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Evaluation of growth, yield and bulb quality of Onion (*Allium cepa* L.) hybrids under Chhattisgarh plains

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ABSTRACT

Onion (*Allium cepa* L.) is an important commercial vegetable crop cultivated widely for its yield and bulb quality. The present investigation was conducted during the rabi season of 2025–26 at the Horticulture Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, to evaluate the growth, yield and bulb quality performance of fifteen onion hybrids under Chhattisgarh agro-climatic conditions. The experiment was laid out in a Randomized Block Design with three replications. Significant variation was observed among the hybrids for all growth, yield and quality traits. Among the evaluated hybrids, RBH-25-71 recorded the highest total bulb yield (334.80 q ha⁻¹) and marketable bulb yield (309.91 q ha⁻¹), followed by RAH-25-55 and RBH-25-73. The superior of RBH-25-71 was associated with higher average bulb weight, larger equatorial bulb diameter, highest leaf length and a higher percentage of A-grade bulbs. The study identified RBH-25-71, RAH-25-55 and RBH-25-73 as promising onion hybrids for cultivation under the Chhattisgarh plains owing to their superior yield potential and desirable bulb quality attributes.

Keywords: *Allium cepa* L., Onion hybrids, Bulb yield, Bulb quality, Marketable yield

Introduction

Onion (*Allium cepa* L.) is one of the most important commercial vegetable crops cultivated worldwide because of its nutritional, medicinal and economic importance. It belongs to the family Amaryllidaceae and possesses a diploid chromosome number of $2n = 16$ (Kale, 2013) [1]. The crop is grown under temperate, tropical and subtropical climatic conditions and is cultivated as annual for bulb production and biennial for seed production (Parmar *et al.*, 2018) [2]. In India, the rabi season contributes the major share of onion production because it produces bulbs with higher yield, better quality and improved storage potential. India is the second-largest producer of onion in the world and the crop plays a significant role in vegetable production, domestic consumption and export. During 2025–26, onion production in India was estimated 307.37 lakh tonnes (30.74 million tonnes). In Chhattisgarh, onion is cultivated over 22.81 thousand hectares with a production of 380.82 thousand metric tonnes, making it an important rabi vegetable crop in the state (Anonymous, 2024) [3]. Bulb yield and quality in onion are influenced by genotype as well as environmental conditions. Since onion is a highly cross-pollinated crop, considerable genetic diversity exists among hybrids, providing opportunities for identifying superior genotypes with better growth, bulb size, marketable yield and quality traits (Porta *et al.*, 2014; Parmar *et al.*, 2018) [4, 2]. Therefore, evaluation of hybrids under specific agro-climatic conditions is essential for selecting suitable cultivars for commercial cultivation. Onion serves multiple purposes as a food item, medicinal resource, spice, and condiment. It is commonly eaten raw in salads, while its bulbs and leaves are widely used in cooking for preparing soups, pickles and various fried or roasted dishes. Owing to its distinctive flavour, aroma and health benefits, it is popularly known as the “Queen of the kitchen” (Selvaraj, 1976; Griffiths *et al.*, 2002) [6, 5].

Several researchers have reported significant variation among onion hybrids for growth, yield and bulb quality traits. Bal *et al.* (2020) [7] observed considerable differences in plant growth, bulb diameter, bulb weight and yield among onion genotypes. Upadhyay *et al.* (2020) [8] reported substantial variation in average bulb weight, marketable yield and total bulb yield in rabi onion accessions, while Gupta *et al.* (2024) [9] identified stable, high-yielding onion genotypes across diverse environments. These studies indicate that hybrid evaluation is an effective approach for identifying region-specific, high-performing onion cultivars. Considering the importance of onion cultivation in Chhattisgarh and the need to identify high-yielding hybrids with desirable bulb quality, the present investigation was conducted during the rabi season of 2025–26 at Indira Gandhi Krishi Vishwavidyalaya, Raipur. The objective of the study was to evaluate the growth, yield and bulb quality performance of fifteen onion hybrids under the agro-climatic conditions of the Chhattisgarh plains.

