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Interrelationship between yield attributing and quality traits and their effect on bulb yield in Onion (*Allium cepa* L.)

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ABSTRACT

The development of kharif onion cultivar is a better option to meet the onion demands and stabilize the market price. The present investigation was conducted to evaluate eighteen onion (Allium cepa L.) genotypes for elucidating the genetic variability as well as the interrelationship between yield attributing and quality traits on onion bulb yield. The genotypes were evaluated consecutively over two years following Randomized block design maintaining three replications. The result revealed the presence of substantial variability for all the studied traits among the onion genotypes. Characters like plant height, double bulb percent, total bulb yield, marketable bulb yield, dry matter, and pyruvic acid content in bulb exhibited high heritability coupled with high genetic advance as a percentage over mean, indicating the influence of additive genetic variance. The present data set also revealed the existence of non-additive variation for traits like days to maturity, polar diameter, and equatorial diameter of the bulb, highlighting the possibility of heterosis breeding for improvement of these traits. Correlation studies indicated that the genotypic correlation coefficients were higher than the corresponding phenotypic correlation coefficients for all the characters reflecting the predominant role of heritable factors. Onion genotypes with better leaf diameter, polar diameter, equatorial diameter and marketable bulb yield with late duration would be beneficial for getting better yield potential. The marketable bulb yield exerted the highest direct effect on total yield. Bulb weight, along with the polar and equatorial diameter of the bulb, were identified as key factors that significantly impact onion bulb yield. The negative correlation of bulb yield with quality traits signified that breeders have to compensate for quality traits during yield improvement. The findings of the present investigation would be valuable for future onion improvement programs.

Keywords: *Onion, Allium cepa, Correlation, genotype, kharif, Variability*

1.0 INTRODUCTION

Onion (*Allium cepa* L.) is one of the major cultivated vegetable crops across the globe. It is an essential component in an array of cuisines as a vegetable and condiment. Besides salad and pickles, onion is used for the preparation of dehydrated forms, such as powder and flakes, in the processing industry to a great extent. India is the second largest producer of onion after China and occupies an area of 1.43 million hectares with a production potential of 26.09 million tons. However, the productivity of onion in India is very meager *i.e.* 18.64 t/ ha as compared to the global productivity. In India, Maharashtra, Madhya Pradesh, Karnataka, Gujarat, Bihar, Andhra Pradesh, Rajasthan, Haryana and Tamilnadu are the major onion-growing states. Maharashtra holds the top position in terms of both area under cultivation and production, followed by Karnataka and Madhya Pradesh in succession.

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Maharashtra contributes 32.6 % of total onion production followed by Madhya Pradesh (17.6%), Karnataka (14%), and Gujarat (9%) as reported by Anonymous [1].

The demand for onion is high in West Bengal and the bulb is typically available from April onwards. Onions are predominantly cultivated during the *rabi* season due to its vulnerability to weather fluctuations and challenges related to inadequate storage capacity and the absence of reliable cultivars, which restrict its cultivation during the *kharif* season. Onion harvesting in the country is limited from June to November. During the period from October to March, the country experiences a significant shortage of this vegetable, leading to an increase in prices. In this context, developing onion varieties suitable for *kharif* season appears to be a more favorable approach to fulfilling year-round demand domestically, capitalizing on pricing benefits, and establishing market price stability. In this background, the objectives have been framed to assess the genetic variability among the *kharif* onion genotypes for yield attributing and quality traits and enumerate the interrelationship between yield and its contributing traits as well as quality parameters in the alluvial plain of West Bengal.

