

## Original Research Article

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## Genetic Diversity in Onion by Multivariate Analysis under Short Day Condition

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### ABSTRACT

#### Keywords

Onion, Correlation coefficient analysis, Multivariate analysis

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Onion (*Allium cepa* L.) is an economical important crop, but genetic diversity among the genotypes is poorly understood. The study was conducted in *Rabi*, 2016 to access the genetic diversity in 33 onion genotypes by correlation and multivariate analysis. The analysis of variance was highly significant for 15 physiological, biochemical and yield traits, which revealed the presence of genetic variability among the entries. Correlation analysis revealed a significant positive association between phenol and bulb yield whereas; flavanoids are strongly associated with antioxidant activity. Multivariate analysis grouped the genotypes into three clusters. Highest inter cluster distance was recorded between cluster II and III whereas, lowest between cluster I and III. In cluster I, all five entries perform outstandingly for parameters viz. chlorophyll, phenol, pyruvic acid, bulb size and yield (42-54  $\text{Tha}^{-1}$ ). Out of the 16 genotypes of cluster II, about 6 entries recorded with lower yield ( $< 30 \text{ Tha}^{-1}$ ) and poor performance while, remaining found better for biochemical traits. The yield performance of 12 genotypes of cluster III is in the range of 42-52  $\text{Tha}^{-1}$ . Thus the entries from cluster I namely, KH-M-1, KH-M-2 and W 344 may be selected as parents in future onion breeding program for developing superior onion variety.

### 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 (Kumar *et al.*, 2017). 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 (Kumar *et al.*, 2015). 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 (Rai *et al.*, 2016; Laxmi *et al.*, 2017). 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. However, onion productivity in India is about  $16.13 \text{ T ha}^{-1}$  which is low in comparison to Republic of Korea where, onion productivity was highest i.e.  $57.03 \text{ T ha}^{-1}$  (Tripathi *et al.*, 2017). This low productivity of onion might be due to the less genetic potential of short day onion varieties predominately grown in Indian sub-continent. Onion is a highly photo and thermo-sensitive crop and hence the available cultivars are categorized as long day and short day onion cultivars. It is well known that long day onion varieties have higher bulb yield with poor storage life whereas, short day varieties are low yielder with good keeping quality (Singh *et al.*, 2013). For increasing onion production under short day condition an improved onion variety and efficient technological intervention are prerequisite. 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 (Sekara *et al.*, 2017). Hence for producing high yielding onion variety with desirable traits, thorough information on the nature and magnitude of genetic variability present in the genotypes and popular cultivars is required for initiating any crop improvement programme. The genetic divergence analysis helps to measure the extent of variability present among genotypes that can be further selected as contrasting parents for a particular hybridization program (Samsuddin, 1985). With this aim the present study has been conducted to estimate the genetic diversity by using multivariate and

correlation analysis in 33 onion genotypes including the popular onion varieties cultivated under short day condition.

## **Materials and Methods**

The study was carried out at ICAR-Directorate of onion and Garlic Research (ICAR-DOGR), Pune, Maharashtra, India ( $18.32^{\circ}$  North latitude and  $73.51^{\circ}$  East longitudes, 553.8 m above mean sea level, annual rainfall 574 mm) in *Rabi* 2016. The experimental plot and soil type is suitable for onion production with 32-35% clay, 20% silt and 40% sand with soil pH of 7.9 and bulk density  $1.4 \text{ Mgcm}^{-3}$ . The experiment was laid out in randomized block design (RBD) with 33 onion entries in three replications (Table 1). All the cultural practices like nursery raising, field preparation, fertigation, agronomic practices, plant protection measures and irrigation were practiced throughout the growth period as per the recommendation in order to raise a good crop.

## **Morphological parameters**

Plant were monitored 50 days after transplanting for various morphological and growth related parameters like plant height, no of leaves per plant, leaf length, pseudo-stem diameter and pseudo-stem length. Yield and associated traits like bulb yield, bulb size, TSS were recorded after harvesting of the crop. The bulb size viz. polar bulb diameter and equatorial bulb diameter was measured using electronic digital calliper. Bulbs were separated from the plants and graded to determine the marketable bulb yield in  $\text{kg ha}^{-1}$ . Observations were recorded for all traits in replicates for each entry.

