

International Journal of Agriculture Extension and Social Development

Volume 8; Issue 10; October 2025; Page No. 473-480

Received: 08-07-2025
Accepted: 11-08-2025

Indexed Journal
Peer Reviewed Journal

Evaluation of Onion (*Allium cepa* L.) Varieties for growth, yield, disease resistance, economic performance, and farmers' preference in rabi season under davanagere conditions

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DOI: <https://www.doi.org/10.33545/26180723.2025.v8.i10g.2571>

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Abstract

A field investigation was conducted to evaluate the performance of five onion varieties Bellary Red (Farmer's Practice), Bhima Red, Agrifound Light Red (AFLR), Bhima Shakti, and Arka Bheem with respect to growth, yield, economic viability, disease incidence, and farmers' acceptability under the agro-climatic conditions of Davanagere district, Karnataka. Significant variation was observed among the varieties. Bhima Shakti recorded the highest germination (93.6%), plant height (65.86 cm), and collar thickness (1.91 cm), along with the highest marketable yield of 285.4 q/ha. It also exhibited superior economic performance with a net return of ₹3,77,959/ha and a B:C ratio of 3.79. Bhima Shakti showed greater tolerance to purple blotch (8.09%), thrips (5.11%), and Stemphylium blight (12.7%) compared to the local check (TO1), which showed significantly higher disease incidence. Farmers' participatory feedback ranked Bhima Shakti as the most preferred variety based on bulb shape, skin quality, color, market preference, and overall acceptability. The findings suggest that Bhima Shakti is a promising variety suitable for large-scale adoption due to its high productivity, profitability, and resistance to major diseases and pests.

Keywords: Onion varieties, Bhima Shakti, yield, disease incidence, economics, farmers' preference, participatory evaluation

Introduction

Onion (*Allium cepa* L.) is one of the most important vegetable crops grown in India. It is used in cooking and food processing all over the world. India is one of the top onion producers in the world, and it makes a big difference in the world market. Karnataka is one of the biggest onion producers in India. In 2024-25, it grew onions on 2.32 lakh hectares and produced over 16.38 lakh tonnes (Department of Horticulture, Govt. of Karnataka). After Maharashtra and Madhya Pradesh, this state is the third largest producer of onions.

Approximately onions are cultivated 1354 ha in the Davanagere region, resulting in an annual yield of approximately 5066 tonnes, according to current statistics. The yield levels of onions may fluctuate depending on the season and the variety.

Rabi onions are picked between April and May, kharif onions between October and November, and late kharif onions between January and February. Most of the food grown during the rabi season is saved until October so that it can be used in the country. From October to December, there is a very big hole in the onion supply. So, according to Deepa Sharma *et al.* (2024), kharif onion is an important

part of both meeting customer needs and keeping the market price of onions in check.

Even in cultivated regions, onions exhibit inferior growth during the Rabi season in comparison to the Kharif season. This is due to meteorological issues, such as erratic monsoons, elevated humidity, and disease prevalence. This has resulted in severe yield and income loss to Onion growers in the region. To mitigate this situation, it is essential to identify and recommend onion varieties that are disease-resistant, climate-resilient, and high-yielding to enhance farmers' profitability and ensure sustainable onion production.

This study aimed to evaluate the growth, bulb production, and quality characteristics of specific onion varieties throughout the Rabi season in the Davanagere district. The findings should assist farmers and extension groups in selecting optimal cultivars for enhanced yields and increased economic returns in the region.

Materials and Methods

Experimental Site and Design

The field experiment was conducted during the Rabi season in farmer-participatory mode across selected villages in

Davanagere district, Karnataka. Kalledevarapura village, in Jagalur taluk, falls under the Central Dry Zone of Karnataka. This zone is characterized by a semi-arid climate with a tendency towards dryness and high temperatures for much of the year. Jagalur taluk itself is considered drought-prone, with an average annual rainfall of 546 mm, primarily concentrated during the South-West monsoon season. The soil was sandy loam with good drainage. The experiment was laid out in a randomized block design with five treatments and three replications.

