Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

J P P Journal of Pharmacognosy and Phytochemistry

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2020; 9(1): 689-692
Received: 10-11-2019
Accepted: 12-12-2019

HM Singh
Senior Technical Officer (Horticulture) & Assistant Director (Horticulture), National Horticultural Research and Development Foundation, Patna, Bihar, India

JK Tiwari
Senior Technical Officer (Horticulture) & Assistant Director (Horticulture), National Horticultural Research and Development Foundation, Patna, Bihar, India

TS Mishra
Subject Matter Specialist (Horticulture), KVK – West Kameng, Arunachal Pradesh, India

Divya
PG Student, Sam Higginbottom University of Agriculture, Technology and Science, Allahabad, Uttar Pradesh, India

Corresponding Author:
HM Singh
Senior Technical Officer (Horticulture) & Assistant Director (Horticulture), National Horticultural Research and Development Foundation, Patna, Bihar, India

Evaluation of technology dissemination through demonstration (TDTD) on the yield and economics of rabi onion (*Allium cepa* L.) crop in major growing district of Bihar

HM Singh, JK Tiwari, TS Mishra and Divya

Abstract
Onion production and post harvest management problem and their solution studied with onion Growers of Samastipur, Muzaffarpur, Vaishali, Begusarai, Lakhisarai, Munger, Sheohar, East Champaran, Rohtash, Buxar, Bhojpur, Nalanda, Patna, Kaimur and Jamui district of Bihar state through planned Technology dissemination through demonstration (TDTD) were conducted on farmer's field with Rabi onion variety Agrifound Light Red (ALR) with *Trichoderma viride* (TV) application in nursery sowing with seed treatment and spray since 2012-13 to 2018-19 for seven years. Result of study indicated good performance over check recorded since seven years and maximum percent over check was recorded 22.20%, technical gap was noticed 67.50 qt/ha with decreasing trend, maximum extension gap recorded 48.30 qt/ha while minimum technology index 11.50% in same year. The maximum grass return (Rs. 519427), net return (Rs. 438627) and B: C (6.42) ratio was also recorded highest in demonstration field (2014-15) due to maximum market price high as compare with all study year/ seasons.

Keywords: TDTD, *Trichoderma viride*, economics, technology gap, extension gap, technology index, onion

Introduction
Onion (*Allium cepa* L.) is one of the important commercial vegetable crops produced in India for its domestic consumption and export significance. India is the second largest producer of vegetables in world followed by China. India occupies second position in onion. As per the world scenario of onion during 2015-16, China was the major producer of onion with 26.3 percent followed by India with 22.6 percent and USA occupied 3rd place with 3.8 percent of production (Anonymous 2015) [1]. In India onion occupied an area of about 1.22 million ha with production 20.99 million tones and productivity of 21.2 tones per ha during the year 2016-17. The major onion growing states are Maharashtra (30%), Madhya Pradesh (15%), Karnataka (11%), Gujarat (10%), Bihar (7%), Andhra Pradesh (5%), Rajasthan (4%), Haryana (3%) and others (15%) (Indian Horticulture Database 2015) [1]. In Bihar area under onion cultivation is 53.78 thousand ha during 2017-18. The productivity of onion in Bihar is 17.67 tons / ha. It is less comparatively from national productivity 22.56 tons/ ha being an onion is a commercial crop required to increase the area and productivity in Bihar. It may play a key role to doubling the income of farmers in Bihar. Whereas about 55-60% of onion comes from Rabi season and 40-45 % from Kharif & late kharif seasons in India (Gupta, R.P.; Singh, R.K. 2010) [2]. The most of onion area of India in rain fed situation and farmers using local and admixed onion variety with traditional practices resultant poor yield. Therefore, technological intervention is required to replacement of old, local and admixes onion seed through Technology dissemination through demonstration (TDTD) with critical inputs as improved variety and *Trichoderma viride* for nursery application to prevent seedling damage and promote healthy seedling which must enhance production and productivity of onion crop and also fetches good income to onion growers of different districts of Bihar state. Keeping in the view as above the TDTD on Rabi onion by improved variety and *Trichoderma viride* application in nursery stage with good agricultural practices (GAP) on farmer's field has been undertaken since 2012-13 to 2018 -19.