## **Physiological and biochemical parameters**

Physiological and biochemical traits namely, chlorophyll, protein and antioxidant activity

was estimated from leaf sample (4<sup>th</sup> leaf) whereas, biochemical traits like phenol, flavanoids, pyruvic acid and TSS were evaluated from bulb sample after harvesting. Chlorophyll was estimated in 0.05g (w) of leaf sample in 10ml (V) DMSO (Dimethyl sulfoxide) by non-maceration method (Hiscox and Israelstam, 1979). Absorbance was recorded at 645 and 665 nm then total chlorophyll was calculated using formula of Arnon (1949). It is calculated as total chlorophyll =  $(20.2 \times A_{645} + 8.02 \times A_{663}) \times \text{Volume of extract} \times \text{Weight of sample}/1000$ .

Total soluble protein was estimated following the method of Lowry *et al.*, (1951). Phenol was measured by the method given by Bray and Thorpe (1954). The antioxidant activity is determined by Ferric Reducing Antioxidant Power (FRAP) Assay method described by Benzie and Strain (1996). Pyruvic acid or pyruvate is an important metabolic in onion bulb directly correlated with its pungency was estimated as per given by Randle and Bussard (1993) whereas, total flavanoids was determined by method given by Olivera (2008). Total Soluble Solids (TSS) was measured from bulbs after harvest by using refractometer and expressed in °Brix (Hanna instruments, USA).

### **Statistical analysis**

The results are expressed as means with standard error (S.E.). The ANOVA and significance critical difference (at 0.05, 0.01, 0.005, 0.001%) were determined by INDOSTAT and Microsoft Excel for all studied parameters. The statistical analysis was carried out using NCSS8 Statistical Analysis and Graphic Software. Genetic diversity was studied following Mahalanobis generalized distance  $D^2$  (Mahalanobis, 1936) extended by Rao (1952). Canonical analysis was done to confirm the results of cluster and  $D^2$  analysis by INDOSTAT software.

### **Results and Discussion**

The present study evaluates the genetic divergence and inter-relationship in 33 onion entries on the basis of their physiological, biochemical and yield traits under short day conditions. The superior entry with all the desirable characters can be implemented in a breeding program intended for improving onion yield and quality. The analysis of variance was highly significant among the 33 onion entries for the 15 different traits, which revealed the presence of considerable genetic variability among the studied entries. The onion varieties of ICAR-DOGR viz. Bhima Kiran, Bhima Shakti, Bhima Red, Bhima Super, Bhima Dark Red, Bhima Safed, Bhima Shweta and Bhima Shubhra followed by advanced line KH-M-2 performed superiorly over the other entries in terms of growth and bulb yield (Table 2 and 3).

In crop improvement and introgression breeding, genetically distant parents are selected for hybridization programs so as to develop superior progeny with desirable traits. This diversity analysis study among the available germplasm would improve our understanding of genetic potential of a particular genotype for a specific or combination of desirable characters.

### **Genetic correlation**

Yield is a complex character resulting from the interaction of a number of external and internal factors. Correlation analysis were performed in the present study in order to determine the correlation between two or more traits, which further helps in determining yield contributing character and potential. Significant positive association was found between plant height, leaf length and pseudo-stem diameter whereas, the important biochemical component of onion bulbs phenol recorded positive association with onion bulb

yield. Flavanoids another chief metabolite of onion are strongly associated with its antioxidant activity (Table 4). This correlation matrix overall summarized, that bulb size and phenol content has direct positive correlation with onion bulb yield. Similar findings reported by Singh *et al.*, (2013), Raghuwanshi *et al.*, (2016), Rivera *et al.*, (2016) to identify the desirable parents so as to be utilized in onion breeding program for varietal development.

### Genetic diversity analysis

Cluster analysis using Ward's method grouped the 33 onion entries into three clusters based on the square Euclidean distance between observations for different traits (Table 5). Great genetic diversity exhibited among the clusters as shown by rescaled square Euclidean distance (Figure 1). In cluster I, five entries viz. KH-M-1, Bhima Red, KH-M-2, Bhima Kiran and W 344 were placed which were 15% of total entries. All the five entries out stand the other entries in yield performance ranging from 42 to 54  $\text{Tha}^{-1}$ . It was observed that cluster I performance for all

the parameters especially, chlorophyll, phenol, pyruvic acid and bulb size was the best. Thus the entries of this group namely, KH-M-1, KH-M-2 and W 344 can be employed in onion improvement and breeding program. In cluster II, sixteen entries viz. Acc.1609, W408, W282, W361, W396, W448, Phule Safed, W009, Bhima Shubhra, W 178, RGP 4, DOGR 1133, Acc.1614, Bhima Super, W 043 and Bhima Shweta were placed which were 48% of total entries. Among the 16 entries in cluster II, about 6 entries recorded with lower yield ( $<30 \text{Tha}^{-1}$ ) and least performance for different morphological, physiological and biochemical traits. Additionally, 50% entries of this group was observed with better biochemical activity namely, pyruvic acid, chlorophyll, flavanoids, TSS and protein.