Treatments

The treatments comprised:

- TO1 - Bellary Red (Farmer's Practice)
- TO2 - Bhima Red
- TO3 - Agrifound Light Red (AFLR)

Observations recorded

Data were recorded on:

- Growth Parameters: Germination (%), plant height (cm), number of leaves/plant, collar thickness (cm)
- Yield and Economics: Total bulb yield (q/ha), gross cost (₹/ha), gross and net returns (₹/ha), B:C ratio
- Pest and Disease Incidence: Purple blotch, thrips, and Stemphylium blight (%)

Farmer Feedback: Participatory scoring on bulb size, shape, color, skin quality, yield, market preference, and seed availability.

Results

1. Growth and Physiological Parameters

The evaluated onion varieties exhibited significant variation in germination percentage, plant height, number of leaves per plant, and collar thickness (Table 1). The highest germination rate was recorded in TO4 - Bhima Shakti (93.6%), followed closely by TO5 - Arka Bheem (92.94%) and TO2 - Bhima Red (92.1%), whereas TO1 - Farmer's Practice (Bellary Red) recorded the lowest germination percentage (78.9%).

Plant height differed markedly among treatments, with Bhima Shakti (TO4) attaining the maximum height (65.86 cm), followed by TO2 - Bhima Red (63.80 cm) and TO5 - Arka Bheem (61.43 cm). The lowest height was observed in TO1 (52.37 cm). The number of leaves per plant ranged from 11.81 (TO5) to 13.54 (TO4), with a mean of 12.32 leaves/plant. Collar thickness, an important indicator of bulb robustness, was highest in TO4 (1.91 cm), followed by TO2 (1.80 cm) and TO5 (1.64 cm). The minimum collar thickness was recorded in TO3 - AFLR (1.16 cm).

2. Yield and Economic Analysis

Significant variation was observed among the onion varieties with respect to yield and economic parameters (Table 2). The variety Bhima Shakti (TO4) recorded the highest bulb yield of 285.4 q/ha, followed by Arka Bheem (TO5) with 269.5 q/ha, AFLR (TO3) with 259.1 q/ha, and Bhima Red (TO2) with 256.2 q/ha. The lowest yield was recorded under the farmer's practice Bellary Red (TO1) at 159.6 q/ha.

Economic analysis revealed that Bhima Shakti also generated the highest gross returns (₹5,13,720/ha) and net

returns (₹3,77,959/ha), with a B:C ratio of 3.79. This was followed by Arka Bheem (net return ₹3,44,832/ha; B:C ratio 3.45), Bhima Red (₹3,30,423/ha; B:C ratio 3.53), and AFLR (₹3,29,465/ha; B:C ratio 3.40). The lowest net return and B:C ratio were recorded under Bellary Red (₹1,57,787/ha; B:C ratio 2.22).

The overall mean yield across treatments was 245.96 q/ha, with an average gross return of ₹4,42,692/ha, net return of ₹3,08,093/ha, and a mean B:C ratio of 3.28. These findings indicate that Bhima Shakti is a superior cultivar for higher productivity and profitability under the prevailing agro-climatic conditions of the study area.

According to the demonstrations conducted by Rajaneesh Sreevatsava *et al* (2022) ^[10] the improved variety of kharif onions (NHRDF Agrifound dark Red) produced an average yield of 274.4 q/ha, which was greater than the average yield of check (N-53) i.e. 228.83 q/ha. The average yield improvement over farmer techniques was 19.91%. It was noted that the average extension gap was 45.57 q/ha.

3. Disease and Pest Incidence

The evaluated onion varieties exhibited significant differences in their susceptibility to major diseases and pests, including purple blotch, thrips infestation, and Stemphylium blight (Table3). Scale for categorizing the varieties against the stemphylium blight of onion was mentioned in Table 5 and Scale for categorizing the varieties against the purple blotch of onion was presented in Table 6.

The incidence of purple blotch, caused by *Alternaria porri*, was lowest in TO4 - Bhima Shakti (8.09%), followed by TO2 - Bhima Red (8.64%) and TO3 - Agrifound Light Red (9.94%). The highest incidence was recorded in the farmer's practice, TO1 - Bellary Red (19.24%), indicating higher vulnerability under traditional cultivar use.

Similarly, thrips (*Thrips tabaci*) incidence was significantly lower in improved varieties compared to the local check. TO4 - Bhima Shakti again exhibited the lowest thrips infestation (5.11%), followed by TO3 - AFLR (5.86%) and TO2 - Bhima Red (6.14%). The highest thrips population was noted in TO1 - Bellary Red (17.14%).

