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IMPACT STUDY ON INTEGRATED NUTRIENT MANAGEMENT IN TOMATO THROUGH FRONT-LINE DEMONSTRATION IN PEDDAPALLI DISTRICT OF TELANGANA, INDIA

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ABSTRACT

In all the vegetables, tomato is a dominant vegetable crop grown in Peddapalli district of Telangana. In order to make effective use of natural resources and concentrate on increasing the yields and revenue of tomato-growing farmers, the KVK, Ramagirikhilla, carried out a study to popularize Integrated Nutrient Management (INM) in tomatoes. In addition to using green manuring, the raised bed technique, stacking, and integrated nutrient management techniques, growing tomatoes decreased pest and disease infestation, increased the soil nutrient status and yields. Front Line Demonstrations were held in several villages within Telangana's Peddapalli district from 2014–15 to 2018–19 in an effort to spread the awareness about Integrated Nutrient Management methods for increasing tomato cultivation's yields. The findings showed that the fruit yield (33.90 t ha^{-1}) increased by 11.87 percent when compared to the farmer's practice (30.40 t ha^{-1}) with a technology index of 23.56%, an extension gap of 3.53 t ha^{-1}, a technology gap of 10.60 t ha^{-1}. And recorded higher benefit-cost ratio (3.75) than farmers' practices (2.72), Integrated Nutrient Management technology generated higher net returns and an increase of Rs. 31,983.50/-. During the study the adoption of Integrated Nutrient Management technology increased from negligible to 391.76% with overall adoption level 270.65% and horizontal spread from 0 ha upto 496 ha. In addition to expanding the area under Integrated Nutrient Management with sustainable tomato cultivation, the acceptance and awareness levels of beneficiary and non-beneficiary farmers were much improved.

Key words : Tomato, Integrated Nutrient Management, Front Line Demonstration, Extension gap, Technology gap, Technology index, Adoption level, Horizontal spread.

Introduction

In India, tomatoes (*Solanum lycopersicon*) are one of the most important food crops and most widely produced vegetable. It is abundant in carbohydrates, dietary fibers, minerals, vitamins and vital amino acids. Additionally, it has higher levels of iron, lycopene, phosphorus, and vitamins B and C (Bagal *et al*., 1989). It contains 20–50 mg of lycopene, 3–4% total sugar, 4–7% total solids, 15–30 mg/100 g ascorbic acid and 7.5–10 mg/100 ml titratable acidity per 100 g fruit.

It is said to be a high nutrient feeder and responds well to fertilizer application. Tomato productivity, quality, size, color and flavor can all be improved by providing a balanced supply of nutrients (Shukla and Naik, 1993). According to Kiran Pilli *et al.* (2018), tomato crops depleted the nutritional quality of post-harvest soil by removing more nutrients from the soil for growth and yield. After harvesting of the crop purely organic treatments and combination of organic and inorganic treatments reflected higher nutrient status than the completely inorganic fertilizers.

In contemporary agriculture, integrated nutrient management is a sophisticated and widely accepted idea. Application of injurious and indiscriminate chemical fertilizers undoubtedly boosts productivity, but they can negatively impact soil qualities. The idea of integrated nutrient management was introduced in order to increase production and quality, taking into consideration the negative effects of using excessive amounts of chemical fertilizers.

The combination and concentration of mineral nutrients in the soil have a significant impact on plant growth and development. The use and appropriate management of organic fertilizers and can reduce the need for chemical fertilizers thus allowing the small farmers to reduce cost of production and management of soil health. Organic fertilizers have lower nutrient concentrations than chemical fertilizers, yet they serve crucial purposes that chemical fertilizers are unable to. Compared to organic fertilizers, inorganic fertilizers have a stronger pattern of nutrient release. Consequently, released nutrients are quickly consumed or lost through various methods. In contrast, organic fertilizers preserve the soil's nutrient status until the crop is harvested because they mineralize more slowly and make nutrients available for a longer period of time (Kiran Pilli *et al*., 2019). Organic manures having humic substances not only improve soil fertility by modifying soil physical and chemical properties (Asik *et al*., 2009), but also improves the moisture holding capacity of the soil, ultimately enhanced productivity and quality of crop produce (Heitkamp *et al*., 2011).

As the tomato crop is a exhaustive crop, to improve the crop yields with low cost of production and to maintain the soil fertility, Krishi Vigyan Kendra Ramagirikhilla has conducted Front Line Demonstrations on Integrated Nutrient Management in Tomato crop in Peddapallli district.