In cluster III, twelve entries viz. KH-M-3, W 172, RGP 2, W 453, W 489, W 443, Bhima Shakti, RGP 1, Bhima Safed, Bhima Dark Red, Bhima Raj and W 355 were placed which were 36% of total entries. The yield performance of DOGR varieties and KH-M-3, RGP 1, W 171, W 443, RGP 2 ranges between 42-52  $\text{Tha}^{-1}$  in cluster III.

**Table.1** Onion entries employed in the present study

Bhima Super	KH-M-1	W 282
Bhima Dark Red	KH-M-2	W 408
Bhima Safed	KH-M-3	W 489
Bhima Shweta	Acc. 1609	W 453
Bhima Shubra	Acc. 1614	W 178
Bhima Red	RGP 1	W 043
Bhima Kiran	RGP 2	W 361
Bhima Shakti	RGP 4	W 396
Bhima Raj	W 009	W 355
Phule Safed	W 448	W 443
DOGR 1133	W 344	W 172

**Table.2** Morphological and Yield associated traits in 33 onion entries

Onion Entries	Leaves plant <sup>-1</sup>	Leaf length (cm)	Plant height (cm)	Pseudo- stem length (cm)	Pseudo- stem diameter (mm)	Yield (Tha <sup>-1</sup> )	Polar bulb size (mm)	Equatorial bulb size (mm)
W 355	12	53.6	55.4	27.8	17.5	35.03	53.7	64.7
Bhima Dark Red	12	52.7	55.4	26.9	17.8	46.48	52.9	66.8
Bhima Safed	10	51.4	54.2	24.7	18.8	44.69	54.7	75.0
Bhima Shweta	11	47.2	50.2	27.0	18.7	43.29	46.8	62.2
Bhima Shubra	12	51.5	54.2	26.8	16.3	46.24	51.2	66.1
W 443	10	55.4	59.5	23.9	21.6	47.79	49.4	62.1
W 009	11	50.6	53.7	32.9	15.8	27.84	48.4	61.6
W 448	11	53.9	56.9	26.1	16.3	39.64	49.3	66.2
W 043	11	44.1	46.6	29.7	15.0	39.78	46.2	65.2
Phule Safed	11	52.4	55.5	32.0	15.1	37.75	46.3	59.3
W 344	13	45.0	47.7	37.9	13.1	42.23	48.2	68.8
W 361	12	50.6	53.8	40.2	15.5	28.45	53.2	65.1
W 396	12	51.3	55.7	29.4	16.8	30.42	44.3	61.9
KH-M-2	13	46.3	48.9	34.4	14.5	47.79	47.2	75.6
Bhima Super	10	43.9	47.0	22.8	18.6	50.86	48.4	62.4
Acc. 1614	10	49.4	53.5	23.2	19.9	23.02	44.6	64.4
RGP 4	10	45.0	48.1	15.3	15.8	40.03	37.9	50.3
RGP 1	13	53.1	57.2	27.5	19.2	48.18	56.6	77.4
Bhima Red	12	48.5	52.3	24.1	16.5	53.88	56.3	78.4
Bhima Kiran	12	46.0	49.8	30.6	16.0	54.57	51.6	74.1
Bhima Shakti	12	57.3	61.1	30.7	20.3	52.01	56.5	82.9
DOGR 1133	11	51.7	55.5	26.2	17.3	40.19	43.1	58.4
W 282	12	49.5	52.0	24.4	15.7	25.38	41.1	68.1
W 408	11	49.3	52.3	28.4	16.8	31.46	48.0	67.4
W 489	12	55.7	57.9	19.6	23.2	37.31	47.1	60.6
W 453	12	50.4	52.8	21.1	21.9	35.24	46.2	69.4
W 178	10	47.8	50.7	31.0	13.0	16.15	39.8	53.7
Bhima Raj	12	51.0	53.0	27.6	19.3	47.08	48.7	65.5
KH-M-1	12	48.6	51.8	21.8	16.2	51.65	51.7	77.2
Acc. 1609	12	45.2	47.1	27.3	14.3	29.27	44.6	58.7
RGP 2	12	51.4	54.1	23.0	22.4	43.26	48.6	65.3
KH-M-3	10	51.2	54.2	21.5	11.9	51.98	57.6	81.3
W 172	14	53.3	56.9	34.3	20.0	48.16	55.0	80.1
<b>C.D @5%</b>	<b>1.82</b>	<b>6.49</b>	<b>7.48</b>	<b>5.34</b>	<b>4.74</b>	<b>8.74</b>	<b>3.43</b>	<b>4.12</b>