In the case of Stemphylium blight, a severe foliar disease caused by *Stemphylium vesicarium*, TO4 - Bhima Shakti recorded the lowest disease incidence (12.7%), followed by TO2 - Bhima Red (14.1%) and TO3 - AFLR (14.62%). TO1 - Bellary Red showed the highest susceptibility with 29.5% incidence.

These observations suggest that Bhima Shakti (TO4) had consistently better resistance or tolerance to key biotic stresses under field conditions, followed closely by Bhima Red (TO2) and Agrifound Light Red (TO3).

Similarly a study by Yadav *et al* (2024) ^[12] observed that Bhima Shweta performed superior regarding most of the traits viz., double (%) on number basis, bolters percentage on number basis, rotten percentage at number basis, days to maturity at 60-70% neck fall, days to harvesting after transplanting, thrips per plant and TSS percentage but the genotype/variety Sukh Sagar took minimum duration and mature only in 80 days after transplanting, it is harvested before others genotypes/varieties and also yielded well, so this variety can be also recommended for cultivation in Uttar Pradesh.

4. Varietal Performance Based on Farmers' Feedback

Participatory evaluation involving farmers' feedback revealed considerable differences among the onion varieties in terms of morphological and market-related traits (Table 4). The scoring was based on farmers' perception and practical experience regarding key quality parameters such as bulb size, shape, color, skin quality, yield performance, market preference, and seed availability.

Among the evaluated entries, TO4 - Bhima Shakti received the highest farmer preference with a total score of 09, securing Rank I, indicating excellent performance in terms of size, shape, color, skin quality, and marketable yield. TO3 - Agrifound Light Red (AFLR) ranked II (score: 12) and was appreciated for early maturity and moderate performance across characters.

TO5 - Arka Bheem secured Rank III with a total score of 16, being moderately accepted by farmers for its color, shape, and availability of seeds. TO2 - Bhima Red (score: 20) and the local check TO1 - Bellary Red (score: 22) were ranked IV and V, respectively. Farmers cited larger bulb size and thick skin in Bellary Red, but lower seed availability and market adaptability influenced its lower preference.

The average score across all varieties was 15.8, indicating that most improved varieties were better accepted compared to the traditional check, particularly in terms of quality attributes and market suitability.

Discussion

The present study revealed significant variation among onion varieties in terms of growth characteristics, yield performance, economic viability, disease resistance, and farmers' preferences. The findings highlight the superiority of Bhima Shakti (TO4) across multiple agronomic and economic indicators.

1. Growth and Physiological Traits

Growth parameters such as germination percentage, plant height, number of leaves, and collar thickness are critical determinants of plant vigor and yield potential. Among the tested varieties, Bhima Shakti exhibited the highest germination (93.6%), tallest plants (65.86 cm), and maximum collar thickness (1.91 cm), indicating its robust vegetative growth and efficient resource utilization. These results align with previous reports by Chavan *et al* (2024), Raa *et al* (2024) [17] and Prakash Mahala *et al* (2019).

The local check, Bellary Red (TO1), recorded the lowest values for all growth parameters, reflecting its genetic limitation under modern production systems. The comparatively moderate performance of Bhima Red (TO2) and Arka Bheem (TO5) also indicated their suitability for broader adaptation with desirable vegetative traits.

2. Yield and Economic Performance

Yield is the ultimate indicator of varietal performance. The highest bulb yield was observed in Bhima Shakti (285.4

q/ha), followed by Arka Bheem (269.5 q/ha) and AFLR (259.1 q/ha). This yield advantage translated directly into higher gross and net returns, with Bhima Shakti recording the maximum net return of ₹3,77,959/ha and B:C ratio of 3.79.

The economic superiority of Bhima Shakti can be attributed to a combination of high yield potential and lower input cost per unit output. In contrast, the farmer's practice using Bellary Red resulted in the lowest yield and profitability (net return ₹1,57,787/ha; B:C ratio 2.22), reaffirming the need to promote improved cultivars to enhance farm income.

According to Airadevi *et al* (2025) [11] onion variety (Bhima Super) recorded average yield of 19.56 t/ha with net return of Rs.93266/-ha as compared to farmers' practice, which produced average yield of 16.23 t/ha with netreturn of Rs. 60958/- ha.

