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Association among growth characters, yield and bulb quality in onion, *Allium cepa* L

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ABSTRACT

An experiment was conducted to study the character association among bulb yield and related traits with ten varieties/lines of onion at the experimental plots, Division of Vegetable Crops, Indian Agricultural Research Institute, New Delhi. The varieties/lines differed significantly for most of the characters and relatively wide range of the mean for most of the characters indicated the existence of variation among the tested varieties/lines. Total yield was significantly and positively correlated with bulb fresh weight, vertical bulb diameter, reducing sugars and weight of the bulb at phenotypic and genotypic level. These associations suggested that selection for these characters will be effective in improving yield.

Keywords: Correlation; growth; *Allium cepa;* onion

INTRODUCTION

Onion is one of the most important commercial vegetable crops grown in India over an area covering 0.75 million hectares with a production of 12.1 million tonnes (Anon 2010). It is an important underground bulb vegetable crop of tropical and sub-tropical parts of the world. It is highly cross pollinated crop in which large amount of variation is observed in many important traits. The productivity of onion in India is far below than that of western countries. Hence immediate attention needs to be given to improve the productivity of onion. The knowledge about interrelationship among bulb yield and its components and their relative contribution towards the bulb yield is important for a fruitful selection. The present investigations were therefore undertaken with a view to estimate the parameters of genetic variability as well as to work out the correlation coefficient among bulb yield and its components so as to make effective selection for yield improvement in onion.

MATERIAL AND METHODS

The present investigations were carried out in the experimental plots of the Division of Vegetable Crops and laboratory

works carried out in the Division of Plant Physiology and Vegetable laboratory, Indian Agricultural Research Institute, New Delhi, during 2002 - 2003.

The experimental material for the present study consisted of ten lines/varieties viz Pusa Red, Pusa Madhvi, B-line, Sel 383, Sel 402, N-53, Sel 126, Early Grano, Pusa White Flat and Pusa White Round.

The experiment was laid out in a Randomized Block Design (RBD) with three replications each consisting of 10 varieties/lines. Each variety/line was grown in 20 rows of 3 m long spaced at 15 cm apart. Fifteen plants were taken at random each in lines/varieties and tagged for recording observations. Biochemical analysis was done in laboratory.

All the cultural operations like nursery raising, main field preparation, transplanting, fertilization, irrigation, weeding, plant protection etc were carried out as per the recommendations in order to raise a successful crop.

The observations recorded at 90 days after transplanting (50% neck fall) were plant height, number of leaves per plant, neck thickness, weight of the bulb, bulb diameter (horizontal and vertical), fresh and dry weight of the bulbs and leaves and leaf area.

Observations recorded at maturity on bulb quality and yield were total soluble solids (TSS), reducing sugars analyzed by Lane and Eynon (1923) and total sugars by Anon (1970). Non-reducing sugars were estimated by subtracting the reducing sugars from total sugars. Ascorbic acid was estimated by the method of Johnson (1948). Yield parameters like weight of the bulb, bulb yield per plot and marketable yield were recorded. The analysis of variance for each character was according to procedures of Cochran and Cox (1950).The phenotypic and genotypic correlation coefficients between variables were calculated using covariance (Al-Jibouri et al 1958).

RESULTS AND DISCUSSION

All the varieties/lines showed significant differences for the characters studied (Table 1). Highest plant height was observed for Pusa madhvi. Maximum number of leaves was recorded in Pusa white round. Early grano showed its highest value for bulb fresh weight whereas the lowest value was recorded for N-53. Variation in leaf fresh weight indicates that translocation of photosynthates take place from leaf to bulb. According to Wiles (1994) a significant increase in bulb development leads to decrease in leaf area. B-line showed the highest values for vertical bulb diameter. These results suggested that demarcation in bulb shape took place at slag periods of bulb growth. Maximum horizontal bulb diameter was recorded from Pusa White Round and the minimum from Sel 126. Pusa Madhvi showed the highest value for neck

Table 1. Growth characters of onion varieties/lines

Plant/line	Plant height (cm)	Number of leaves	Bulb fresh wt (g)	Bulb dry wt (g)	Leaf fresh wt (g)	Leaf dry wt (g)	Horizontal bulb dia (cm)	Vertical bulb dia (cm)	Neck thickness (cm)	Leaf area (cm^2)
Sel 383	51.6	10.5	75.26	10.64	49.15	5.55	5.66	4.04	1.66	46.24
PR	53.3	8.0	82.66	11.12	34.84	3.97	5.42	4.29	1.25	58.12
EG	54.0	7.3	104.84	13.60	31.59	3.56	5.87	5.35	1.38	97.84
PWF	42.0	9.7	70.66	11.85	41.07	8.49	5.81	4.66	1.81	51.99
Sel 126	50.1	10.1	81.72	8.40	60.14	9.48	6.06	4.32	1.62	53.81
N-53	50.3	9.7	70.33	9.61	34.45	7.38	5.67	4.53	1.68	79.48
PM	54.8	10.0	96.79	9.68	68.27	9.44	5.84	4.60	1.92	48.01
Sel 402	50.2	8.7	96.07	12.01	48.65	7.44	5.39	4.05	1.43	47.09
B-line	47.0	10.7	93.95	13.52	53.17	5.87	6.27	4.33	1.72	70.95
PWR	50.1	12.8	93.74	11.52	36.41	4.97	5.84	4.62	1.61	58.58
Mean	50.3	9.7	86.60	11.20	45.77	6.62	5.78	4.48	1.61	61.21
$CD_{0.05}$	4.5	1.7	6.34	0.86	2.68	1.44	0.07	0.21	0.07	14.78