**Table.3** Physiological and biochemical traits evaluated in 33 onion entries

Onion Accessions	Pyruvic acid content	Chlorophyll content	Flavanoid content	Phenol content	TSS	Protein content	Antioxidant activity
W 355	5.4	0.4	99.3	286.2	12.7	43.5	38.77
Bhima Dark Red	3.4	0.2	66.0	368.6	12.7	47.7	16.91
Bhima Safed	5.6	0.3	63.6	268.6	12.2	50.8	16.61
Bhima Shweta	11.3	0.2	45.7	518.9	12.4	50.1	23.38
Bhima Shubra	10.3	0.3	48.1	377.1	14.8	61.7	8.08
W 443	9.8	0.2	61.2	526.1	12.6	11.2	7.01
W 009	2.6	0.3	51.7	435.2	14.3	75.9	9.72
W 448	9.2	0.2	75.5	628.7	12.9	41.0	22.74
W 043	9.2	0.2	54.0	482.2	13.0	56.1	9.10
Phule Safed	6.3	0.4	77.9	523.8	13.3	65.0	16.35
W 344	3.1	0.2	44.5	601.2	13.6	60.3	22.46
W 361	8.9	0.2	43.3	468.6	13.6	22.1	15.85
W 396	9.9	0.2	50.5	452.2	12.2	35.8	21.91
KH-M-2	9.7	0.3	54.0	789.8	11.9	11.4	40.29
Bhima Super	5.0	0.3	42.1	777.7	12.5	16.5	16.50
Acc. 1614	10.3	0.3	55.2	467.9	13.7	52.3	20.41
RGP 4	9.3	0.3	51.7	760.7	13.9	48.0	26.88
RGP 1	5.6	0.2	63.6	869.9	12.7	57.4	25.32
Bhima Red	3.5	0.3	51.7	854.8	11.0	72.0	25.79
Bhima Kiran	1.6	0.3	62.4	652.9	13.5	48.0	17.35
Bhima Shakti	0.2	0.3	58.8	605.8	12.5	38.8	33.73
DOGR 1133	2.3	0.3	33.8	733.9	13.1	40.6	9.72
W 282	11.0	0.2	120.5	124.8	13.7	37.0	30.50
W 408	4.5	0.2	115.1	564.0	12.2	34.1	44.62
W 489	1.9	0.4	52.9	516.2	13.7	36.0	44.03
W 453	8.0	0.2	57.0	447.6	13.5	18.5	34.13
W 178	0.2	0.5	53.7	292.7	11.5	31.8	21.05
Bhima Raj	0.9	0.4	81.4	622.2	12.8	45.6	26.07
KH-M-1	8.4	0.4	102.9	891.4	12.5	39.9	22.66
Acc. 1609	4.6	0.3	82.6	619.5	12.3	56.0	29.35
RGP 2	1.0	0.3	89.8	647.6	13.2	44.4	163.30
KH-M-3	1.5	0.3	100.5	735.2	14.3	27.8	143.03
W 172	3.1	0.3	74.3	369.2	12.8	44.3	160.59
<b>C.D@5%</b>	<b>0.67</b>	<b>0.049</b>	<b>8.282</b>	<b>5.084</b>	<b>0.614</b>	<b>4.903</b>	<b>0.979</b>

**Table.4** Pearson’s correlation matrix for physiological and biochemical traits in 33 onion entries at 0.05%, 0.01%, 0.005% and 0.001% level of significance