3. Disease and Pest Resistance

Incidence of purple blotch, thrips, and Stemphylium blight significantly varied among genotypes. Bhima Shakti consistently showed the lowest disease incidence for all three major biotic stresses, suggesting better tolerance or inherent resistance mechanisms. It recorded only 8.09% purple blotch, 5.11% thrips, and 12.7% Stemphylium blight incidence, whereas Bellary Red was the most susceptible with the highest disease levels. These results are in line with the findings of Shahanaz *et al* (2024) and Ram Dutta *et al* (2024) [5].

These differences in disease susceptibility not only influence marketable yield but also reduce the need for chemical interventions, thereby contributing to sustainable crop production. The observed resistance in Bhima Shakti may be utilized in breeding programs aimed at developing multi-disease tolerant genotypes.

4. Farmers' Feedback and Varietal Acceptance

Participatory varietal evaluation provides practical insights into the adoptability of new technologies. Based on farmers' scoring, Bhima Shakti was ranked first (total score: 09) due to its favorable bulb shape, size, color, skin quality, and market preference. AFLR and Arka Bheem also gained moderate acceptance due to their distinct appearance and good keeping quality. Similar studies were noticed from the results of Choudhary *et al* (2021), [13] Stuti Pathak *et al* (2025) [11] and Dubey *et al* (2019) [14]. In contrast, Bellary Red, despite being traditionally cultivated, was ranked lowest (score: 22) due to larger but less uniform bulbs, thicker skin, and declining market demand. The feedback emphasized the increasing importance of market-driven traits and seed accessibility in varietal selection.

The participatory approach validated the experimental findings, establishing Bhima Shakti as the preferred variety not only from a productivity and profitability standpoint but also from the end-user (farmer and consumer) perspective.

Table 2: Growth Parameters of Onion Varieties

	TO 1 Farmers Practice (Bellary Red)	TO 2 Bhima Red	TO 3 Agrifound Light Red	TO 4 Bhima Shakti	TO 5 Arka Bheem	Mean
Germination (%)	78.9	92.1	90.4	93.6	92.94	89.588
Plant Height(cm)	52.37	63.80	59.47	65.86	61.43	60.586
No of leaves/plant	12.34	11.86	12.05	13.54	11.81	12.32
Collar Thickness(cm)	1.35	1.80	1.16	1.91	1.64	1.572

