



Assessment, estimation and economic performance of different Kharif Onion (*Allium cepa* L.) varieties under Malwa Plateau of Madhya Pradesh

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Summary

A farm testing trial (OFT) was conducted on the 13 farmers' fields of the Mandsaur district of Madhya Pradesh to assess the most of assessing variety of Kharif onion for two consecutive years i.e. 2018-19 and 2019-20. The present study revealed that onion variety Bhima Dark Red (BDR) performed better for most of the growth parameters, yield and yield attributing traits and economic performance as well as gross and net returns compared to Bhima Super and N-53 varieties. Maximum plant height (63.72 cm), number of leaves per plant (13.17), leaf length (51.85 cm), bulb diameter (5.95 cm), fresh weight of bulb (102.53 g), cured weight of bulb (93.38 g), bulb yield (262.56 q/ha), minimum neck thickness of bulb (1.10 cm) and bolting percentage (0.70%) were observed in Bhima Dark Red. Bhima Dark Red variety recorded an additional net return of Rs. 71,541 and Rs. 198667 over Bhima Super and N-53. Highest B: C ratio was obtained with Bhima Dark Red (6.74) as compared to Bhima Super (5.47) and N-53 (3.42), respectively.

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Introduction

Onion (*Allium cepa* L.) is a vital bulb crop of India, extensively cultivated throughout India for its high nutritional and medicinal properties. It is also called "Queen of Kitchen" (Selviraj 1976) and is widely used as salad, cooked in curries, boiled, fried, baked and pickled. Onion is a stimulant, diuretic and has expectorant and antibacterial properties. It prevents heart disease by lowering blood cholesterol and lipid level (Sharangi & Datta 2005). With 31.77 MT of onion production from a 26.64 MH area in 2021-22 (NHB-2021), India is the second largest onion producer in the World after China. In India, the share of Maharashtra in the total onion production is around 38.06% in contrast to Madhya Pradesh contributing only 15.23% (Horticultural Statistics at a Glance-2021, Department of Agriculture, Cooperation & Farmers Welfare, 2021). The production seasons and arrivals of onion in India lead to a typical situation where prices peak from September to November and reduce from January to March-April every year. Generally, the onion storage filled by Rabi onion gets emptied by around August to September, and storage loss rises to 30% and above (Samra et al. 2006; Sethupathi & Paramasivan 2019). Production of onion in kharif and late kharif season is beneficial for farmer's point of view to get maximum price as compared to rabi onion. Kharif onion is an off-season cultivation of the crop for which standardization of varieties is of immense utility.

Unfortunately, there is limited varietal wealth for Kharif and late Kharif. As a result, few varieties are being grown to some extent, but scientific information is meagre on their performance on growth and yield (Fahima Fathima et al. 2019). Mandsaur district which comes under the Malwa agro-climatic zone of Madhya Pradesh is a vital onion-growing district but the major area under onion cultivation in the district is during rabi season and the area under kharif onion cultivation is negligible. During the Participatory Rural Appraisal (PRA) survey, farmers and scientists come to the conclusion that there is a vast scope of onion cultivation in Kharif season which will be more profitable over the traditional crop soybean. Hence, in this regard, the present on-farm testing (OFT) study was undertaken to explore the possibility of cultivation of this bulb crop and assess the suitable kharif onion varieties in different locations in the Mandsaur district through farmer's participatory approach.

Materials and Methods

The Krishi Vigyan Kendra, Mandsaur, carried out the present study during the Kharif season of 2018-19 and 2019-20 in the 13 farmers' fields of adopted villages of the operational area of KVK. Two improved varieties viz. Bhima Super and Bhima Dark Red along with one check variety i.e. N-53 were evaluated in an area of 0.4 ha. Seeds of each variety were sown in line on well levelled raised beds in the month of May every year and healthy seedlings of 42 days old were transplanted in the field after cutting upper 1/3 portions of leaves to reduce the loss of water through transpiration. Soil of the study area is light to medium black in texture with low organic carbon, low nitrogen, medium phosphorus and high available potassium. All the recommended practice packages were uniformly adopted in all the entries to

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raise a good crop.