	No of Leaves	Leaf length	Plant height	Pseudo stem length	Pseudo stem diameter	Pyruvic acid content	Chlorophyll Content	Flavanoids Content	Phenol Content	TSS	Protein Content	No of Bulbs	Yield (Tha <sup>-1</sup> )	Polar bulb size	Equatorial Bulb size	Antioxidant activity
<b>Onion Accessions</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>No of Leaves</b>	1	0.15534	0.13249	0.3632	0.09618	-0.08189	-0.13095	0.1628	0.0511	-0.04041	0.00736	0.16457	0.1776	0.23844	0.42605*	0.25886
<b>Leaf length</b>		1	0.9836****	-0.04256	0.52419***	-0.18259	0.05738	0.15755	-0.23591	0.09163	-0.08348	0.14109	0.06691	0.42534*	0.22851	0.18964
<b>Plant height</b>			1	-0.02921	0.51947***	-0.15681	0.00873	0.09046	-0.17209	0.06318	-0.07878	0.12561	0.0918	0.43375*	0.25647	0.16804
<b>Pseudo stem length</b>				1	-0.36689*	-0.11347	-0.11474	-0.19383	-0.20383	-0.09565	0.10676	-0.04071	0.00307	0.18663	0.14871	-0.08492
<b>Pseudo-stem diameter</b>					1	-0.0452	-0.06477	-0.0869	-0.06507	-0.02493	-0.18427	-0.05952	0.15843	0.14133	0.05526	0.16259
<b>Pyruvic acid</b>						1	-0.45991***	-0.05737	-0.14238	0.10562	-0.15154	0.11598	-0.17635	-0.28942	-0.17661	-0.35778*
<b>Chlorophyll</b>							1	0.09999	0.02986	-0.11032	0.09228	-0.30529	-0.00885	-0.08219	-0.14903	0.09084
<b>Flavanoids</b>								1	-0.13116	-0.00845	-0.05942	0.13546	-0.05763	0.12683	0.25546	0.4041*
<b>Phenol</b>									1	-0.17593	-0.0297	0.08493	0.43247*	0.18187	0.2273	0.05672
<b>TSS</b>										1	0.14995	-0.05848	-0.25675	-0.08109	-0.138	0.10317
<b>Protein content</b>											1	-0.41466*	0.08556	0.09363	-0.02595	-0.13567
<b>No of Bulbs</b>												1	0.21753	0.17411	0.31124	-0.11054
<b>Yield (Tha<sup>-1</sup>)</b>													1	0.73605	0.71063****	0.17195
<b>Polar bulb size</b>														1	0.79744****	0.28328
<b>Equatorial bulb size</b>															1	0.36247*
<b>Antioxidant activity</b>																1

**Table.5** Distributing pattern of 33 onion entries into three clusters based on Euclidean analysis

Cluster group	No. of entries	Name of onion entries
<b>Cluster I</b>	<b>5</b>	KH-M-1, Bhima Red, KH-M-2, Bhima Kiran, W 344
<b>Cluster II</b>	<b>16</b>	Acc. 1609, W 408, W 282, W 361, W 396, W 448, Phule Safed, W 009, Bhima Shubhra, W 178, RGP 4, DOGR 1133, Acc. 1614, Bhima Super, W 043, Bhima Shweta
<b>Cluster III</b>	<b>12</b>	KH-M-3, W 172, RGP 2, W 453, W 489, W 443, Bhima Shakti, RGP-1, Bhima Safed, Bhima Dark Red, Bhima Raj, W 355