Materials and methods

The field experiment was conducted during the Rabi season of 2025–26 at the Horticulture Research cum Instructional Farm, Department of Vegetable Science, Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, Chhattisgarh, India. The experimental site is located in the Chhattisgarh plains under subtropical agro-climatic conditions and is suitable for rabi onion cultivation. The soil of the experimental field was sandy loam in texture with medium fertility status and good drainage. Fifteen onion hybrids obtained from the All-India Network Research Project on Onion and Garlic (AINRPOG) were evaluated in a Randomized Block Design (RBD) with three replications. Seedlings were transplanted at a spacing of 15 cm × 10 cm in a net plot size of 2.0 m × 2.5 m (5.0 m²). All the recommended agronomic practices, including fertilizer application, irrigation, weeding and plant protection measures, were followed uniformly for all the treatments throughout the crop growth period. Observations were recorded from five randomly selected plants in each plot for growth, yield and bulb quality characters. Growth parameters included plant height, number of leaves per plant, leaf length, neck length, neck thickness, polar diameter and equatorial diameter. Yield and yield-attributing characters comprised average bulb weight, number of bulbs per plot, bulb fresh weight, marketable bulb yield, total bulb yield and days to harvesting. Bulb quality parameters such as total soluble solids (TSS), reducing sugar, non-reducing sugar and total sugar were estimated using standard laboratory procedures. Bulbs were also graded into A, B, C, bolter, double, undersized and rotten categories based on bulb size and marketable quality.

Statistical analysis

The experimental data were subjected to analysis of variance (ANOVA) for Randomized Block Design following the procedure described by Panse *et al.* (1967) [10]. The significance of differences among hybrids was tested at the 5% level of significance and the standard error of mean ($SEm^{\pm}$), critical difference (CD) and coefficient of variation (CV) were calculated for all the studied characters.

Results and discussion

Growth parameters

Significant variation was observed among the fifteen onion hybrids for growth parameters under the agro-climatic conditions of Chhattisgarh (Table 1). The differences observed in vegetative characters indicate the genetic variability and adaptability of the hybrids under the experimental conditions.

Plant height (cm)

Plant height ranged from 47.71 to 62.33 cm among the fifteen onion hybrids (Table 1). The highest plant height was recorded in RAH-25-57 (62.33 cm), followed by RBH-25-75 (60.61 cm) and RBH-25-71 (60.10 cm), whereas the lowest plant height was observed in RCH-25-82 (47.71 cm). The variation in plant height among the hybrids indicated differences in vegetative growth and adaptability under the Chhattisgarh agro-climatic conditions. Similar findings were reported by Bal *et al.* (2020) [7] and Upadhyay *et al.* (2020) [8].

Number of leaves per plant

The number of leaves per plant ranged from 9.07 to 12.58 (Table 1). The highest number of leaves was recorded in RBH-25-71 (12.58), followed by RAH-25-55 (11.75) and RAH-25-57 (11.73), while the lowest number of leaves was observed in RAH-25-59 (9.07). Hybrids with a higher number of leaves are expected to produce more photosynthates, thereby favouring bulb growth and yield. Similar observations were reported by Upadhyay *et al.* (2020) [8].

Leaf length (cm)

Leaf length ranged from 36.88 to 47.28 cm (Table 1). The highest leaf length was recorded in RBH-25-71 (47.28 cm), followed by RBH-25-69 (46.24 cm) and RBH-25-75 (45.51 cm), while the lowest leaf length was observed in RCH-25-82 (36.88 cm). Longer leaves pro-

vide a greater photosynthetic surface area, resulting in better vegetative growth and bulb development. Similar observations were reported by Chattoo *et al.* (2015) [11] and Bal *et al.* (2020) [7].

Neck length (cm)

Neck length ranged from 2.98 to 4.29 cm (Table 1). The highest neck length was recorded in RBH-25-71 (4.29 cm), followed by RBH-25-69 (4.26 cm) and RBH-25-75 (4.01 cm), whereas the lowest neck length was observed in RBH-25-67 (2.98 cm). Shorter neck length is considered desirable because it is associated with better bulb maturity and storage quality. Similar findings were reported by Upadhyay *et al.* (2020) [8].