The crop was fertilized with a recommended dose of 100:50:50:40 Kg NPKS and 5 kg zinc per hectare as ICAR-DOGR, Rajgurunagar, Pune recommended. 50% N₂ and 100% P₂O₅, K₂O, S and ZnSO₄ were added as basal dose and the remaining 50% N₂ was in two equal splits at an interval of 28 and 42 DAT. Frequent training programmes and field visits were conducted on the farmer's field by the KVK scientists during the various field operations like transplanting, weeding, intercultural operations, nutrient management, irrigation, plant protection measures and harvesting etc. All other steps like site and farmer selection, the layout of the demonstration, farmers' participation etc, were followed as Choudhary (1999) suggested.

Ten plants were randomly selected from each variety during both the years to record observations on growth, yield, quality parameters, pest and disease incidence. The bulb yield was accounted on plot bases. Economics of onion was worked out on the basis of production cost and monetary returns. Cost of cultivation was calculated on the basis of prevailing rate of inputs. Gross income was calculated by yield multiplied with a whole sale rate of onion. The B:C ratio was computed by the following formula.

$$\text{Benefit Cost Ratio} = \frac{\text{Gross Income}}{\text{Cost of Cultivation}}$$

Statistical Analysis

Continuous two years data obtained for the growth parameters, yield and yield attributing traits will be evaluated by using one-way ANOVA (Analyses of Variance). P values < 0.05 will be regarded as "significant" and P values < 0.01 as "very significant". The experimental result of the trial will be performed in triplicate and given as Mean ± Standard Error (SE).

Results and Discussion

The results obtained from the present investigation during Kharif 2018-19 and 2019-20 are discussed given below.

Growth parameters and yield attributing traits

A. Growth Parameters

Plant height (cm), No. of leaves/ plant, leaf length (cm) and neck thickness of bulb (cm).

The effect on plant height in onion differed significantly due to different micronutrient treatments. The increase in growth parameters of onion with progressive increase in the application of boron and zinc might be due to their role in cell division, meristematic activity of plant tissue and expansion of cells (Patil et al. 2009). The favourable effect of boron on plant growth might also be due to its role in physiological processes such as carbohydrate and protein metabolism and cellular function within the plant. Since boron is mainly involved in the hormone development and stimulation or inhibition of specific metabolism pathways (Waqar et al. 2009). The present investigation revealed that among the three kharif onion varieties, profound effect was seen on growth parameters (Table 1). The maximum plant height (61.84 cm), number of leaves per plant (13.17), leaf length (51.85cm). The increase in growth parameters with the application of zinc might be due to their role in the cell division and other physiological processes like photosynthesis, nitrogen metabolism etc. Zinc is also a part of several other enzymes such as superoxide dismutase and catalase, which prevents oxidative stress in plant cells. In addition to above zinc plays an important role in production of tryptophan which in turn is precursor of auxin, an essential growth hormone for plant growth. The results are in conformity with Verma et al. (1995) in onion; Tiwari et al. (2003) in garlic.

Table 1. Growth and yield attributing parameters of onion as influenced by different varieties

Parameters	N-53			Bhima Super			Bhima Dark Red		
	2018-19	2019-20	Mean	2018-19	2019-20	Mean	2018-19	2019-20	Mean
Plant Height(cm)	55.78	54.22	55.00	56.62	55.23	55.93	59.96	63.72	61.84
No. of leaves/plant	9.25	8.77	9.01	11.25	11.48	11.37	12.96	13.39	13.17
Leaf Length (cm)	38.88	39.19	39.04	46.56	47.12	46.84	51.25	52.44	51.85
Neck thickness of bulb (cm)	0.97	1.01	0.99	1.19	1.26	1.23	1.09	1.11	1.10
Fresh weight of bulb (g)	78.23	79.56	78.90	87.45	89.32	88.39	101.81	103.24	102.53
Cured weight of bulb(g)	71.06	73.14	72.10	78.18	80.17	79.18	92.23	94.52	93.38
Bolting%	1.32	1.39	1.36	1.09	1.17	1.13	0.72	0.67	0.70
Bulb Diameter(cm)	4.44	4.63	4.54	4.95	5.17	5.06	5.88	6.01	5.95
Days to Harvest	105	101	103.00	114	118	116.00	110	108	109.00

