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Performance evaluation of onion (*Allium cepa*) genotypes for growth, yield, quality and pest incidence in Dharwad, Karnataka, India

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Abstract

The performance of 50 onion (*Allium cepa* L.) genotypes for growth, yield, bulb quality and pest incidence evaluated during the *rabi* 2023-24 and 2024-25 at University of Agricultural Sciences, Dharwad, Karnataka. Pooled analysis of variance (ANOVA) revealed significant genotypic differences for all traits in both seasons. High yielding genotypes were NHRDF Red-2 (50.89 tonnes/ha in 2024-25), NHRDF Red-4 (47.72 tonnes/ha) and Bhima Raj (46.42 tonnes/ha). Genotype Telagi-L exhibited desirable thin neck thickness (0.52 cm), while DOGR-1771 showed high dry matter content (18.42 g). Low pest incidence was observed in NHRDF Red-4 and NHRDF Red-2 (0.50% and 0% purple blotch, respectively) and Arakera local (0.51 thrips/plant). These findings highlight superior genotypes for cultivation and potential use in breeding programmes in similar agroclimatic regions.

Key words: Genotypes, Yield attributes, Bulb quality, Pest incidence, *Rabi*.

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Onion (*Allium cepa* L.), a biennial herb of Alliaceae family, is a critical vegetable crop globally, ranking fourth among consumable vegetables after tomato, cabbage, and watermelon (Best, 2000). In India, onion cultivation spans 1.54 million ha., producing 24.21 million tonnes with a productivity of 16.10 tonnes/ha, while Karnataka contributes 0.25 million hectares with 2.05 million tonnes at 14.17 tonnes/ha (MA&FW New Delhi, 2024). Despite its economic importance, India's productivity lags behind countries like the USA (55.95 tonnes/ha) and the Netherlands (49.70 tonnes/ha), largely due to limited adoption of high-yielding hybrids and region-specific genotypes (Gupta *et al.*, 2024).

Onion crop is affected by its photo-thermo sensitivity, requiring specific temperature (12.8–25.0°C) and day length (12–13 hours for *rabi* varieties) for optimal growth and bulb development (Thamburaj and Singh, 2019). Genotypic variation in traits such as plant height, bulb yield, total soluble solids (TSS), and pest resistance is critical for selecting suitable cultivars for specific regions (Malik *et al.*, 2024; Rani *et al.*, 2024). Therefore, performance of 50 onion genotypes over two *rabi* seasons (2023-24 and 2024-25), focusing on growth, yield, bulb quality, and pest incidence to identify superior genotypes for cultivation was evaluated at Dharwad.

MATERIALS AND METHODS

The experiment was conducted at Horticultural Research Station, University of Agricultural Sciences, Dharwad (15°26'N, 75°07'E, 678 m ASL) during *rabi* seasons 2023-24 and 2024-25. The soil was medium black clay with a pH of 7.5. A randomized complete block design with two replications was used. Seedlings were raised in nursery beds. The seedlings of 60 days old were transplanted at into plots of 1 m × 1.2 m at 15 cm × 10 cm spacing. Fifty genotypes, were collected from institutions. These included red, light red, dark red, and white bulb types. Five plants per replication were sampled at maturity (120–150 days post-transplanting). Pooled ANOVA was performed using OPSTAT software, with critical difference (CD) calculated at 5% significance. Weather conditions varied between seasons. In 2023-24, total rainfall was 510.70 mm, with average maximum and minimum temperatures of 31.85°C and 18.95°C, respectively, and maximum relative humidity of 76.76%. In 2024-25, rainfall increased to 976.10 mm, with average maximum and minimum temperatures of 31.17°C and 18.89°C and maximum relative humidity of 81.14%.