2.0 MATERIALS AND METHODS

The present investigation was conducted at C block farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani in New Alluvial zone of West Bengal during *Kharif* season of 2020-21 and 2021-2022. The farm is located very close to the Tropic of Cancer having approximately 23.5°N latitude and 89°E longitude. The altitude of the experimental site is about 9.75 m above the mean sea level. The topographic situation of the experimental site comes under the Gangetic new alluvial plains of West Bengal. The eighteen onion genotypes were evaluated for yield attributing and quality parameters following Randomized Block Design (RBD) with three replications. The plot size was being kept 2.25 m X 2 m. Planting was done in the main field at a spacing of 15 cm x 10 cm. Data were recorded using ten randomly selected plants from each replication excluding the border rows and the mean values were considered for statistical analysis. The average total soluble solid content was worked out from randomly selected ten bulbs in triplicates of each genotype with the help of Digital Refractometer. The pyruvic acid content was estimated using the Di-nitro phenyl hydrazine (DNPH) Reagent (Anthon and Barrett)[2] method with slight modification to the Schwimmer and Weston [3] method.

Analysis of variance (ANOVA) was performed for each character, treating genotypes as random factors and replications as fixed factors following the method described by Panse and Sukhatme [4] to ascertain the total variances among the onion genotypes concerning distinct traits and their significance was evaluated through 'F' test. Genotypic co-efficient of variation (GCV) and phenotypic co-efficient of variation (PCV) were calculated based on Burton's formula (Burton and De Vane,)[5]. Genetic advance as a percentage of mean and heritability were estimated as suggested by Johnson *et al*. [6]. A correlation and path coefficient analysis between different characters were carried out to determine the relationship between each of them and bulb yield. Correlation coefficients at genotypic and phenotypic levels were enumerated as suggested by Li [7] while path coefficient analysis was done as per the standard procedure of Dewey and Lu [8].

3.0 RESULTS AND DISCUSSION

Analysis of variance:

Analysis of variance revealed that the genotypes under the study differed highly significantly for leaf length, plant height, polar diameter, equatorial diameter, days to maturity, bulb weight, total bulb yield, marketable bulb yield, total soluble solid (TSS), dry matter content and pyruvic acid content in bulb (Table 1). The characteristics like the number leaves per plant, leaf diameter, double bulb percent and neck diameter did not differ significantly among genotypes. The sufficient genetic variability for many traits had also been reported by Hosmani *et al*. [9] and Ibrahim *et al*. [10] for bulb yield in onions.

3.1 Genetic variability appraisal of *Kharif* onion genotypes

The extent of variations observed due to genetic factors were worked out and are presented in Table 2 and Figure 1. The presence of substantial genetic variability among the tested onion genotypes were depicted through the genetic parameter. The PCV and GCV for all the traits were varied from 4.81 % for days to maturity to 32.22 % for double bulb percent and 3.98 % for number of leaves per plant to 30.26 % for double bulb percent, respectively. Low to moderate PCV and GCV were recorded for all traits except for double bulb percentage which had exhibited high PCV and GCV for the tested genotype, indicating the influence of both genetic as well as environmental factors towards the expression of this trait. These results were close conformity to the findings of Singh *et al*. [11] and Pyasi and Tiwary [12]. The heritability and genetic advance as a percentage of mean (GAM) were varied from 38.65 % (number of leaves per plant) to 97.89 % (pyruvic acid content) and 5.10 (number of leaves per plant) to 58.53 (double bulb percent), respectively. The traits *viz*., leaf length, leaf diameter, plant height, polar diameter, neck diameter, average weight of bulb, double bulb percent, days to maturity, total soluble solid, dry matter and pyruvic acid content in bulb exhibited high heritability offering opportunity for selection. Whereas, equatorial diameter (48.69%) and number of leaves per plant (38.64%) revealed moderate heritability, thus indicated the higher influence of the environment. High heritability coupled with high GAM for traits like total bulb yield and marketable yield indicates the preponderance of additive gene action. These attributes could prove valuable for immediate inclusion in onion improvement programme through direct selection. The similar results were also reported by Shivkumar [13] Pyasi and Tiwari [12] and Singh *et al.* [14].