B. Yield attributes

Fresh weight of bulb (g) Cured weight of bulb (g) Bolting % Bulb Diameter (cm) and Days to Harvest

This may be due to boron and zinc enhances the enzyme activity which in turn triggers the physiological process like protein and carbohydrate metabolism in plants. This in turn increases the diameter of the onion.

These results were in conformity with and Manna (2013). Fresh weight of bulb (102.53g), cured weight of bulb (93.38g), bulb diameter (5.95cm) was recorded in Bhima Dark Red variety followed by Bhima super while check variety N-53 observed minimum growth and yield attributing parameters are in accordance of the result recorded by Dewangan et. al. (2012) and Kerure et al.

(2016). In onion for better keeping quality, the cultivar should have minimum neck thickness, a desirable parameter. The present study showed significantly lowest neck thickness was observed in Bhima Dark Red (1.10 cm) than rest of the cultivars. Besides this Bhima Dark Red observed minimum bolting percentage (0.70%) while check variety N-53 recorded a maximum (1.36%) bolting percentage. These differences in different growth and yield attributing parameters of onion might be due to the genetic makeup of variety and suitability under different climatic and soil conditions. These findings are in close conformity with the findings of Mohanty & Prusti (2001), Dwivedi et al. (2012), Kushal et al. (2015), Hiraveet et al. (2015) and Sarkar et al. (2015) in onion.

This may be due to zinc and boron playing an essential role in plant growth through the biosynthesis of endogenous hormones which is responsible for promotion of plant growth, role in cell division, meristematic activity of plant tissue and expansions of cells. This in turn results in highest fresh weight of the bulb. The results are similar to Hansch & Mendel (2009). The higher bulb yield was observed in Bhima Dark Red variety (262.56 q/ha) followed by Bhima Super (208.35 q/ha) and N-53 (180.53 q/ha) varieties (Table 2). The improvement in growth and yield attributes might have led to higher total yield in onion. These results confirm the findings of Manna (2013) who observed improvement in growth and bulb yield of onion due to foliar nutrition of zinc and boron. Higher photosynthesis

accumulation in the bulb would ensure higher individual bulb weight, bulb diameter which leads to higher yield. These results are in close agreement with those of Acharya et al. (2015) and Ballabh et al. (2013).

"A" and "B" grade onion yield (120.17 q/ha and 88.99 q/ha) was observed to be highest in Bhima Dark Red, while "C" and "D" grades (42.07 q/ha and 16.77 q/ha) in N-53. The highest superior yield of Bhima Dark Red variety was mainly due to higher growth and yield parameters like plant height, number of leaves per plant and bulb weight (fresh and cured) because bulb weight is ultimately governed by the accumulation of carbohydrates and other metabolites which depend ultimately on the synthesis and supply of photosynthates by leaves or subsequent translocation vertically downward to bulb and root as reported by Lawande et al. (2011), Tripathy et al. (2013), Hiremath & Mantur (2018) and Sahoo et al. (2020).

A. Grading parameters

To fetch the better remunerative price and to get higher profitability, grading of onion bulb was also done and bulb was categorized into four categories viz. "A", "B", "C" and "D" grade as shown in Table-2. Maximum "A" and "B" grade onion bulb (45.75% and 33.90% respectively) was found in the Bhima Dark Red variety, while minimum in check variety N-53 (39.34% and 28.06% respectively), whereas, "C" and "D" grade onion bulb was observed maximum in N-53 (23.31% and 9.28% respectively) variety as compared to other varieties.