RESULTS AND DISCUSSION

Pooled ANOVA showed significant genotypic effects ($P<0.05$) for all traits, indicating substantial genetic variability (Table 1). Replication effects were significant only for bulb polar and equatorial diameters, suggesting stable genotypic performance in both the seasons. Low error variances and coefficients of variation for most traits (e.g., 8.47% for plant height, 0.29% for thrips incidence) confirm the reliability of data. Genotypic performance for growth traits showed consistency across seasons. Bagdal Local had the highest pooled plant height (56.53 cm), followed by Bhima Safed (56.43 cm) and Bhima Raj (55.85 cm). Bhima Safed recorded the highest pooled number of leaves/plant (10.00), followed by W-364 GP, Bhima Shweta, Bhima Shubra and W-344 (9.75 each). Leaf area and LAI were highest in DOGR-1769 (498.21 cm^2, 3.32)

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Table 1: Pooled Analysis of variance for yield and yield attributing traits of onion genotypes

Source of variation/ parameter	Means			S.Em±	CD (5%)
	Replication	Genotypes	Error		
Degrees of freedom	**1**	**49**	**49**		
Plant height (cm)	449.86	40.58*	6.05	1.74	4.94
Number of leaves plant	0.04	0.87*	1.07	0.73	2.08
Leaf area (cm^2)	39315.75	4208.46*	417.31	14.44	41.05
Leaf area index	1.74	0.19*	0.02	0.10	0.27
Days to maturity (days)	28.09	12.43*	6.48	1.80	5.11
Pre-mature bolting (%)	5.29	2.18*	0.88	0.66	1.88
Bulb polar diameter (cm)	1182.67	23.11*	28.83	3.80	10.79
Bulb equatorial diameter (cm)	1028.29	23.63*	5.29	1.63	4.62
Bulb shape index	0.01	0.02*	0.00	0.04	0.11
Bulb neck thickness (cm)	0.02	0.05*	0.01	0.07	0.21
Number of rings per bulb	0.25	1.72*	0.55	0.52	1.48
Bulb dry matter content (g)	0.43	2.41*	0.40	0.45	1.27
Total soluble solid (^{0}B)	12.62	3.47*	0.20	0.31	0.89
Average weight of bulb (g)	8447.26	92.55*	65.74	5.73	16.29
Bulb yield per plot (kg)	0.20	0.39*	0.02	0.11	0.30
Bulb yield per hectare (t)	19.70	39.24*	2.25	1.06	3.01
Purple blotch incidence	65.61	0.76*	0.68	0.58	1.66
Thrips incidence	0.01	15.54*	0.00	0.01	0.03

* Significant at 5 % level of significance

Table 2: Mean performance of onion genotypes for bulb yield quality and pest incidence parameters