3.2 Association of yield components and quality traits of *kharif* onion genotypes with bulb yield

Examinations of correlations among the fifteen traits for 18 *kharif* onion genotypes revealed varying degree of association, both at the genotypic and phenotypic levels (Table 3). In all the traits, the genotypic correlation was higher than the phenotypic correlation, thus revealing significant influence of genetic factors. The growth parameter, number of leaves per plant showed positive but non-significant association with leaf length, leaf diameter, plant height, days to maturity, bulb weight, total bulb yield, marketable bulb yield, total Soluble Solid (TSS) and pyruvic acid content in bulb at both genotypic and phenotypic level. The positive association of these characters might be due to photosynthetic factors. However, it was negatively associated with polar diameter, equatorial diameter, double bulb percent, neck diameter and dry matter content in bulbs at genotypic and phenotypic levels. The positive association of growth parameters with yield was reported by Benyamin *et al.* [15] and Chavda *et al*. [16]. Leaf length exhibited a highly significant correlation with leaf diameter at both genotypic (r=0.701**) and phenotypic (r=0.633**) levels. Similarly, leaf diameter had also shown a significant positive correlation with equatorial diameter, total yield and marketable yield at both genotypic and phenotypic level while with bulb weight (r=0.405*) at only genotypic level. Polar diameter also exhibited a positive and highly significant correlation with equatorial diameter (r=0.626**) and average bulb weight (r=0.692**) on total bulb yield. The major yield attributing characters *viz*., bulb weight showed highly significant and positive association with total bulb yield (r=0.854**) and marketable bulb yield (r=0.851**). The total bulb yield was positively and significantly correlated with leaf diameter (r=0.499*), polar diameter (r=0.752**), equatorial diameter of bulb (r=0.715**), bulb weight (r=0.956**) and marketable bulb yield (r=0.999**). It would be inferred that, selection of high yield would be effective through selection for these traits. These results are in agreement with Morsy *et al*. [17], Nikhil *et al*. [18] and Sahu *et al*. [19].

The present study further revealed that all the quality traits like TSS (r=-0.395), dry matter content (r=-0.014) and pyruvic acid content (r=-0.668**), revealed negative association with bulb yield, indicating the ambiguity in the simultaneous improvement of these quality traits along with yield potential. These findings were in agreement with earlier findings of Monpara *et al*. [20], Mahanthesh *et al*. [21] and Chattopadhyay *et al*. [22].

3.3 Direct or Indirect effects of different yield components and quality traits on bulb yield in *kharif* onion genotypes

The path analysis of eighteen onion genotypes for total bulb yield with different characters is presented in Table 4 and Figure 2. The analysis represented that the significantly and positively associated characters viz., leaf diameter (0.1153), polar diameter (0.0586), bulb weight (0.0774), and marketable bulb yield (0.8646) exhibited high positive direct effect on total bulb yield. Similarly, the total bulb yield was also influenced through bulb weight via high magnitude of positive indirect effects of leaf diameter (0.0394), polar diameter (0.0362), double bulb percent (0.0030), neck diameter (0.0016), days to maturity (0.0019), marketable bulb yield (0.7355), pyruvic acid content (0.0026), dry matter content (0.0008) and TSS content (0.058). Similar results of high direct effect via bulb weight, equatorial diameter, plant height and number of leaves were also reported by Singh and Dube [23], Nikhil *et al*. [18] and Chattoo *et al.* [24]. Polar diameter and weight of bulb traits exhibited strong association as well as a positive direct effect on total bulb yield. Among the genotypes, some of the traits namely, average bulb weight of bulb, double bulb percent, leaf length, leaf diameter and plant height were found to be good contributors to bulb yield. Hence, taking these traits into consideration within the breeding program would prove highly beneficial for breeders when making targeted selections to enhance onion bulb yield.