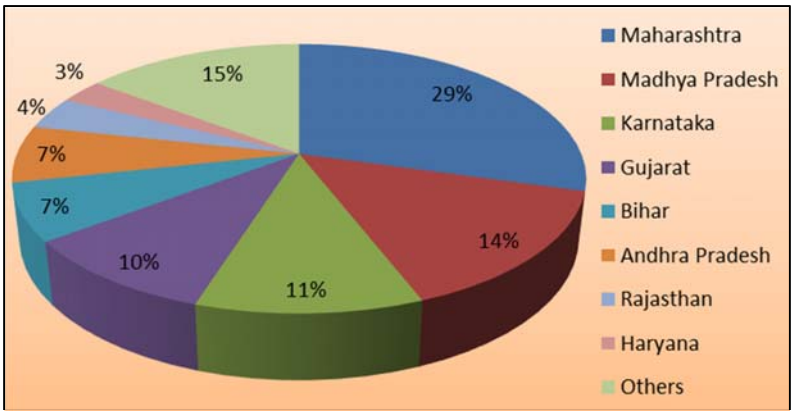

Fig 1: State Wise Share of Onion Production in India

Methodology

The present study was conducted by NHRDF, Patna (Bihar) during Rabi season from 2012-13 to 2018-19 (7 years) in the farmers' fields of different villages in Samastipur, Vaishali, Muzaffarpur, Begusarai, Lakhisarai, Munger, Sheohar, East Champaran, Rohtash, Buxar, Bhojpur, Nalanda, Patna, Kaimur and Jamui district of Bihar state. The material used for study is good agriculture practices and recommendation of NHRDF on onion cultivation, improved variety of onion Agrifound Light Red (ALR) with *Trichoderma viride* and comparison of local variety Patna Red & Sukhsagar as local check as per table 1. The total 276 TDTD farmers in 67.5 ha area were conducted covering different villages & district of Bihar. Materials for the present study with respect of TDTDs and farmers practices were given in Table 1. In case of local check plots, existing practices being used by farmers were followed. In general soils of the area under study were sandy loam to red loamy sand and medium to low in fertility status. The TDTD was conducted to study the gaps between the potential yield and demonstration yield, extension gap and technology index. In the present evaluation study, the data on output of Rabi onion cultivation were collected from TDTD plots, besides the data on local practices commonly adopted by the farmers of this region were also collected and was calculated by using following formula –

Technology gap = Potential yield – Demonstration yield

Extension gap = Demonstration yield – yield under existing practice

$$\% \text{ increased in yield} = \frac{\text{Demonstration Yield} - \text{Farmers Yield}}{\text{Farmers yield}} \times 100$$

$$\text{Technology index} = \frac{\text{Potential Yield - Demonstration Yield}}{\text{Potential yield}} \times 100$$

In demonstration plots, a few critical inputs in the form of quality seed, *Tricoderma viridi* balance fertilizers, Agro-chemical, etc. were provided and non monetary inputs like timely sowing in raised bed low tunnel, poly house, transplanting on ridges were also performed. Traditional practices were maintained in case of local checks. The farmers involved in demonstration were facilitated by NHRDF experts/ scientist in performing field operations like nursery sowing, transplanting, irrigation, spraying, weeding, harvesting etc. during the course of training and visit. The technologies demonstrated are mentioned in Table1 and compared with local practices.

Table 1: Particulars sowing the details of onion production under TDTD and existing Practices

S. N.	Operation	Existing practices	Improved practices demonstrated
1	Variety used	Local variety/ own seed use etc.	Agrifound Light Red (ALR) it is Improved & high yielding with realized variety.
2	Seed sowing time	December - January	October – 15th December
3	Method of seed Sowing	Direct sowing/ Broadcasting	Line sowing; Spacing- Row to row 15 cm and Plant to plant- 10 cm
4	Nursery raising	Flat bed or direct seed sowing without mulching	Raised bed (3 m x 0.6 m size, raised up to 15- 25 cm.) with mulching.
5	Seed rate	12-15 kg/ ha.	8-10 kg/ ha.
6	Seed treatment	without seed treatment	Seed treatment with Thiram @ 2 gm / kg.
7	Soil treatment	Without treated	Soil treatment with Carbendazin @ 4 gm / m2 and *Trichoderma viride* @ 10 kg per ha.
8	Transplanting	Flat bed without labelling	Small size (4x3 m) bed with ridges in 15 cm distance. Spacing- Row to row – 15 cm. plant to plant 10 cm.
9	Irrigation	Regular Flood	In 1/3 rows as and when required.
10	Fertilizer application	Unbalance doses application of fertilizer, mostly higher dose of nitrogenous fertilizers	Application of recommended dose of manures/ fertilizers based on soil test report/ recommended dose with basal and split top dressing
11	Weed management	No hand weeding/ used high dose of herbicide	Used pre-emergence herbicide with spraying of Pendimethalin as per required under guidance
12	Plant protection	Spraying many insecticides and fungicides without guidance of expert.	As per required under the guidance of agriculture expert/ Scientists.
13	Post harvest handling & quality improvement	Un-hygienic and improper practices	Adopted improved post harvest techniques with proper sorting grading.

