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# Genetic Divergence Studies in Onion (*Allium cepa* L.) Genotypes for Growth and Yield Parameters

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**ABSTRACT**

*Mahalanobis $D^2$ statistics was used to study the genetic divergence for 15 characters among 29 genotypes of Onion. Genotypes were grouped in to nine clusters on the basis of realative magnitude of $D^2$ values. The highest number of genotypes (9) appeared in cluster I. The maximum inter cluster distance was observed between cluster VIII and cluster IX followed by cluster IV and VII. The minimum inter cluster distance was observed between cluster IV and V. Maximum intra cluster distance was in cluster I followed by cluster VII. Clusters differed with respect to their mean performance. Cluster IV ranked first with respect to where desirable characters bulb weight, equatorial bulb diameter, polar bulb diameter, bulb shape index and number of rings. The same cluster also recorded lower mean value for doubles, thrips and purple blotch incidence which were desirable characters and have to be considered in future crop improvement programme.*

***Key words:*** Onion, *Genotypes, Crop, Cultivation*

## INTRODUCTION

Onion (*Allium cepa* L.) is an important vegetable crop of the genus *Allium* and the most widely cultivated species across the world. The major onion producing countries are China, India, Pakistan, Bangladesh, Indonesia, Vietnam, Russia, Myanmar, Brazil, Turkey, Egypt, Netherlands, Iran etc[3]. Onion being member of *Alliaceae* family, are cultivated throughout the world for food, therapeutic and medicinal value since historic times. In India, it is the most popular and consumed vegetable in the daily diet and cultivated at small and large scale. In world, India ranks first in area and second in onion production. India has about 1.04 million hectares area under onion cultivation constituting about 26.38% of total world area with an annual production of 19.4 MT in 2015[4]. From the last few years, area under onion cultivation is increasing due to its continuous demand in the national and international market. India itself supplies onion to 38 different countries throughout the world in varying quantity. Thus, onion is an important crop not only from food security point of view but also provide an economic security to country.

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However, onion productivity in India is about 16.13 T ha-1 which is low in comparison to Republic of Korea where, onion productivity was highest i.e. 57.03 T ha-1[13]. The important economical trait in onion crop is the bulb yield and quality that are regulated by several internal genetic and external environmental factors. Genetic factors are the major contributors influencing the different morphological, physiological, crop duration, biochemical traits, bulb yield, size, shape, storage life and quality among the different onion cultivars[12]. Genetic diversity in a crop is most important in selecting the better genotype for improvement in desired characters. For a successful breeding program, the presence of genetic diversity and variability play a vital role. Selection of genetically diverse parents in any breeding programme is of immense importance for successful recombination breeding[1]. Precise information on the nature and degree of genetic diversity helps the plant breeder in choosing the diverse parents for purposeful hybridization[10]. Improvement in yield and quality is normally achieved by selecting genotypes with desirable character combinations existing in the nature or by hybridization. The D2 statistic provides a quantitative measure of genetic divergence among populations and assists in classifying genetic stocks into distinct groups which is further helpful for evolving superior genotypes. When breeding for a particular set of growing conditions, it is highly important to know the use of local populations, since in them the relationships among yield components are balanced and in harmony with the effects of the specific climatic and edaphic factors. The information on genetic divergence of various traits particularly of those that contribute to yield and quality would be most useful in planning the breeding programme.

## 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 130 651 North latitude and 790 421 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 soil sample was analyzed for pH, electrical conductivity and organic carbon content. 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 genotypes are collected from IIHR – Bangalore, NHRDF – Pune, DOGR – Pune, TNAU – Coimbattore and selections of karnataka. Genetic diversity was studied using Mahalanobis generalized distance (D2) extended by Rao[9]. Clustering of genotypes was done according to Tocher's Method Rao[9]. Average intra-cluster distance was calculated by the following formula as suggested by Singh and Choudhary[11].

## RESULTS AND DISCUSSION

Genetic diversity has been considered as an important factor in discriminating the genotypes for selecting genetically diverse parents for obtaining high yielding lines for efficient and successful hybridization programme. Choice of parents for any crop improvement program based on genetic divergence is the outcome of the hypothesis that divergent parents offer substantial variability that reflects in segregating generations. Mohanty[5]. and Mohanty and Prusti[6]. also reported that genotypic diversity was independent of geographical region. Mahalanobis's D2 provides a useful statistical method for measuring the amount of genetic diversity among the genotypes. In the present study, the data collected on the fifteen characters were used for quantitative assessment of genetic divergence by adopting Mahalanobis's D2 statistic.