4.0 CONCLUSION

Out of several traits studied in the present investigation, double bulb percentage exhibited high GCV as well as PCV indicating the presence of wider variability with higher influence of both genotypic and environmental factors. High heritability coupled with high GAM for traits like total bulb yield and marketable yield indicated the preponderance of additive gene action. These traits could play a pivotal role in the selection process for advancing improvement efforts in onion cultivation. Moderate to high heritability coupled with low to moderate genetic advance as a percentage of mean was recorded for days to maturity, polar diameter and equatorial diameter of the bulb, such association of genetic parameter attributed to non-additive gene action. Due to its cross-pollination nature, these characteristics could hold significance in the context of heterosis breeding programs. Leaf diameter, polar diameter, equatorial diameter, bulb weight and marketable bulb yield exhibited significantly positive associations with total bulb yield, thus highlighting the significance of these traits towards yield improvement in onions. The inverse correlation between quality attributes and yield parameters suggests that breeders must compromise quality traits when enhancing yield characteristics. Path analysis revealed that, the marketable bulb yield exerted highest direct effect on total yield followed by average weight of bulb, polar diameter, leaf diameter, plant height and these characters also exhibited positive correlation with total bulb yield and had positive indirect effect among themselves on yield. Considering these traits into account would hold significance when conducting direct selection to enhance bulb yield in onions.

FUTURE SCOPE OF STUDY

The experiments of studies revealed considerable outcome from the different genotypes of *kharif* season. But still a large number of important aspects such as performance of promising genotypes under different environmental conditions to evaluate their stability and adaptability are left, selected genotypes can be incorporated in future breeding programmes and those genotypes can also be evaluated for their resilience towards different biotic and abiotic stresses which may help in future line of work.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest

Table 1. Analysis of Variance (mean squares) for growth, yield and quality character in kharif onion

Sl. No.	Source of variation/ characters	Replication	Genotypes	Error
	Degree of freedom	2	17	34
1	Number of leaves per plant	0.026	0.589	0.204
2	Leaf length (cm)	3.075	37.621**	3.048
3	Leaf diameter (cm)	0.001	0.018	0.001
4	Plant height (cm)	10.643	114.305**	4.707
5	Polar diameter (mm)	27.471	29.413**	5.667
6	Equatorial diameter (mm)	2.015	27.993**	7.278
7	Double bulb (%)	0.08	1.030	0.044
8	Neck diameter (cm)	0.001	0.048	0.006
9	Days to maturity	0.721	76.509**	3.716
10	Bulb weight (g)	24.545	137.575**	9.89
11	Total bulb yield (q/ha)	128.549	4,798.25**	112.78
12	Marketable bulb yield (q/ha)	188.642	4,531.98**	125.957
13	Total soluble solid (^{0}Brix)	0.685	3.023**	0.058
14	Dry matter content (%)	0.081	5.887**	0.05
15	Pyruvic acid (µmol/g)	0.025	4.211**	0.03

*** and * significant at 1% and 5% respectively*

Table 2. Genetic components of variance, heritability and genetic advance as percentage of mean for growth, yield and quality parameters

Sl. No.	Characters	Range	GCV (%)	PCV (%)	Heritability (%)	GAM (%)
1	Number of leaves per plant	8.25 – 9.76	3.98	6.41	38.65	5.10
2	Leaf length (cm)	31.58 – 44.30	9.15	10.28	79.08	16.75
3	Leaf diameter (cm)	0.89 – 1.14	7.48	8.41	79.21	13.72
4	Plant height (cm)	38.03 – 56.80	13.21	14.03	88.59	25.61
5	Polar diameter (mm)	41.77 – 51.52	6.00	7.86	58.28	9.44
6	Equatorial diameter (mm)	42.21 – 53.36	5.48	7.85	48.69	7.87
7	Double bulb (%)	0.58 – 3.10	30.26	32.22	88.17	58.53
8	Neck diameter (cm)	1.01 – 1.43	9.69	11.63	69.36	16.62
9	Days to maturity	103.58 – 118.78	4.48	4.81	86.72	8.59
10	Bulb weight (g)	40.96 – 65.63	12.25	13.59	81.15	22.72
11	Total bulb yield (q/ha)	153.37 –288.58	18.24	18.89	93.27	36.29
12	Marketable bulb yield (q/ha)	145.65 – 267.77	18.86	19.65	92.10	37.29
13	Total soluble solid (^{0}Brix)	10.09 – 13.23	8.37	8.61	94.42	16.74
14	Dry matter content (%)	7.99 – 12.34	13.24	13.40	97.51	26.92
15	Pyruvic acid (μmol/g)	7.34 – 11.49	12.75	12.89	97.89	25.98