Materials and Methods

The Front Line Demonstrations entitled "Integrated nutrient management (INM) in Tomato (*Lycopersicon esculentum* Mill.)" was carried out during the *kharif* season from 2014-15 to 2017-18 (four consecutive years) at various farm fields in Hanumanthulapeta, Julapalli, Nagaram and Mutharm villages of Peddapalli district of Telangana, India. During these three years of study, an area of 16 ha was covered under FLDs with active participation of 40 farmers. All the soils of tomato growing fields in the selected villages are sandy loam in nature. In which the soils having low organic carbon content, low nitrogen, high phosphorus and medium potassium content were selected for the present study as it represents the most of the tomato growing regions of the district. Before conducting FLDs, a list of farmers was prepared from group meetings and specific skill training was imparted to the selected farmers regarding different aspects of cultivation. In demonstration plots tomato seedlings are transplanted in raised bed distance Row to Row 90 cm & Plant to Plant 60 cm, stacking method also followed

Table 1: Difference between Demonstration (INM) and Farmers practice.

Particulars	INM package	Farmer practice
Variety	US - 440	US - 440
Green manuring	Sunhemp	No green manuring
Fertilizer dose	FYM 10 t ha^{-1}	No FYM application
	Nitrogen – 150 kg ha^{-1}	Nitrogen – 250 kg ha^{-1}
	Phosphorus (P_2O_5) – 100 kg ha^{-1}	Phosphorus (P_2O_5) – 150 kg ha^{-1}
	Potassium (K_2O) – 115 kg ha^{-1}	Potassium (K_2O) – 150 kg ha^{-1}
	Borax – 10 kg ha^{-1}	No Borax application
Time of fertilizer applications	Basal dose - FYM 10 t, Borax 10 kg, 115 kg P_2O_5 ha^{-1}	Basal dose – ½ of P_2O_5 ha^{-1}
	Top dressing - N and K each in 3 equal splits at 30, 45 and 60 Days after transplanting	Top dressing – ½ of P_2O_5 ha^{-}1, N and K each in 2 equal splits at irregular intervals
Foliar spray of nutrients	$ZnSO_4$ @ 2 g/lit at 20 DAT, 19:19:19 @ 2 g/lit at 20, 40 and 60 DAT	No foliar application

whereas in farmers practice seedlings are transplanted on flatbeds with a distance Row to Row 60 cm & Plant to Plant 30 cm without stacking. The difference between the demonstration package and existing farmer's practices are mentioned in Table 1.

Regular monitoring was conducted on the exhibited trials, and all relevant data pertaining to the required qualities were gathered. Extension study parameters *i.e.*, technology gap, extension gap and technology index were calculated by using formula suggested by Samui *et al.* (2000).

Extension gap (t/ha) = Demonstration yield - Farmers yield

Technology gap (q/ha) = Potential yield – Demo yield

$$\text{Technological Index (\%)} = \frac{\text{Potential Yield} - \text{Demo yield}}{\text{Potential yield}} \times 100$$

$$\text{Yield increase (\%)} = \frac{\text{P Demonstration yield} - \text{Farmers practice}}{\text{Demonstration yield} - \text{Farmers practice}} \times 100$$

However, data about adoption and horizontal spread of technologies were collected from the farmers with the help interview schedule. The following formulae (Singh *et al*., 2018) were used to assess the impact on different parameters of drum seeding method of paddy cultivation.

Impact on Adoption (% change)

$$= \frac{\text{No. of Adopter after Demonstration} - \text{No. of Adopter before Demonstration}}{\text{No. of Adopter before Demonstration}} \times 100$$

Impact on Horizontal Spread (% change)

$$= \frac{\text{After area (ha)} - \text{Before area (ha)}}{\text{Before area (ha)}} \times 100$$

Results and Discussion

Tomato yield (t ha^{-1})

The data obtained from FLD on Integrated Nutrient Management (INM) in Tomato indicates that yield of demonstration plots was higher as compared to check (farmers practice) may be attributed to INM and raised bed cultivation practice. The results of yield performance between demonstration fields and farmers practices are given in Table 2. During the four years of the study the demonstration fruit yield ranged from 30.00 to 41.00 t ha^{-1} and farmers yield ranged from 26.10 to 37.90 t ha^{-1} with a cumulative average yield of 33.90 and 30.40 t ha^{-1}, respectively. Demonstration of Integrated Nutrient Management (INM) in Tomato increased the fruit yield 11.87% yield than the farmers practice. The result revealed the positive effects of FLD over the existing practices as it enhanced the fruit yield. Tekale *et al.* (2017) also reported similar yield enhancement in tomato crop by INM practices. Shalini *et al*. (2016) reported that an average yield of 708.50 q/ha was obtained in demonstrated plot over control (625.17 q/ha) with an additional yield of 83.33 q/ha and the increasing the average tomato productivity by 13.33 per cent with the adoption of improved practices in FLDs during study period. Similar findings also found by Aklade *et al.* (2018) in Okra crop.

