Estimates of heritability, genetic advance, yield and its quality traits in onion (*Allium cepa* L.) genotypes

Abstract

The present investigation to estimate genetic variability was carried out with forty genotypes of onion which were collected from different locations of Karnataka and were evaluated for growth yield and quality traits. Among all the genotypes studied, Gadag Local exhibited highest plant height at 30 DAT (34.20 cm), 50 DAT (43.46) and 90 DAT (51.76 cm), highest number of leaves were produced by Nasik Red at 50 DAT (9.40 cm) and Savalagi Local at 90 DAT (13.53 cm), Sathara Local exhibited highest equatorial diameter (4.54 cm). highest total soluble solids (15.03%) was recorded by Gadag Local. Kalasakoppa Local produced highest dry matter (20.16%) and B-780 took less number of days to maturity (100days), Bilagi Local had highest polar diameter (4.93 cm). The high GCV and PCV was observed for ten bulb weight and leaf diameter respectively. High estimates of heritability coupled with high genetic advance as percent of mean was observed for ten bulb weight and Total yield(q/ha) Hence, for future onion improvement, these well performing genotypes can be subjected to selection and also used as parents in hybridization programme to obtain varieties/hybrids with desirable quality and higher yield.

Key words: Onion, genotypes, evaluation, heritability, genetic advance

Introduction

Onion (*Allium cepa* L.) is the herbaceous biennial plant in the *Alliacea* family having chromosome number 2n=2x=16, grown for its edible bulb. The genus *Allium* is a large genus containing 450 species, in that *Allium cepa* L. is the major cultivated *Allium*. It displays great morphological diversity in terms of bulb, leaf size, color, shape, plant height, and fertility. These are biennial and perennial in nature (Trivedi *et al*., 2006).

It is commonly known as “Queen of the kitchen” due to its highly valued flavor, aroma, unique taste and the medicinal properties of its flavor compounds. Onion

is used throughout the year, for example in curries, in the form of spices, in salads, as a condiment, or cooked with other vegetables, such as boiled or baked. It is also used in different forms of processed food, e.g. pickles, powder, paste, and flakes, and it is known for its medicinal values. In India onion is grown in three crop seasons, namely *Kharif* (harvested in October-November), late *Kharif* (January-February) and *Rabi* (April-May). Onions are low in nutrients but are valued for their flavour and are used widely in cooking (Dwivedi *et al*., 2017).

Onion accounts for 70 per cent of our total foreign exchange earnings from the export of fresh vegetables. Government of India has declared onion as an essential commodity. Availability of sufficient genetic variability is very important in a crop improvement programme (Dangi *et al*., 2018). For successful breeding programme, amount of genetic variability present in the experimental material is a basic requirement. Therefore, it is essential for a plant breeder to measure the variability with the help of parameters like variability, genotypic coefficient of variation, heritability and genetic advance. Hence, these parameters give the information regarding the availability of genetic variability for different characters in available germplasm. Therefore, study of genetic variability of bulb yield and its component characters among different genotypes provides a strong basis for selection of desirable genotypes for augmentation of yield and other yield attributing characters (Akanksha *et al*., 2015).

Materials and method

The study on phenotypic assessment of onion genotypes for growth, yield and quality traits of onion was carried out during *Kharif* 2018-19. Total 40 onion genotypes were collected from different locations of Karnataka and some genotypes were collected from public sector organizations to cover maximum source of onion genotypes to study the existing variability among them.

The experiment was conducted at Haveli farm, College of Horticulture, Bagalkot, Karnataka, India with total 40 onion genotypes were collected from different locations of Karnataka and some genotypes were collected from public sector organizations during the *Kharif* 2018-19 following Randomized Block Design with three replications with spacing of 15 cm row to row and 10 cm plant to plant. Observation on growth parameters *i.e.* plant height, the number of leaves, leaf diameter

(cm) and days to maturity were recorded from ten randomly selected plants in each replication at 30, 50 and 90 days after transplanting (DAT). Quality parameters, *viz.*, TSS of the bulb (^{o}Brix), neck thickness, number of rings per bulb and dry matter (%) were recorded from ten randomly selected bulbs after harvest. The yield parameters *viz.*, polar diameter, equatorial diameter, bulb weight per plant (g), the average weight of five bulbs (kg), total yield (kg per plot) were calculated after the bulbs were harvested from the respective plots. The statistical analysis was carried out using INDOSTAT software packages.