PR: Pusa Red, EG: Early Grano, PM: Pusa Madhvi, PWF: Pusa White Flat, PWR: Pusa White Round

thickness and Pusa Red the lowest. Magnitude of variability for different characters was clearly visualized in onion. Highly significant differences in values indicated great amount of variation among the treatments. The large amount of variation existed in the varieties/lines revealed that considerable improvement can be made in this crop. Similar results of variability were reported by Patil et al (1987) in 45 cultivars of onion for bulb yield, biochemical and storage characters.

While considering the bulb quality and yield characteristics (Table 2) in all the varieties/lines significant amount of variation was observed among the treatments. Maximum values for TSS were recorded for Sel 126 (Table 2). Reducing sugars ranged from 2.1 per cent (Sel 383) to 3.61 per cent (Early Grano). Sel 126 possessed highest non-reducing sugars while the lowet was found in Early Grano. Total sugars ranged from 7.0 per cent (Sel 383) to 12.2 per cent (Sel 126). Pusa Red possessed the highest amount of ascorbic acid while the lowest was observed in Early Grano . Bulb yield per plot was maximum in Early Grano followed by Sel 402. Total yield ranged from 262.5 q/ha to 399.3 q/ha. Similar results were reported by Masika et al (1994).

Character association

The perusal of results showed that the genotypic correlation coefficient showed higher values for most of the variable pairs than the phenotypic correlation coefficients suggesting that there was a strong inherent association between the various characters studied. Further as the genotypic correlation coefficient is parallel to the phenotypic correlation coefficient it may be assumed that there is not much influence of environment in determining the association of this growth and yield attributing characters with yield and it is due to a strong genetical make up of the plant.

Considering the association of morphological parameters with quality and yield (Table 3) total yield was significantly and positively correlated with bulb fresh weight, vertical bulb diameter, reducing sugars and weight of the bulbs at phenotypic and genotypic level. These associations suggested that selection for these characters will be effective in improving yield. Similar results were reported by Netra Pal et al (1988).

Ascorbic acid was significantly and negatively correlated with bulb fresh weight, bulb dry weight, horizontal bulb diameter, reducing sugars and total yield at phenotypic and genotypic level. This association suggests that increase in fleshiness lead to decrease in ascorbic acid content. Total sugars were significantly and positively correlated with non-reducing sugars and non-reducing sugars were significantly and negatively correlated with reducing sugars at both phenotypic and genotypic level. It shows that contribution of non-reducing

Table 2. Mean performance of onion varieties/lines for different bulb quality and yield characters

Variety/line	TSS (°Brix)	Reducing sugars (%)	Non-reducing sugars (%)	Total sugars (%)	Ascorbic acid (mg/ 100 g)	Wt of bulb (g)	Bulb yield/plot (kg)	Total yield (q/ha)	Marketbale yield (q/ha)
Sel 383	12.50	2.10	4.90	7.00	4.58	127.91	19.17	272.91	210.62
Pusa Red	12.20	2.45	5.88	8.33	15.66	122.02	23.30	323.61	309.72
Early Grano	9.10	3.61	4.28	7.89	13.50	163.92	28.75	399.30	343.75
Pusa White Flat	11.00	2.45	7.89	10.30	14.04	144.29	22.47	312.08	291.25
Sel 126	14.50	2.31	9.94	12.20	15.33	83.40	18.90	262.51	248.61
N-53	10.10	2.29	7.32	9.61	15.02	100.74	19.26	267.51	239.72
Pusa Madhvi	12.00	2.42	6.98	9.41	15.12	96.72	25.25	350.69	336.80
Sel 402	14.10	2.27	7.89	10.16	14.58	147.50	25.41	352.91	325.13
B-Line	11.40	2.54	8.36	10.90	13.62	156.05	26.16	369.58	321.66
Pusa White Round	12.40	2.18	8.72	10.90	14.68	101.29	20.96	291.11	277.22
Mean	11.93	2.46	7.22	9.67	13.61	124.38	22.96	320.22	290.45
$CD_{0.05}$	1.90	0.71	0.82	0.72	0.74	9.74	1.80	22.22	11.09