Genotype	Bulb dry matter			TSS			Avg. weight of bulb			Bulb yield (t/ ha)			Purple blotch (%)			Thrips		
	23-24	24-25	Pooled	23-24	24-25	Pooled	23-24	24-25	Pooled	23-24	24-25	Pooled	23-24	24-25	Pooled	23-24	24-25	Pooled
Arka Bheem	14.21	13.39	13.80	13.10	13.75	13.43	74.80	63.43	69.12	33.94	33.37	33.66	2.00	3.50	2.75	4.47	4.45	4.46
Balichakra-W	15.57	15.83	15.70	16.05	15.34	15.70	75.55	57.65	66.60	34.50	32.77	33.64	2.00	2.00	2.00	6.01	5.98	6.00
Bagdal Local	15.13	15.37	15.25	11.75	13.34	12.55	72.30	55.18	63.74	42.58	37.54	40.06	1.50	2.50	2.00	5.04	5.02	5.03
Arka Kalyan	15.90	18.18	17.04	13.10	13.76	13.43	67.80	61.90	64.85	41.37	43.32	42.35	1.00	3.50	2.25	2.31	2.29	2.30
Balichakra-R	16.21	16.46	16.34	11.80	12.39	12.10	84.15	57.38	70.77	48.69	44.94	46.82	1.00	1.50	1.25	3.90	3.88	3.89
NHRDF Red	14.97	16.73	15.85	15.65	15.43	15.54	80.95	69.13	75.04	37.90	37.49	37.70	2.50	2.00	2.25	4.70	4.67	4.69
Telagi -L	15.25	15.49	15.37	11.70	12.81	12.26	81.70	75.35	78.53	39.14	39.33	39.24	2.00	1.50	1.75	3.68	3.65	3.67
Telagi -W	14.54	14.77	14.66	11.50	12.07	11.79	91.40	65.90	78.65	29.61	31.96	30.79	1.00	3.00	2.00	5.60	5.57	5.59
Bellary Red	15.23	15.47	15.35	12.50	13.13	12.82	73.80	60.38	67.09	43.23	41.70	42.47	1.50	2.00	1.75	1.59	1.59	1.59
GWO-1	15.94	16.19	16.07	12.35	12.97	12.66	76.00	66.85	71.43	43.70	41.36	42.53	1.00	3.50	2.25	4.35	4.34	4.35
GJRO-11	15.59	15.83	15.71	14.60	14.85	14.73	68.40	56.88	62.64	41.52	39.95	40.74	2.00	4.00	3.00	5.88	5.85	5.87
GJWO-3	15.13	15.37	15.25	14.85	15.59	15.22	80.75	64.20	72.48	32.31	33.71	33.01	1.00	3.50	2.25	4.33	4.30	4.32
Bhima Red	14.49	14.72	14.61	11.30	11.87	11.59	91.90	61.28	76.59	40.82	41.79	41.31	1.00	3.50	2.25	5.21	5.19	5.20
DOGR-1770	13.91	14.13	14.02	9.80	10.29	10.05	92.90	69.68	81.29	42.44	39.38	40.91	1.00	3.00	2.00	4.63	4.61	4.62
DOGR-1760	12.53	12.73	12.63	10.65	11.19	10.92	78.95	88.45	83.70	45.94	43.79	44.87	0.00	3.00	1.50	4.19	4.16	4.18
DOGR-1761	15.89	16.14	16.02	10.95	10.97	10.96	76.65	69.33	72.99	44.42	41.39	42.91	1.00	3.50	2.25	3.78	3.75	3.77
DOGR-1771	18.14	18.42	18.28	12.95	13.60	13.28	79.10	54.30	66.70	40.49	37.59	39.04	1.00	2.50	1.75	3.95	3.93	3.94
DOGR-1773	13.20	13.41	13.31	12.15	12.76	12.46	83.85	61.20	72.53	39.41	37.36	38.39	1.00	2.50	1.75	1.62	1.63	1.63
DOGR-1774	14.25	14.47	14.36	11.65	12.24	11.95	81.60	66.85	74.23	41.52	40.13	40.83	1.00	3.00	2.00	8.02	7.99	8.01
Bhima Super	13.89	14.11	14.00	12.90	13.54	13.22	82.05	76.90	79.48	43.05	40.15	41.60	1.00	4.00	2.50	2.09	2.08	2.09
Bhima Raj	15.05	15.28	15.17	10.35	10.87	10.61	85.40	69.33	77.37	45.42	46.42	45.92	1.00	3.50	2.25	2.07	2.07	2.07
Bhima Shakti	16.93	17.19	17.06	11.20	13.26	12.23	81.70	74.58	78.14	43.65	41.25	42.45	1.00	2.00	1.50	4.33	4.30	4.32
BhimaLightRed	14.51	14.74	14.63	12.05	12.65	12.35	74.60	57.18	65.89	39.05	40.07	39.56	1.00	1.00	1.00	1.98	1.97	1.98
DOGR-1772	13.25	13.46	13.36	13.10	13.76	13.43	75.55	60.43	67.99	39.81	41.83	40.82	0.50	2.50	1.50	1.92	1.91	1.92
DOGR-1769	15.09	15.33	15.21	10.60	11.13	10.87	77.20	65.45	71.33	45.21	41.00	43.11	1.00	1.00	1.00	8.39	8.35	8.37
DOGR-1768	14.39	14.61	14.50	10.50	11.03	10.77	83.45	78.10	80.78	34.04	33.38	33.71	0.50	2.00	1.25	11.00	10.93	10.97
BhimaDarkRed	15.73	15.97	15.85	9.50	12.98	11.24	84.95	68.98	76.97	34.46	35.13	34.80	0.00	1.00	0.50	6.42	6.40	6.41
Bhima Kiran	14.59	14.82	14.71	9.55	12.03	10.79	94.25	65.25	79.75	45.73	39.81	42.77	1.00	2.50	1.75	8.02	7.99	8.01
W-364 GP	14.55	14.78	14.67	11.80	12.39	12.10	96.60	71.18	83.89	36.53	40.29	38.41	0.00	3.50	1.75	6.28	6.26	6.27