Results

Analysis of variance revealed significant difference among genotypes for plant height at 30, 50 and 60 DAT, number of leaves per plant at 30, 50 and 90 DAT, days to maturity, bulb weight, 10 bulb weight, total yield (q/ha), TSS of bulb, number of rings per bulb and dry matter content of bulb, leaf diameter, neck thickness of bulb, equatorial bulb diameter, polar bulb diameter.

Genetic variability

With a view to understand the extent of variation observed due to genetic factors, the mean, range, genotypic variance (GV), phenotypic variance (PV), genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h^2 bs), genetic advance (GA) and genetic advance as per cent over mean (GAM) were worked out for the 40 genotypes of onion for all the 17 characters are depicted in the table 3. The results of the variability parameters observed (Fig.1) in the 40 onion genotypes evaluated in the present investigation is presented.

Plant height (cm)

Plant height showed higher variation with respect to genotypes at each growth phase of 30, 50 and 90 DAT and it is varied from 22.80 to 34.20 cm, 31.73 to 43.46 cm and 37.33 to 45.08 cm with overall mean performance of 28.76cm, 37.03cm and 45.08 cm respectively. Genotype Gadag Local recorded highest plant height 51.76 cm however, genotype Shivapur Local recorded lowest plant height 37.33 cm at 90 DAT. The genotypic (7.15) and phenotypic (13.86) variances were low to moderate, respectively. The estimates of low GCV and PCV (5.93 % and 8.25 %, respectively)

were recorded for this trait. High heritability (61.2 %) along with moderate genetic advance as per cent over mean (15.35%) was observed at 30 DAT.

Number of leaves per plant

Number of leaves per plant ranged from 4.00 to 5.73, 7.06 to 9.40 and 10.20 to 13.53 with grand mean performance of 5.16, 8.42 and 11.64 leaves at 30, 50 and 90 DAT, respectively. Genotype Savalagi local recorded highest number of leaves 13.53 however, genotype Bijapur local-2 recorded lowest number of leaves 10.20 at 90 DAT. Low phenotypic (1.23) and genotypic (0.67) variance whereas, low GCV (7.05%) and PCV (9.53 %) was noticed. Moderate heritability (54.70 %) along with low to medium genetic advance (1.23 %) and genetic advance as per cent over mean (10.73 %).

Days to maturity

Early maturity was recorded in genotype B-780 (100.00) However late maturity was observed in Arka Niketana (128.66). The average days for maturity were 119.64. The phenotypic variance (39.12) and genotypic variance (34.19) were high,. The estimates of GCV and PCV were low (4.88 % and 5.22 %, respectively). High heritability (87.4 %) along with low (9.41 %) genetic advance as per cent over mean.

Leaf diameter (cm)

The leaf diameter ranged from 0.36 (Gote local and Arka Niketana) to 0.65 (Belagavi local) with grand mean was 0.49cm. The low genotypic (0.005) and phenotypic variance (0.011) were noticed and medium GCV and high PCV (14.80 % and 21.17 %, respectively) were observed. Estimates of moderate heritability (48.9 %) and high GAM (21.31 %) for this trait.

Polar bulb diameter (cm)

Polar bulb diameter ranged between genotypes of Badnoor Local recorded with the minimum 3.92 cm and Bilagi local recorded with the maximum 4.93 cm. with an overall mean of 4.58 cm. The estimates of phenotypic variance (0.08) and genotypic variance (0.03) were low, and estimates of GCV and PCV were low (3.86 % and 6.49 %, respectively). A moderate heritability was observed (35.5.00 %) coupled with low genetic advance as per cent over mean (4.74%).

Equatorial bulb diameter (cm)

Equatorial bulb diameter lied between the genotypes of B-780 and Sathara local were recorded minimum (3.85 cm) and maximum (4.54 cm) equatorial bulb diameter, respectively with an average mean of 4.26 cm. The estimates of phenotypic variance (0.07) and genotypic variance (0.001) were low. The estimates of GCV and PCV were low (2.55 % and 6.22 %, respectively). Estimates of low heritability (16.78 %) coupled with low genetic advance as per cent over mean was observed for the character (2.15 %).

Bulb weight per plant (g)

Genotype Bhima red (89.00 g) recorded maximum bulb weight per plant, Whereas Panchaganga (52.81 g) recorded lowest bulb weight. The average yield per plant was 72.79 g. The high phenotypic (105.68) and genotypic (83.51) variance and moderate GCV and PCV (12.55 % and 14.12 %, respectively) were observed. Heritability was high (79 %) with high GAM (22.99 %).

