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Genetic Variability Studies for Yield and Yield Components in Onion (*Allium cepa)* Genotypes

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ABSTRACT

The present study was aimed at investigating the growth and yield contributing traits in onion in order to generate information regarding the extent of genetic variability, heritability and genetic advance. The experiment was laid under randomized block design replicated thrice at Citrus Research Station,Tirupati Dr. YSR Horticultural University, Andhra Pradesh, during 2016-17, Rabi season along with twenty nine genotypes. High degree of variation was observed for the for plant height, neck thickness, days to 50 per cent neck fall, polar bulb diameter, bulb weight, bulb yield, thrips infestation, purple blotch disease incidence and bulb splitting. The difference between phenotypic (PCV) and genotypic (GCV) coefficient of variation was found to be narrow for most of the traits except bulb shape index. The GCV ranged from 3.44 (bulb shape index) to 41.11 per cent while PCV ranged from 4.61 (total sugars) to 41.13 per cent for the various characters studied. In the present study, high genetic advance over per cent mean coupled with high heritability was observed in all characters except bulb shape index. These characters are therefore governed by additive gene effects. Selection on the basis of these characters will be more useful for the improvement of this crop towards attaining higher yield. Superior genotypes like Bhima kiran, Bhima safed, Bhima shubhra and single red exhibited high total yield.

Key words: *Variability; Heritability; Genetic advance; GCV; PCV; Onion.*

INTRODUCTION

Onion is one of the important vegetable and spice crops of India and is commonly used for salad and culinary purposes. The green leaves, immature and mature bulbs are used for vegetables and spice purposes. It is an important bulb crop throughout the world and is commercially cultivated in more than hundred countries. The main onion producing countries are China, India, USA, Russia, Japan, Turkey and Netherlands. India ranks second in the world in area and production after China and third in export after Netherland & Spain. India exports 12 per cent of total world export of onion. Onion accounts for 77 per cent of total foreign exchange earnings in India among fresh vegetables. Export of onion from India during 2015 was 17.00 lakh tonnes. Indian onions are famous for their pungency and are available round the year.

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India is producing 20.93 million tonnes of onion from an area of 1.32 million hectare with an average productivity 16.10 t/ha (NHRDF Database, 2015 - 16). The major onion producing states are Maharashtra, Gujarat, Uttar Pradesh, Orissa, Karnataka, Tamil Nadu, Madhya Pradesh and Bihar. Maharashtra stands first in area (0.05 million hectare) and production (6.5million tonnes) of onions with a productivity of 12.50 tonnes per hectare. In terms of productivity, Gujarat ranks first with a productivity of 25.48 tonnes per hectare. In Andhra Pradesh, major onion growing districts are Kurnool, Kadapa, Anantapur, Guntur and Srikakulam. Onion growing area in Andhra Pradesh state is 0.45 million hectares with a production of 0.89 million tonnes having productivity of 19.67 tonnes per hectare (NHRDF, 2015 - 16).

Onion has become an important commercial crop in Andhra Pradesh because of its area, production and consumption. Yield is a complex character; it depends on a number of agronomic traits and is influenced by many factors which could be genetic or environmental[10]. To improve the bulb yield, quality and storability through selection the information on the nature and magnitude of variability for yield and yield contributing characters present in the population owing to its genetic and non-genetic causes plays an important role and as such it is a basic prerequisite for any systematic breeding programme. Thus for improving the efficiency of selection in any base population the knowledge of genetic variability present in it is of prime importance to the breeder. The improvement in any crop is proportional to the magnitude of its genetic variability present in the genotypes[9]. Most of the economic traits in onion are polygenic in nature and highly influenced by the environment. To improve the yield through selection of better varieties, knowledge of variability and nature of association of bulb yield with yield contributing characters is very essential. Therefore present field investigation was carried out with a view to study the genetic variability, heritability and genetic advance in onion.