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Genotype	Bulb dry matter			TSS			Avg. weight of bulb			Bulb yield (t/ ha)			Purple blotch (%)			Thrips		
	23-24	24-25	Pooled	23-24	24-25	Pooled	23-24	24-25	Pooled	23-24	24-25	Pooled	23-24	24-25	Pooled	23-24	24-25	Pooled
BhimaShweta	14.47	14.20	14.34	12.75	14.39	13.57	79.30	54.60	66.95	40.26	38.78	39.52	0.00	3.00	1.50	4.01	3.99	4.00
W-405	17.59	15.86	16.73	11.10	11.65	11.38	80.55	58.80	69.68	31.99	30.94	31.47	0.00	3.50	1.75	11.85	11.78	11.82
Bhima Shubra	14.94	15.17	15.06	14.10	14.31	14.21	79.25	67.05	73.15	35.16	35.20	35.18	1.00	2.00	1.50	1.74	1.73	1.74
Bhima Safed	14.91	15.14	15.03	13.10	13.76	13.43	73.85	54.95	64.40	40.01	38.94	39.48	0.00	3.00	1.50	7.39	7.35	7.37
W-310-GP	16.80	16.59	16.70	11.70	12.29	12.00	82.95	66.00	74.48	33.09	34.73	33.91	1.00	2.50	1.75	3.06	3.09	3.08
W-344	15.11	15.35	15.23	10.75	11.79	11.27	93.95	62.28	78.12	42.99	41.17	42.08	0.00	2.50	1.25	3.33	3.32	3.33
W-355	16.51	16.27	16.39	11.75	12.34	12.05	96.85	77.83	87.34	40.52	41.03	40.78	0.00	3.00	1.50	0.90	0.91	0.91
W-361	17.09	15.36	16.23	13.40	14.07	13.74	88.00	68.73	78.37	40.96	37.74	39.35	0.00	2.50	1.25	2.01	2.01	2.01
W-504	16.01	14.76	15.39	13.65	14.33	13.99	95.85	53.20	74.53	33.20	33.69	33.45	0.50	2.50	1.50	8.99	8.94	8.97
W-448	16.03	16.28	16.16	12.15	12.76	12.46	92.50	58.75	75.63	44.95	40.06	42.51	0.00	3.00	1.50	6.35	6.32	6.34
W-125-GP	15.22	15.46	15.34	13.00	13.65	13.33	58.35	69.70	64.03	34.27	35.81	35.04	1.00	2.50	1.75	12.35	12.29	12.32
W-210-GP	15.41	15.67	15.54	12.90	13.54	13.22	95.80	59.18	77.49	33.15	34.12	33.64	0.50	3.00	1.75	8.45	8.41	8.43
W-203-GP	16.02	18.81	17.42	12.40	13.02	12.71	77.75	61.95	69.85	36.69	37.60	37.15	0.50	3.50	2.00	8.13	8.09	8.11
W-408	16.85	15.61	16.23	11.80	12.36	12.08	86.05	65.85	75.95	40.73	39.70	40.22	0.00	2.00	1.00	5.27	5.26	5.27
Furasangi	13.81	16.05	14.93	13.15	13.81	13.48	96.45	72.35	84.40	45.40	44.49	44.95	1.00	1.00	1.00	1.21	1.21	1.21
AFLR	15.65	14.39	15.02	12.50	13.13	12.82	83.90	64.85	74.38	46.33	44.51	45.42	0.50	1.00	0.75	7.70	7.66	7.68
NHRD Red-4	14.60	15.33	14.97	11.95	12.55	12.25	103.60	73.28	88.44	47.43	47.72	47.58	1.00	0.00	0.50	3.35	3.35	3.35
NHRDFRed-2	15.65	13.86	14.76	11.35	11.92	11.64	113.35	66.50	89.93	50.24	50.89	50.57	0.00	0.00	0.00	4.26	4.25	4.26
AFDR	13.25	13.97	13.61	10.80	11.34	11.07	96.80	61.23	79.02	40.96	38.93	39.95	0.00	2.00	1.00	5.19	5.15	5.17
Arakera local	14.94	15.17	15.06	11.15	11.71	11.43	66.10	64.63	65.37	34.43	36.64	35.54	0.00	0.50	0.25	0.51	0.51	0.51
N-53	16.25	15.00	15.63	14.45	14.66	14.56	81.70	57.70	69.70	37.72	35.68	36.70	1.00	1.00	1.00	6.54	6.48	6.51
S.Em±	0.90	0.96	0.45	0.86	0.93	0.31	7.76	5.55	5.73	3.38	2.80	1.06	0.26	0.51	0.58	0.47	0.44	0.01
CD (5%)	2.57	2.72	1.27	2.44	2.64	0.89	22.05	15.76	16.29	9.62	7.95	3.01	0.73	1.45	1.66	1.33	1.25	0.03
CV	8.40	8.80	4.15	9.96	10.18	3.52	13.15	12.06	10.92	11.96	10.11	3.79	45.78	29.93	51.59	13.33	12.61	0.29