**Table.6** Descriptive statistics for physiological and biochemical traits in 33 onion entries under different clusters

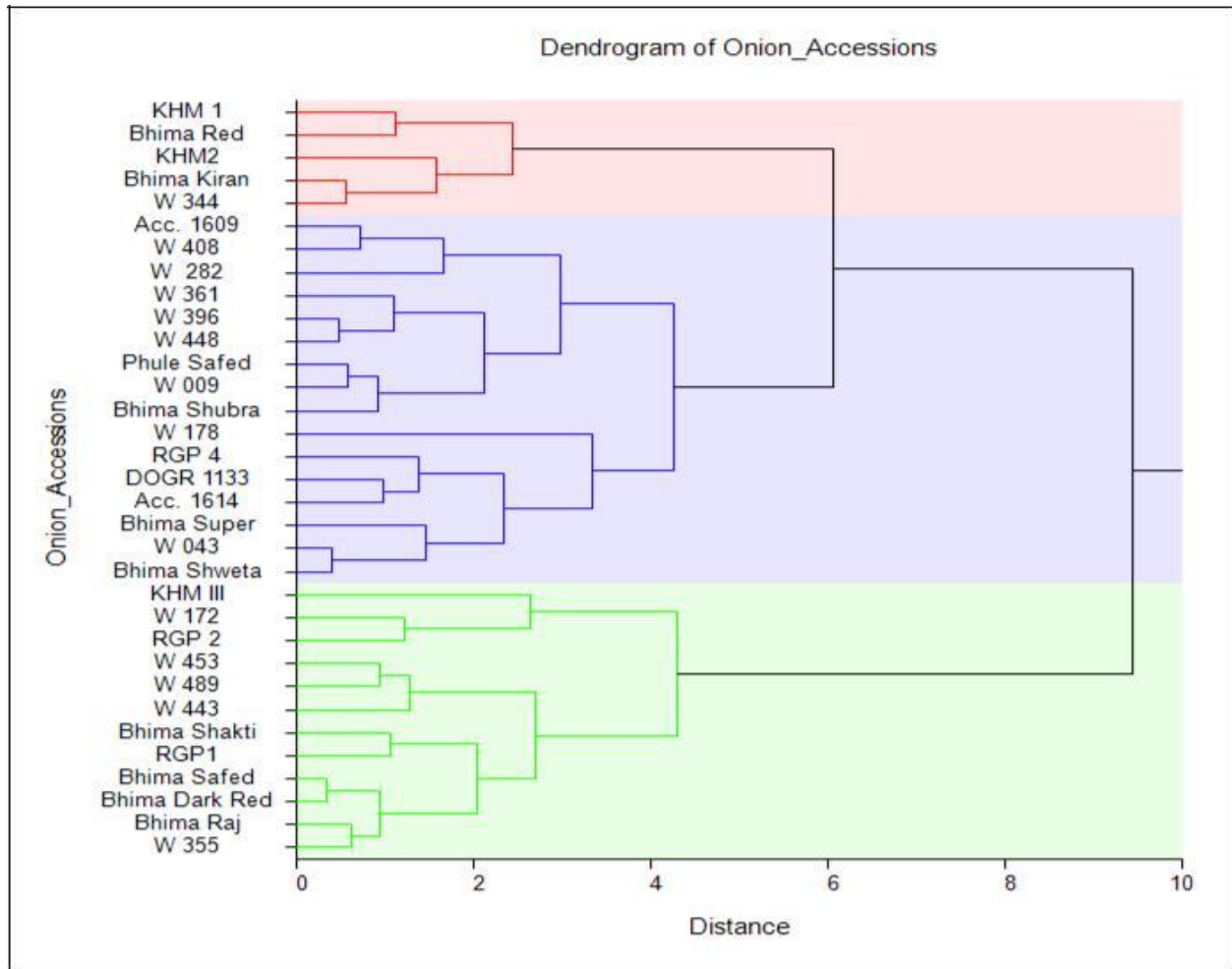
Parameters	Cluster I		Cluster II		Cluster III		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Leavesplant <sup>-1</sup>	12.01	0.71	12.5	0.92	11.26	0.82	11.92	0.81
Leaf length (cm)	52.10	2.15	50.67	3.45	47.48	3.12	50.08	2.90
Plant height (cm)	55.00	2.27	53.93	3.67	50.50	3.49	53.14	3.14
Pseudo-stem length (cm)	26.60	5.15	27.55	4.87	27.75	6.04	27.30	5.35
Pseudo-stem diameter (mm)	18.18	2.62	17.63	3.15	16.05	2.30	17.28	2.69
Yield (Tha <sup>-1</sup> )	37.34	7.66	49.85	3.52	32.03	11.29	39.74	7.49
Polar Bulb size (mm)	49.25	4.14	52.98	3.89	44.93	3.47	49.05	3.83
Equatorial Bulb size (mm)	66.11	3.85	75.78	6.05	60.45	5.22	67.44	5.04
Pyruvic acid activity(μmoleg <sup>-1</sup> )	7.32	3.03	3.55	3.30	5.83	3.71	5.56	3.34
Chlorophyll (mg gDW <sup>-1</sup> )	0.25	0.05	0.30	0.05	0.30	0.07	0.28	0.05
Flavanoids (mg/100g Quercitin)	71.08	26.33	73.94	18.89	53.90	14.52	66.30	19.91
Phenol (mg/100g Gallic acid)	419.05	141.87	703.88	159.14	564.88	150.81	562.60	150.60
TSS (°Brix)	13.06	0.80	12.72	0.88	13.05	0.82	12.94	0.83
Protein content (mg/g)	36.61	14.18	42.96	16.12	50.23	16.20	43.26	15.50
Antioxidant activity (mg/100g FW)	25.09	13.12	65.81	16.50	18.62	6.98	11.92	0.81