Neck thickness (cm)

The average neck thickness ranged from 0.79 to 1.23 cm among the fifteen onion hybrids (Table 1). The minimum neck thickness was recorded in RCH-25-84 (0.79 cm), followed by RBH-25-67 (0.86 cm) and RBH-25-69 (0.87 cm). In contrast, the maximum neck thickness was observed in RAH-25-61 (1.23 cm), followed by RBH-25-75 (1.17 cm) and RCH-25-86 (1.12 cm). Thinner necks are generally associated with improved bulb curing, reduced storage losses and better keeping quality. Similar findings were reported by Bal *et al.* (2020) [7] and Upadhyay *et al.* (2020) [8].

Polar diameter (cm)

Polar diameter ranged from 4.28 to 5.98 cm (Table 1). The highest polar diameter was recorded in RBH-25-71 (5.98 cm), followed by RBH-25-69 (5.71 cm) and RAH-25-57 (5.61 cm), whereas the lowest polar diameter was observed in RCH-25-84 (4.28 cm). Larger polar diameter indicates better bulb development and contributes positively to bulb size and yield. Similar findings were reported by Bal *et al.* (2020) [7] and Gupta *et al.* (2024) [9].

Equatorial diameter (cm)

Equatorial diameter ranged from 5.06 to 6.44 cm (Table 1). The highest equatorial diameter was recorded in RBH-25-71 (6.44 cm), followed by RAH-25-57 (6.27 cm) and RBH-25-69 (5.89 cm), whereas the lowest equatorial diameter was observed in RCH-25-78 (5.06 cm). Larger equatorial diameter is an important marketable trait because it is directly associated with bulb size and bulb weight. Similar observations were reported by Upadhyay *et al.* (2020) [8] and Bal *et al.* (2020) [7].

Days to harvesting

Days to harvesting ranged from 118.00 to 123.33 days among the evaluated hybrids (Table 1). The maximum days to harvesting were recorded in RBH-25-75 (123.33 days), followed by RBH-25-73 (123.00 days) and RBH-25-69 (122.00 days), whereas the minimum days to harvesting were observed in RAH-25-55 (118.00 days) and RAH-25-57 (118.00 days). The variation in maturity period indicated differences in the growth duration of the hybrids under rabi conditions.

PH- Plant height (cm), NOL-Number of leaves per plant, NL- Neck length (cm), LL- Leaf length (cm), PD-Polar diameter (cm), ED-Equatorial diameter (cm), NT- Neck thickness (cm), D to H- Days to harvesting from transplanting,

Yield parameters

ABW- Average bulb weight (g), NB- No. of bulb per plot (%), BFW- Bulb fresh weight (kg/plot), %A- % A grade bulb (by number), %B- % B grade bulbs (by number), %C- % C grade bulbs (by number), MY-Marketable yield (A+B+C) (q/ha), TY-Total yield (q/ha),

Average bulb weight (g)

Average bulb weight ranged from 50.21 to 76.90 g among the fifteen onion hybrids (Table 2). The highest average bulb weight was recorded in RBH-25-71 (76.90 g), followed by RBH-25-75 (70.43 g) and RCH-25-86 (68.75 g), whereas the lowest average bulb weight was observed in RAH-25-59 (50.21 g). Higher average bulb weight contributes directly to increased marketable bulb yield. Similar find

ings were reported by Upadhyay *et al.* (2020) [8] and Gupta *et al.* (2024) [9].

