Environment and Ecology 41 (1A) : 256—261, January—March 2023
ISSN 0970-0420

Analysis of Genetic Divergence in Onion

Yogita, Ramesh Kumar, Srishti

Received 20 September 2022, Accepted 25 December 2022, Published on 6 February 2023

ABSTRACT

Genetic divergence plays an important role in understanding the general distance among the genotypes selected as parents. Less divergent genotypes are grouped together, while more divergent genotypes are placed in other clusters. An experiment was carried out to determine the genetic diversity in 30 onion genotypes, including the check cultivar Nasik Red during the *rabi* season of 2019-20 and 2020-21 and analysis of pooled data of both years was done. Based on analysis of genetic divergence, all the genotypes accommodated in 5 clusters and cluster I accommodated maximum number of genotypes (14) followed by cluster II (8), III (6), IV (1) and V (1) respectively. Based on the values of inter cluster distance, hybridization between the genotypes of cluster III and cluster IV will be successful in enhancing various horticultural qualities. Cluster IV and II had the highest cluster mean values for the majority of the traits studied. Bulb yield per plot was the most important contributor to overall genetic difference, followed by polar diameter neck thickness, equatorial diameter, plant height, doubles/deformed bulbs, bulb shape index. As a result, these might be utilized as the parameters for selecting genetically different parents for hybridization in order to increase population diversity.

Keywords Onion, Genotypes, Cluster, Genetic diversity.

INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important bulbous vegetable crop, belongs to the family Alliaceae and having diploid chromosome number 2n=2x=16. It is a cool season crop. It can be cultivated in a vast range of climatic conditions. It is a cross pollinated crop, mainly pollinated by honey bees and blowflies. The crop is annual for bulb production and biennial for seed production (Hazra *et al.* 2011). India is the second largest producer of onion in the world after China and ranks third in export. Maharashtra is the leading state in area and production followed by Karnataka. In India, it occupies an area of 1431 thousand hectares with the production of 26148 thousand metric tonnes and productivity is 18.27 metric tonnes per hectare (NHB 2020). In Himachal Pradesh onion occupies an area of 3.06 thousand hectares with a production of 65.11 thousand metric tonnes and productivity is 21.28 metric tonnes per hectare (NHRDF 2020). For initiating systematic breeding and improvement program in any crop, it is essential to study variability present in genetic material. The knowledge on genetic divergence is essential in plant

Yogita[1]*, Ramesh Kumar[2], Srishti[3]
[1,3]PhD Scholar, [2]Principal Scientist,
[1] Department of Vegetable Science, College of Horticulture, Maharana Pratap Horticultural University, Karnal 132117, Haryana, India
[2]Department of Vegetable Science, College of Horticulture, Dr. Yashwant Singh Parmar University of Horticulture and Forestry Nauni, Solan 173230, Himachal Pradesh, India
[3]Department of Vegetable Science and Floriculture, College of Agriculture, CSK HPKV, Palampur (HP), India
Email : yogita3006@gmail.com
*Corresponding author

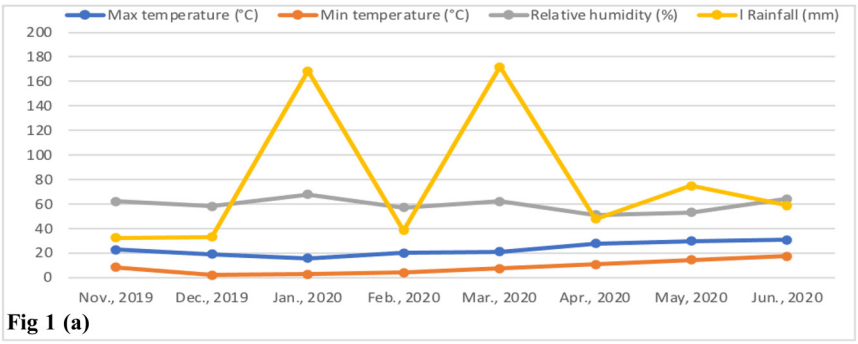

Fig 1 (a)

