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Short communication

Studies on genetic divergence in onion advance lines

R.K. Singh* and B.K. Dubey

National Horticultural Research and Development Foundation, Chitegaon Phata, Post Darna Sangavi, Niphad, Nashik 422 001, Maharashtra

India is one of the major onion growing and exporting ranking second in production and third in export in the world. It is one of the important vegetable and spices consumed by almost all the sections of the societies throughout the year. Though many factors play significant role in onion production, genotypes can be considered as one of the basic factors. Diversity arises either due to geographical separation or due to genetic barriers to cross ability and its plays an important role in plant breeding because hybrids between lines with diverse origin generally display a greater heterosis than those between closely related strains. Reports on genetic diversity among onion are limited. The knowledge of genetic diversity, its nature and degree of variability would be helpful for selecting desirable parents for available germplasm and cultivars for a successful breeding programme to generate new variability and desirable recombinants.

Keeping in above facts, the present investigation was undertaken to determine the information on genetic divergence among existing genotypes and factors influencing genetic diversity and variability of economic traits to identify the suitable genotypes of onion improvement programme with available collections collected from the different parts of country.

Studies were carried out at National Horticultural Research and Development Foundation at Nashik, Maharashtra, during 2006-08. The experiment was laid out in randomized block design with three replications. Nashik (20° N latitude and 73° E longitude) is located at altitude of 492.0 m above mean sea levels. The minimum and maximum temperature and humidity is ranges between 16.0 to 32.0°C and 48.0 to 80.0%, respectively with an annual rain fall around 881.0 mm. The soil is clay loam, medium in organic carbon (0.58%), available nitrogen (385.2 kg/ha), phosphorus (45.13 kg/ha) and high in available potash (291.2 kg/ha). The study comprises twenty six diverse onion advance lines along with two checks Agrifound Light Red and Agrifound White. Eight-week-old seedlings of each advance lines were transplanted in flat beds during the last week of December at a spacing of 15 cm × 10 cm in a plot of 3.6 m × 1.8 m size. The recommended package of practices was uniformly followed during whole experiment period to raise a successful crop. Randomly selected ten plants from each plot were taken to record the observations on plant height (cm), leaves per plant, neck thickness (cm), bulb diameter (cm), bulb size index (cm^2), weight of 20 bulbs (kg), days for bulb initiation, days for harvesting, doubles (%), bolters (%), total soluble solids (%), dry matter content (%), gross yield (q/ha) and marketable yield (q/ha). The pooled data of 2006-08 were analyzed to work out of variance components and coefficient of variation as per method suggested by Arunachalam (1), and Burton and DeVane (2). Heritability in broad sense and expected genetic advance as percent of mean estimated as suggested by Johnson *et al.* (3).

The Mahalanobis, (5) D^2 statistics was used to find out generalized distance between the genotypes as per Rao (9). The D^2 values were used to have clustering which was done following Tocher's method. The clusters were grouped in to four divergence classes (DC) on the basis of mean (M) and standard deviation (S). The analysis of variance revealed significant difference among twenty six onion lines for all the traits indicating sufficient genetic diversity among the cultivars. On the basis of D^2 values, the twenty six genotypes were grouped in six clusters (Table 1). The cluster I[st] was largest consisting twenty genotypes followed by cluster II with two genotypes (L-352, L-424), cluster III, IV, V and VI with one genotype were the smallest cluster. The genotypes belonging to same status or origin were grouped in to different clusters and the genotypes belonging to different origin were grouped in same clusters. The grouping pattern of the genotypes suggested no parallelism between genetic divergence and geographical distribution of genotypes. Mohanty (6), and Mohanty and Prusti (8), also reported that genotype diversity was independent of geographical region. Intra- and inter-cluster D^2 values and corresponding genetic distance have been presented in Table 2. The highest intra-cluster value (D^2) and genetic distance was noted for cluster I (61.68),(7.83) followed by cluster II (39.63), while other clusters III, IV, V and VI had zero intra cluster value. Clusters with single genotype (III, IV, V and VI) indicating their independent identity and importance due to various unique characters possessed by them.

*Corresponding author's E-mail: singhrknbpgr@yahoo.com

Table 1. Distribution of onion advance lines in different cluster obtained by multivariate analysis.