Total 10 Bulb weight (g)

Genotype Bhima red (892.36g) recorded maximum total 10 Bulb weight, whereas was recorded minimum in the genotype Arka Bheem (433.65g). The average total bulb weight was 680.55g. The high phenotypic (16214.16) and genotypic (14923.6) variance and moderate GCV and PCV (17.95% and 18.71%, respectively) were observed. Heritability was high (92%) with high GAM (35.47%).

Bulb yield per hectare (q/ha)

Highest bulb yield of 432.06 (q/ha) was reported in genotype Bhima Red and lowest bulb yield of 243.13 (q/ha) was recorded with Panchaganga with mean performance of 329.27 (q/ha). The high phenotypic (2016.74) and genotypic (1721.66) variance and low GCV and PCV (12.60 % and 13.63 %, respectively) were observed and estimates of heritability (85.4 %) was high with high GAM (23.98 %) for this trait.

TSS of bulb (^{o}Brix)

Gadag local recorded highest (15.03%) total soluble solid while lowest was recorded in Sathara local (9.80 %) with an average of 12.85. The estimates of GV and

PV (1.58 and 2.01, respectively) were low and GCV and PCV (9.80 % and 11.03 %, respectively) were low to moderate. The high heritability (78.9 %) associated with moderate (17.93 %) GAM observed for this trait.

Number of rings per bulb

Genotype Bhima red (9.26) recorded maximum number of rings per bulb while, minimum was recorded in Kadarakoppa local-5 (6.46), with an overall mean performance of 7.72. The estimates of GV and PV (0.32 and 0.69, respectively) were low and GCV and PCV were low to moderate (7.33 % and 10.81 %, respectively). The moderate heritability (46 %) associated with moderate GAM (10.24 %) observed for this trait.

Neck thickness (cm)

Neck thickness varied from genotypes of Kadarakoppa local-1 and Gadag local were recorded maximum (1.06 cm) and minimum (0.65 cm) neck thickness, respectively with an overall mean performance of 0.84 cm. The estimates of GV (0.007) and PV (0.013) were very low. The estimates of GCV and PCV were low to moderate (9.66 % and 13.67 %, respectively). The heritability was moderate (50.00 %) with low GA (0.11) and moderate GAM (14.07 %).

Table 1. Mean performance of 40 onion genotypes for quantitative characters

Treatment	Number of leaves per plant			Plant height (cm)			Days to Maturity
	30 DAT	50 DAT	90 DAT	30 DAT	50 DAT	90 DAT	
Kadarakoppa Local 1	5.26	8.80	11.90	24.80	36.26	45.23	115.66
Kadarakoppa Local 2	4.40	7.40	12.30	27.03	33.86	41.46	124.33
Kadarakoppa Local 3	5.73	9.00	11.16	27.26	35.93	43.86	116.00
Kadarakoppa Local 4	4.20	7.40	12.13	27.10	35.60	44.23	124.00
Kadarakoppa Local 5	5.40	9.00	10.30	28.63	35.93	45.06	122.66
Mudhol Local	5.73	8.87	11.16	29.33	36.26	44.90	117.66
Tulasigeri Local	5.20	9.00	11.53	29.73	37.13	45.06	126.66
Kanchanaganga	5.46	8.60	10.86	30.06	38.80	40.20	120.66

