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GENETIC VARIABILITY, INTERRELATIONSHIP AND PATH ANALYIS FOR YIELD AND YIELD RELATED TRAITS IN ONION (*ALLIUM CEPA* L.) UNDER TEMPERATE CONDITION IN KASHMIR VALLEY

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Abstract

Genetic variability, correlation and path analysis were carried out in forty eight genotypes/hybrid of onion for bulb yield and yield related traits. The magnitude of PCV and GCV were low to high, which indicated that the traits were less influenced by environment and are genetically controlled. % doubles genotypes, % bolters, % splited bulb, dry matter, total bulb yield and average bulb weight exhibited high heritability with high genetic advance. Total bulb yield was found to be positively correlated with average bulb weight, days to harvest, % splited bulb, equatorial diameter, dry matter, polar diameter, total soluble solids, plant height, collar thickness and % double genotypes. Path coefficient analysis revealed that average bulb weight had maximum positive direct effect on total bulb yield followed by days to harvest, % splited bulb, equatorial diameter, dry matter, polar diameter, TSS, plant height, collar thickness and % double genotypes indicating true and perfect relationship.

Key words : Correlation, path analysis, onion.

Introduction

Onion (*Allium cepa* L.) is one of the most important vegetable and spices crop grown in temperate, sub-tropical and tropical climate throughout the world (Singh *et al*., 2013). It is commercially cultivated in India for both vegetable and spices purpose and India occupies second position in production after china with 12.1 million tonnes (Anonymous, 2010). It is mainly grown in Rabi season in our country. The onion bulb and rich in minerals like Ca, K and P (Ullah *et al*., 2005). The crop is grown for various purposes from kitchen to industry made products/food and also for dehydration. Onion are used as a salad or cooked in various ways in all curries, fried or baked and is also used in processed from *e.g.* flakes, powder paste, crush and pickles etc. (Singh *et al*., 2010).

It is consumed by the people around the world due to its medicinal properties in various cardiac diseases, rheumatism, cancer, digestive disorders, blood sugar and prolong cough (Singh *et al*., 2013). It is valued for its distinct pungent flavor and its essential ingredients cuisine. For any crop improvement programe the selection of parents for hybridization is largely based on diversity, adaptation and high yield. The studies related to genetic variability, heritability and inter relationship between yield and yield component traits may be helpful to exercise an efficient selection programe. Although many varieties have been released, the systematic crop improvement is lacking in onion when compared to other commercial vegetable crop. The present investigation was an attempt towards the improvement in onion to assess the nature and magnitude of genetic variability present in onion genotypes. Further, the extent of trait heritability and interrelationship among the characters was estimated. Correlation coefficients were partitioned into direct and indirect effects and their contribution towards bulb yield was studied.

Materials and Methods

Forty eight diverse genotypes/hybrids of onion were evaluated in RBD design with three replications at Horticultural Research Farm, Faculty of Agriculture, SKUAST-K, Wadura, Sopore, Kashmir ($34^0$17' N and 740^0 33' E at an altitude of 1,524m amsl) under rain-fed condition. The seedlings of 50 days old were transplanted in the main field during *rabi* season (2012-2013) at spacing of 20×10 cm in the plot size of 2.0×1.0 meter.

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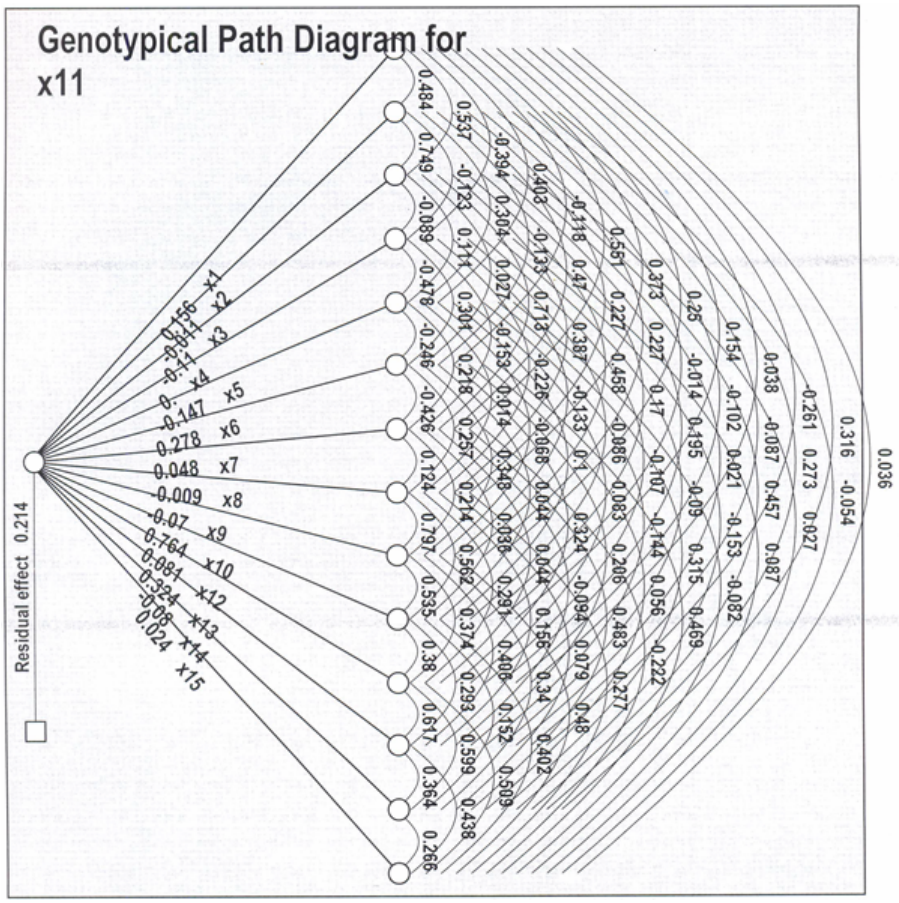