Result and Discussion

Result of 276 demonstrations conducted during 2012-13 to 2018-19 in 67.5 ha. area on farmers field of different villages of Samastipur, Vaishali, Muzaffarpur, Begusarai, Lakhisarai, Munger, Sheohar, East Champaran, Rohtash, Buxar, Bhojpur, Nalanda, Patna, Kaimur and Jamui district indicate that the cultivation practices comprised under TDTD viz.,use of improved verities (Agrifound Light Red), raised bed nursery raising, seed and soil treatment, transplanting on ridges, fertilizer application (N:P:K @ 100:50:50 kg/ ha) and control of purple blotch (Alternaria porri), produced on an average 18.63% more yield of Rabi onion as compared to local check (213.85 q/ha.).

It is confirmed that demonstration yield of onion var. ALR was better in comparison of local check as per table 2. The onions var. ALR maximum yield recorded 265.80q/ha and percentage increase yield over check was recorded highest 22.20 in Rabi 2018-19. (Hiremath, S.M. and Hilli, J.S. 2012) [8]. The yield improvement of onion ALR was noticed due to effect of good climate and moderate disease incidence of purple blotch, stemphyllium blight and thrips attack (Singh, H.M. & Singh, S. 2018) [5]. Result of table 2 revealed that yield of TDTD and potential yield of variety was compared to estimate the yield of Extension gap, Technology gap and technology index. The technology gap showed gap of demonstration yield and potential yield which was recorded of highest value 67.5 qt. /ha in 2014-15 (Singh, H. M. & Singh, S.K. 2018) [6]. It could be due to gap of awareness about improved variety and its seed availability. Hence to minimise Extension gap needs to educated the farmers more about good agricultural practices (GAP). Further maximum extension gap was noticed in 48.30 qt/ha in 2018-19 and maximum technology Index 22.5% in 2014-15 and seen decreasing order since 2015-16 to 2018-19 (Singh, H.M. & Singh, S. 2018) [7]. The lower technology index indicated good possibility of onion variety and technology of demonstration 11.50 to 22.50 means fluctuation of technology index percentage gap is appropriation of stable crop performance (Ojha, M. D. & Singh, H. 2013) [9].

Table 2: Impact of Rabi onion TDTD on yield, technology gap, extension gap & Technology Index

Year	Area (ha.)	Number of TDTD/ farmers	Yield (q./ha.)		% yield increase over Existing	Technology index (%)	Technology gap (q./ha.)	Extension gap (q./ha.)
			TDTD	Farmer Practice				
2012-13	5	13	257.5	218.0	18.11	14.16	42.5	39.5
2013-14	5	20	245.0	206.5	18.64	18.33	55.0	38.5
2014-15	5	20	232.5	192.5	20.77	22.50	67.5	40.0
2015-16	5	20	252.4	216.6	16.52	15.83	47.5	35.8
2016-17	12.5	50	263.6	231.2	14.01	12.13	36.4	32.4
2017-18	15	60	258.3	214.7	20.16	13.90	41.7	43.3
2018-19	20	93	265.8	217.5	22.20	11.50	34.5	48.3

Potential yield 300 qt. / ha.

