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Per se performance for yield and quality attributes in Bathua (*Chenopodium album* L) genotypes

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Abstract
The present investigation was conducted to evaluate the comparative performance of twenty four bathua genotypes at Vegetable field unit, Kittur Rani Channamma College of Horticulture, Arabhavi during 2017-18 following Randomized Complete Block Design with three replications. The study reveals that highly signifiacant difference were observed for most of the traits, it indicating the substantial amount of variation. However, potential of these genotypes is needed to be further tested for the leaf yield and other quality parameters under different climatic conditions of Karnataka to elicit substantial conclusion.

Keywords: Bathua, phenotype, critical value, *Per se* performance

1. Introduction
Bathua (*Chenopodium album* L., 2n=36) is a minor leafy vegetable belongs to spinach family i.e Chenopodiaceae. It is native to Europe and extensively distributed in different parts of world *viz.*, West Indies, South America, North America, Africa, Australia, Oceania and India (Pandey, 2008) [13]. In India, it is usually found in Upper gangetic plains, Kashmir, Punjab, West Bengal, Kumaon (Uttaranchal), Maharastra, Tamil Nadu, Karnataka and Peninsular India. Bathua is an annual hermaphrodite plant which grows to a height of up to 30-200 cm and an excellent leafy vegetable in terms of both taste and nutrition. It is a very rich source of vitamin-A and vitamin-C, protein (Pandey, 2008) [13]. Bathua also shows some medicinal values *Viz.*, laxative, anthelmintic for hookworms, roundworms, antiphlogistic, antirheumatic, odontalgic and also acts as a blood purifier (Sanwal, 2008) [16]. The area and production of bathua in India is very limited, and not commercially grown india only grown in some local area (Pandey, 2008) [13]. Nowdays bathua gaining more popularity in world mainly because of its nutritious leaves and seeds. The area and production of this crop is limited mainly because of the unavailability of high yielding genotypes and also very little systemic attention has been paid to study performance for yield and its components in bathua. Therefore, present study has taken up to find out genotypes which serves high leaf yield and high nutrition.

2. Material and Methods
The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications at Vegetable field unit, Kittur Rani Channamma College of Horticulture, Arabhavi during *Kharif* season in 2017. The details of twenty four genotypes with their source of collection is mentioned in Table 1. The seeds of different genotypes sown in lines at a spacing of 30 x 20 cm. Necessary prophylactic measures were taken to raise a good crop. Bathus genotypes evaluated for seventeen characters which includes 10 yield contributing traits and 7 quality parameters. The observations on growth characters were recorded in five randomly selected and tagged plants in each treatment and average of five plants was computed. ANOVA was done base on RCBD as suggested by Panse and Sukhatme (1985) [14] for each characters separately. The data obtained were analysed using WINDOWSTAT software. Vitamin-A content was estimated by trichloroacetic acid method (Bayfield, *et al.*, 1980) [3]. Vitamin-C content was estimated by volumetric method as suggested by AOAC (2001). Total protein content of leaf from each genotype was estimated using the protocol given by Lowry *et al.* (1951) [11]. The calcium, magnesium, iron, zinc content was estimated using atomic absorption spectrophotometer method using diacid extract prepared from sample (Perkin-Elmer, 1982) [15].