Fig. 1 : Genotypic correlation for bulb yield and yield attributes in onion.

Recommended package of practices and plant protection measures were followed to raise a good crop. The crop was harvested at maturity when the tops had fallen and became withered. Five randomly selected plants in each plot were selected for recording data on the following traits *viz*. plant height (cm), no. of leaves per plant, collar thickness (cm), doubles (%) genotypes, bolters (%), total soluble solids (%), neck thickness(cm), polar diameter (cm), equatorial diameter (cm), average bulb weight (gm), total bulb yield (Q ha^{-1}), splited (%) bulb and days to harvest (in days). The total soluble solids (TSS %) were determined with digital refractometer calibrated using distilled water.

Average values were statistically analysed for variance, genotypic and phenotypic coefficients of variation, heritability, genetic advance and correlation coefficients following standard procedure described by Panse and Sukhatme (1985) and Burton and De Vane (1953). Path analysis was carried out as described by Dewey and Lu (1959) to assess the associations, direct and indirect influence of various components on bulb yield.

Results and Discussion

Estimates of variability, heritability and genetic advance are presented in table 1. A close resemblance between the corresponding estimates of PCV and GCV suggested little role of environment in the expression of different traits. Neck thickness (64.16 and 62.26) showed highest PCV and GCV followed by % bolters (59.61 and 53.3), % double genotypes (49.75 and 47.58), % splited bulb (29.08 and 27.94), collar thickness (25.81 and 22.23), dry matter (25.48 and 24.60), total bulb yield (20.29 and 19.64) and average bulb weight (19.47 and 18.58) shows low PCV and GCV values. Heritability estimates varied from 0.94% for neck thickness to 0.65% for polar diameter. High to moderate estimates for GCV and PCV coupled with high estimates of heritability were observed for the characters neck thickness, % bolters, % double genotypes, % splited bulb, collar thickness, dry matter, total bulb yield and average bulb weight which indicate an advantage through selection. All the traits except equatorial diameter, polar diameter and no. of leaves exhibited comparatively higher estimates of GCV, heritability and genetic advance as percent of mean which is indicative of predominance of additive gene action in

Table 1 : Estimates of different genetic parameters for different yield and yield traits in onion.

Character	Range		Mean	CV	PCV	GCV	GAPM	H^2 bs	GA	ECV
	Minimum	Maximum								
Plant height (cm)	35.33	68.33	42.55	6.58	15.30	13.81	25.69	0.81	10.93	6.58
No. of leaves	4.00	11.33	6.99	12.23	21.32	17.46	29.47	0.67	2.06	12.23
Collar thickness (cm)	0.52	2.11	1.05	13.10	25.81	22.23	39.46	0.74	0.41	13.10
% doubles genotypes	1.71	19.66	10.02	14.54	49.75	47.58	93.73	0.91	9.40	14.54
% bolters	0.50	2.60	1.18	26.60	59.61	53.35	98.34	0.80	1.16	26.60
% TSS	9.81	16.90	13.62	7.77	15.31	13.19	23.41	0.74	3.19	7.77
Neck thickness (cm)	0.10	0.900	0.20	15.50	64.16	62.26	124.45	0.94	0.25	15.50
Polar diameter (cm)	4.29	6.64	5.18	6.96	11.82	9.55	15.90	0.65	0.82	6.96
Equatorial diameter (cm)	4.54	6.90	5.70	6.17	12.08	10.38	18.38	0.73	1.04	6.17
Average bulb weight (10 bulb) (gm)	57.00	132.33	85.21	5.83	19.47	18.58	36.51	0.91	31.11	5.83
Total bulb yield (Q ha^{-1})	311.96	618.33	465.76	5.09	20.29	19.64	39.17	0.93	182.44	5.09
% SB	1.41	4.50	2.29	8.07	29.08	27.94	55.30	0.92	1.65	8.07
Days to harvest (in days)	143.33	255.66	210.43	4.41	16.23	15.62	30.97	0.92	65.18	4.41
Dry matter (gm)	3.97	12.60	5.97	6.63	25.48	24.60	48.93	0.93	2.92	6.63