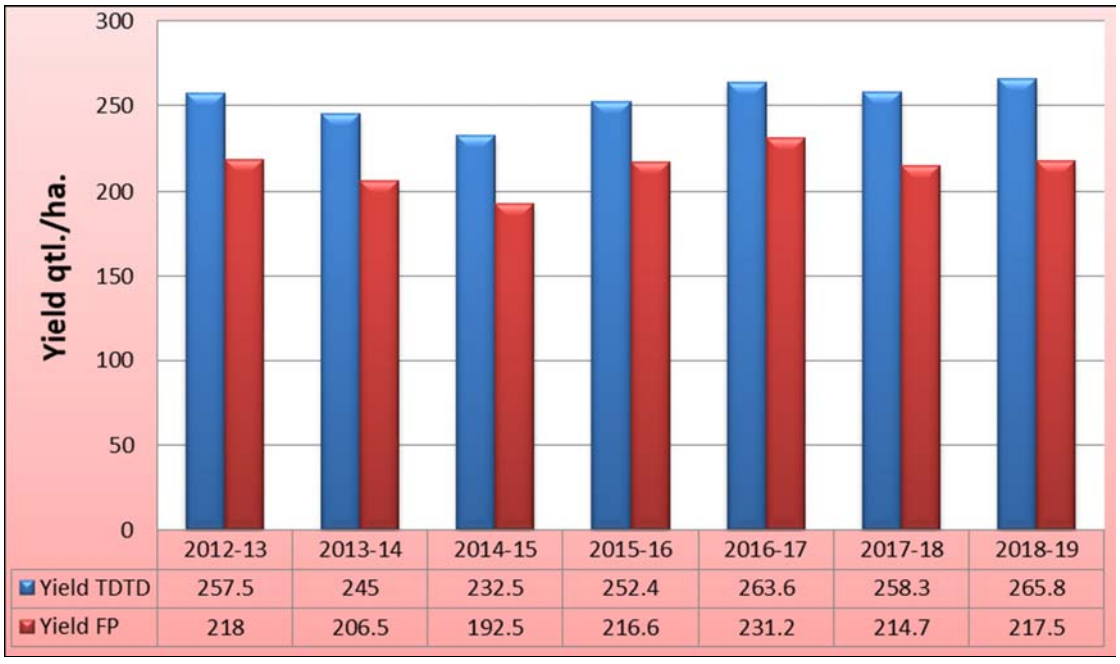

Fig 2: Yield of Productivity of Onion cultivation in Bihar

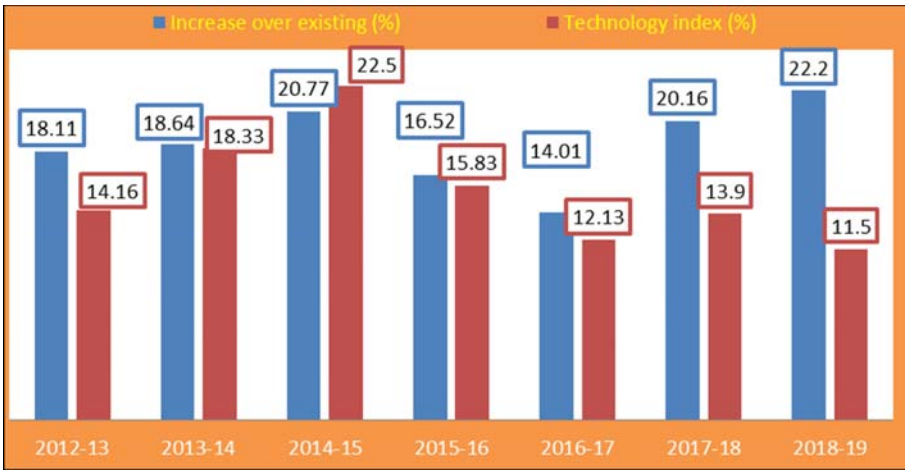

Fig 3: Percentage Increase over existing and Technology index (%)

Table 3 showed economic analysis data of TDTD since 2012-13 to 2018-19. The maximum net return was recorded in 2014-15 the BC ratio maximum (6.42) in same year where's as minimum BC ratio (3.07) was recorded in 2017-18. BC ratio was based on production and net return from the crop due to good market price as mentioned from bellow table 3 same result reported by (Singh, Satyendra & Singh, H. M. 2018) [5]. The maximum net income Rs. 438627/- in TDTD plot and Rs. 272119/- in existing practices was observed, which is significantly differences on income of farmers. This is effect due to market price fluctuations and awareness of farmers regarding technologies. Technology gap noticed mostly decreasing order since 2012-13 till 2018-19. It means the initiation taken by expert/ scientist/ farmers for awareness of onion production and post harvest technology gives positive impact. Whether, Extension gap noticed unchanged up and down trends in every year shows continuous efforts to educate and train to onion grower for onion production technology and post harvest management.

Table 3: Economics of onion production under Technology Dissemination through Demonstration

Year	Cost of cultivation (Rs. / ha.)		Grass Income (Rs. / ha.)		Net Income (Rs. / ha.)		B.C. Ratio (Gross Return/ Gross cost)	
	TDTD	FP	TDTD	FP	TDTD	FP	TDTD	FP
2012-13	68000	65000	235380	172348	170380	107348	3.46	2.65
2013-14	72500	67400	226825	158472	154325	91072	3.12	2.35
2014-15	80800	76500	519427	348619	438627	272119	6.42	4.55
2015-16	80400	73800	256318	148768	175918	74968	3.18	2.01
2016-17	78450	67200	248285	137367	169835	70167	3.16	2.04
2017-18	77300	66100	237935	126236	160635	60136	3.07	1.90
2018-19	76800	64700	271489	132173	194689	67473	3.53	2.04

FP = Farmer practice

Conclusion

By conducting demonstrations of improved scientific technologies, yield potential of onion can be increased to a great extent. Hence it is concluded from the study that yield was associated better due to improved varieties Agrifound Light Red and *Trichoderma viride* application with adoption of improved practices in cultivation. Onion grower should adopt technology transfer through TDTD, It will be profitable and economically viable based on market rate fluctuation of onion bulb crop. It is also concluded that continuous technology backstopping on onion crop is necessary for improvement of area, production and postharvest management for growers of the different district of Bihar. This should be brought to the access of farmers through transfer of technology by scientific guidance etc.

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