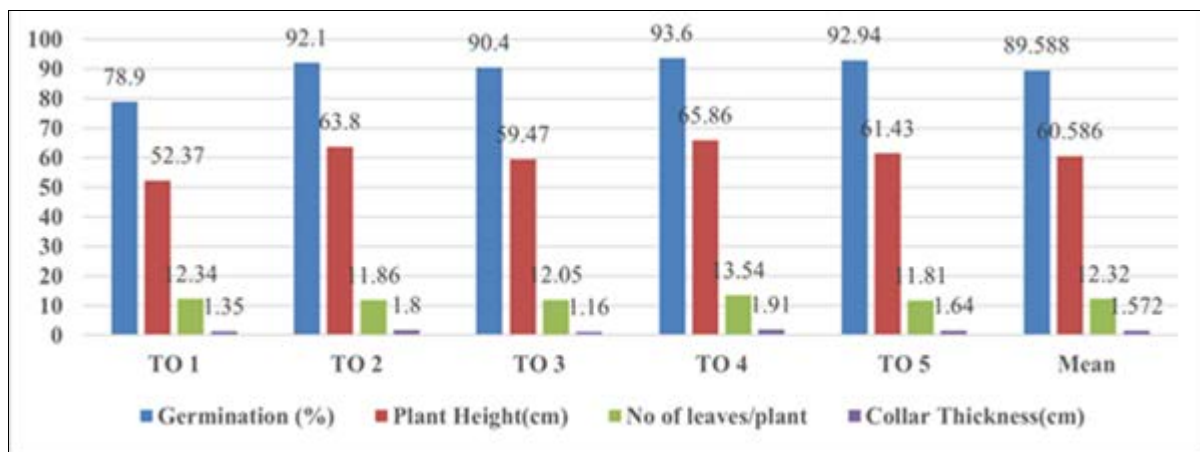
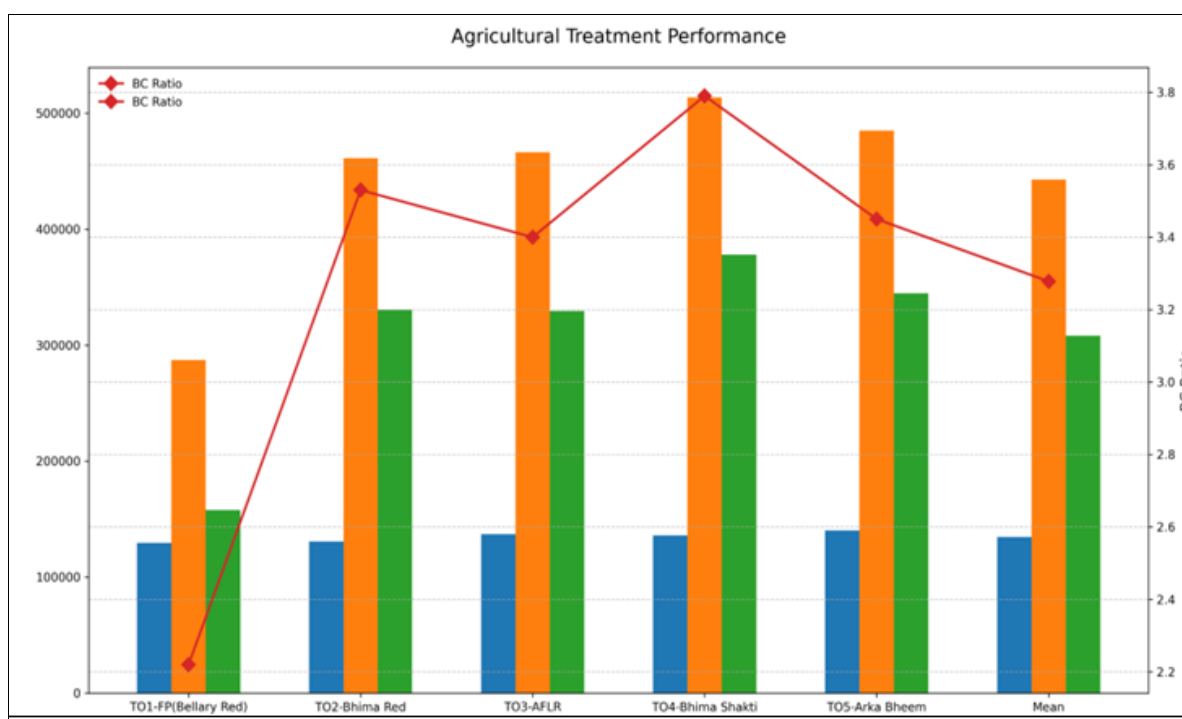


Fig 1: Growth Parameters of Onion Varieties

Table 3: Yield Performance of Onion Varieties

Treatments	Yield (q/ha)	Gross cost(Rs)	Gross Return(Rs)	Net Returns (Rs)	BC ratio
TO1-FP(Bellary Red)	159.6	129433	287220	157787	2.22
TO2-Bhima Red	256.2	130676	461100	330423	3.53
TO3-AFLR	259.1	136855	466320	329465	3.40
TO4-Bhima Shakti	285.4	135761	513720	377959	3.79
TO5- Arka Bheem	269.5	140268	485100	344832	3.45
Mean	245.96	134598.6	442692	308093.2	3.278



Selling Price: Rs.1800/q

Fig 2: Yield Performance of Onion Varieties

Table 4: Performance of pest and disease incidence of Onion Varieties

Parameters	TO 1 Farmers Practice (Bellary Red)	TO 2 Bhima Red	TO 3 Agrifound Light Red	TO 4 N Bhima Shakti	TO 5 Arka Bheem
Incidence of Purple Blotch (%)	19.24	8.64	9.94	8.09	10.72
Incidence of Thrips (%)	17.14	6.14	5.86	5.11	8.61
StemPhyllum Blight (%)	29.5	14.1	14.62	12.7	15.2