The twenty nine genotypes were grouped into nine clusters using Tocher's method[9]. and distribution of genotypes into each of nine

clusters is presented in Table 1. Cluster I was the largest with nine genotypes, followed by cluster IV with five genotypes, cluster III with four genotypes, cluster II with three genotypes, cluster V, VI and VII with two genotypes and VIII & IX with only genotype to each indicating their independent identity and importance due to unique characters. Similar results were also reported by Dhotre[2], wherein he grouped 14 onion genotypes in 5 clusters and Ningadalli[7] grouped 34 genotypes into nine clusters.

The intra and inter cluster D2 values among 9 clusters were presented given in Table 2. Intra-cluster average D2 values ranged from 0.00 to 1939.53. Among the clusters, cluster I had the maximum intra cluster distance (1939.53) followed by cluster VII (1882.94) and cluster II (1784.16).while the clusters VIII and IX had recorded zero values as they included only single genotype in each cluster. The maximum inter cluster D2 values was recorded between cluster IV and VII (13036.57), followed by cluster II and VII (12451.99), while the minimum D2 value was found between cluster IV and cluster V (863.39), followed by cluster II and IV (11.61). The intra cluster values were lesser than inter cluster values, indicating homogeneous and heterogeneous nature of genotypes within and between the clusters. The inter cluster D2 value is the main criterion for selection of genotypes. The genotypes belonging to cluster IV and VII (13036.57), followed by cluster II and VII (12451.99) are genetically more divergent and hybridization between these genotypes will produce desirable segregants. Therefore it is suggested that based upon large cluster distances, crossing of genotypes may lead to broad spectrum of favourable genetic variability for bulb improvement in onion.

The cluster means for each of sixteen characters are presented in Table 3. Considerable differences between clusters means were observed for most of the characters studied. The plant height was maximum in cluster VIII (71.31 cm) and minimum in cluster VII (58.98 cm). Similarly number of leaves clusters ranged from 8.67 cm in cluster II to 13.10 cm in cluster VIII, neck thickness ranged from 12.48 mm in cluster VII and 18.34 mm in cluster IX, days to 50 per cent neck fall ranged from 79 days in cluster VIII to 118.50 days in cluster V, equatorial bulb diameter ranged from 47.29 mm in cluster VII to 66.24 mm in cluster IV. Polar bulb diameter ranged from 47.80 mm in cluster VII to 68.61 mm in cluster IV. The genotypes of cluster IV recorded high bulb weight (141.62g) and yield (63.80 t/ha), while genotypes of cluster VII recorded low bulb weight (41.10 g) and yield (40.41 t/ha). The genotypes in cluster IV recorded high bulb shape index (1.15 mm) while genotypes in cluster IX recorded low bulb shape index (1.01 mm). The cluster mean for doubles was highest in cluster VII (44.94) and was lowest in cluster IX (14.32 %), while the cluster mean for number of rings was highest in cluster V (8.61) and was lowest in cluster VII (5.78). The genotypes of cluster VIII had high thrips infestation (63.88%) and low in cluster VII (20.94%). The cluster mean for purple blotch intensity was maximum in cluster VIII (76.09%) and minimum in cluster V (37.13%) while, for ascorbic acid it was maximum in cluster V (10.99 mg/ 100 g) and minimum in cluster VII (8.55 mg/100g). Clusters differed with respect to their mean performance. Cluster IV ranked first with respect to where desirable characters bulb weight, equatorialbulb diameter, polar bulb diameter, bulb shape index and number of rings. The same cluster also recorded lower mean value for doubles, thrips and purple bloth incidence which were desirable characters and have to be considered in future crop improvement programme. Patil[8] and Dhotre[2]. also reported that the most diverse cluster had the superior *per se* performance with respect to fresh bulb weight and yield.