3. Result and Discussion

The analysis of variance (Table 4) revealed the significant difference among the genotypes for all the traits. Mean performance of all 24 bathua genotypes were given in Table 2 and 3. The topranked genotypes in terms of foliage yield per plant in descending order is HUB-7 (144.66 g) and HUB-8 (117 g). The lowest foliage yield recorded in EC-359444 (33.60 g). From the table 2 it is evident that plant height of genotypes varied from 31.93 to 75.89 cm with a total mean of 56.40 cm. Among the 24 genotypes, the genotype HUB – 7 (75.89 cm) recorded maximum while minimum plant height (31.93cm) was observed in HUB-9. Bhargava *et al.* (2007) [5], Selvin *et al.* (2013) [17] and Buragohain *et al.* (2013) [7] also reported differences in plant height among the genotypes bathua and amaranthus respectively under evaluation trails. Number of leaves per plant is another yield increasing trait in bathua. Here, the mean values varied from 47.33 to 124.33 with a grand mean of 91.01(table 2).The genotype EC-359444 (47.33) recorded less number of leaves whereas highest number was recorded in HUB- 7 (124.43). The genotypes HUB – 8 (112.33), HUB-6 (110.2), IC-540842 (108.93) and HUB – 4 (108.93) exhibited significantly higher number of leaves per plant than grand mean. These results are in close conformity with the findings of Buragohain *et al.* (2013) [7], Ahammed *et al.* (2012) and Umakanta *et al.* (2014) [18]. Number of branches of bathua genotype studied varied from 6.66 (EC-359444) to 13.13(HUB- 7) with an average of 10.05. Twelve genotypes were found to be significantly superior to grand mean.

It is clear from table 2 that mean values for leaf area varied from 39.92 to 76.04 cm^2 with a general mean of 57.95 cm^2. The genotype, IC-109235 (39.92 cm^2) recorded less leaf area, while HUB-7 was found to be more leaf area (76.04 cm^2). Three genotypes IC-243192, HUB-6 and HUB-8 were found significantly superior to grand mean similar results were reported in Bhargava *et al.* (2010) and Panda *et al. (*2015) [12]. The mean values for stem girth varied from 1.68 to 2.73 cm with a grand mean of 2.18 cm. Genotype IC-540842 (2.73 cm) shows highest value and genotype NIC-22506 (1.68cm) shows lowest value for stem girth. Five genotypes exhibited lowest values for stem girth than grand mean.

The grand mean for days to first flowering was 39.31. range of days to first flowering among the bathua genotypes evaluated was in between 33.97 (NC-58616) to 42.86 (HUB-6). Four genotypes were found to be significantly superior to grand mean. The bathua genotype NC-58616 took least number of days (36.66) to 50% flowering while, HUB-3 took maximum number of days (50.66) to 50% flowering. On average bathua genotypes took 43.06 days for appearance of 50% flower. These results are in close conformity with the findings Bhargava *et al.* (2008) [6], Arif *et al.* (2013) [2] and Selvin *et al.* (2013) [17], who reported significant variation for days to flowering.

A wide range of variability was observed in foliage yield per plant which is ranged from 33.60 (EC-359444) to 144.66 g (HUB-7) with a over all mean of 62.99 g. The top five genotypes HUB-7(144.66g), HUB-8(117g), HUB-6 (92.83g), IC-540842(85g) and IC-540831(84g)which shows higher foliage yield per plant. Range for foliage yield per plot among bathua genotypes evaluated was in between 0.84 kg (EC-359444) to 2.45 kg (HUB-7) with an grand mean of 1.34 kg. Estimated foliage yield per hectare in bathua genotypes ranged from 5.62 (EC -359444 to 16.37 t (HUB-7) with an average of 8.96 t. Eight genotypes were found to be significantly superior to grand mean. These results could be similar with Yogendra *et al.* (2015), Bhargava *et al.* (2007) [5] and Hasan *et al.* (2013) [10].

Vitamin-A content of leaves in the table 2 indicated significant variation among bathua genotypes, which varied from 248.83 (IC-109249) to 523.73 mg (HUB-7) with grand mean of 389.16 mg. the highest Vitamin-A content reported in HUB-7 (523.73 mg) followed by HUB – 8(497.56mg), HUB – 6 (467.1mg), IC-540842 (465.36mg), IC-540831(423.76mg) (Table.5) the similar results were found in Bhargava *et al.* (2008) [6], Umakanta *et al.* (2014) [18] and Guil *et al.* (1997) [9]. The genotypes HUB-7, HUB – 8, HUB – 6, IC-540842, IC-540831 (Table.5) reported for highest Vitamin- C content of leaves in bathua genotypes studied. The range of Vitamin-C varied from 37.83 to 46.27 mg with grand mean of 43.07 mg. The lowest Vitamin-C content reported in genotype (EC-359444). These results are in close conformity with the findings of Bhargava *et al.* (2007) [5], and Guil *et al.* (1997) [9]. Range of Estimated protein content of leaves in bathua genotypes was in between 2.84 (HUB-9) to 6.04 g (HUB-3) with an average of 4.11 g. eight genotypes were found to be significantly superior compared to grand mean the similar results were found in Galwey *et al.* (1990) [8], Iheanacho *et al.* (2009) and Shukla *et al.* (2005) [7] who reported significant variation for protein content.