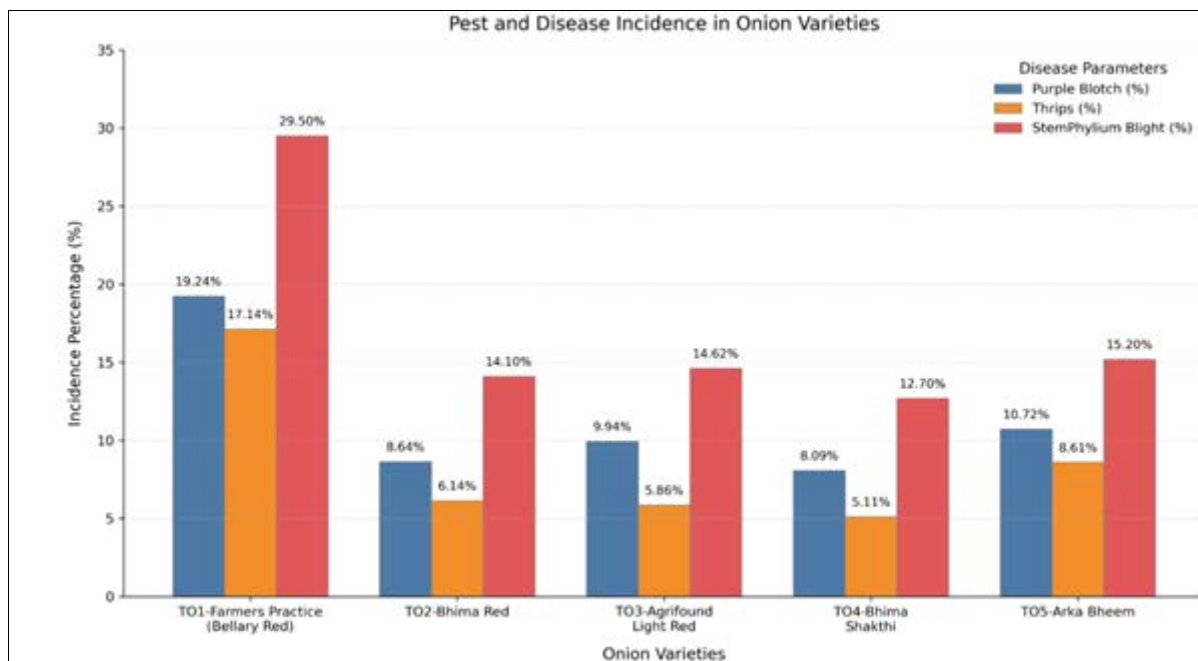


Fig 3: Performance of pest and disease incidence of Onion Varieties

Table 4: Varietal Performance and Farmers feedback on various characters of Onion

Sl. No	Variety	Size	Shape	Colour	Skin	Yield	Market Preference	Availability of seeds	Total Points	Ranking
01	TO1-FP(Bellary Red)	3	3	3	4	3	4	2	22	V
02	TO2-Bhima Red	3	3	3	4	2	3	2	20	IV
03	TO3-AFLR	1	2	1	2	2	1	3	12	II
04	TO4-Bhima Shakti	1	2	1	1	1	1	2	09	I
05	TO5- Arka Bheem	2	2	2	3	2	2	3	16	III
	Mean	2	2.4	2	2.8	2	2.2	2.4	15.8	