Table 1. Mean performance of onion hybrids for growth parameters under Chhattisgarh Plains

GENOTYPES	PH	NOL	LL	NL	NT	PD	ED	DTH
RAH-25-55	55.14	11.75	41.51	3.24	0.98	4.61	5.87	118.00
RAH-25-57	62.33	11.73	45.38	3.59	1.02	5.61	6.27	118.00
RAH-25-59	54.29	9.07	42.50	3.20	1.09	4.99	5.59	119.00
RAH-25-61	56.03	10.20	39.88	3.80	1.23	5.08	5.89	119.00
RAH-25-63	54.24	10.40	40.86	3.92	1.03	5.10	5.53	119.00
RBH-25-67	57.14	9.52	40.84	2.98	0.86	5.13	5.35	118.33
RBH-25-69	59.78	10.15	46.24	4.26	0.87	5.71	5.89	122.00
RBH-25-71	60.10	12.58	47.28	4.29	0.94	5.98	6.44	122.00
RBH-25-73	59.74	9.97	43.56	3.44	1.03	4.82	5.32	123.00
RBH-25-75	60.61	11.03	45.51	4.01	1.17	4.92	5.54	123.33
RCH-25-78	49.84	10.95	39.85	3.40	0.90	4.74	5.06	120.00
RCH-25-80	53.72	10.92	42.20	3.54	1.11	4.97	5.38	120.00
RCH-25-82	47.71	10.02	36.88	3.65	0.88	4.98	5.33	120.67
RCH-25-84	50.52	11.08	41.13	3.61	0.79	4.28	5.10	121.33
RCH-25-86	56.55	10.23	42.53	3.13	1.12	4.61	5.19	121.00
CD@5%	7.74	1.48	5.05	0.67	0.23	0.62	0.72	3.00
CV (%)	8.29	8.34	7.12	11.11	13.76	7.37	7.75	1.49

Number of bulbs per plot

The number of bulbs per plot ranged from 214.67 to 276.33 (Table 2). The highest number of bulbs was recorded in RAH-25-57 (276.33), followed by RAH-25-55 (270.33) and RBH-25-67 (269.00), whereas

the lowest number of bulbs was observed in RAH-25-59 (214.67). Variation in bulb number among the hybrids influenced the overall bulb yield under Chhattisgarh conditions. Similar observations were reported by Bal *et al.* (2020) [7].

Table 2. Mean performance of onion hybrids for yield and yield-attributing parameters under Chhattisgarh Plains

GENOTYPES	ABW	NB	BFW	A (%)	B (%)	C (%)	MY	TY
RAH-25-55	66.45	270.33	16.02	53.64	25.16	17.76	309.51	320.40
RAH-25-57	67.06	276.33	15.58	47.77	32.57	13.03	289.38	311.60
RAH-25-59	50.21	214.67	11.69	43.79	26.09	20.96	209.82	233.00
RAH-25-61	55.37	231.00	12.37	43.72	32.03	14.72	223.25	247.40
RAH-25-63	51.87	256.00	12.40	42.19	32.03	12.50	220.29	248.00
RBH-25-67	61.39	269.00	14.94	46.84	23.79	20.82	268.72	298.80
RBH-25-69	60.16	264.00	14.23	44.32	32.20	13.64	255.57	284.60
RBH-25-71	76.90	226.68	16.74	54.70	24.70	17.65	309.91	334.80
RBH-25-73	66.77	261.33	15.73	48.98	26.02	16.07	285.93	314.60
RBH-25-75	70.43	236.00	15.69	50.00	32.20	11.02	288.55	313.80
RCH-25-78	62.08	246.69	14.38	45.81	33.24	11.35	264.41	287.60
RCH-25-80	65.25	251.34	15.33	48.14	23.87	20.69	279.12	306.60
RCH-25-82	57.45	234.00	12.94	41.88	31.62	15.38	224.35	258.80
RCH-25-84	56.50	266.36	13.22	40.92	31.54	14.64	231.44	264.40
RCH-25-86	68.75	240.68	15.39	49.86	25.76	14.54	279.43	307.80
CD@5%	10.40	33.49	2.82	7.52	6.79	4.67	60.35	56.62
CV (%)	9.95	8.02	11.68	9.60	14.07	17.82	13.74	11.72

Bulb fresh weight per plot (kg)