MATERIAL AND METHODS

Experimental site is situated at Citrus Research Station, Dr.YSR Horticultural University, Tirupati, which comes under Rayalaseema region of Andhra Pradesh state, located at 13^0 65^1 North latitude and 79^0 42^1 East longitude, with an altitude of 162 meters above mean sea level. The climate of the research station is tropical with maximum temperature ranging from 36-42°C during *rabi* season, average temperature25.6°C during crop growing period. The relative humidity generally fluctuates between 63 percent with a rainfall of 51 mm. The soil of the experimental site was red sandy loam. The experiment was laid out in Randomized Block Design and replicated thrice. Plants were spaced 15 cm between row to row and 10 cm between plants to plant. Recommended Fertilizer Dose: 120: 50: 100: 40 @ N: P2O5: K2O: S, kg ha-1. Farm Yard Manure (FYM): 20 tons ha-1. Observations on growth parameters were taken from randomly selected ten plants per replication at 30, 60 and 90 days after transplanting. Bulb characters and yield were recorded from randomly selected ten bulbs after harvest. The mean values obtained from the ten competitive plants selected at random from each genotype in each replication for different horticultural traits were subjected to statistical analysis as suggested by Panse and Sukhatme. Twenty nine genotypes of onion were collected from different locations. The study on genetic variability and diversity in onion was planned to carry out during Rabi 2016-17.The list of genotypes and sources of collection are presented in Table-1.

RESULTS AND DISCUSSION

Mean performance

Analysis of variance indicated significant differences among genotypes for all traits. (Table 2) These differences indicated the presence of variability and opportunity for improvement. Sufficient genetic variability for many traits had also been reported by[7,8,5,6] for bulb yield in onion. Among twenty nine genotypes the genotype Dharwad local was tallest followed by shahapur local and bellary

local. Maximum number of leaves were found in the genotype shahapur local .Desirable minimum neck thickness was found in Agrifound rose followed by co (on)5 and arka bindu. Highest bulb weight and yield was found in the variety Bhima super followed by Agrifound white, Bhima kiran and Bhima shakti. In case of days to maturity co (on) 5 and Agrifound rose requires minimum no of days to mature while Bhima kiran required maximum no of days to maturity. Highest ascorbic acid was found in Bhima shubhra followed by NHRDF RED 3. Bhima shubhra had highest total sugars among twenty nine genotypes. (Table3).

Phenotypic variance includes both genetic and environmental effects. It is essential to split total variance into genetic and non genetic components. Higher value of phenotypic and genotypic variation for characters like Plant height, days to maturity, bulb weight, equatorial bulb diameter, polar bulb diameter, doubles or bulb splitting, thrips and purple blotch incidence and bulb yield indicates presence of significant variation for these characters in the genotypes under study. Similar findings were reported by Gurjar and singhania[4] and Hyder *et al.* and Ananthan and Balakrishnamoorthy[1].

The magnitude of variance as such does not reveal the relative amount of variability as ascertained through co-efficient of variation. The extent of variability with respect to various characters in different genotypes was measured in terms of range, general mean, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h2) and expected genetic advance as per cent of mean (Table 4). The PCV was found to be greater of its GCV for all the characters studied. The results are similar to the findings of Chattopadhyay *et al*. The GCV ranged from total sugars 4.35 to 41.11 % per GCV was observed for doubles (41.11 %) followed by thrips infestation (34.09%) and low values of GCV were observed for bulb yield (14.40%), followed by number of rings (12.47%), neck thickness (11.49) and least GCV were recorded in bulb shape index (3.44%). Gurjar *et al.*[4] reported low GCV and PCV for plant height and days to maturity. The PCV ranged from total sugars (4.61%) to doubles (41.13%) for the various characters studied. The moderate PCV was record for the character bulb yield (14.59%), neck thickness (13.23%) and number of rings (12.50%). However low values of PCV were observed for days to maturity (7.08%), reducing sugars (6.00%) and total sugars (4.61%). Hosamani *et al.*[5] reported high value of GCV and PCV for yield per hectare and for average bulb weight. Exactly not equal but somewhat similar magnitude of GCV and PCV was recorded for the characters viz plant height, days to maturity, polar bulb diameter, thrips, purple blotch, Ascorbic acid, Total sugars, Reducing sugars and bulb yield (t/ha).

As the coefficient of variation indicated only the extent of variability it does not reflect on heritable proportion of variation. Hence estimation of heritability coupled with genetic advance as per cent over mean permits greater effectiveness for selection by separating out the environmental influence from the total variability and thereby allowing accurate selection of a potential phenotype. The heritability estimates in broad sense were high for all the characters. Similar results were reported by Ananthan and Balakrishnamoorthy[1]. The range was observed from 0.97 to 152.66 per cent for all the traits under study (Table 4). These heritability values in that order were for equatorial bulb diameter (48.20%), neck thickness (75.39%), number of leaves (75.55%), plant height(82.63%), bulb weight (84.95%), Total sugars (88.92%), bulb shape index (90.67%), Ascorbic acid (90.85%), polar bulb diameter (96.79 %), Reducing sugars (97.25 %), bulb yield (97.39%), Purple blotch (99.19 %), Number of rings (99.44 %), Thrips (99.62 %) , Days to maturity and doubles are same i.e (99.87 %) .