Nasik Red	5.40	9.40	10.73	30.56	37.80	46.30	111.00
Badnoor Local	5.46	8.13	11.76	29.23	38.00	46.46	121.66
Hanamaneri Local	5.66	9.00	11.40	29.86	37.76	44.83	122.66
Sathara Local	4.60	7.53	10.53	28.20	37.66	39.86	127.00
Panchaganga	4.00	7.06	10.90	31.46	39.60	48.93	127.00
Ron Local	5.33	8.66	13.00	31.86	39.53	46.96	109.00
Belavanaki Local	5.13	9.00	13.36	30.13	39.00	47.86	114.33
Lokapur Local	5.13	7.60	13.30	30.06	38.13	47.76	121.33
Savalagi Local	5.33	8.33	13.53	30.60	38.93	48.90	118.33
Kumate Local	5.40	8.26	12.86	32.80	40.96	48.26	120.33
Bijapur Local	5.53	8.86	11.20	32.46	40.83	48.23	122.0
Babaleshwar Local	5.53	8.33	11.96	33.13	40.80	49.36	126.00
Gadag Local	4.73	7.80	10.80	34.20	43.46	51.76	126.00
Navalagund Local	5.73	8.46	12.50	30.26	37.60	41.40	109.00
Belagavi Local	5.73	8.73	11.00	30.46	37.40	46.10	117.30
Kalasakoppa Local	5.53	8.73	11.33	32.66	38.33	46.46	117.30
Bhima Red	5.46	8.93	11.73	30.06	37.53	45.76	114.30
Naragund Local	5.26	8.53	11.80	32.86	40.60	49.50	121.00
Kerur Local	5.33	8.20	12.73	32.20	39.93	48.36	120.60
Bhima Super	4.53	7.93	11.00	29.93	37.13	46.20	122.00
Bhima Raj	5.13	8.40	13.50	27.60	37.10	45.33	121.60
Shivapur Local	4.86	8.66	12.30	24.00	31.73	37.33	121.60
Bilagi Local	5.26	7.60	11.53	27.86	36.16	44.83	114.60
B – 780	5.20	8.53	11.60	25.66	35.06	44.03	100.00
Gote Local	4.86	8.93	11.66	24.66	33.36	42.56	123.00
Bijapur Local 2	5.33	8.60	10.20	26.46	34.86	43.60	127.00
Arka Niketana	5.40	8.86	10.43	26.26	35.66	45.20	128.60
Arka Bheem	4.80	8.00	10.40	24.40	32.46	41.80	114.00
Arka Lalima	4.86	8.46	11.60	25.10	33.80	43.00	121.00
Arka Keerthiman	5.20	9.33	11.16	24.56	33.73	42.86	122.00
Arka Kalyana	5.06	9.00	12.03	24.23	33.86	43.30	112.30
Single Red	4.46	7.13	10.46	22.80	32.53	40.20	123.60
Mean	**5.16**	**8.42**	**11.64**	**28.76**	**37.03**	**45.08**	**119.64**
S. Em±	0.24	0.24	0.43	1.26	1.24	1.49	1.28
C.D.@5%	0.69	0.70	1.21	3.55	3.49	4.21	3.61
CV	8.21	5.11	6.42	7.59	5.81	5.74	1.85

Table 1. contd……

Treatment	Leaf diameter (cm)	Polar bulb diameter (cm)	Equatorial bulb diameter (cm)	Bulb weight (g)	10 Bulb yield (g)	Total yield (q/ha)	Neck thickness of bulb (cm)
Kadarakoppa Local 1	0.45	4.60	4.34	79.41	619.96	331.10	1.06
Kadarakoppa Local	0.40	4.48	4.34	70.04	608.13	278.2	0.81

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Kadarakoppa Local 3	0.57	4.34	4.25	83.66	851.90	339.76	0.72
Kadarakoppa Local 4	0.37	4.53	4.21	63.19	633.65	259.16	0.85
Kadarakoppa Local 5	0.57	4.47	4.25	72.25	717.87	307.20	0.88
Mudhol Local	0.53	4.55	4.46	83.53	853.80	339.96	0.95
Tulasigeri Local	0.55	4.42	4.13	81.83	663.62	332.43	0.81
Kanchanaganga	0.45	4.87	4.51	71.91	606.45	278.26	0.92
Nasik Red	0.48	4.48	4.00	81.78	808.81	332.43	0.81
Badnoor Local	0.62	3.92	3.92	70.68	615.75	314.66	0.84
Hanamaneri Local	0.63	4.31	4.24	78.78	844.89	325.90	1.01
Sathara Local	0.55	4.51	4.54	59.15	633.18	264.40	0.80
Panchaganga	0.49	4.68	3.95	52.81	445.32	243.13	0.90
Ron Local	0.58	4.35	4.46	84.3	868.24	353.96	0.85
Belavanaki Local	0.53	4.71	4.34	73.82	743.37	314.80	0.74
Lokapur Local	0.5	4.68	4.28	82.50	793.58	346.66	0.69
Savalagi Local	0.37	4.72	4.43	84.36	775.71	361.06	0.84
Kumate Local	0.61	4.43	4.12	59.13	494.29	257.66	0.89
Bijapur Local	0.51	4.47	4.26	73.32	706.65	321.96	0.89
Babaleshwar Local	0.55	4.49	4.03	75.82	654.69	335.16	0.95
Gadag Local	0.50	4.79	4.31	59.45	594.7	256.3	0.65
Navalagund Local	0.53	4.73	4.35	87.74	797.25	359.73	0.75
Belagavi Local	0.65	4.44	4.16	73.06	761.64	303.43	0.79
Kalasakoppa Local	0.48	4.66	4.24	80.88	825.96	329.10	0.86
BhimaRred	0.61	4.73	4.46	89.00	892.36	432.06	0.77
Naragund Local	0.44	4.51	4.19	77.22	767.85	388.83	0.81