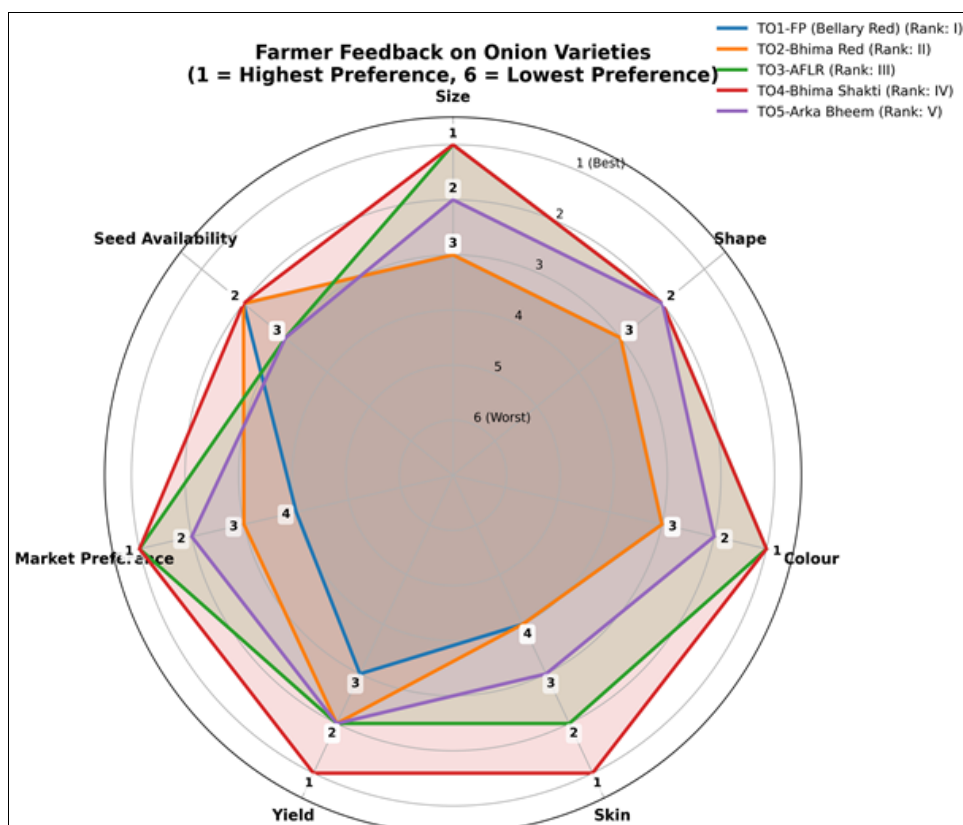
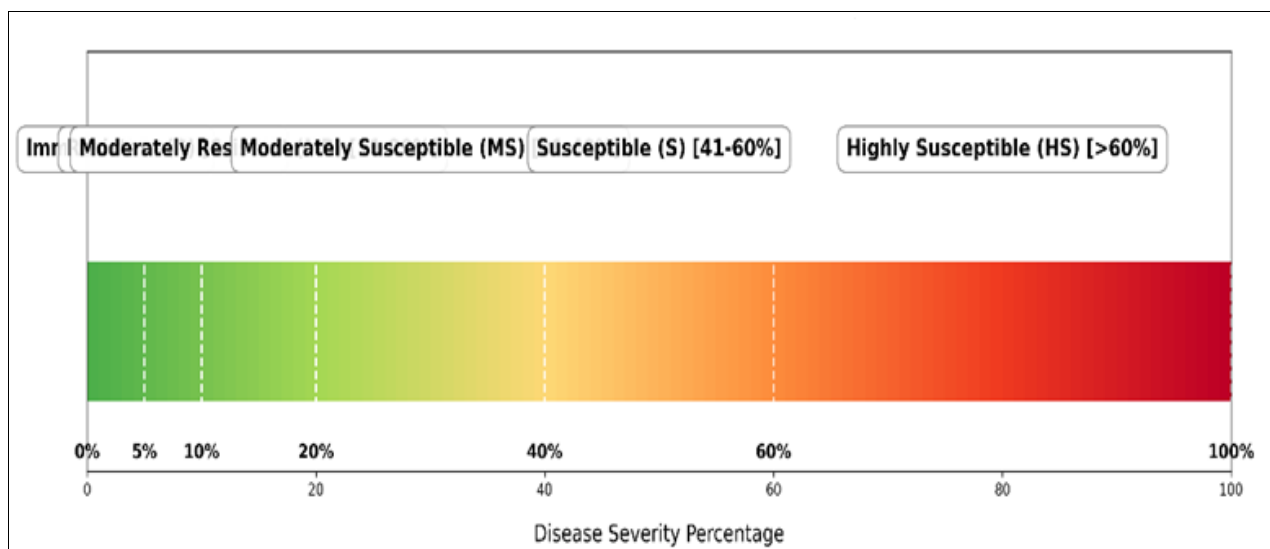


Fig 4: Varietal Performance and Farmers feedback on various characters of Onion

Table 5: Scale for categorizing the varieties against the stemphylium blight of onion

Score	Disease Severity (%)	Disease reaction
0	<5	Immune(I)
1	6-10	Resistant(R)
2	11-20	Moderately Resistant(MR)
3	21-40	Moderately susceptible (MS)
4	41-60	Susceptible(S)
5	>60	Highly Susceptible(HS)

**Fig 5:** Disease Severity Scale for Stemphylium Blight in Onions**Table 6:** Scale for categorizing the varieties against the purple blotch of onion

Sr No	Percent leaf area covered	Grade(X)
1	1	0
2	2	1
3	2-10	3
4	11-25	5
5	26-50	7
6	>50	9