GCV= Genotypic coefficient of variance, PCV= Phenotypic coefficient of variance, GAM= Genetic advance as percentage of mean

Table 3. Genotypic and Phenotypic correlation coefficients among growth, yield and quality parameters

Characters	NOL	LL (cm)	LD (cm)	PH (cm)	PD (mm)	ED (mm)	DB (%)	ND (cm)	DM (Days)	WB (g)	TY (q/ha)	MY (q/ha)	TSS (^{0}Brix)	Dry. M (%)	PA (μmol/g)
Number of leaves per plant	**G**	0.362	0.234	0.014	-0.282	-0.066	-0.218	-0.504*	0.190	0.195	0.215	0.218	0.108	-0.204	0.015
	P	0.109	0.026	0.017	-0.164	-0.061	-0.191	-0.404*	0.120	0.080	0.094	0.116	0.035	-0.133	0.031
Leaf length (cm)		**G**	0.701**	0.182	0.061	0.611**	-0.382	0.078	-0.050	0.159	0.249	0.260	-0.388	0.116	-0.201
		P	0.633**	0.167	0.093	0.436*	-0.308	0.033	-0.021	0.125	0.206	0.228	-0.307	0.083	-0.171
Leaf Diameter (cm)			**G**	0.026	0.098	0.722**	0.102	0.036	-0.302	0.405*	0.499*	0.471*	-0.209	0.376	-0.492*
			P	-0.020	0.064	0.542**	0.062	0.101	-0.242	0.342	0.450*	0.426*	-0.158	0.325	-0.442*
Plant height (cm)				**G**	-0.014	0.011	-0.071	0.376	0.208	-0.072	0.107	0.103	-0.225	-0.403*	0.044
				P	-0.004	0.032	-0.068	0.269	0.181	-0.056	0.098	0.093	-0.204	-0.389	0.058
Polar diameter (mm)					**G**	0.626**	0.162	-0.329	-0.261	0.692**	0.752**	0.757**	-0.281	0.073	-0.334
					P	0.563**	0.156	-0.120	-0.106	0.617**	0.588**	0.581**	-0.158	0.049	-0.264
Equatorial diameter (mm)						**G**	0.054	-0.144	-0.634**	0.671**	0.715**	0.688**	-0.607**	0.350	-0.615**
						P	0.028	-0.048	-0.326	0.545**	0.496*	0.509*	-0.361	0.264	-0.440*
Double bulb (%)							**G**	-0.028	-0.027	0.020	0.208	0.147	0.258	0.219	-0.038
							P	-0.076	-0.010	0.047	0.177	0.104	0.229	0.215	-0.033
Neck diameter(cm)								**G**	-0.002	-0.107	-0.159	-0.139	0.047	-0.169	0.001
								P	-0.015	-0.049	-0.102	-0.097	0.097	-0.169	-0.013
Days to maturity									**G**	-0.341	-0.241	-0.244	0.479*	-0.661**	0.515*
									P	-0.246	-0.176	-0.171	0.431*	-0.606**	0.472*
Bulb weight (g)										**G**	0.956**	0.974**	-0.411*	-0.044	-0.697**
										P	0.854**	0.851**	-0.351	-0.044	-0.624**
Total bulb yield(q/ha)											**G**	0.999**	-0.395	-0.014	-0.688**
											P	0.989**	-0.371	-0.012	-0.661**
Marketable bulb yield (q/ha)												**G**	-0.418*	-0.032	-0.696**
												P	-0.391	-0.024	-0.669**
Total soluble solid (^{0}Brix)													**G**	-0.019	0.422*
													P	-0.024	0.410*
Dry Matter content (%)														**G**	-0.367
														P	-0.360