The discrepancy in productivity between farmers practice and demonstration may be explained by the extension gap. The average extension gap (Table 2) between demonstration and farmers practice was recorded 3.53 t ha^{-1} with a range of 3.90 to 3.20 t ha^{-1} which emphasizes the need to educate the farmers through various means for the adoption of INM practices in Tomato crop to reverse the trend of wide extension gap. In the four years period of study the extension gap declining due to acceptability and adoption of the technology in the district. Similar findings were also reported by Singh *et al.* (2018) as the extension gap re reduced from 136.08 q ha^{-1} to 78.78 q ha^{-1}. The results are also in conformity with the findings of Teggelli *et al.* (2015), who stated the progressive use of improved crop production technologies with high yielding varieties will subsequently change this alarming trend of galloping extension gap.

Table 2 : Yield, Extension gap, Technology Gap, Technological Index (%) and Percent increase (%) in yield over farmers practice of Tomato as influenced by Integrated Nutrient Management in Peddapalli District.

Year	Area (ha)	No. of Demos	Potential Yield (t/ha)	Demo Yield (t/ha)	FP Yield (t/ha)	Extension gap (t/ha)	% increase in Yield	Technology gap (t/ha)	Technology Index (%)
2014-15	4.00	10	45.00	30.00	26.10	3.90	14.94	15.00	33.33
2015-16	4.00	10	45.00	30.90	27.10	3.80	14.02	14.10	31.33
2017-18	4.00	10	45.00	33.70	30.50	3.20	10.49	11.30	25.11
2018-19	4.00	10	45.00	43.00	39.80	3.20	8.04	2.00	4.44
		Average	**45.00**	**33.90**	**30.40**	**3.53**	**11.87**	**10.60**	**23.56**

* FLD- Front Line Demonstration, Demo- Demonstration conducted, FP- Farmers Practice, t- Tonne, ha- Hectare.

The trend of technology gap (Table 2) ranging between 15.00 to 2.00 t ha^{-1} with mean of 10.60 t ha^{-1} reflected the farmer's cooperation in carrying out such demonstration with encouraging results in subsequent years. The technology gap observed may be attributed to the dissimilarity in soil fertility status and weather condition of the area and management practices implemented by the farmers. Hence, more location specific recommendations and precise use of technology in the fields are necessary to bridge the technology gap as supported by Singh *et al.* (2018) as the technology gap declined from 424.71 q ha^{-1} to 394.58 q ha^{-1}. These findings are in line with findings of Misra *et al.* (2014).

The technology index (Table 2) showed the feasibility of the evolved technology at the farmer's field. The lower the value of technology index, the more is the feasibility of the technology. As such, the reduction in technology index from 33.33% during 2014-15 to 4.44% during 2018-19 exhibited the feasibility of the demonstrated technology in this region. The decrease in technology index reflects the acceptance and adaptation of the technology in the district. Similar findings were also reported by Singh *et al.* (2018) as the front line demonstrations reduced the technology index from 56.62% to 52.61%. Kiran Pilli *et al.* (2025) reported that cluster front line demonstrations in Bengal gram crop decreased the extension gap, technology gap and technology index.

Economics

The effect of front line demonstration on farm income (Table 3) indicates that the average cost of cultivation involved in demonstration was Rs. 44,374.50 ha^{-1}, which is lower than the farmers practice (Rs. 52,505.00 ha^{-1}). The data concluded that the higher gross monetary returns (Rs. 1,67,270.75 ha^{-1}) as well as net monetary returns (Rs. 1,22,896.25 ha^{-1}) were obtained with the adoption of INM technology over farmers practice (gross monetary returns Rs. 1,43,417.75 ha^{-1}) and net monetary returns (Rs.90,912.75 ha^{-1})) during the course of trial. A mean benefit cost ratio of 3.75 was recorded in demonstrations with an increase of Rs. 31,983.50/ha net returns and with 33.34% increase of net returns than farmers practices (2.72). The benefit-cost ratio increased from least 2.87 in 2014-15 to 3.75 in 2018-19, reflecting the positive impact of FLD on both fruit yield and profitability. The increase in the yield and monetary returns with demonstration might be attributed to the adoption of green manuring before transplanting, following raised bed method with spacing distance Row to Row 90 cm & Plant to Plant 60 cm, application of FYM provides the nutrients throughout the crop period, timely application

Table 3 : Cost of cultivation, Gross return, Net return and Benefit cost ratio of Tomato as influenced by Integrated Nutrient Management in Peddapalli District.