PR: Pusa Red, EG: Early Grano, PM: Pusa Madhvi, PWF: Pusa White Flat, PWR: Pusa White Round

Table 3. Estimates of phenotypic and genotypic correlation coefficients between morphological, quality and yield characters

Character		TSS	Reducing sugars	Non-reducing sugars	Total sugars	Ascorbic acid	Wt of bulb	Total yield
Leaf area	P	-0.118	0.579**	-0.009	0.136	-0.418	0.114	0.328
	G	-0.201	0.639**	0.002	0.161	-0.502	0.115	0.371
Bulb fresh wt	P	-0.325	0.514*	-0.413	-0.324	-0.738**	0.902**	0.718*
	G	-0.443*	0.534*	-0.422	-0.33	-0.808**	0.912**	0.743**
Bulb dry wt	P	-0.221	0.273	-0.392	-0.362	-0.586**	-0.859**	0.416
	G	-0.304	0.266	-0.387	-0.359	-0.682**	0.902**	0.435
Leaf fresh wt	P	0.497*	-0.293	0.34	0.3	0.128	-0.332	-0.02
	G	0.604**	-0.326	0.361	0.315	0.138	-0.353	-0.025
Leaf dry wt	P	0.473*	-0.285	0.617**	0.607**	0.393	-0.566*	-0.427
	G	0.592**	-0.347	0.682**	0.662**	0.491	-0.600**	-0.450*
Neck thickness	P	-0.112	-0.229	0.143	0.099	-0.129	0.117	-0.032
	G	-0.531*	-0.639**	0.470*	0.357	-1.155	0.696**	-0.178
Plant height	P	-0.361	0.565*	-0.655**	-0.577**	-0.074	0.225	0.408
	G	-0.532*	0.736**	-0.836**	-0.735**	-0.209	0.286	0.511*
No of leaves	P	0.209	-0.555**	0.442	0.346	0.019	-0.386	-0.404
	G	0.322	-0.675**	0.617**	0.510*	-0.12	-0.481*	-0.528*
Horizontal bulb dia	P	-0.108	0.112	-0.12	-0.104	-0.612**	0.649**	0.350
	G	-0.103	0.169	-0.183	-0.159	-0.972**	0.779**	0.401
Vertical bulb dia	P	-0.375	0.776**	-0.11	0.075	-0.234	0.196	0.587**
	G	-0.438	0.851**	-0.125	0.074	-0.308	0.203	0.600**
TSS	P	1.000	-0.556*	0.427	0.33	0.236	-0.325	-0.342
	G	1.000	-0.722**	0.535*	0.408	0.468*	-0.443*	-0.403
Reducing sugars	P		1.000	-0.493*	-0.29	-0.458*	0.514*	0.672**
	G		1.000	-0.487*	-0287	-0.496*	0.534*	0.694**
Non-reducing sugars	P			1.000	0.976**	0.233	-0.413	-0.33
	G			1.000	0.976**	0.192	-0.422	-0.328
Total sugars	P				1.000	0.141	-0.324	-0.194
	G				1.000	0.088	-0.330	-0.188
Ascorbic acid	P					1.000	-0.738**	-0.563**
	G					1.000	-0.808**	-0.663**
Wt of bulb	p						1.000	0.718**
	G						1.000	0.743**
Total yield	P							1.000
	G							1.000

*Significant at 5%; **Significant at 1%

P: Phenotypic correlationship coeffocient
G: Genotypic correlationship coeffocient

sugars was more to the total sugars rather than reducing sugars.

The significant negative correlation between ascorbic and reducing sugars indicated that acidity and sweetness are inversely related. Number of leaves showed significant positive correlation with non-reducing sugars and total sugars at genotypic level but not at phenotypic level suggesting that a strong association between these characters for genetically and phenotypic values was masked by the significant interaction with environment. Similar trend has been reported by Bharati (2000). Reducing sugars were significantly and positively correlated with weight of the bulbs and total yield at phenotypic and genotypic level. The non-structural or storage carbohydrates of onions make up much of the dry matter. These results are similar to those of Hansen (1999) and Jaine et al (2001).

CONCLUSION

Analysis of variance showed that ten genotypes of onion under investigation differed significantly among themselves for all the characters studied. Considering biochemical and yield characteristics Sel 126 was superior in total soluble solids, total sugars and ascorbic acid content whereas Early Grano, B-line, Sel 402, Pusa Madhvi were superior in yield. Morphological characters, quality and total yield were significantly and positively correlated with bulb fresh weight, vertical bulb diameter and reducing sugars whereas these were negatively correlated with ascorbic acid. Hence yield contributing characters like bulb weight, bulb diameter (horizontal and vertical), plant height and leaf area are the most dependable characters and could be effectively used in breeding for improvement in yield.

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