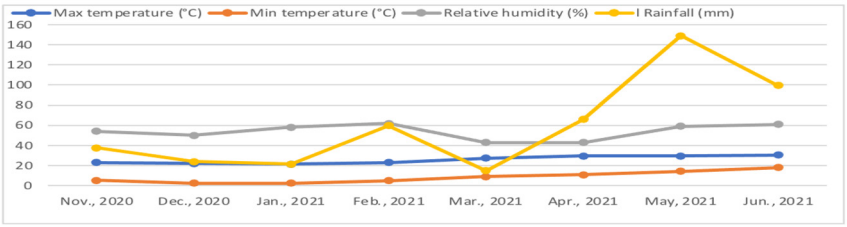

Fig 1 (b)

Fig. 1(a) Graphical representation of data pertaining to temperature, relative humidity and rainfall during the growing season (November 2019 to June 2020). **1 (b)** Graphical representation of data pertaining to temperature, relative humidity and rainfall during the growing season (November 2020 to June 2021). Source : Meterological observatory, department of environmental sciences, UHF, Nauni, Solan, (HP) 173230.

improvement because the crosses made between genetically diverse parents are likely to produce superior transgressive segregants than the closely related parents (Kale *et al.* 2015). The selection of parents is often a crucial step in any hybridization program because greater genetically diverse parents lead to a better selection of segregants. So, Mahalanobis's D^2 statistic approach has been used to estimates the distances between the two populations in terms of inter and intra- cluster distances and gives information about various characters of the divergent parents prior to any hybridization procedure.

Table 1. Clustering pattern of different genotypes on the basis of genetic divergence.

Cluster	Number of genotypes	Genotypes
I	14	UHF-ONI-6, UHF-ONI-8, UHF-ONI-9, UHF-ONI-10, UHF-ONI-19, UHF-ONI-20, UHF-ONI-21, Bhima Shubhra, Bhima Raj, Bhima Shakti, Bhima Shweta, Bhima Dark Red, Palam Lohit and Nasik Red
II	8	UHF-ONI-12, UHF-ONI-14, UHF-ONI-15, UHF-ONI-16, UHF-ONI-17, UHF-ONI-18, Bhima Red and Bhima Kiran
III	6	UHF-ONI-1, UHF-ONI-2, UHF-ONI-3, UHF-ONI-5, UHF-ONI-7 and UHF-ONI-11
IV	1	UHF-ONI-13
V	1	UHF-ONI-4

MATERIALS AND METHODS

The investigation was carried out at the Experimental Farm of Department of Vegetable Science, Dr

Table 2. Average intra and inter cluster distance among 30 genotypes of onion.

Cluster	Cluster distances I	II	III	IV	V
I	**40.08**				
II	112.85	**46.71**			
III	95.52	284.15	**40.24**		
IV	232.02	70.46	455.63	**0.00**	
V	112.04	145.05	136.90	202.32	**0.00**

Table 3. Cluster means for different characters among 30 genotypes of onion.

Traits	Cluster I	II	III	IV	V
Plant height (cm)	46.41	54.68	40.00	69.09	41.30
Number of leaves per plant	7.36	7.98	7.13	8.30	7.34
Leaf length (cm)	37.22	42.79	32.81	55.00	34.58
Neck thickness (cm)	1.34	1.44	1.17	1.59	1.21
Polar diameter (cm)	4.34	4.91	4.35	5.83	5.77
Equatorial diameter (cm)	5.04	5.32	4.45	5.23	4.66
Bulb shape index	0.86	0.93	0.98	1.11	1.19
Days to 50% neck fall	144.20	150.83	138.28	147.33	129.67
Days to harvest	152.05	159.71	147.14	157.17	135.84
Dry matter (%)	14.25	12.58	15.21	11.96	14.56
Total soluble solids (°B)	14.96	14.06	17.38	12.89	17.10
Doubles/ Deformed bulbs (%)	5.77	4.53	5.80	4.45	2.34
Average bulb weight (g)	60.67	75.96	46.14	81.45	65.72
Bulb yield per plot (kg)	5.77	7.37	4.33	8.70	4.96
Bulb yield per hectare (q)	307.97	393.21	231.04	463.97	264.52

YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during *rabi* season of 2019-20 and 2020-21 on 30 diverse genotypes of onion including Nasik Red as check. The experiment field is situated at 30°86' North of latitude and 77°17' East of longitude with an altitude of 1,275 m above mean sea level at Nauni, about 14 km away from the South-East of Solan (HP). The experimental material was laid out in Randomized Complete Block Design (RCBD) with three replications. Seedlings were transplanted in the last week of December, 2019-20 and 2020-21 at a spacing of 15×10 cm in a plot size

Table 4. Per cent contribution of different traits towards genetic divergence.