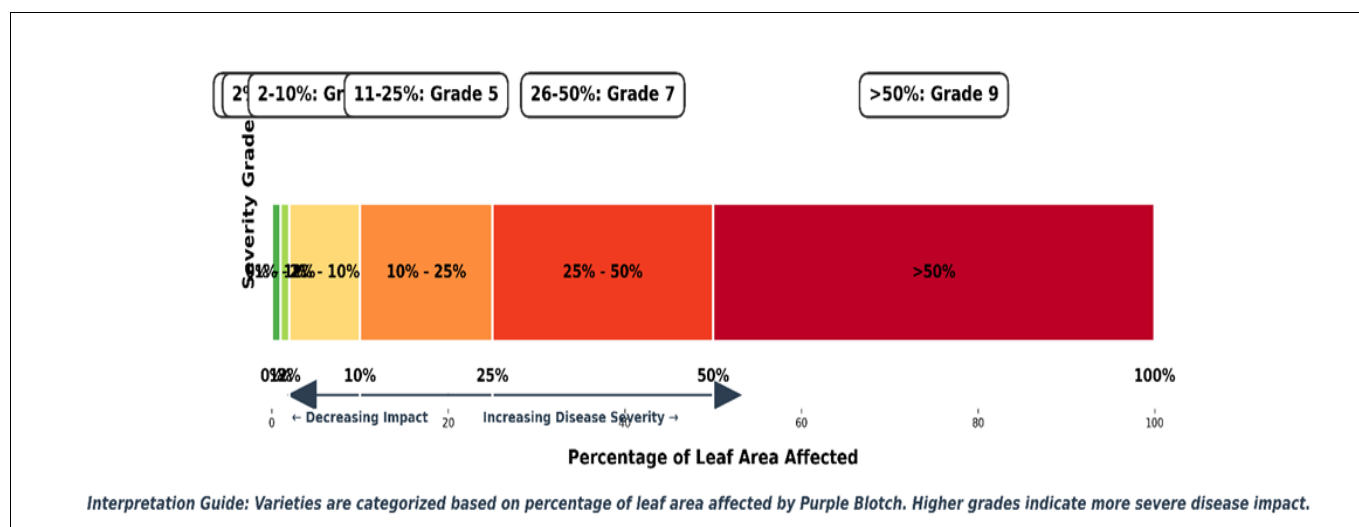
**Fig 6:** purple blotch disease severity scale for onions



Fig 7: Training on Production Technology of Onion



Fig 8: General View of the On Farm Testing Plot



Fig 9: Diagnostic field visit and interaction with Farmer



Fig 10: Field day of the Technology Assessment



Fig 11: Average weight of five bulbs of Assessed Varieties

Conclusion

The present study clearly demonstrated the superior performance of Bhima Shakti (TO4) among the tested onion varieties under the agro-climatic conditions of the study area. Bhima Shakti exhibited the highest germination percentage, plant height, number of leaves per plant, and collar thickness, indicating robust vegetative growth. It also produced the highest bulb yield (285.4 q/ha), which translated into the maximum gross and net returns and the highest benefit-cost ratio (3.79), confirming its economic viability for commercial cultivation.

In terms of biotic stress tolerance, Bhima Shakti recorded the lowest incidence of purple blotch, thrips, and Stemphylium blight, suggesting a promising level of resistance that could reduce the need for chemical plant protection measures. Farmers' participatory evaluation further supported its acceptability, ranking it first in terms of bulb quality traits, yield potential, market preference, and overall satisfaction.

Considering its high productivity, better resistance to pests and diseases, favorable market traits, and positive feedback from farmers, Bhima Shakti is recommended for large-scale cultivation in the region to enhance productivity, profitability, and sustainability in onion farming.

Acknowledgment

The authors express their sincere gratitude to the Subject Experts from ICAR Taralabalu Krishi Vigyan Kendra, Davanagere for their technical guidance and field supervision throughout the experiment. Special thanks are extended to the participating farmers for their valuable cooperation and feedback during the varietal evaluation process. The support of ICAR-ATARI, Bangalore, ICAR-Directorate of Onion and Garlic Research (DOGR), Pune, National Horticulture Research Development Foundation, New Delhi and ICAR-Indian Institute of Horticultural Research, Bengaluru for providing improved seed materials is also duly acknowledged.

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