***** and * significant at 1% and 5%, respectively, G=Genotypic correlation coefficients, P= Phenotypic correlation coefficients,*** *NOL= Number of Leaves, LL= Leaf Length, LD= Leaf Diameter, PH= Plant Height, ND= Neck Diameter, DB= Double Bulb, PD= Polar diameter, ED= Equitorial diameter, WB= Bulb Weight, TY= Total yield (quintal/ hectare), MY= Marketable Yield(quintal/ hectare), TSS= Total Soluble Solid, Dry M- Dry Matter Content, PA= Pyruvic Acid*

Table 4. Direct and Indirect (Phenotypic) effects of different characters on total bulb yield

Characters	Phenotypic Correlation with total yield	NOL	LL (cm)	LD (cm)	PH (cm)	PD (mm)	ED (mm)	DB (%)	ND (cm)	DM (Days)	WB (g)	MY (q/ha)	TSS (^{0}Brix)	Dry. M (%)	PA (μmol/g)
NOL	0.094	**-0.0090**	-0.0037	0.0030	0.0006	-0.0096	0.0048	-0.0123	0.0128	-0.0009	0.0062	0.1003	-0.0006	0.0023	-0.0001
LL(cm	0.206	-0.0010	**-0.0341**	0.0730	0.0062	0.0054	-0.0340	-0.0198	-0.0011	0.0002	0.0097	0.1967	0.0050	-0.0014	0.0007
LD(cm)	0.450*	-0.0002	-0.0216	**0.1153**	-0.0008	0.0038	-0.0423	0.0040	-0.0032	0.0019	0.0265	0.3681	0.0026	-0.0055	0.0018
PH (cm)	0.098	-0.0002	-0.0057	-0.0023	**0.0372**	-0.0003	-0.0025	-0.0044	-0.0085	-0.0014	-0.0043	0.0805	0.0033	0.0066	-0.0002
PD (mm)	0.588**	0.0015	-0.0032	0.0074	-0.0002	**0.0586**	-0.0439	0.0100	0.0038	0.0008	0.0478	0.5026	0.0026	-0.0008	0.0011
ED (mm)	0.496*	0.0006	-0.0149	0.0625	0.0012	0.0330	**-0.0779**	0.0018	0.0015	0.0025	0.0422	0.4399	0.0059	-0.0045	0.0018
DB (%)	0.177	0.0017	0.0105	0.0072	-0.0025	0.0091	-0.0022	**0.0643**	0.0024	0.0001	0.0036	0.0901	-0.0038	-0.0037	0.0001
ND(cm)	-0.102	0.0036	-0.0011	0.0116	0.0100	-0.0070	0.0037	-0.0049	**-0.0317**	0.0001	-0.0038	-0.0840	-0.0016	0.0029	0.0001
DM (Days)	-0.176	-0.0011	0.0007	-0.0279	0.0067	-0.0062	0.0254	-0.0006	0.0005	**-0.0077**	-0.0191	-0.1482	-0.0071	0.0103	-0.0020
WB (g)	0.854**	-0.0007	-0.0043	0.0394	-0.0021	0.0362	-0.0425	0.0030	0.0016	0.0019	**0.0774**	0.7355	0.0058	0.0008	0.0026
MY(q/ha)	0.989**	-0.0010	-0.0078	0.0491	0.0035	0.0341	-0.0397	0.0067	0.0031	0.0013	0.0659	**0.8646**	0.0064	0.0004	0.0028
TSS (^{0}Brix)	-0.371	-0.0003	0.0105	-0.0183	-0.0076	-0.0093	0.0281	0.0147	-0.0031	-0.0033	-0.0271	-0.3378	**-0.0164**	0.0004	-0.0017
Dry. M (%)	-0.012	0.0012	-0.0028	0.0374	-0.0145	0.0028	-0.0206	0.0138	0.0054	0.0047	-0.0034	-0.0208	0.0004	**-0.0170**	0.0015
PA (μmol/g)	-0.661**	-0.0003	0.0058	-0.0510	0.0021	-0.0155	0.0343	-0.0022	0.0004	-0.0036	-0.0483	-0.5781	-0.0067	0.0061	**-0.0041**