Calcium content of leaves varied from 799.83 (HUB-9) to 1599.83 mg (HUB-7) with grand mean of 1202.19 mg (Adedapo *et al.* (2011) and Thoufeek *et al.* (1998). Estimated magnesium content of leaves in bathua genotypes ranged from 72.90 (NIC-22492) to 1440.90 mg (HUB-7) with an average of 597.56 mg (Iheanacho *et al.* (2009). Iron content of leaves in bathua genotypes ranged from 1.41 (IC-4152393) to 11.60 mg (HUB-7) with grand mean of 6.19 mg (Adedapo *et al.* (2011). Zinc content of leaves in bathua genotypes ranged from 0.03 (NC- 50229) to 0.156 mg (HUB-7) with grand mean of 0.11 mg the similar results were found in Bhargava *et al.* (2010) [4] and Bozokalfa *et al.* (2011) who reported significant variation for iron, magnesium and zinc content.

Table 1: Details of bathua genotypes used in study

Sl. No.	Genotypes	Source
1	EC-359444, NC-50229, IC-341703, EC-359445, IC-243192, IC-109249, NIC-22506, NC-58616, NIC-22492, IC-109235, IC-415477, IC-540831, NIC-22517, IC-540842, IC-4152393,	NBPGR, New Delhi
2	HUB – 1, HUB – 2, HUB – 3, HUB – 4, HUB – 5, HUB-6, HUB – 7, HUB – 8, HUB – 9.	Local genotypes collected from different parts of Karnatak.

Table 2: Mean performance of bathua genotypes for growth, earliness, and yield parameters