Sl. No.	Source	Contribution %	Times ranked 1st
1	Plant height (cm)	3.00	13
2	Number of leaves per plant	2.00	09
3	Leaf length (cm)	4.00	17
4	Neck thickness (cm)	6.44	28
5	Polar diameter (cm)	3.50	15
6	Equatorial diameter (cm)	4.03	18
7	Bulb shape index	4.70	20
8	Days to 50% neck fall	5.00	22
9	Days to harvest	4.30	19
10	Dry matter (%)	2.99	13
11	Total soluble solids (°B)	1.38	06
12	Doubles/Deformed bulbs (%)	3.68	16
13	Average bulb weight (g)	12.00	52
14	Bulb yield per plot (kg)	23.00	100
15	Bulb yield per hectare (q)	20.00	87

of 1.5×1 m^2 which accommodated 100 plants per plot. During the cropping period from November to June for both years. Graphical representation of data pertaining to the temperature, relative humidity during the growing seasons is presented in Figs. 1 (a) – 1 (b).

The observations were recorded for different characters viz., plant height (cm), number of leaves per plant, leaf length (cm), neck thickness (cm), polar and equatorial diameter (cm), bulb shape index, bulb skin color, days to 50% neck fall, days to harvest,

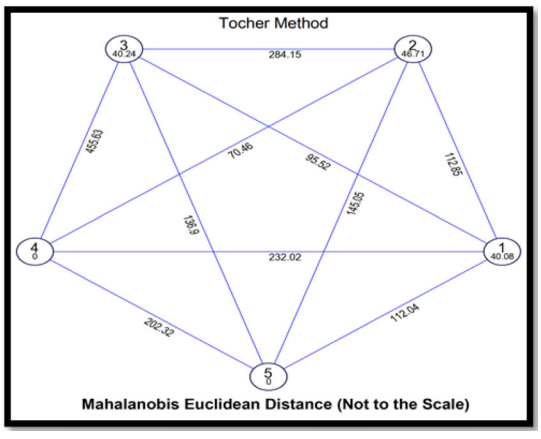

Fig. 2. Mahalanobis euclidean distance by tocher method.

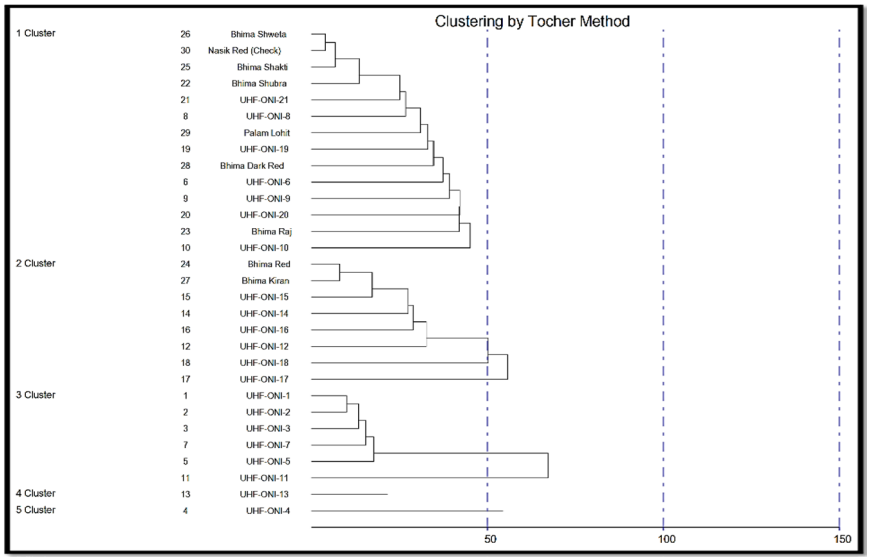

Fig. 3. Dendrogram of onion genotypes depicting cluster pattern.

dry matter (%), total soluble solids (˚B), doubles/deformed bulb (%), average bulb weight (g), bulb yield per plot (kg), bulb yield per hectare (q) and disease incidence. The genetic divergence was estimated by Mahalanobis 'D^2' statistics generalized distance as suggested by Rao (1952).