Residual Effect = 0.00994, ** and * significant at 1% and 5%, respectively, NOL*= Number of Leaves, LL= Leaf Length, LD= Leaf Diameter, PH= Plant Height, ND= Neck Diameter, DB= Double Bulb, PD= Polar diameter, ED= Equitorial diameter, WB= Bulb Weight, TY= Total yield, MY= Marketable Yield, TSS= Total Soluble Solid, Dry M- Dry Matter Content, PA= Pyruvic Acid*

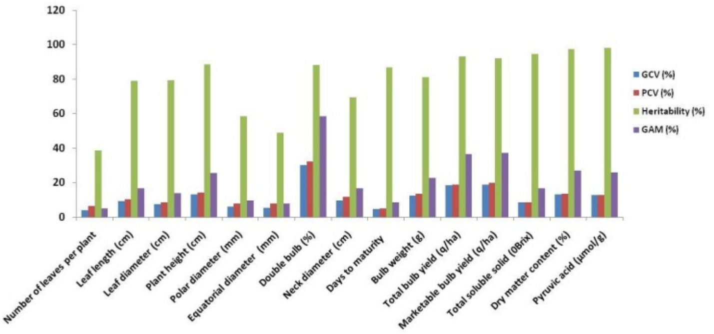

Figure 1. Genetic components of variance (GCV and PCV), heritability and genetic advance as percentage of mean for growth, yield and quality parameters

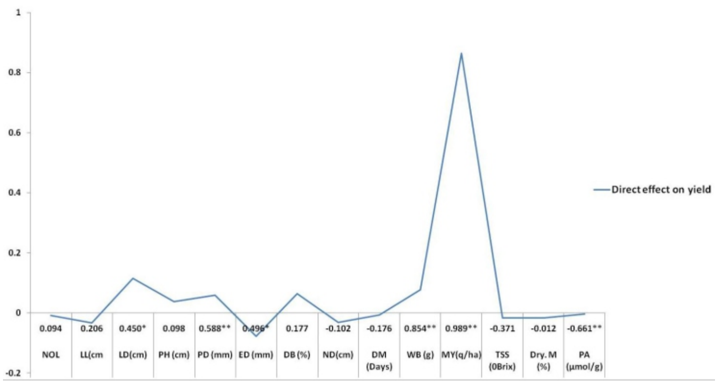

Figure 2. Direct (Phenotypic) effects of different characters on total bulb yield alongwith phenotypic correlation value (on X-axis)

REFERENCES

1. Anonymous (2020). National Horticulture database, NHB, Govt. of India..

2. Anthon, G. E., & Barrett, D. M. (2003). Modified method for the determination of pyruvic acid with dinitrophenylhydrazine in the assessment of onion pungency. *Journal of the Science of Food and Agriculture*, 83(12), 1210-1213.

3. Schwimmer, S. and Weston, W. J. (1961). Enzymatic development of pyruvic acid in onion as a measure of pungency. *J. Agri. Food Chem.*, 9(4): 301-304.

4. Panse, V. G. and Sukhatme, P. V. (1985). Statistical methods for agricultural workers. Indian Council of Agricultural Research, New Delhi.

5. Burton, G. W. and De Vane, E. H. (1953). Estimating heritability in tall fescue (Fescue arundianceae L.) from replicated clonal material. Agronomy Journal. 45: 478-481.

6. Johnson, H. W., Robinson, H. F. and Comstock, R. E. (1955). Estimates of genetic and environmental variability in soybean. Agronomy Journal. 47(7): 314-318.

7. Li, C.C. (1968). Population Genetics. The University of Chicago press, London. Cambridge University press. 366.

8. Dewey, D. R. and Lu, K. H. (1959). A correlation and path coefficient analysis of components of crested wheat grass seed reduction. J. Agron., 51: 515-518.