Bulb fresh weight per plot ranged from 11.69 to 16.74 kg (Table 2). The highest bulb fresh weight was recorded in RBH-25-71 (16.74 kg), followed by RAH-25-55 (16.02 kg) and RBH-25-73 (15.73 kg), whereas the lowest bulb fresh weight was observed in RAH-25-59 (11.69 kg). Hybrids with higher fresh bulb weight exhibited superior productivity under the experimental conditions. Similar findings were reported by Upadhyay *et al.* (2020) [8]

A-grade bulbs (%)

The percentage of A-grade bulbs ranged from 40.92 to 54.70% (Table 2). The highest percentage of A-grade bulbs was recorded in RBH-25-71 (54.70%), followed by RAH-25-55 (53.64%) and RBH-25-75 (50.00%), whereas the lowest percentage was observed in RCH-25-84 (40.92%). A higher proportion of A-grade bulbs indicates better marketable bulb size and commercial value. Similar observations were reported by Singh *et al.* (2020).

B-grade bulbs (%)

B-grade bulbs ranged from 23.79 to 33.24% among the hybrids (Table 2). The highest percentage of B-grade bulbs was recorded in RCH-25-78 (33.24%), followed by RAH-25-57 (32.57%) and RBH-25-69 (32.20%), whereas the lowest percentage was observed in RBH-25-67 (23.79%). The variation in B-grade bulbs reflects differences in bulb size distribution among the hybrids.

C-grade bulbs (%)

The percentage of C-grade bulbs ranged from 11.02 to 20.96% (Table 2). The highest percentage of C-grade bulbs was recorded in RAH-25-59 (20.96%), followed by RBH-25-67 (20.82%) and RCH-25-80 (20.69%), whereas the lowest percentage was observed in RBH-25-75 (11.02%). Hybrids with a lower proportion of C-grade bulbs are considered more desirable for commercial cultivation because they produce a higher percentage of marketable bulbs.

Marketable bulb yield ($q\ ha^{-1}$)

Marketable bulb yield ranged from 209.82 to 309.91 $q\ ha^{-1}$ among the fifteen onion hybrids (Table 2). The highest marketable bulb yield was recorded in RBH-25-71 (309.91 $q\ ha^{-1}$), followed by RAH-25-55 (309.51 $q\ ha^{-1}$) and RAH-25-57 (289.38 $q\ ha^{-1}$), whereas the lowest marketable bulb yield was observed in RAH-25-59 (209.82 $q\ ha^{-1}$). The superior marketable yield of these hybrids may be attributed to their higher bulb weight and greater proportion of A-grade bulbs. Similar findings were reported by Gupta *et al.* (2024) [9] and Upadhyay *et al.* (2020) [8].

Total bulb yield ($q\ ha^{-1}$)

Total bulb yield ranged from 233.00 to 334.80 $q\ ha^{-1}$ among the evaluated hybrids (Table 2). The highest total bulb yield was recorded in RBH-25-71 (334.80 $q\ ha^{-1}$), followed by RAH-25-55 (320.40 $q\ ha^{-1}$) and RBH-25-73 (314.60 $q\ ha^{-1}$), whereas the lowest total bulb yield was observed in RAH-25-59 (233.00 $q\ ha^{-1}$). The higher total bulb yield observed in RBH-25-71 indicates its superior yield potential and adaptability under the Chhattisgarh agro-climatic conditions. Similar results were reported by Bal *et al.* (2020) [7], Gupta *et al.* (2024) [9] and Upadhyay *et al.* (2020) [8].

Bulb quality parameters**Total soluble solids (TSS, °Brix)**

Total soluble solids ranged from 9.83 to 12.83 °Brix among the fifteen onion hybrids (Table 3). The highest TSS was recorded in RBH-25-69 (12.83 °Brix), followed by RCH-25-78 (11.83 °Brix) and RBH-25-75 (11.33 °Brix), whereas the lowest TSS was observed in RAH-25-57 (9.83 °Brix). Higher TSS is considered a desirable quality trait as it improves bulb flavour, dry matter content and storage potential. Similar findings were reported by Sharma *et al.* (2014) [12] and Mota *et al.* (2019) [13].

