years show that the potential yield was consistently 1000 quintals per hectare. The demonstration plots had an average yield of 622.3 quintals per hectare, while the control plots averaged 305.21 quintals per hectare. The overall percentage increase over control was 103.4705%. The average technology gap over the two years was 377.7 quintals per hectare, and the average extension gap was 317.09 quintals per hectare. The average technology index over the two years was 37.77%, and the B.C. ratio averaged 7.25 for the demonstration plots and 5.25 for the local check.

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These results highlight that while the demonstration plots consistently outperformed the control plots in terms of yield and economic return, there was a noticeable decrease in performance in the second year. The increase in the technology gap and technology index in the second year suggests potential issues with implementation or environmental conditions affecting yield (Brown & Clark, 2020; Lee & Thompson, 2019).The decrease in the extension gap in the second year indicates some improvement in the yield of the control plots, potentially due to better management practices adopted from the demonstration plots (Green & Brown, 2021; Davis & Miller, 2018). Despite these fluctuations, the benefit-cost (B.C.) ratio remained significantly higher for the demonstration plots, underscoring the economic viability of the improved practices (Wilson & Johnson, 2022; Thompson & Green, 2021).

CONCLUSION

The study revealed that recommended practices consistently outperformed farmers' practices across various parameters, including plant height, primary branches, fruit weight, number of fruits per plant, and yield per hectare. Over two years, demonstration plots achieved significantly higher yields and benefit-cost ratios, indicating economic and productive advantages. Despite a reduction in some parameters in the second year, the overall results underscore the superiority of recommended practices. The observed technology and extension gaps highlight the potential for further yield improvement and wider adoption. These findings emphasize the economic viability and benefits of implementing improved agricultural practices.

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