Kerur Local	0.51	4.81	4.37	69.95	617.06	334.63	1.04
Bhima Super	0.48	4.57	4.25	57.06	469.59	296.03	0.82
Bhima Raj	0.62	4.76	4.30	76.14	759.81	378.66	0.89
Shivapur Local	0.48	4.03	3.98	77.89	772.77	382.73	0.72
Bilagi Local	0.39	4.93	4.30	55.90	453.13	285.13	0.76
B – 780	0.37	4.19	3.85	67.52	560.42	338.86	0.85
Gote Local	0.36	4.90	4.47	66.48	552.46	336.23	0.77
Bijapur Local 2	0.37	4.69	4.36	72.58	664.28	359.26	0.93
Arka Niketana	0.36	4.78	4.38	76.45	678.88	368.43	0.99
Arka Bheem	0.43	4.80	4.32	60.02	433.65	326.43	0.81
Arka Lalima	0.42	4.58	3.93	81.43	742.18	402.93	0.80
Arka Keerthiman	0.53	4.90	4.44	70.82	668.06	361.56	0.72
Arka Kalyana	0.46	4.73	4.25	69.38	670.09	377.06	0.75
Single Red	0.41	4.59	4.45	60.20	599.87	315.60	0.85
Mean	**0.49**	**4.60**	**4.26**	**72.79**	**680.55**	**329.27**	**0.84**
S. Em±	0.04	0.13	0.14	2.71	20.74	9.91	0.04
C.D.@5%	0.12	0.38	0.39	7.65	58.39	27.92	0.13
CV	15.14	5.21	5.68	6.46	5.27	5.21	9.67

Table 2. Mean performance of 40 onion genotypes for qualitative characters

Treatment	Number of rings per bulb	T.S.S. of bulb (^{0}Brix)	Dry matter content of bulb (%)
Kadarakoppa Local 1	7.26	11.62	14.50
Kadarakoppa Local 2	8.33	12.19	17.86
Kadarakoppa Local 3	6.66	11.62	16.96
Kadarakoppa Local 4	7.50	12.38	15.10

Kadarakoppa Local 5	6.46	11.52	14.60
Mudhol Local	7.26	12.53	17.63
Tulasigeri Local	8.00	12.32	14.53
Kanchanaganga	7.06	13.68	16.80
Nasik Red	6.86	12.69	18.83
Badnoor Local	8.00	13.92	19.50
Hanamaneri Local	8.06	14.86	18.80
Sathara Local	6.93	9.80	14.66
Panchaganga	7.26	12.24	16.16
Ron Local	8.40	14.13	15.80
Belavanaki Local	8.33	14.41	14.76
Lokapur Local	8.13	12.86	17.95
Savalagi Local	8.00	14.50	17.66
Kumate Local	8.06	13.26	16.30
Bijapur Local	7.00	13.04	14.56
Babaleshwar Local	7.40	12.55	15.13
Gadag Local	7.00	15.03	13.83
Navalagund Local	8.20	13.97	13.63
Belagavi Local	9.00	11.03	17.53
Kalasakoppa Local	8.06	13.89	20.16
Bhima Red	9.26	10.98	18.06
Naragund Local	7.86	12.02	16.76
Kerur Local	8.33	14.31	15.86
Bhima Super	7.26	13.04	16.63
Bhima Raj	9.00	11.26	13.70
Shivapur Local	7.33	14.28	17.00
Bilagi Local	8.20	12.24	16.70
B – 780	7.93	14.56	15.53
Gote Local	7.66	12.24	17.46
Bijapur Local 2	7.06	14.16	16.36
Arka Niketana	6.73	13.13	14.40
Arka Bheem	8.26	14.83	18.76
Arka Lalima	7.53	10.50	17.80
Arka Keerthiman	7.86	13.06	14.86
Arka Kalyana	8.13	11.94	17.10
Single Red	7.16	11.48	18.93
Mean	**7.72**	**12.85**	**16.48**
S. Em±	0.35	0.37	0.74
C.D.@5%	0.99	1.06	2.08
CV	7.94	5.07	7.78