Cluster No.	No. of line(s)	Name of line(s)
I	20	343,501,380,400,359,574,472,382,562, 627,589,351,494,350,672,629,546,652, 453,590
II	02	352,424
III	01	Agrifound White
IV	01	653
IV	01	474
VI	01	Agrifound Light Red

of plant height (65.96 cm),bulb diameter (5.55 cm), bulb size index (23.31 cm^2), 20 bulb weight (1.38 kg), gross yield (394.97 q/ha), marketable yield (378.96 q/ha) and minimum doubles (1.60%). Cluster-V was promising for highest number of leaves per plant (9.06) and minimum bolters (1.35%) and days taken for in harvesting (107.33). The cluster IV and II showed minimum neck thickness (1.42 cm) and minimum days taken in bulb initiation (47.08) respectively. Cluster III characterized by high TSS (13.44%) and dry matter (14.31%). The largest cluster-I had more and less average values for most of the traits like yield and yield contributory traits. Study on genetic divergence existing in germplasms for selecting the parent for hybridization is realistic. Any attempt to strengthen the existing gene pool with introduction of onion materials and their evaluation for desirable traits like resistant adoptability, yield and quality is relevant for improving the potentiality of onion crop. The individual characters contributing, studies revealed that days for bulb initiation contributed maximum (31.077%) toward genetic divergence followed by days for harvesting (13.538%), marketable yield (12.923%), gross yield (12.308%), bolters (11.692%) and neck thickness (8.923%). These all above traits were considered to be most important for genetic divergence, they contributed (90.46%) towards genetic divergence in this present investigation. The similar finding for contributions regarding marketable yield and gross yield were also reported by Mehta *et al.* (4).

Table 2. Inter- and intra-cluster D^2 value (light) and Distance (D^2) in onion advance lines.

S. No.	Cluster	I	II	III	IV	V	VI
1	I	61.68 (7.83)*	103.71 (10.18)	143.25 (11.97)	159.20 (12.62)	102.07 (10.10)	94.84 (9.74)
2	II		39.63} (6.30)	68.03 (8.25)	167.53 (12.94)	118.89 (10.90)	211.39 (14.54)
3	III			0.00 (0.00)	206.37 (14.37)	191.11 (13.82)	247.63 (15.74)
4	IV				0.00 (0.00)	274.01 (16.55)	200.83 (14.17)
5	V					0.00 (0.00)	123.81 (11.13)
6	VI						0.00 (0.00)

The intra-cluster values are lesser than inter-cluster values. It is indicated that homogenous and heterogeneous nature of the genotypes within and between the clusters. The inter-cluster distance (D^2) is the main criterion for selection of genotype. The genotypes belonging to the cluster with maximum inter cluster distance are genetically more divergent and hybridization between genotypes of divergent cluster is likely to produce wide variability with desirable sergeants, (Arunachalam, 1). Therefore, it is suggested that based upon large cluster distances to attempt crossing of genotypes from all the clusters, which may lead to broad spectrum of favorable genetic variability for bulb yield improvement.

Estimates of the cluster means for different traits are measure of inter cluster divergence and degree of homogeneity in this clusters. Cluster mean were worked out and presented in Table 3, indicated that the different clusters were superior in respect of various traits. The cluster VI had the highest value

The extent of variability with respect of fourteen polygenic traits in different genotypes measured in terms of range, general mean, genotypic coefficient of variation (GCV), phenotype coefficient of variation

Table 3. Cluster mean for different traits in onion advance lines.

Trait	Cluster						% Contribution
	I	II	III	IV	V	VI	
Plant height (cm)	62.01	59.88	56.58	62.36	61.86	65.96	3.077
Leaves per plant	8.84	8.73	8.66	8.66	9.06	8.76	2.769
Neck thickness (cm)	1.50	1.50	1.72	1.42	1.63	1.60	8.923
Bulb diameter (cm)	5.38	5.20	5.32	5.41	5.33	5.55	0.308
Bulb size index (cm^2)	21.46	19.55	19.47	20.95	21.68	23.31	0.615
Weight of 20 bulbs (kg)	1.28	1.14	1.15	1.20	1.30	1.38	0.923
Doubles (%)	3.86	2.45	6.33	12.30	2.56	1.60	1.231
Bolters (%)	3.99	8.91	13.22	14.73	1.35	3.02	11.692
Days for bulb initiation	50.40	47.08	49.33	49.16	47.16	50.16	31.077
Days for harvesting	111.77	110.58	112.83	113.0	107.33	113.66	13.538
Total soluble solids (%)	12.00	12.62	13.44	11.66	12.00	13.16	0.615
Dry matter (%)	13.09	13.15	14.31	13.37	13.23	13.96	0.000
Gross yield (q/ha)	344.76	306.23	272.17	360.57	377.01	394.97	12.308
Marketable yield (q/ha)	312.73	262.37	251.81	326.26	353.23	378.96	12.923