expression of these traits therefore for these characters selection appears to be effective. The GA as percent mean was found to be highest for % bolters (98.34) followed by % double genotypes (93.73), % splited bulb (55.30), dry matter (48.93), collar thickness (39.46), total bulb yield (39.17) and average bulb weight (36.51). The results are in accordance with earlier findings of Dhotre *et al*. (2013) and Haydar *et al*. (2007). High heritability estimates coupled with high GA percent of mean were observed for % doubles genotypes, % bolters, % splited bulb, dry matter, total bulb yield and average bulb weight. High heritability of these characters may be due to additive gene effects; hence these characters are likely to respond to direct selection.

The total bulb yield showed maximum magnitude of positive correlation (table 2) with average bulb weight (0.849) followed by days to harvest (0.592), % splited bulb (0.581), equatorial diameter (0.580), dry matter (0.572), polar diameter (0.527), TSS (0.380), plant height (0.165), collar thickness (0.072) and % double genotypes (0.018). Such types of associations are expected to improve grain yield. Most of the traits studied showed positive correlation with each other except no. of leaves with % double genotypes (-0.122), TSS (-0.132), average bulb weight (-0.014), total bulb yield (-0.165), % splited bulb (-0.102) and days to harvest (-0.087); collar thickness with % double genotypes (-0.089); % double genotypes with % bolters (-0.477), neck thickness (-0.153), Polar diameter (-0.225), equatorial diameter (-0.133), average bulb weight (-0.086), % splited bulb (-0.106), days to harvest (-0.090) and dry matter (-0.152); % bolters with TSS (-0.246), equatorial diameter (-0.068), total bulb yield (-0.144) and days to harvest (-0.144); TSS with neck thickness (-0.425); and neck thickness with total bulb yield (-0.159) and days to harvest (-0.093). Similar results were reported by Ashok *et al*. (2013) and Hosamani *et al*. (2010).

Positive correlation of a particular character with yield does not necessarily mean a direct, positive effect of that trait on yield. Path coefficient analysis measures the direct and indirect influence of a variable on the dependent trait and is an effective device for meritorious characters to be used in selection programme to get maximum yield. Therefore, path coefficient analyses which analyses cause and effect relationship and partitions the correlation into direct and indirect effects were carried out. Path analysis (table 3) showed maximum amount of positive direct effect on total bulb yield was exerted by average bulb weight (0.849), days to harvest (0.592), splited bulb (0.581), equatorial diameter (0.580), dry matter (0.572), polar diameter (0.527), TSS (0.380), plant height (0.165), collar thickness (0.072) and % double genotypes (0.018) indicating the relative significance of these traits in determining the total bulb yield. Therefore, these traits should be given preference while practicing selection which aimed at the improvement of bulb yield. Plant height had an influence on bulb yield through positive indirect effect of average bulb weight (0.117), neck thickness

Table 2 : Genotypic correlation matrix for total bulb yield and yield related traits in onion. PH = Plan height (cm), NL = No. of leaves/plant, CT = Collar thickness (cm), DG = % double genotypes, BR = % bolters, TSS = % total soluble solids, NT = neck thickness (cm), PD = Polar diameter (cm), ED= Equatorial diameter (cm), AW= Average bulb weight (gm), TBY= Total bulb yield (Q ha $^{-1}$), SB = % splited bulb, DAH= Days to harvest (in days), DM= Dry matter (gm).