s/n	Genotype	PH (cm)	NLP	NBP	LA (cm^2)	SG (cm)	DF	DFF	FYP (g)	FYPP (kg)	FYPH (t)
1	EC-359444	43.40	47.33	6.66	40.65	2.30	40.10	44.00	33.60	0.84	5.62
2	NC-50229	48.33	95.80	8.73	64.48	2.36	39.31	40.66	43.13	1.37	7.31
3	HUB – 1	58.46	82.26	10.33	40.72	2.67	37.17	38.33	52.13	1.24	8.29
4	HUB – 2	64.93	82.73	11.06	67.19	2.09	34.18	49.66	64.80	0.93	6.20
5	EC-359445	53.46	72.40	10.26	43.66	2.13	41.18	43.66	41.00	1.07	7.18
6	IC-243192	43.73	102.53	10.26	71.01	2.34	42.85	46.33	52.60	1.36	9.05
7	HUB – 3	51.66	100.66	10.40	69.81	1.76	42.59	50.66	54.06	1.22	8.11
8	IC-341703	65.06	102.86	11.26	67.73	2.30	40.34	43.33	69.86	1.09	9.12
9	HUB – 4	59.66	108.93	11.40	68.70	2.37	40.34	43.00	72.66	1.26	11.59
10	IC-109249	57.46	90.80	12.00	41.10	2.08	37.83	43.00	48.33	1.08	7.20
11	NIC-22506	44.80	79.20	9.93	57.36	1.66	36.92	38.00	53.66	1.17	7.85
12	HUB – 5	47.80	70.60	8.33	44.33	1.88	42.01	46.33	42.50	1.18	7.90
13	NC-58616	53.26	86.73	9.06	56.45	2.31	33.97	36.66	56.66	1.22	8.12
14	NIC-22492	62.60	84.93	7.86	41.80	2.25	42.84	44.33	49.33	1.29	8.61
15	IC-109235	55.93	81.20	9.20	39.92	2.13	41.54	44.00	44.70	44.70	1.35
16	HUB-6	69.73	110.20	9.46	73.74	2.14	42.86	45.00	92.83	92.83	1.42
17	HUB – 8	72.20	112.33	12.06	75.04	2.13	36.30	45.33	117.00	117.00	2.24
18	IC-415477	60.40	91.13	9.80	57.54	2.14	38.38	42.66	53.58	53.58	1.43
19	IC-540831	65.40	92.26	10.40	69.40	2.43	38.51	40.33	84.00	84.00	1.74
20	NIC-22517	60.46	101.80	9.20	59.38	2.12	39.49	41.00	64.70	64.70	1.25
21	HUB – 7	75.89	124.43	13.13	76.04	2.15	37.45	39.00	144.66	144.66	2.45
22	IC-540842	65.60	108.93	11.60	48.94	2.73	39.30	44.33	85.00	85.00	1.51
23	IC-4152393	41.60	80.06	9.66	56.83	1.90	37.72	41.66	44.75	44.75	1.34
24	HUB – 9	31.93	74.40	9.13	59.08	1.87	40.19	42.33	46.33	46.33	1.24
	Mean	56.40	91.01	10.05	57.95	2.18	39.31	43.06	62.99	62.99	1.34
	S.Em±	6.18	10.49	1.12	2.96	0.20	1.39	0.79	4.87	4.87	0.18
	CD (0.05)	17.60	29.86	3.19	8.44	0.59	3.97	2.27	13.88	13.88	0.52
	CV(%)	18.98	19.96	19.30	8.86	16.48	6.15	3.21	13.4	13.4	23.6

Table 3: Mean performance of bathua genotypes for Quality parameters

s/n	Genotype	VA (mg)	VC (mg)	PR (g)	Ca (mg)	Mg (mg)	Fe (mg)	Zn (mg)
1	EC-359444	345.73	37.83	3.78	879.83	5.34	456.90	0.076
2	NC-50229	341.33	43.51	3.85	1079.83	2.96	456.90	0.033
3	HUB – 1	353.83	43.58	3.90	1159.83	5.26	336.90	0.133
4	HUB – 2	410.50	43.77	3.89	1359.83	4.99	456.90	0.133
5	EC-359445	381.93	43.70	3.75	1279.83	7.03	456.90	0.066
6	IC-243192	334.00	43.58	4.09	1079.83	8.35	528.90	0.126
7	HUB – 3	325.50	41.26	6.04	1319.83	4.53	792.90	0.116
8	IC-341703	455.76	43.90	4.75	1439.83	8.75	432.90	0.120
9	HUB – 4	250.56	44.41	4.21	1079.83	8.31	240.90	0.116
10	IC-109249	248.83	40.35	3.24	1226.50	9.70	192.90	0.116
11	NIC-22506	329.16	41.16	4.64	879.83	2.36	576.90	0.116
12	HUB – 5	365.40	43.07	3.95	1279.83	1.75	504.90	0.116
13	NC-58616	308.30	44.51	4.20	1159.83	4.71	456.90	0.126
14	NIC-22492	463.40	40.50	3.32	799.83	1.43	72.90	0.096
15	IC-109235	429.73	40.76	4.02	1199.83	4.26	528.90	0.110
16	HUB-6	467.10	45.96	4.63	1399.83	8.99	1272.90	0.116
17	HUB – 8	497.56	46.10	4.68	1599.83	9.62	1360.90	0.156
18	IC-415477	409.50	43.25	3.84	1199.83	9.76	888.90	0.130
19	IC-540831	423.76	45.08	4.47	1159.83	7.73	792.90	0.123
20	NIC-22517	475.33	44.50	4.06	1349.83	8.93	216.90	0.146
21	HUB – 7	523.73	46.27	5.50	1559.83	11.60	1440.90	0.156
22	IC-540842	465.36	45.25	4.22	1359.83	8.28	888.90	0.123
23	IC-4152393	345.00	40.66	2.85	1199.83	1.41	216.90	0.096
24	HUB – 9	388.70	40.73	2.84	799.83	2.54	768.90	0.096
	Mean	389.16	43.07	4.11	1202.19	6.19	597.56	0.114
	S.Em±	17.19	1.11	0.16	42.51	0.37	23.57	0.0017
	CD (0.05)	48.95	3.16	0.47	121.02	1.06	67.09	0.0048
	CV(%)	7.65	4.47	6.99	6.12	10.42	6.83	2.56