**Relative contribution of each character towards diversity:**

The number of times that each of the sixteen characters appeared in first rank and its respective per cent contribution towards diversity presented in Table 4 Among all the

characters studied bulb yield contributed the maximum (49.75%) to the diversity by taking first rank in 202 times out of 406 combinations, followed by doubles (22.66% with 92 times ranked first), equatorial bulb diameter (7.38% with 30 times ranked first), thrips infestation (7.14% with 29 times ranked first). The characters *viz*., purple blotch, number of rings, reducing sugars, bulb weight, total sugars and ascorbic acid contributed 4.18%, 3.44%, 2.95%, 1.23%, 0.73%, and 0.49%, respectively to the genetic divergence in decreasing order. On contrary, plant height, number of leaves, neck thickness, days to maturity, polar bulb diameter and bulb shape index had negligible contribution towards genetic divergence. Mohanty[5] reported highest contribution from bulb weight. Whereas, Patil[8]. reported that ten bulb weight maximum contribution towards the diversity in onion. Ningadalli[7]. reported bulb yield, bulb weight and number of leaves as the maximum contributing characters towards genetic diversity.

From the present study it can be concluded that, the genotypes Bhima Kiran, Bhima Safed, Bhima Shubhra, Garva, Bhima Red, Single Red, Bhima Shakti, Agrifound Light red, Bellary Local, Arka Bheem, NHRDF Red and Bhima Super recorded higher yield and found superior over all other genotypes. Genotypes like Arka Pragathi, Arka Kalyan, Arka Niketan, Arka Bindu could be utilized in the future breeding programmes for the improvement of different quantitative characters in onion. The study also revealed the wealth of variability available in the onion crop offering good prospects for its improvement in near future.

**Table 1: Cluster composition of twenty nine onion genotypes (Tocher's method)**

| Cluster No. | No. of genotypes | Genotypes |
|---|---|---|
| **I** | 9 | Arka Pragathi, Arka Niketan, NHRDF Red2, Agrifound White, Agrifound Light Red, Bhima Kiran, NHRDF Red, Gadag, Single Red |
| **II** | 3 | NHRDF Red3, Bhima Shwetha, Bhima Red |
| **III** | 4 | Arka Kalyan, Arka Bindu, Bijapur Local, Shahapur Local |
| **IV** | 5 | Bhima Shakti, Bhima Dark Red, Bhima Super, Bhima Raj, Bhima Safed |
| **V** | 2 | Purandhar Local, Bhima Shubhra |
| **VI** | 2 | Bellary Local, Garva |
| **VII** | 2 | Co(ON)5, Agrifound Rose |
| **VIII** | 1 | Dharwad Local |
| **IX** | 1 | Arka Bheem |

**Table 2: Intra cluster (diagonal) and inter cluster D - square values for nine clusters in onion**

| Cluster No | I | II | III | IV | V | VI | VII | VIII | IX |
|---|---|---|---|---|---|---|---|---|---|
| **I** | **1939.530 (44.04)** | 2749.935 (52.44) | 3663.996 (60.53) | 2367.525 (48.65) | 2042.387 (45.19) | 2358.086 (48.56) | 8635.283 (92.92) | 6540.292 (80.87) | 1930.231 (43.93) |
| **II** | | **1784.164 (42.23)** | 6933.480 (83.26) | 1167.609 (34.17) | 1323.168 (36.37) | 4492.581 (67.02) | 12451.993 (111.58) | 11720.134 (108.26) | 2029.249 (45.04) |
| **III** | | | **1645.103 (40.56)** | 7088.289 (84.19) | 6341.265 (79.63) | 2809.612 (53.00) | 6010.913 (77.53) | 1917.975 (43.79) | 4195.938 (64.77) |
| **IV** | | | | **718.945 (26.81)** | 863.387 (29.38) | 4269.161 (65.33) | 13036.568 (114.17) | 11746.206 (108.38) | 1831.091 (42.79) |
| **V** | | | | | **1018.682 (31.91)** | 3412.374 (58.41) | 11788.712 (108.57) | 10959.563 (104.68) | 2263.998 (47.58) |
| **VI** | | | | | | **1737.092 (41.67)** | 4728.783 (68.76) | 5213.775 (72.20) | 4132.046 (64.28) |
| **VII** | | | | | | | **1882.937 (43.39)** | 8073.146 (89.85) | 10852.867 (104.17) |
| **VIII** | | | | | | | | **0.000** | 7112.352 (84.33) |
| **IX** | | | | | | | | | **0.000** |