Traits	PH	NL	CT	DG	BR	TSS	NT	PD	ED	AW	DM	SB	DAH	TBY
PH	**1.00**	0.483	0.537	-0.394	0.403	-0.117	0.551	0.373	0.250	0.153	0.316	0.037	-0.261	0.165
NL		**1.00**	0.749	-0.122	0.304	-0.132	0.407	0.227	0.226	-0.014	0.272	-0.102	-0.087	-0.165
CT			**1.00**	-0.089	0.110	0.027	0.713	0.386	0.457	0.170	0.456	0.195	0.021	0.072
DG				**1.00**	-0.477	0.301	-0.153	-0.225	-0.133	-0.086	-0.152	-0.106	-0.090	0.018
BR					**1.00**	-0.246	0.217	0.013	-0.068	0.100	0.315	0.083	-0.144	-0.144
TSS						**1.00**	-0.425	0.256	0.347	0.044	0.056	0.323	0.206	0.380
NT							**1.00**	0.124	0.213	0.035	0.483	0.043	-0.093	-0.159
PD								**1.00**	0.797	0.561	0.078	0.291	0.155	0.527
ED									**1.00**	0.534	0.340	0.374	0.405	0.580
AW										**1.00**	0.151	0.380	0.293	0.849
DM											**1.00**	0.572	0.581	0.572
SB												**1.00**	0.616	0.581
DAH													**1.00**	0.592
TBY														**1.00**

Table 3 : Estimate of direct and indirect effects on total bulb yield and yield related traits. PH= Plant height (cm), NL=Number of leaves, CT= Collar thickness (cm), DG = % Doubles, BR = % Bolters, TSS= % total soluble solid, NT= Neck thickness (cm), PD= Polar diameter (cm), ED = Equatorial diameter (cm), AW = Average bulb weight (gm), TBY= Total bulb yield (Q ha^{-1}), SB= % splited bulb, DAH = Days to harvest (in days), DM = Dry matter (gm).

Traits	PH	NL	CT	DG	BR	TSS	NT	PD	ED	AW	DM	SB	DAH
PH	**0.155**	0.075	0.083	-0,061	0.062	-0.018	0.085	0.058	0.038	0.023	0.005	-0.040	0.049
NL	-0.005	**-0.011**	-0.008	0.001	-0.003	0.001	-0.005	-0.002	-0.002	-0.001	0.000	0.001	-0.003
CT	-0.058	-0.082	**-0.109**	0.009	-0.012	-0.003	-0.078	-0.042	-0.050	-0.018	-0.003	-0.002	-0.050
DG	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BR	-0.059	-0.044	-0.016	0.070	**-0.147**	0.036	-0.032	-0.002	0.010	-0.014	0.012	0.021	-0.046
TSS	-0.032	-0.036	0.007	0.083	-0.068	**0.278**	-0.118	0.071	0.096	0.012	0.130	0.057	0.015
NT	0.026	0.022	0.034	-0.007	0.010	-0.020	**0.048**	0.006	0.010	0.001	-0.010	-0.004	0.023
PD	-0.003	-0.002	-0.003	0.002	-0.000	-0.002	-0.001	**-0.009**	-0.007	-0.005	-0.002	-0.001	-0.000
ED	-0.017	-0.015	-0.032	0.009	0.004	-0.024	-0.015	-0.055	**-0.070**	-0.037	-0.033	-0.028	-0.023
AW	0.117	-0.011	0.130	-0.066	0.076	0.033	0.027	0.429	0.408	**0.764**	0.307	0.224	0.115
DM	-0.084	-0.082	0.006	-0.029	-0.046	0.066	-0.030	0.050	0.131	0.095	**0.199**	0.177	0.141
SB	-0.025	-0.021	-0.036	0.012	-0.025	-0.004	-0.038	-0.006	-0.027	-0.012	-0.048	**-0.080**	-0.021
DAH	0.009	-0.001	0.000	0.002	0.001	-0.005	0.006	0.001	0.009	0.012	0.010	0.006	**0.023**
TBY	0.165	-0.165	0.072	0.018	-0.144	0.380	-0.159	0.527	0.580	0.849	0.572	0.581	0.592

(0.026) and days to harvest (0.009); no. of leaves through plant height (0.075) and neck thickness (0.022); collar thickness via average bulb weight (0.130), plant height (0.83) and neck thickness (0.034); % double genotypes through TSS (0.083) and % bolters (0.070); % bolters through average bulb weight (0.076) and plant height (0.062); TSS via dry matter (0.066); neck thickness through plant height (0.085); polar diameter through average bulb weight (0.429) and TSS (0.071); equatorial diameter via average bulb weight (0.408) and dry matter (0.131); average bulb weight through dry matter (0.095); dry matter via average bulb weight (0.307) and TSS (0.130); splited bulb through average bulb weight (0.224) and dry matter (0.177) and days to harvest through average bulb weight (0.115) and dry matter (0.141). On the other hand, direct effects of % bolters, collar thickness, splited bulb, equatorial diameter, no. of leaves and polar diameter were negative. Greater role of average bulb weight, TSS, dry matter and plant height was observed in determining the bulb yield, as the magnitude of their

direct effects were very high. The results are in agreement with earlier findings of Singh *et al*. (2013) and Ashok *et al*. (2013).

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