PH- Plant Height(cm) NLP- Number of leaves per plant NBP- Number of branches per plant LA- Leaf Area(cm^2) SG- Stem girth(cm) DF- Days to first flowering DFF – Days to 50% flowering FYP- Foliage yield per plant (g) FYPP- Foliage yield per plot (kg) FYPH- Foliage yield per hectare (t/ha) VA- Vitamin-A(mg/100 g) VC- Vitamin-C(mg/100 g) PR- Protein (g/100 g) Ca- Calcium (mg/100 g) Mg- Magnasium (mg/100 g) Fe- Iron (mg/100 g) Zn-Zinc (mg/100 g)

Table 4: Analysis of variance (Mean Sum of Squares) for Growth, earliness, yield and quality parameters

s/n	Source	Mean Sum of Squares		
		Replication	Treatment	Error
1	Plant Height (cm)	862.51	348.24**	114.72
2	Number of leaves per plant	3.85	858.98*	330.24
3	Number of branches per plant	0.88	6.42	3.76
4	Leaf area (cm^2)	1002.59	468.98**	26.38
5	Stem girth (cm)	0.15	0.19	0.12
6	Days to first flowering	6.59	19.77**	5.85
7	Days to 50% flowering	20.22	34.26**	1.91
8	Foliage yield per plant (g)	129.84	2032.14**	71.34
9	Foliage yield per plot (kg)	0.02	0.39**	0.10
10	Foliage yield per hectare (t)	1.27	17.36**	4.36
11	Vitamin- A (mg/100g)	148.25	16558.91**	887.16
12	Vitamin –C (mg/100g)	5.79	14.32**	3.71
13	Protein (g/100g)	8.14	1.58**	0.08
14	Calcium (mg/100g)	5873.55	138453.56**	5422.22
15	Magnesium (mg/100g)	1721.48	403549.20**	1666.66
16	Iron (mg/100g)	0.61	28.69**	0.41
17	Zinc (mg/100g)	0.001301	0.002261**	0.000009

* Significance at 5% level.

Table 5: Top five bathua genotypes with best mean performance

Sl. No.	Genotypes	Foliage yield per plant (g)	Vitamin-A (mg/100 g)	Vitamin-C (mg/100 g)	Ca (mg/100 g)	Mg (mg/100 g)
1	HUB – 7	144.66	523.73	46.27	1559.83	1440.9
2	HUB – 8	117	497.56	46.1	1599.83	1360.9
3	HUB – 6	92.833	467.1	45.96	1399.83	1272.9
4	IC-540842	85	465.36	45.25	1359.83	888.9
5	IC-540831	84	423.76	45.08	1159.83	792.9

4. Conclusion

From the table 5, it can be inferred that out of twenty four bathua genotypes, HUB – 7 with significant foliage yield per plant(144.66g), Vitamin-A(523.73mg/100 g), Vitamin-C(46.27mg/100 g), Ca(1559.83mg/100 g) and Mg(1440.9mg/100 g). The results of the present study show that high-yielding and good quality bathua germplasm (HUB-7, HUB-8, HUB-6, IC-540842 and IC-540831) are available in the India. Selected promising germplasm collections are being tested in replicated elite variety trails to determine their adaptability.

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