**Table 3: Mean performance of the clusters with respect to different characters**

| Character/ Cluster | Plant height (cm) | Number of leaves | Neck thickness (mm) | Days to maturity | Polar bulb diameter (mm) | Equatorial bulb diameter (mm) | Bulb shape index | Number of rings | Doubles (%) | Bulb weight (gm) | Ascorbic acid (mg/100gm) | Total sugars (%) | Reducing sugars (%) | Thrips infestation (%) | Purple blotch (%) | Yield (t/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **I** | 59.39 | 8.81 | 16.18 | 116.55 | 63.08 | 63.01 | 1.07 | 7.73 | 22.40 | 128.77 | 9.45 | 6.22 | 3.45 | 36.51 | 45.65 | 62.69 |
| **II** | 61.81 | 8.67 | 17.76 | 118.00 | 65.18 | 65.13 | 1.08 | 8.24 | 15.65 | 133.08 | 9.66 | 5.86 | 3.28 | 24.95 | 41.61 | 60.81 |
| **III** | 61.19 | 10.19 | 15.89 | 112.50 | 58.07 | 58.16 | 1.10 | 7.24 | 31.93 | 101.85 | 9.85 | 6.21 | 3.34 | 51.62 | 61.83 | 49.54 |
| **IV** | 63.14 | 9.17 | 18.05 | 114.73 | 68.61 | 66.24 | 1.15 | 8.54 | 15.37 | 141.62 | 9.73 | 6.18 | 3.20 | 27.36 | 41.95 | 63.80 |
| **V** | 62.88 | 10.81 | 18.32 | 118.50 | 66.31 | 66.09 | 1.02 | 8.61 | 17.96 | 137.63 | 10.99 | 6.56 | 3.58 | 28.23 | 37.13 | 59.50 |
| **VI** | 60.97 | 8.84 | 17.72 | 110.50 | 62.59 | 62.24 | 1.05 | 7.78 | 33.28 | 97.73 | 9.95 | 6.17 | 3.44 | 30.99 | 45.81 | 56.79 |
| **VII** | 58.98 | 10.66 | 12.48 | 97.50 | 47.80 | 47.29 | 1.08 | 5.78 | 44.94 | 41.10 | 8.55 | 5.96 | 2.96 | 20.94 | 32.94 | 40.41 |
| **VIII** | 71.31 | 13.10 | 18.21 | 79.00 | 61.59 | 60.87 | 1.06 | 6.33 | 35.33 | 99.93 | 8.95 | 6.20 | 3.40 | 63.88 | 76.09 | 57.67 |
| **IX** | 68.80 | 11.54 | 18.34 | 113.00 | 59.67 | 59..24 | 1.01 | 7.20 | 14.32 | 115.13 | 8.63 | 6.13 | 3.23 | 36.82 | 55.37 | 59.93 |

**Table 4 Contribution of different quantitative characters to diversity in onion**

| S.No. | Character | Times ranked first | Contribution (%) |
|---|---|---|---|
| **1** | **Plant height (cm)** | 0 | 0.00 |
| **2** | **Number of leaves/plant** | 0 | 0.00 |
| **3** | **Neck thickness (mm)** | 0 | 0.00 |
| **4** | **Days to maturity** | 0 | 0.00 |
| **5** | **Polar diameter (mm)** | 0 | 0.00 |
| **6** | **Equatorial diameter (mm)** | 30 | 7.38 |
| **7** | **Bulb shape index** | 0 | 0.00 |
| **8** | **Number of rings** | 14 | 3.44 |
| **9** | **Bulb weight (gm)** | 5 | 1.23 |
| **10** | **Doubles (%)/splits** | 92 | 22.66 |
| **11** | **Thrips (%)** | 29 | 7.14 |
| **12** | **Purple blotch (%)** | 17 | 4.18 |
| **13** | **Bulb yield (t/ha)** | 202 | 49.75 |
| **14** | **Ascorbic acid (mg/100gm)** | 2 | 0.49 |
| **15** | **Total sugars (%)** | 3 | 0.73 |
| **16** | **Reducing sugars (%)** | 12 | 2.95 |
| | **Total** | 406 | 100 |

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