The parameter genetic advance in per cent of mean is a more reliable index for understanding the characters because its estimate is derived by involvement of deviation and intensity of selection. Expected

genetic advance in percentage over mean was estimated for different characters and indicated that the expected genetic advance over mean observed was in the range of 2.20 to 84.63 per cent for different characters. It was observed low in case of bulb shape index (2.20 %) and moderate for the characters viz Days to maturity (14.58 %), Ascorbic acid (16.14 %), Plant height (16.92%), Polar bulb diameter (18.81 %). The values of expected genetic advance in percent overmean was recorded high for the characters viz Doubles (84.63%), Thrips (70.09%), Purple blotch (52.92 %) and bulb weight (45.33%). Bharti *et al.*[3] also reported high expected genetic advance in percentage over mean for bulb weight. Thus heritability and genetic advance in per cent of mean in combination provide clearer picture regarding the effectiveness of selection for improving the characters.

Table 1. List of onion genotypes used for study and their sources

S. No	Genotype	Source of supply
1	Arka Pragathi	IIHR, Bangalore
2	Arka Niketan	IIHR, Bangalore
3	NHRDF Red – 2	NHRDF, Pune
4	Agrifound White	NHRDF, Pune
5	Agrifound Light Red	NHRDF, Pune
6	Bhima Kiran	DOGR, Pune
7	NHRDF Red	NHRDF, Pune
8	NHRDF Red – 3	NHRDF, Pune
9	Arka Kalyan	IIHR, Bangalore
10	Arka BINDU	IIHR, Bangalore
11	Bhima Shakti	DOGR, Pune
12	Bhima Dark Red	DOGR, Pune
13	Bhima super	DOGR, Pune
14	Bhima Shweta	DOGR, Pune
15	Bhima Raj	DOGR, Pune
16	Bhima safed	DOGR, Pune
17	Co (ON) 5	TNAU, Coimbattore
18	Bhima Red	DOGR, Pune
19	Agrifound Rose	NHRDF, Pune
20	Bijapur Local	Bijapur, Karnataka
21	Bellary Local	Bellary, Karnataka
22	Dharwad Local	Dharwad, Karnataka
23	Purandhar Local	Purandar, Maharashtra
24	Garva	Maharashtra
25	Bhima Shubhra	DOGR, Pune
26	Gadag Local	Gadag, Karnataka
27	Shahapur Local	Yadgiri, Karnataka
28	Arka Bheem	IIHR, Bangalore
29	Single Red	Bangalore, Karnataka

Table 2. Analysis of variances (mean squares) for growth and yield characters in onion during 2016-17

S. No	Source of variation/characters	Replication	Genotypes	Error
	Degree of freedom	**2**	**28**	**56**
1	Plant height (cm)	16.48	99.53	6.51
2	Number of leaves/plant	4.55	13.84	1.34
3	Neck thickness (mm)	25.23	12.36	1.21
4	Days to maturity	28.01	195.22	0.08
5	Polar diameter (mm)	0.98	101.06	1.10
6	Equatorial diameter (mm)	18.22	104.01	27.43
7	Bulb shape index	0.01	0.01	0.03
8	Number of rings	0.76	2.78	0.005
9	Bulb weight (gm)	280.12	25551.8	142.27
10	Doubles (%)/splits	3.00	291.57	0.12
11	Thrips (%)	12.30	422.68	0.53
12	Purple blotch (%)	23.87	437.63	1.17
13	Bulb yield (t/ha)	121.27	214.51	1.89
14	Ascorbic acid (mg/100gm)	1.67	1.93	0.06
15	Total sugars (%)	0.29	0.22	0.00
16	Reducing sugars (%)	0.02	0.11	0.00

Table 3. *Per se* performance of onion genotypes for growth and yield parameters during 2016-17