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and N-53 (497.42 cm², 3.32) in 2024-25, indicating strong photosynthetic capacity (Verma *et al.*, 2022). Days to maturity ranged from 87.50 days (DOGR-1774) to 100.00 days (Balichakra-W, Bhima Kiran, AFLR) in 2024-25. Bolting was lowest (0%) in NHRDF Red, GJWO-3 and DOGR-1769 in 2024-25, with a pooled minimum of 0% in W-310-GP and W-125-GP. These results align with those of Malik *et al.* (2024). The higher rainfall during 2024-25 (976.10 mm vs. 510.70 mm in 2023-24) likely influenced vegetative growth, reducing plant height in some genotypes (GJRO-11: 61.75 cm in 2023-24 to 50.45 cm in 2024-25).

Bulb traits exhibited significant variation. Telagi-W had highest pooled polar diameter (52.86 cm in 2024-25), while Bhima Shweta had the lowest (34.96 cm). W-504 showed the largest equatorial diameter (63.27 cm), and Balichakra-R and AFDR had highest shape index (1.04). Telagi-L exhibited thinnest neck (0.52 cm), ideal for storage (Gupta *et al.*, 2024). W-448 had the highest number of rings/bulb (11.50 pooled), DOGR-1771 the highest dry matter (18.42 g) and GJWO-3 the highest TSS (15.59 °Brix) in 2024-25 (Table 2.). Thin neck thickness and high TSS are critical for storage and processing (Saha *et al.*, 2024). The consistency of traits like neck thickness across seasons suggests genetic stability, as noted by Rani *et al.* (2024).

Bulb yield ranged from 30.94 tonnes/ha (W-405) to 50.89 tonnes/ha (NHRDF Red-2) in 2024-25. Other high yielding NHRDF Red-4 (47.72 tonnes/ha), Bhima Raj (46.42 tonnes/ha), and Balichakra-R (44.94 tonnes/ha). DOGR-1760 recorded the highest bulb weight (88.45 g). Pooled yield data showed stable performance for top genotypes, despite higher rainfall during 2024-25, which may have enhanced bulb development in some genotypes (Choudhary *et al.*, 2022).

Pooled pest incidence data (Table 2) showed NHRDF Red-2 (0%) and Arakera local (0.25%) with the lowest purple blotch incidence and Arakera local (0.51) and W-355 (0.91) with the lowest thrips incidence. High thrips incidence was observed in W-125-GP (12.32 pooled) and DOGR-1768 (10.97). Low pest incidence in NHRDF lines aligns with findings of Chauhan *et al.* (2023), suggesting potential resistance.

CONCLUSION

The genotypes Telagi-L (thin neck), DOGR-1771 (high dry matter), and GJWO-3 (high TSS) are suitable for storage and processing. Low pest incidence in NHRDF Red-2 and Arakera local highlights their potential for integrated pest management. These genotypes are recommended for cultivation in Karnataka and similar agroclimatic zones, with potential for use in breeding programmes to enhance yield and quality.

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