RESULTS AND DISCUSSION

In this study, thirty onion genotypes were grouped into five clusters based on various characters under study. The cluster I includes 14 genotypes (UHF-ONI-6, UHF-ONI-8, UHF-ONI-9, UHF-ONI-10, UHF-ONI-19, UHF-ONI-20, UHF-ONI-21, Bhima Shubhra, Bhima Raj, Bhima Shakti, Bhima Shweta, Bhima Dark Red, Palam Lohit and Nasik Red), cluster II contains eight genotypes namely (UHF-ONI-12, UHF-ONI-14, UHF-ONI-15, UHF-ONI-16, UHF-ONI-17, UHF-ONI-18, Bhima Red and Bhima Kiran), cluster III contains six genotypes (UHF-ONI-1, UHF-ONI-2, UHF-ONI-3, UHF-ONI-5, UHF-ONI-7 and UHF-ONI-11) and cluster IV and V includes one genotype each viz., UHF-ONI-13 and UHF-ONI-4 respectively (Table 1).

Average intra and inter-cluster distances (D^2) values were presented in Table 2 and Fig. 2. The diagonals values in the figure represent the intra-cluster distance. The intra cluster distances ranged from 0.00 (cluster-IV and V) to 46.71 (cluster-III). The inter- cluster distance was found highest (455.63) between cluster III and IV and lowest (70.46) between cluster II and IV. The genotypes from cluster III and IV can further be used in hybridization programs and in improvement of different horticultural attributes in onion. Singh *et al.* (2013), Akter *et al.* (2015), Nikhil and Jadhav (2016), Dangi *et al.* (2018), Bal *et al.* (2020) and Jeevitha *et al.* (2020) also reported similar results.

For all the traits under study, pooled cluster mean was calculated and presented in the Table 3. The cluster IV recorded to have maximum values of traits like, plant height (69.09 cm), number of leaves per plant (8.30), leaf length (55.00 cm), neck thickness (1.59 cm), polar diameter (5.83 cm), average bulb weight (81.45 g), bulb yield per plot (8.70 kg) and bulb yield per hectare (463.97 q). In cluster II, maximum equatorial diameter (5.32 cm), days to 50% neck fall (150.83) and days to harvest (159.71). The maximum bulb shape index was recorded in cluster V (1.19). In cluster III, includes maximum value of dry matter per cent (15.21), total soluble solids (17.38 °B) and per cent of doubles/deformed bulbs (5.80).

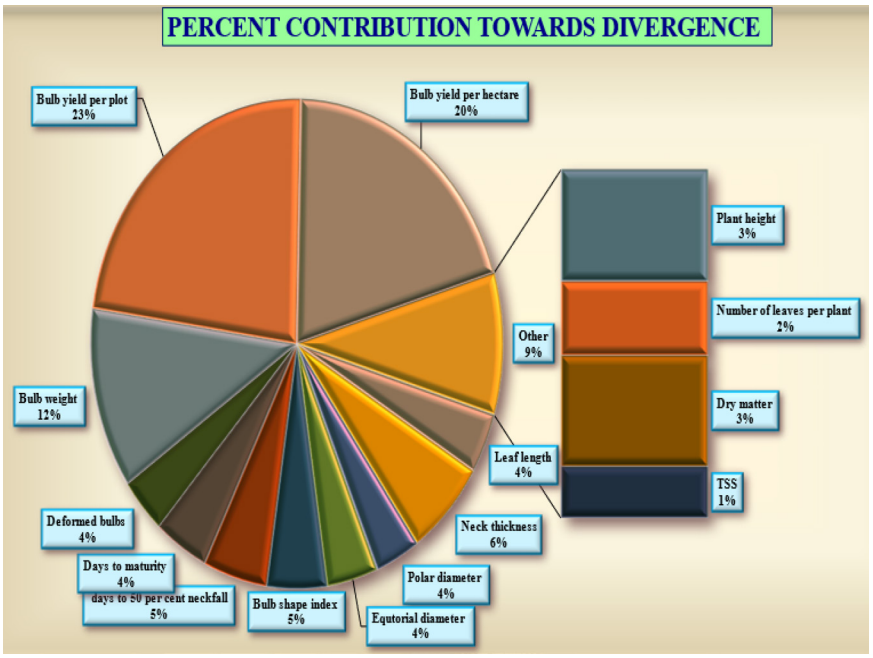

Fig. 4. Per cent contribution of different traits towards genetic divergence.