S.No	Genotypes	Plant height (cm)	No. of leaves	Neck thickness (mm)	Days to maturity	Number of rings	Bulb weight (gm)	Polar bulb diameter (mm)	Equatorial bulb diameter (mm)	Bulb shape index	Doubles (%)	Thrips (%)	Purple blotch (%)	Yield (T/Ha)	Ascorbic acid (mg/100 g)	Total sugars (%)	Reducing sugars (%)
1	**Arka pragathi**	58.35	6.89	16.68	110	7.8	136.80	64.60	65.13	0.98	17.54	31.23	39.24	55.73	9.20	6.36	3.55
2	**Arka niketan**	55.27	7.29	14.91	116	7.5	102.93	57.51	57.90	0.99	19.12	29.73	39.66	59.56	9.72	6.42	3.46
3	**Nhrdf red 2**	59.13	8.83	15.86	115	6.63	137.13	61.76	59.94	1.03	34.55	38.38	37.87	60.13	9.54	6.31	3.50
4	**Agrifound white**	52.29	7.39	13.55	116	7.40	147.66	63.61	65.43	0.97	21.41	35.81	44.43	63.90	10.06	6.32	3.56
5	**Agrifound light red**	59.77	7.95	17.16	115	8.20	128.33	67.93	67.73	0.95	23.03	32.15	41.64	62.30	9.82	6.44	3.57
6	**Bhima kiran**	61.77	7.90	15.67	130	8.00	143.73	67.78	67.87	0.99	15.62	28.43	32.66	69.00	8.93	5.62	3.32
7	**Nhrdf red**	61.11	8.47	16.82	120	9.20	135.13	57.20	59.49	0.98	16.58	33.25	44.99	64.40	9.51	6.18	3.54
8	**Nhrdf red 3**	64.49	7.89	19.86	119	8.80	128.06	64.85	63.18	1.03	17.65	24.31	39.68	60.40	11.09	6.11	3.42
9	**Arka kalyan**	55.55	7.60	13.54	110	7.90	123.26	57.46	57.18	1.01	34.50	40.36	51.55	59.98	9.85	6.46	3.46
10	**Arka bindu**	50.37	6.15	13.39	108	6.33	65.73	50.73	50.17	1.00	26.63	49.30	57.14	34.36	10.12	6.15	3.54
11	**Bhima shakti**	57.73	8.06	19.42	130	7.83	144.40	64.26	65.15	0.99	16.10	28.87	44.47	66.30	9.34	6.29	3.42
12	**Bhima dark red**	65.00	10.28	18.12	98	8.00	129.13	62.44	61.23	1.02	16.50	28.90	40.08	62.38	10.34	5.75	2.96
13	**Bhima super**	61.15	7.89	16.93	113	8.26	152.66	71.44	70.53	1.01	15.34	26.19	43.58	63.58	10.66	6.34	3.06
14	**Bhima shweta**	60.73	8.63	16.74	119	8.06	140.20	65.93	66.44	0.99	14.19	28.41	45.89	60.26	8.76	5.53	3.20
15	**Bhima raj**	68.09	9.91	18.09	124	9.73	132.66	65.72	65.13	1.00	15.22	26.51	38.32	60.64	9.33	6.51	3.24

Contd……..

S.No	Genotypes	Plant height (cm)	No. of leaves	Neck thickness (mm)	Days to maturity	Number of rings	Bulb weight (gm)	Polar bulb diameter (mm)	Equatorial bulb diameter (mm)	Bulb shape index	Doubles (%)	Thrips (%)	Purple blotch (%)	Yield (T/Ha)	Ascorbic acid (mg/100 g)	Total sugars (%)	Reducing sugars (%)
16	**Bhima safed**	63.75	9.73	17.69	108	8.90	149.26	69.19	69.15	0.99	13.70	26.34	43.29	66.10	8.97	6.02	3.35
17	**Co (on) 5**	60.11	9.16	13.28	95	5.50	37.66	50.72	50.27	1.01	50.38	21.30	33.27	47.25	8.61	6.16	3.01
18	**Bhima red**	60.22	9.50	16.70	116	7.86	131.00	64.76	65.76	0.98	15.12	22.13	39.27	61.78	9.13	5.96	3.24