Table 2. Grade wise distribution of onion bulb and yield as influenced by different varieties

Parameters	N-53			Bhima Super			Bhima Dark Red		
	2018-19	2019-20	Mean	2018-19	2019-20	Mean	2018-19	2019-20	Mean
Yield(q/ha)									
Total yield(q/ha)	182.14	178.92	180.53	204.52	212.18	208.35	256.35	268.77	262.56
A Grade (>6.5cm)	72.65	69.42	71.04	86.27	88.62	87.445	118.47	121.73	120.10
B Grade (5.5 -6.5cm)	51.38	49.95	50.67	71.88	72.56	72.22	87.38	90.61	88.99
C Grade (4.5 -5.5cm)	40.17	43.96	42.07	30.25	32.62	31.435	36.17	38.45	37.31
D Grade (<4.5cm)	17.94	15.59	16.77	16.12	18.38	17.25	14.33	17.98	16.16
Grade %									
A Grade (>6.5cm)	39.89	38.80	39.34	42.18	41.77	41.97	46.21	45.29	45.75
B Grade (5.5 -6.5cm)	28.21	27.92	28.06	35.15	34.20	34.67	34.09	33.71	33.90
C Grade (4.5 -5.5cm)	22.05	24.57	23.31	14.79	15.37	15.08	14.11	14.31	14.21
D Grade (<4.5cm)	9.85	8.71	9.28	7.88	8.66	8.27	5.59	6.69	6.14

B. Percentage (%) Pest and Disease incidence

Besides these growth parameters and yield attributing traits, Bhima Dark Red (BDR) variety recorded the lowest pest i.e. thrips (14.12) and disease incidence i.e. purple

leaf blotch (22.06%) as compared to Bhima Super and N-53 variety (Table 3). Similar findings were also in close conformity of Tripathi et.al. (2013), Hiremath & Mantur (2018) and Konjengbam & Devi (2020).

Table 3. Percentage (%) of pest and disease incidence in different varieties

Parameters	N-53			Bhima Super			Bhima Dark Red		
	2018-19	2019-20	Mean	2018-19	2019-20	Mean	2018-19	2019-20	Mean
Thrips incidence (%)	19.44	17.92	18.68	15.22	15.78	15.5	13.98	14.26	14.12
Incidence of purple blotch disease (%)	32.51	34.88	33.70	24.17	26.45	25.31	20.94	23.17	22.06

C. Economics: Gross returns (Rs./ ha.), Net returns (Rs./ha.) and B:C ratio

The year-wise economics of onion production under on-farm testing (OFT) were estimated and the results have been presented in Table 4. The economic analysis of the data over the years revealed that Bhima Dark Red (BDR) variety recorded higher gross returns (Rs. 375840 per ha), net returns (Rs. 320090 per ha) and B:C ratio of 6.74

as compared to a Bhima Super and N-53 variety. Further by the inclusion of the Bhima Dark Red (BDR) variety and additional net returns of Rs. 71,541 and Rs. 198667 over Bhima Super and N-53 were gained suggesting its higher profitability and economic viability. A similar better economic return by the cultivation of Bhima Super variety compared to other varieties was reported by Kerure et al. (2016) and Saha et al. (2020).

Table 4. Yield and economics of different kharif onion varieties

Parameters	N-53			Bhima Super			Bhima Dark Red		
	2018-19	2019-20	Mean	2018-19	2019-20	Mean	2018-19	2019-20	Mean
Yield(q/ha)	182.14	178.92	180.53	204.52	212.18	208.35	246.35	254.77	250.56
Cost of Cultivation (Rs/ha)	49000	51000	50000	54000	56500	55250	55000	56500	55750
Gross Return (Rs/ha)	163926	178920	171423	286328	318270	302299	369525	382155	375840
Net Return (Rs/ha)	114926	127920	121423	235328	261770	248549	314525	325655	320090
B:C Ratio	3.34	3.50	3.42	5.30	5.63	5.47	6.71	6.76	6.74

Declaration of interests

The authors have no conflict of interest to declare.

Data Sharing

All relevant data are within the manuscript.

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