Hierarchical cluster analysis was also used to generate a dendrogram using the 15 quantitative characteristics under investigation. Five groups were identified based on the study as presented in the Fig. 3. Dhotre *et al.* (2010), Singh and Dubey (2011), Singh *et al.* (2013), Akter *et al.* (2015), Kale *et al.* (2015), Nikhil and Jadhav (2016), Dangi *et al.* (2018), Bal *et al.* (2020), Jeevitha *et al*. (2020) and many others have reported the genetic divergence in their germplasm of their respective onion breeding material.

Contribution of each trait towards divergence has been assessed from the number of times that each character appeared in the first rank. The contribution of individual characters to divergence has also been worked out (Table 4 and Fig. 4). Bulb yield per plot contributed maximum towards the total genetic divergence followed by polar diameter, neck thickness, equatorial diameter, plant height, doubles/deformed bulbs, bulb shape index, dry matter, leaf length, average bulb weight, total soluble solids, number of leaves per plant, days to 50% neck fall and days to harvest. Therefore, it could also be used as the parameters based on specific trait (s) in selecting genetically diverse parents for hybridization to create variability in the population.

CONCLUSION

In the present investigation, Mahalanobis D^2 statistics revealed that 30 genotypes were grouped into five clusters. Cluster I accommodated maximum number of 14 genotypes followed by II (8), III (6), IV (1) and V (1). The intra cluster distance was found maximum in cluster III. The maximum inter cluster distance was observed between cluster III and IV. Hybridization between the genotypes of cluster III and cluster IV will be effective in improving many horticultural features based on the values of inter cluster distance. Based on cluster mean values, cluster IV and II gave maximum cluster mean for most of the attributes under study. Bulb yield per plot contributed maximum towards the total genetic divergence followed by polar diameter, neck thickness, equatorial diameter, plant height, doubles/deformed bulbs, bulb shape index, dry matter, leaf length, average bulb weight, total soluble solids, number of leaves per plant, days to 50% neck fall and days to harvest. Therefore, it could also be

used as the parameters based on specific trait (s) in selecting genetically diverse parents for hybridization to create variability in the population.

REFERENCES

Akter MS, Biswas A, Siddique SS, Hossain S, Ivy NA (2015) Estimation of genetic diversity in onion (*Allium cepa* L.). *The Agric* 13 : 26—34.

Bal S, Maity TK, Sharangi AB, Majumder A (2020) Quality assessment in association with yield attributes contributing improved yield in onion (*Allium cepa* L.). *J Crop Weed* 15 : 107—115.

Dangi R, Kumar A, Khar A (2018) Genetic variability, heritability and diversity analysis studies in short day tropical onion (*Allium cepa*). *Ind J Hortic Sci* 88 : 140—149.

Dhotre M, Alloli TB, Athani SI, Halemani (2010) Genetic variability, character association and path analysis studies in *kharif* onion (*Allium cepa* var. *cepa* L.). *The Asian J Hortic* 5 : 143—146.

Hazra P, Chattopadhyay A, Karmakar K, Dutta S (2011) Modern Technology in Vegetable Production. New India Publishing Agency, New Delhi, pp 417.

Jeevitha D, Dharmatti PR, Patil RV, Biradar BD, Patil MS (2020) Diversity studies in onion genotypes. *Int J Curr Microbiol Appl Sci* 9 : 3051—3058.

Kale SM, Ajjappalavara PS, Utagi S, Patil HB, Muthal KM (2015) Genetic variability for horticultural and nutritional traits in onion (*Allium cepa* L.). *Ecol Environ Conserv* 21 : 291—297.

NHB (2020) Area and production of Horticultural Crops for 2019—2020 (3rd Advance Estimate). http://nhb.gov.in [12:15 PM, 4th June, 2022].

NHRDF (2020) Statewise area and production data for onion, pp 2019—2020. http://nhrdf.org 10:00 AM, 10th June 2022.

Nikhil BSK, Jadhav AS (2016) Estimation of genetic diversity in *kharif* onion (*Allium cepa* L.). *Ecol Environ Conserv* 22 : 445—448.

Rao R (1952) Advanced Statistical Methods in Biometrical Research. John Wiley and Sons Inc., New York, pp 390.

Singh RK, Dubey BK (2011) Interrelationship and path coefficient studies on yield attributing factors in onion (*Allium cepa* L.). *Prog Hortic* 43 : 874—879.

Singh SR, Ahmed N, Lal S, Ganie SA, Amin M, Jan N, Amin A (2013) Determination of genetic diversity in onion (*Allium cepa* L.) by multivariate analysis under long day conditions. *Afr J Agricult Res* 8 : 5599—5606.