19	**Agrifound rose**	57.86	12.15	11.68	100	6.06	44.53	44.87	44.30	1.01	39.49	20.58	32.62	33.56	8.50	5.76	2.92
20	**Bijapur local**	69.21	13.26	17.92	121	7.23	107.33	61.55	61.90	0.99	34.56	57.88	66.22	49.72	10.63	6.34	3.22
21	**Bellary local**	69.62	10.14	17.88	112	8.03	90.73	59.92	59.44	1.00	39.24	32.45	49.39	62.95	10.48	5.93	3.32
22	**Dharwad local**	71.31	13.10	18.21	109	6.33	99.93	61.59	60.87	1.00	35.33	63.88	76.09	57.66	8.95	6.20	3.40
23	**Purandar local**	68.93	12.07	18.86	116	9.33	131.06	66.54	66.24	0.99	32.13	29.63	41.25	55.73	10.38	6.51	3.58
24	**Garva**	52.32	7.54	17.57	109	7.53	104.73	65.26	65.05	1.00	27.32	29.53	42.22	50.63	9.41	6.41	3.57
25	**Bhima shubhra**	56.84	9.55	17.78	121	7.90	144.20	66.09	65.94	0.99	13.79	26.84	33.00	63.27	11.60	6.62	3.58
26	**Gadag local**	60.49	12.62	17.91	109	7.33	109.06	63.47	61.11	1.05	27.32	46.36	66.97	63.45	8.70	6.20	3.19
27	**Shahapur local**	69.64	13.76	18.72	111	7.50	111.06	62.52	63.41	0.98	32.02	60.15	72.42	54.11	8.81	5.92	3.15
28	**Arka bheem**	68.80	11.54	18.34	113	7.20	115.13	59.67	59.24	1.00	14.32	36.82	55.37	59.93	8.62	6.13	3.19
29	**Single red**	66.31	11.94	17.05	117	7.53	118.20	63.88	62.50	1.02	26.48	53.22	63.33	65.71	9.58	6.13	3.41
	Mean	61.59	9.56	16.77	113.85	7.72	118.68	62.18	61.99	1.00	23.97	34.79	46.75	58.44	9.61	6.17	3.34
	S.Em	1.47	0.67	0.63	0.16	0.04	6.88	0.60	3.024	0.04	0.20	0.42	0.62	0.79	0.145	0.05	0.01
	C.D @ 5 **%**	4.18	1.90	1.80	0.47	0.11	19.56	1.72	8.59	NS	0.58	1.19	1.78	2.26	0.41	0.15	0.05

Table4. Estimates of mean, range, components of variance, heritability and genetic advance for growth and yield parameters in onion during 2016-17

S. No	Characters	Mean	Range	GV	PV	GCV	PCV	H^2bs	GA	GAM
1	**Plant height (cm)**	61.59	47.60-72.20	31.00	37.52	9.03	9.94	82.63	10.42	16.92
2	**Number of leaves**	9.56	5.60-15.20	4.16	5.51	21.34	24.55	75.55	3.65	38.22
3	**Neck thickness (mm)**	16.77	10.59-22.21	3.71	4.93	11.49	13.23	75.39	3.44	20.56
4	**Days to maturity**	113.85	94-131	65.04	65.13	7.08	7.08	99.87	16.60	14.58
5	**Number of rings**	7.72	5.40-9.90	0.92	0.93	12.47	12.50	99.44	1.97	25.62
6	**Bulb weight (gm)**	118.68	34-178	803.20	945.47	23.87	25.90	84.95	53.81	45.33
7	**Equatorial diameter (mm)**	61.99	38.77-74.02	25.52	52.96	8.15	11.73	48.20	7.22	11.65
8	**Polar diameter (mm)**	62.18	44.25-72.07	33.31	34.42	9.28	9.43	96.79	11.69	18.81
9	**Bulb shape index**	1.00	0.98-1.05	0.00	0.01	3.44	11.06	9.67	0.02	2.20
10	**Doubles (%)/ splits (%)**	23.97	13.48-50.75	97.14	97.27	41.11	41.13	99.87	20.29	84.63
11	**Thrips (%)**	34.79	20.15-65.00	140.71	141.24	34.09	34.15	99.62	24.39	70.09
12	**Purple blotch (%)**	46.75	32.22-76.83	145.48	146.66	25.79	25.90	99.19	24.74	52.92
13	**Bulb yield (t/ha)**	58.44	31.50-72.70	70.87	72.26	14.40	14.59	97.39	17.11	29.28
14	**Ascorbic acid (mg/100gm)**	9.61	8.14 - 11.91	0.62	0.68	8.22	8.62	90.85	1.55	16.14
15	**Total sugars (%)**	6.17	5.34 – 6.87	0.07	0.08	4.35	4.61	88.92	0.52	8.45
16	**Reducing sugars (%)**	3.34	2.89 – 3.64	0.03	0.04	5.92	6.00	97.25	0.40	12.03

GV = Genotypic variance, PV = Phenotypic variance, GCV = Genotypic coefficient of variance, h^2 = Heritability, PCV = Phenotypic coefficient of variance, GA = Genetic advance, GAM = Genetic advance (per cent mean)

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