9. Hosamani, R. M., Patil, B. C. and Ajjappalavara, P. S. (2010). Genetic Variability and Character Association Studies in Onion (*Allium cepa* L.). *J. Farm Sci.,* 23(2).

10. Ibrahim, B. G., Simon, S. Y. and Bashir, L.U. (2013). Inheritance studies of some quantitative traits in onion (*Allium cepa* L.) *Int. J. Biosci.*, 3(4):135-141.

11. Singh, R. K., Dubey, B. K., Bhonde, S. R. and Gupta, R. P. (2010). Estimates of genetic variability, heritability and correlation in red onion (*Allium cepa* L.) advance lines. *Indian J. Agri. Sci*., 80(2).

12. Pyasi, R. and Tiwari, A. (2016). Genetic variability and character association for yield and its component traits in kharif onion genotypes. International Journal of Basic and Applied Agricultural Research. 14(1), pp. 43-49.

13. Shivkumar (2015). Studies on genetic variability, divergence and storage of onion (*Allium cepa* L.) genotypes for growth, yield and shelf life parameters. Ph.D Thesis, University of Horticulture Science, Bagalkot.

14. Singh, P., Soni, A.K., Diwaker, P., Meena, A. R. and Sharma D. (2017). Genetic Variability Assessment in Onion (*Allium cepa* L.) Genotypes. International Journal of Chemical Studies 2017; 5(5): 145-149.

15. Benyamin, K., Hannen, E., Hussen, M., Abdullah, K. and Albaiaty, H. (2019). Correlation and path coefficient analysis in onion (*Allium cepa* L.). *Int. J. Adv. Sci. Eng. Tech.,* 7(4): 58-61.

16. Chavda, K. A., Jethva, A. S., Zinzala, S.N., Sapovadiya, M. H. and Vachhani, J. H. (2021). Character association and their direct and indirect effect on bulb yield in onion (*Aillum cepa* L.). The Pharma Innovation Journal. 10(4):179-181.

17. Morsy, M. G. Marey, R.A. and Genies, L. S. M. (2011). Genetic variability, heritability, genetic advance and phenotypic correlation in some onion varieties. *J. Agric. Res*., 37(1):57.

18. Nikhil, B. S. K., Jadhav, A. S. and Kumar, S. (2016). Studies on correlation and path analysis in Rabi onion (*Allium cepa* L.). *Eco. Env. & Cons*., 449- 452.

19. Sahu, K., Sharma, P. K., Dixit, A. and Nair, S. K. (2018). Correlation and path coefficient analysis in kharif onion (*Allium cepa* L.) genotypes for Chattisgarh plains. *Int. J. Curr. Microbiol. App. Sci*., 6:256-263.

20. Monpara, B. A., Chhatrola, M. D., Golan, I. J and Vaddoria, M. A. (2005). Evaluation of onion germplasm: variability and trait relationship studies. *Nat. J. Plant Improvement*. 7(1): 11-14.

21. Mahanthesh, B., Raviprasad, M. S., Harshavardhan, M., Vishnuvardhana and Janardhan, G. (2008). Evalution of different onion genotypes yield and processing quality parameters in kharif season under irrigated condition. *As. J. Hort.,* 3(1): 5-9.

22. Chattopadyay, A. Sharangi, A.B., Dutta, S. Das, S. and Dentre, M. (2013). Genetic relatedness between quantitive and qualitative parameter in onion (*Aillum cepa* L.). Vegetos-An International Journal of Plant Research. 26(1): 151-157.

23. Singh, R. K. and Dubey, B.K. (2011). Studies on genetic divergence in onion advance lines Indian J. Hort., 68(1): 123-127.

24. Chattoo., M. A., Angrej, A. and Kamaluddin (2015). Genetic Variability, Interrelationship and Path analysis for yield and yield related traits in onion (*Aillum cepa* L.) under temperate condition in Kashmir valley. Plant Archives. 15(2):1161-1165.