Reducing sugar (%)

Reducing sugar content ranged from 2.59 to 3.70% among the evaluated hybrids (Table 3). The highest reducing sugar content was recorded in RBH-25-69 (3.70%), followed by RCH-25-78 (3.56%) and RAH-25-61 (3.48%), while the lowest was observed in RAH-25-57 (2.59%). Variation in reducing sugar content among hybrids may be attributed to genetic differences affecting bulb quality and taste. Similar observations were reported by Mota *et al.* (2019) [13].

Non-reducing sugar (%)

Non-reducing sugar ranged from 3.88 to 5.55% among the fifteen onion hybrids (Table 3). The highest non-reducing sugar was recorded in RBH-25-69 (5.55%), followed by RCH-25-78 (5.35%) and RBH-25-75 (5.22%), whereas the lowest was observed in RAH-25-57 (3.88%). The variation in non-reducing sugar content reflects differences in carbohydrate composition among the hybrids.

Total sugar (%)

Total sugar content ranged from 6.47 to 9.25% among the evaluated onion hybrids (Table 3). The highest total sugar was recorded in RBH-25-69 (9.25%), followed by RCH-25-78 (8.91%) and RBH-25-75 (8.70%), while the lowest total sugar was observed in RAH-25-57 (6.47%). Higher total sugar content contributes to better flavour and consumer acceptability of onion bulbs. Similar findings were reported by Sharma *et al.* (2014) [12] and Mota *et al.* (2019) [13].

Table 3. Mean performance of onion hybrids for bulb quality parameters under Chhattisgarh Plains

GENOTYPES	Total Soluble Solids	Reducing Sugar	Non-Reducing Sugar	Total Sugar
RAH-25-55	10.03	3.17	4.76	7.93
RAH-25-57	9.83	2.59	3.88	6.47
RAH-25-59	11.07	3.22	4.82	8.04
RAH-25-61	11.33	3.48	5.21	8.69
RAH-25-63	10.67	3.08	4.63	7.71
RBH-25-67	10.17	2.98	4.48	7.46
RBH-25-69	12.83	3.70	5.55	9.25
RBH-25-71	10.40	3.14	4.71	7.85
RBH-25-73	11.18	3.26	4.88	8.14
RBH-25-75	11.33	3.48	5.22	8.70
RCH-25-78	11.83	3.56	5.35	8.91
RCH-25-80	11.27	3.28	4.92	8.20
RCH-25-82	10.67	3.13	4.69	7.82
RCH-25-84	10.39	2.98	4.48	7.46
RCH-25-86	10.17	2.90	4.35	7.25
CD@5%	0.56	0.24	0.36	0.59
CV (%)	3.09	4.44	4.48	4.45

Conclusion

The present investigation demonstrated significant variation among the fifteen onion hybrids for growth, yield and bulb quality traits under the agro-climatic conditions of the Chhattisgarh plains. Among

the evaluated hybrids, RBH-25-71 exhibited superior performance by recording the highest marketable bulb yield (309.91 $q\ ha^{-1}$) and total bulb yield (334.80 $q\ ha^{-1}$), along with higher average bulb weight, larger equatorial diameter and the maximum percentage of A-grade bulbs. RAH-25-55 and RBH-25-73 also performed consistently well

for important growth and yield attributes, indicating their suitability for cultivation in the region. Considerable variation in total soluble solids and sugar content further revealed differences in bulb quality among the hybrids.

Based on the overall performance, RBH-25-71 emerged as the most promising onion hybrid under the agro-climatic conditions of the Chhattisgarh plains due to its superior growth, higher marketable and total bulb yield, larger bulb size and desirable bulb quality attributes. RAH-25-55 and RBH-25-73 also exhibited consistently good performance for important growth and yield parameters and may be considered as promising alternatives for commercial cultivation in the region. The identified superior hybrids can be utilized for enhancing onion productivity and producing better quality bulbs under the Chhattisgarh plains, thereby providing useful information for farmers, researchers and future onion improvement programmes.

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