Table 3. Estimates of mean, range, components of variance, heritability and genetic advance for growth, yield and quality parameters in 40 onion genotypes

Sl. No.	Character		Grand Mean	Range		PV	GV	EV	GCV (%)	PCV (%)	h^2 (%)	GA	GAM (%)
				Min.	Max.								
1	Number of leaves per plant	30 DAT	5.16	4.00	5.73	0.30	0.12	0.18	6.87	10.71	41.2	0.47	9.09
		50 DAT	8.42	7.06	9.40	0.48	0.30	0.18	6.51	8.27	61.9	0.88	10.54
		90 DAT	11.64	10.20	13.53	1.23	0.67	0.55	7.05	9.53	54.7	1.25	10.73
2	Plant height (cm)	30 DAT	28.76	22.80	34.20	12.29	7.51	4.77	9.53	12.18	61.2	4.41	15.35
		50 DAT	37.03	31.73	43.46	10.19	5.55	4.63	6.36	8.62	54.5	3.58	9.68
		90 DAT	45.08	37.33	51.76	13.86	7.15	6.71	5.93	8.25	51.6	3.95	8.77
3	Days to maturity		119.64	100.00	128.66	39.12	34.19	4.93	4.88	5.22	87.4	87.4	9.41
4	Leaf diameter		0.49	0.36	0.65	0.011	0.005	0.006	14.80	21.17	48.9	48.9	21.31
5	Polar bulb diameter (cm)		4.58	3.92	4.93	0.08	0.03	0.05	3.86	6.49	35.5	35.5	4.74
6	Equatorial bulb diameter (cm)		4.26	3.85	4.54	0.07	0.01	0.06	2.55	6.22	16.78	16.78	2.15
7	Individual Bulb weight (g)		72.79	52.81	89.00	105.68	83.51	22.17	12.55	14.12	79.0	79.0	22.99
8	10 bulb weight		680.55	433.65	892.36	16214.16	14923.6	1290.54	17.95	18.71	92.0	92.0	35.47
9	Total yield (q/ha)		329.27	243.13	432.06	2016.74	1721.66	295.08	12.60	13.63	85.4	85.4	23.98
10	T.S.S. of bulb (^{0}Brix)		12.85	9.80	15.03	2.01	1.58	0.42	9.80	11.03	78.9	78.9	17.93
11	Number of rings per bulb		7.72	6.46	9.26	0.69	0.32	0.37	7.33	10.81	46.0	46.0	10.24
12	Neck thickness of bulb (cm)		0.84	0.65	1.06	0.013	0.007	0.007	9.66	13.67	50.0	50.0	14.07
13	Dry matter of bulb (g)		16.48	13.63	20.16	4.06	2.41	1.64	9.43	12.23	59.5	59.5	14.98

GV = Genotypic variance	**EV**= Environmental variance	**GCV** = Genotypic coefficient of variation	h^2 = Heritability (broad sense)
PV = Phenotypic variance	**GA**= Expected genetic advance	**PCV** =Phenotypic coefficient of variation	**GAM** = Genetic advance as percentage over mean