(PCV) along with amount of heritability (h^2) and expected genetic advance as percent of mean are given in Table 4. The range of variations were high for gross yield (266.66–394.97 q/ha) marketable yield (251.70–378.96 q/ha), bolters (1.07–14.73%), doubles (1.60–12.30%) and bulb size index (19.19–23.31 cm^2). The narrow difference between phenotypic and genotypic coefficient of variation was recorded for gross yield (10.68–9.67), marketable yield (12.26–11.57), days for harvesting (1.40–1.23) and days for bulb initiation (3.90–3.63), indicating less in environmental inheritance on the expression on these traits. Hence, it is suggested that the major contribution of genetic variability towards the total variance indicating ample scope for effective improvement. The phenotypic coefficient of variation (PVC) was higher than the genotypic coefficient of varieties (GCV) for all the traits studies. The traits bolters showed higher PCV and GCV (81.25) (66.71%) followed by doubles (72.08) (46.41) and marketable yield (12.36) (11.57). Mehta *et al.* (4) also reported similar result for high PCV and GCV for bolting. The heritability in broad sense ranged from (8.60–87%). The high heritability were obtained for marketable yield (87.70%), gross yield (82.00%), days for harvesting (76.50%), neck thickness (73.50%), plant height (70.00%) and bolters (67.40%). High heritability estimates have been found helpful in selection of superior genotypes on the basis of phenotypic estimates along with genetic advance is more useful than the heritable value alone for the best individual**.** Mohanty (7) and Mehta *et al.* (4) also reported high heritability for yield, plant height, and weight of bulb. High genetic advance as percent of mean was noted for bolters (113.00%) followed by doubles (61.63%) marketable yield (22.30%) and gross yield (18.05%). Remaining traits showed low genetic advance. The high heritability estimates along with genetic advance is more useful than the heritability values alone for selecting the best individual. In the present study, the traits marketable yield, gross yield, bolters and doubles showed high heritability coupled with high genetic advance as percent of mean. Days for harvesting, day for bulb initiation, neck thickness and plant height showed high heritability along with low genetic advance. The traits which exhibited high heritability with high genetic advance as percent of mean are genetically correlated by additive gene action and can be improved through mass selection or any other modified selection procedure. Thus from the present investigation it may be concluded that the traits, weight of 20 bulbs, days for bulb initiation, days for bulb harvesting, gross yield and marketable yield will be effective to bring rapid improvement in onion.

Table 4. Range, mean, coefficient of variation, heritability and genetic advance for different traits in onion.

Trait	Range	SEm±	G Mean	Variance		Coefficient of Variation		Heritability (%)	Genetic advance (GA)	GA as percent of mean
				VG (%)	VP (%)	PCV (%)	GCV (%)			
Plant height (cm)	56.58-65.96	1.07	61.80	4.01	5.73	3.87	3.24	70.00	3.45	5.58
Leaves per plant	8.20-9.80	0.22	8.82	0.06	0.14	4.29	2.91	46.00	0.36	4.08
Neck thickness (cm)	1.36-1.72	0.04	1.52	0.01	0.01	6.29	5.39	73.60	0.15	9.86
Bulb diameter (cm)	5.14-5.62	0.10	5.37	0.01	0.03	2.94	1.56	28.20	0.09	1.67
Bulb size index (cm^2)	19.19-23.31	0.79	21.30	0.55	1.51	5.78	3.50	36.80	0.93	4.36
Weight of 20 bulbs (kg)	1.14-1.46	0.05	1.26	0.01	0.01	7.81	5.81	55.30	0.11	8.73
Double (%)	1.60-12.30	1.82	4.04	3.51	8.48	72.08	46.41	41.50	2.49	61.63
Bolters (%)	1.07-14.73	1.89	5.00	11.14	16.53	81.25	66.71	67.40	5.65	113.00
Days for bulb initiation	46.66-52.83	0.58	49.92	3.29	3.80	3.90	3.63	86.70	3.48	6.97
Days for harvesting	107.33-114.0	0.62	111.67	1.88	2.46	1.40	1.23	76.50	2.48	2.22
Total soluble solids (%)	11.16-13.44	0.55	12.14	0.22	0.68	6.82	3.87	32.20	0.55	4.53
Dry matter (%)	12.17-14.31	0.70	13.16	0.07	0.80	6.82	2.00	8.60	0.16	1.21
Gross yield (q/ha)	266.66-394.97	12.69	342.79	1100.49	1342.08	10.68	9.67	82.00	61.88	18.05
Marketable yield (q/ha)	251.70-378.96	11.09	311.14	1296.33	1480.95	12.36	11.57	87.50	69.39	22.30

Table 5. Onion genotypes collected from different areas for study.

Genotype	Source	Genotype	Source	Genotype	Source	Genotype	Source
343	NBPGR, New Delhi	400	Nashik (MS)	546	Nashik (MS)	652	Ottur, Pune
350	NBPGR, New Delhi	424	Khargaon (MP)	562	Amarawati (MS)	653	Indore (MP)
351	NBPGR, New Delhi	453	Nashik (MS)	574	Pune (MS)	672	Indore (MP)
352	NBPGR, New Delhi	472	Nashik (MS)	589	MPKV, Rahuri	ALR	Dindori, Nashik
359	NBPGR, New Delhi	474	Nashik (MS)	590	Dindori, Nashik (MS)	A. White	Nimar (MP)
380	NBPGR, New Delhi	494	IARI, New Delhi	627	Ludhiana, Haryana		
382	NBPGR, New Delhi	501	IARI, New Delhi	629	Karnal, Haryana		

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