Year	Demo			FP			% increase in Net returns	Additional net income (Rs./ha)	Demo	FP
	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)			B:C	B:C
2014-15	42864.00	123000.00	80136.00	48724.00	113500.00	64776.00	23.71	15360.00	2.87	2.33
2015-16	42760.00	154809.00	112049.00	48620.00	138771.00	90151.00	24.29	21898.00	3.62	2.85
2017-18	45474.00	172174.00	126700.00	54510.00	148110.00	93600.00	35.36	33100.00	3.79	2.72
2018-19	46400.00	219100.00	172700.00	58166.00	173290.00	115124.00	50.01	57576.00	4.72	2.98
Average	**44374.50**	**167270.75**	**122896.25**	**52505.00**	**143417.75**	**90912.75**	**33.34**	**31983.50**	**3.75**	**2.72**

*OFT- On Farm Trails, FLD- Front Line Demonstration, Demo- Demonstration conducted, FP- Farmers Practice, Rs.- Rupees, ha- Hectare.

Table 4 : Impact of Front Line Demonstration (FLDs) on Adaptation and horizontal spread of Integrated Nutrient Management in Tomato in Peddapalli District.

Year	No. before adoption	No. after adoption	Impact on Adoption (% change)	Area before (ha)	Area after (ha)	Impact on Horizontal Spread (% change)
2014-15	0	43	**0.00**	0.00	4.60	**0.00**
2015-16	43	180	**318.60**	4.60	20.20	**339.13**
2017-18	180	850	**372.22**	20.20	96.20	**376.24**
2018-19	850	4180	**391.76**	96.20	496.00	**415.59**
Average	**268**	**1313**	**270.65**	**30.00**	**154.00**	**282.74**

of fertilizers, foliar spray of micro nutrients helps in obtaining good yields than the framers practices. The higher additional returns and higher benefit cost ratio obtained under demonstration might be due to improved technology, non-monetary factors and timely operations of crop cultivation as well as scientific monitoring. Singh *et al*. (2018) also reported that the front line demonstrations increased the yield, gross returns, net returns and benefit cost ration in tomato crop. Similar results were also reported by Misra *et al*. (2019), Shalini *et al*. (2016).

In present study, efforts were made to study the impact of FLD on Adaptation and horizontal spread of INM technology in Tomato (Table 4). It was found that adoption of INM technology in tomato by the farmers before demonstration was negligible during 2014-15, which increased by 391.76% after demonstration at 2018-19. There was a significant increase in area horizontally from 0 ha to 496.00 ha with 415.59% horizontal spread of the technology over the four years of study, therefore the study concludes that FLDs organized by KVK, Ramagirikhilla made significant impact on horizontal spread of this technology. Therefore, target oriented awareness and training programme on INM technology in tomato, regular field visits, conducting field days, communications through mass media enhanced level of knowledge and skills of growers which ultimately lead to adoption of technology in the Peddapalli district. Singh *et al*. (2018) also reported that front line demonstrations on Tomato Cultivation with improved package of practices increased the adaptation and horizontal spread of the technology. Similar findings are also reported by Chapke (2012) in case of jute crop and Mahale *et al.* (2016) in mustard crop.

Conclusion

Frontline demonstrations on INM in tomato during 2014- 15 to 2018-19 resulted that average yield of 33.90 t ha-1 with an increment of 11.87% yield higher than the farmers practice (30.40 t ha^{-1}), which created greater awareness and motivated the fellow farmers for adoption the INM package of practices for Tomato. The yield difference between farmers' practices and demonstrations thus made the financial returns very evident. Furthermore, the outcomes of these demonstrations strengthened the scientifically supported strategies for improved natural resource management and higher productivity. It is determined that the FLD programme is a successful tool for expanding the area planted to horticultural crops, improving tomato productivity, and altering the farmers' knowledge, mindset, and skill set. In addition to improving the socioeconomic situation, this has reduced crop failures due to poor drainage, nutrient deficiencies, and maintained the nutrient status of the soils used for tomato cultivation.

Conflict of interest

The authors declare that there is no conflict of interest exist (both financial and non-financial).

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