**Table.7** Intra (bold) and inter cluster distance among 33 genotypes of onion

Clusters	I	II	III
Cluster I	<b>86.105</b>	441.324	211.002
Cluster II		<b>87.374</b>	622.163
Cluster III			<b>64.051</b>

**Fig.1** K wards minimum variance Dendrogram classifying 33 onion entries



Descriptive statistic for different traits under different cluster revealed that genotypes of cluster I recorded with significantly higher mean value for leaf length, plant height, pseudo-stem diameter, pyruvic acid over the mean value for respective trait in 33 onion entries. The genotypes of cluster II recorded with considerably higher mean value for bulb yield, bulb size, flavanoids and phenols

whereas, genotypes of cluster III contributed for the higher mean value of TSS, chlorophyll and protein (Table 6). Similar results were also reported by Akter *et al.*, (2015) in onion crop to select the parents with suitable characters for hybridization program.

Genetic diversity among the onion entries further studied following the  $D^2$  technique

based on multivariate analysis developed by Mahalanobis (1936). It is the most effective method for quantifying the degree of genetic diversity among the genotypes. Thirty three onion entries on the basis of Mahalanobis Euclidean method for clustering were grouped into three clusters. Distribution pattern for all the entries into different clusters illustrates the presence of significant genetic diversity among these entries for the majority of studied parameters. The procedure outlined to estimate average inter and intra cluster distances were as per given by Singh and Choudhary (1977). A wide range of diversity was observed in the experimental material for the majority of characters studied. The highest inter-cluster distance was observed (Table 7) between cluster II and III (622.16), followed by cluster I and II (441.32). Parental lines selected from these three clusters may be used in a hybridization programme, since hybridization between divergent parents is likely to produce wide variability and transgressive segregations with high heterotic effects (Rama, 1992). Such recommendations were also made by Murty and Arunachalam (1966) and Qian and He (1991). The lowest inter-cluster distance was observed between I and III (211.00). The lines belonging to these clusters were relatively closer to each other, in comparison to lines grouped in other clusters. Such analysis was meant to avoid selection of parents from genetically homogeneous clusters and to maintain a relatively broad genetic base. The intra cluster distance was the highest (87.374) in cluster II followed by cluster 1 (86.105). Moderate intermediate distances were found between clusters III and I (211.002). Arunachalam and Bandyopadhyay (1984) suggested that the magnitude of heterosis for yield and its components were higher in cross between intermediate divergences than extreme ones. Accessions among the cluster separated by high  $D^2$  values could be used in hybridization program for obtaining wide spectrum of

variations among the segregates. It was favored to decide that intra-cluster distance was highest in cluster II i.e. more heterogeneous whereas, intra-cluster distance was lowest in cluster III i.e. comparatively homogenous. It was thus revealed that crosses should be made between accessions belonging to the distant clusters for high heterotic response.

Overall it was observed that genotypes from cluster I namely, KH-M-1, KH-M-2 and W 344 perform superiorly best for all the studied morphological, biochemical and yield parameters in comparison to other entries from clusters I, II and III hence, these entries can be successfully employed in onion breeding program. The present study will provide with insight knowledge about the various traits contributing towards the final bulb yield in the respective onion cultivar/genotype. Additionally it will help to identify the genetic diversity among the studied genotypes so that the genotype with useful traits can be employed in further breeding and crop improvement program for increasing onion productivity.

## References

- Akter, M.S., Biswas, A., Siddique, S.S., Hossain, S. and Ivy, N.A., 2016. Estimation of genetic diversity in onion (*Allium cepa* L.). *The Agriculturists*, 13: 26–34.
- Arnon, D., 1949. Estimation of Total chlorophyll. *Plant Physiol*, 24: 1–15.
- Arunachalam, V. and Bandyopadhyay, A., 1984. Limit to genetic divergence for occurrence of heterosis: Experimental evidence from crop plant. *Indian J. Genet.* 44, 548–554.
- Benzie, I.F. and Strain, J.J., 1996. The ferric reducing ability of plasma (FRAP) as a measure of “antioxidant power”: the FRAP assay. *Analytical biochemistry*, 239: 70–76.
- Bray, H. G. and Thorpe, W. V. 1954. Analysis of phenolic compounds of interest in metabolism. *Methods Biochem Anal.*, 1: 27-52.
- Hiscox, J.T. and Israelstam, G.F., 1979. A method