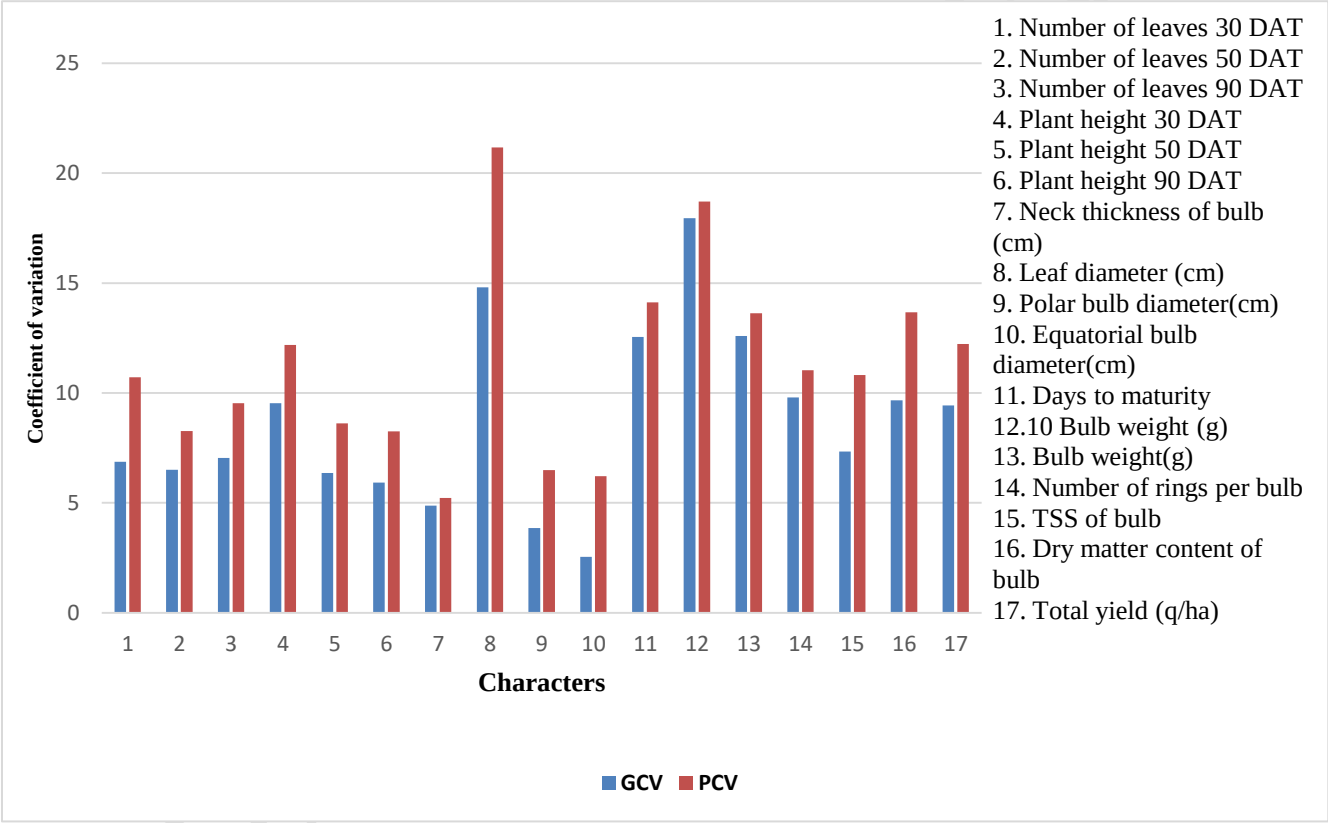

Fig.1 Comparison of variation measured at genotypic and phenotypic level for different parameters

Dry matter content of bulb (%)

The maximum dry matter content was recorded in the genotypes of Kalasakoppa local (20.16%) while, it showed minimum in Navalagund local (13.63 %) with the grand mean of 16.48 per cent. Estimates of phenotypic variance and genotypic variance (4.06 and 2.41, respectively) were low and GCV and PCV (9.43% and 12.23 %, respectively.) were low to moderate. And Moderate heritability (59.5 %) was coupled with moderate GAM (14.98%).

Discussion

The main objective of the present investigation was to study the diversity present in 40 onion genotypes. The estimates of mean sum of square due to genotypes were highly significant for all the characters indicating the presence of genetic diversity in the existing material. Sharma *et al.* (2017) also reported the high estimates of variability for selection of important onion genotypes to achieve the good breeding material.

Mean performance Genetic variability

The mean performance of the genotypes revealed a wide range of variability for all the traits. The variation was highest for total 10 bulb weight (433.65 – 892.36g.) with mean weight of 680.55g followed by total yield (243.13 – 432.06 q/ha) with mean yield of 329.27q/ha, bulb weight (52.81 – 89.00 g) with mean of 72.79 g (Kasera *et al*., 2019). days to maturity (100.00 - 128.66) having mean of 119.64 days. plant height at 90 DAT (37.33 – 51.76 cm), plant height at 50 DAT (31.73 – 43.46 cm) plant height at 30 DAT (22.80 – 34.20cm) (Ganie *et al*., 2019). Dry matter of bulb (13.63 – 20.16 g) with mean value of 16.48g singh *et al*. (2017) reported similar results. TSS of bulb (9.80-15.03 ^{0}Brix) with mean Brix of 12.85 (Ganie *et al.* 2019). High GCV and PCV were observed for the traits like 10 bulb weight and leaf diameter respectively, It shows the presence of high variability in the genotypes for selection and the difference between PCV and GCV were minimum for the traits studied in this experiment, indicating that trait under the study was less influenced by the environmentThe findings were quite similar to as reported by Pyasi and Tiwari (2016). The high degree of experimental precision was maintained during the study was evident from the CV values which were below 18% for all the characters. the CV was highest in leaf diameter (15.14%), followed by neck thickness of bulb (9.67%), number of leaves per plant (8.21%). It can be attributed to the influence of environmental fluctuations on this character. similarly CV values were estimated to the below for all the character being the least for days to maturity (1.85%) similar results were reported by Naresh *et al.*. (2021)

Heritability and genetic advance

Heritability which denotes the proportion of genetically controlled variability expressed by a programme for a particular character or a set of character is a very important biometrical tool for guiding plant breeders for adoption of appropriate breeding procedures. High heritability in broad sense is helpful in identifying appropriate character for selection and enables the breeder to select superior genotypes on the basis of phenotypic expression of quantitative characters.