- for the extraction of chlorophyll from leaf tissue without maceration. *Can J Bot.*, 57: 1332–1334.
- Kumar, A., Koshta, V.K., Nirmal, A. and Taram, S.K., 2017. Seasonal Incidence of Major Insect Pests of Onion in Relation To Biotic and Abiotic Factors.
- Kumar, V., Neeraj, S.S. and Sagar, N.A., 2015. Post-harvest management of fungal diseases in onion—a review. *Int. J. Curr. Microbiol. App. Sci.*, 4: 737–752.
- Laxmi, S., Sen, C. and Singh, R., 2017. Profitability, potential and progress of organic onion production: Evidences from Nalanda district of Bihar. *Economic Affairs*, 62: 33.
- Lowry, O.H., Rosebrough, N.J., Farr, A.L. and Randall, R.J., 1951. Protein measurement with the Folin phenol reagent. *J. Biol. Chem.*, 193: 265–275.
- Mahalanobis, P.C. 1936. On generalized distance in statistics. *Proceedings of National Institute of Science*, 2: 49–55.
- Murty, B.R., Arunachalam, V. 1966. The nature of genetic diversity in relation to breeding system in crop plant. *Indian J. Genet.*, 26, 188–198.
- Oliveira, I., Sousa, A., Ferreira, I. C., Bento, A., Estevinho, L., Pereira, J. A., 2008. Total phenols, antioxidant potential and antimicrobial activity of walnut (*Juglans regia* L.) green husks, *Food Chem Toxicol.*, 46: 2326–2331.
- Qian, Y.W., He, K.M., 1991. Utilization of exotic rice germplasm resources in Guang-dong province. *Crop Genet. Resour.*, 2, 36–37.
- Raghuwanshi, O.S., Jain, P.K., Sengupta, S.K., Dangi, A.S., Verma, N.R. and Sunil, P., 2016. Correlation and path analysis study in diverse onion (*Allium cepa* L.) genotypes. *Asian Journal of Horticulture*, 11: 19–24.
- Rai, S., Rani, P., Kumar, M., Rai, A. and Shahi, S.K., 2016. Effect of Integrated Nutrient Management on Nutrients Uptake and Productivity of Onion. *Nat. Env. Poll. Tech.*, 15: 573.
- Rama, T., 1992. Heterosis and inbreeding depression in rice. IRRI Newsletter, *Los Bonos.*, 17: 7
- Randle, W.M. and Bussard M.L., 1993. Stream lining onion pungency analysis. *Hort Science.*, 28:60.
- Rao, C.R., 1952. Advanced Statistical Method in Biometric Research, John Wiley and Sons, Inc., New York, 15: 130–134.
- Rivera, A., Mallor, C., Garcés-Claver, A., García-Ulloa, A., Pomar, F. and Silvar, C., 2016. Assessing the genetic diversity in onion (*Allium cepa* L.) landraces from northwest Spain and comparison with the European variability. *NEW ZEAL J CROP HORT.*, 44: 103–120.
- Samsuddin, A.K., 1985. Genetic diversity in relation to heterosis and combining analysis in spring wheat. *Theoretical Appl. Genet.*, 70:306–308.
- Sekara, A., Pokluda, R., Del Vacchio, L., Somma, S. and Caruso, G., 2017. Interactions among genotype, environment and agronomic practices on production and quality of storage onion (*Allium cepa* L.) –A review. *Horticultural Science*, 44: 21–42.
- Singh, R.K. and Choudhary, B.D., 1977. Biometrical Methods in quantitative genetic analysis kalyani Publishers, New Delhi., 304
- Singh, S.R., Ahmed, N., Lal, S., Ganie, S.A., Amin, M., Jan, N. and Amin, A., 2013. Determination of genetic diversity in onion (*Allium cepa* L.) by multivariate analysis under long day conditions. *Afr. J. Agric. Res.*, 8: 5599–5606.
- Tripathi, P.C., Sankar, V. and Lawande, K.E., 2017. Micro irrigation in onion (*Allium cepa*) and garlic (*A. sativum*)—a review. *Current Horticulture*, 5: 3–14.

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