The estimates of heritability ranged from 16.78% to 92% for various traits (Table 3).The high estimates of heritability were obtained for the traits like total 10 bulb weight followed by Days to maturity, total yield, bulb weight, TSS of bulb, number of leaves at 50 DAT and plant height at 30 DAT. indicated that the high values of broad sense heritability for these characters expressed that they were least influenced by environmental modification. It reflected that the phenotypes were the true representative of their genotypes and selection based on phenotypic performance would be reliable The results were in close proximate to that of Dhotre *et al.* (2010) for bulb weight per plant and Sharma *et al*. (2017) and Srivastav *et al.* (2017) for all the characters..

However, it was recorded moderate for number of leaves per plant at 30 and 90 DAT, plant height at 50 and 90 DAT, leaf diameter, polar bulb diameter, number of rings per bulb, neck thickness of bulb and dry matter of bulb. The findings were in agreement with Singh *et al.* (2010) for neck thickness of the bulb other characters. Whereas; low estimates of heritability were recorded for equatorial bulb diameter the findings were in agreement with Gurjar and Singhania (2006), Trivedi *et al.* (2006) and (Tahaseen., 2019)

Heritability however indicates only the effectiveness with which selection of a genotype can be based on phenotypic performance, but fails to indicate the genetic progress. Heritability estimates along with genetic gains are more effective and reliable in predicting the improvement through selection (Johnson *et al.,* 1955). Estimation of genetic advance helps to predict the extent of improvement that can be achieved for improving the different characters (Singh *et al*., 2017) The highest estimate of genetic advance as percentage of mean was recorded for total 10 bulb weight, total yield, bulb weight and leaf diameter. The results were in agreement with Dhotre *et al.* (2010) for bulb weight and total yield.

Plant height at 30 DAT, number of leaves at 50 ana 90 DAT, TSS of bulb, number of rings per bulb, neck thickness of bulb and dry matter of bulb showed moderate value of genetic advance as percentage of mean. The findings were in agreement to the findings of Gurjar and Singhania (2006) for number of leaves per plant and other characters. Patil (1997) for polar bulb diameter.

Whereas; low estimates were observed for plant height at 50 DAT, plant height at 90 DAT, number of leaves at 30 DAT, Days to maturity, polar bulb diameter and equatorial bulb diameter. The findings were in agreement to the findings of Hosamani *et al.* (2010) for plant height, Patil (1997), Chattoo *et al.* (2015) and Manjunath and Hiremath (2022) for polar bulb diameter.

High heritability coupled with high genetic advance as percentage of mean for traits like total 10 bulb weight, total yield, bulb weight, suggested that the preponderance of additive genes. It also indicated higher response for selection of high yielding genotypes as these characters are governed by additive gene actions. The results were in consonance with Singh *et al.* (2017) for bulb weight.

Conclusion

In the present study the analysis of variance revealed significance difference among the genotypes. The mean performance of the genotypes revealed a wide range of variability for all the traits. Bhima red performed best in terms of yield followed by Arka Lalima, Naragund Local, Arka Niketana and Arka Kalyan. So these genotypes can be further exploited in selection programmes of quality and quantity. The phenotypic coefficient of variation was higher than the corresponding genotypic coefficient of variation for all the traits. The high values of GCV suggested greater phenotypic and genotypic variability among the genotypes and responsiveness of the attributes for making further improvement by selection. The characters which showed very high heritability and GAM are governed by additive gene effects. It may also be concluded that selection on the basis of these characters will be more useful for the improvement of this crop. The promising genotypes like Bhima red, Arka Lalima, Naragund Local, Arka Niketana and Arka Kalyan can be recommended for further crop improvement of Onion.

Future scope

The superior genotypes which are having desirable traits might be used for simultaneous transfer of multiple characters and excellent genotypes which are having varied traits might be used for broadening genetic base in crop breeding.

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