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Genetic Variability for Yield and Yield Attributing Characters in Late Kharif Onion Genotypes Under New Alluvial Zone of West Bengal

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Abstract

Highly significant variation for all characters due to genotype exhibited wide range of variability in the studied material. Moderate PCV and GCV were observed for average bulb weight, number of leaves, equatorial bulb diameter, polar bulb diameter, total soluble solid and bulb yield.The results indicated that the all characters exhibited high heritability. However, high heritability coupled with high genetic advance as percentage over mean (GAM) was observed in traits viz. number of leaves, leaf diameter, plant height, polar diameter, neck diameter, average weight of bulb, marketable yield and dry matter content in bulb indicating that simple selection would be sufficient for these traits to bring genetic improvement. In most of the cases, the genotypic correlation was higher than phenotypic correlation indicating highly heritable nature of the character like bulb yield per hectare which had positive and significant correlation with bulb weight (0.584),bulb polar diameter (0.390) and equatorial diameter(0.338) were the most influencing factors.

Key words : *Late kharif onion, correlation and path coefficient analysis.*

Introduction

Onion is a major vegetable crop, and it is an essential ingredient in many dishes as a vegetable and condiment. Besides salad and pickles, onion is used for preparation of dehydrated forms, such as powder and flakes, in processing industry to a great extent. The demand for onion is high in West Bengal. The bulb is typically available from April onwards, as onion is mostly grown during rabi season. Due to weather fluctuations, poor storage capabilities and farmer'signorance of its production technologyand a lack of promising varieties, onion cultivation in West Bengal is rarely practiced in Kharif. Onion harvesting in the country is limited to June to November (1). There is a severe onion shortage in the country between October and March, which causes prices to rise. A local onion harvest during the kharif season could be critical to closing the gap between supply and demand and stabilizing onion prices when there is a shortage. Furthermore, farmers can obtain higher returns during kharif through the production of onion.In the presence of varying environmental conditions or agro-climatic zones, crop varieties have wide variation in yield capacity. Because of this, it is difficult to determine which variety is superior. The selection of suitable genotype(s) plays an important role in enhancing the yield, productivity and keeping quality for particular environmental condition. For a continuous supply of onions throughout the year, onion production in the late kharif season is crucial. Selection of high-yielding genotypes under West Bengal's agro-climatic conditions is necessary to meet out the domestic demand, ensure year-round supply as well as meet export demand.

Materials and Methods

The investigation was conducted at C block farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani in New Alluvial zone of West Bengal during *late kharif*, 2020-21. In a Randomized Block Design with three replications, fifteen onion genotypes were measured for growth, yield, and quantitative traits, using ten randomly selected plants from each replication.For elucidating the valid information from these experiments, various statistical analyses were performed on the data. A variety of parameters were used to evaluate the genetic variation, including genotypic and phenotypic co-efficient of variation, heritability as well as genetic advance over mean. Analysis of variance was performed with the data (2). Based on Burton's formula (3), we calculated genotype co-efficient of variation (GCV) and phenotype co-efficient of variation (PCV). In order to estimate genetic advance and heritability, formula suggested by (4) was used. Later, correlation coefficients at genotypic and phenotypic levels were calculated (5). Path coefficient was done as per Dewey and Lu (6). A correlationand path coefficient analysis between different characters werecarried out to determine the relationship between each of them and bulb yield. Below are the most notable findings of the experiment.

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Results and Discussion

Mean performance of genotypes for growth, yield and quality parameters : The result on mean performance of late kharif onion genotype on growth, yield and quality parameters showed significant variation among tested genotypes and the data pertaining to these parameters have been depicted in Table-1. Among fifteen genotypes, the genotype RPG-1 produced significantly maximum number of leaves (11.30) which is closely followed by PRO-7 (11.07) and NHRDF Red 2 (10.83). Whereas lowest (7.33) number of leaves was found in Bhima Red. The existence of variability as leaf length ranged from 52.21 cm for DOGR-1657 to 31.07 cm for DOGR-1606 with a overall mean value of 44.80. Leaf diameter varies from 0.89 to 1.48 cm with an overall average value of 1.18 cm. The genotype NHRDF Red-2 was recorded the maximum leaf diameter (1.48 cm) which was followed by DOGR-1657 (1.37) and Bhima Shakti (1.37) while, minimum leaf diameter (0.89 cm) was recorded in genotype DOGR-1606.Among the different fifteen genotype PRO-7 had tallest (66.38 cm) followed by NHRDF Red-2 (65.55 cm) and DOGR-1669 (65.63 cm) (7, 8). The genotype Bhima Super had minimum neck thickness (0.92 cm) while maximum neck thickness was recorded in genotype Bhima red (1.62 cm) [9].The genotype RPG-1 (101.27 days) took significantly minimum time to maturity. However, the genotype DOGR 1606 required maximum number of days to maturity (115.67days) with a grand mean of 106.27 days [10] [11]. The production of doubles bulb varies from 0.41% (PYO-102) to 2.73% (NHRDF Red-2) (9). The polar diameter and equatorial diameter showed minimum values as 38.20 mm and 55.80 mm respectively for genotype Bhimakiran and RPG-2 (9, 10). The highest average bulb weight was found in genotype DOGR-1605 (72.20 g) whereas the minimum was recorded for DOGR-1606 (38.40 g) (8, 9).

The total yield varied from 179.74 q/ha (DOGR-1606) to 273.96 q/ha (Agrifound Light Red) with overall average of 236.80 q/ha. Similarly marketable yield varied from171.63 q/ha (DOGR-1605) to 271.63 q/ha (DOGR-1605) with an overall mean of 230.52 q/ha. A significant difference may be due to contribution by higher individual bulb weight and size which might resulted in highest bulb yield (7, 8). The highest total soluble solid was found in genotype DOGR-1605 (12.99^{0}Brix) while minimum was found in Bhima Red (9.72) (1).

The genotype BhimaKiran had maximum dry matter content in bulb (14.45%) whereas minimum of 9.70 % was found in PRO-7.The pyruvic acid content in bulb was varied from 1.46 to 2.54 with an overall mean value of

Table-1: Mean performance of late kharif genotypes for growth, yield and quality parameter.

Genotypes	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 (°Brix)	Dry. M (%)	PA (µmol/g)
BhimaKiran	8.53	44.66	1.22	64.23	38.20	41.44	2.16	1.09	111.11	53.66	187.80	175.31	9.95	14.45	1.83
Bhimashakti	8.80	46.05	1.37	58.23	52.82	53.64	2.39	1.02	102.72	62.63	201.63	189.27	12.65	13.92	2.18
Bhima Super	6.74	40.33	1.06	53.79	53.88	47.10	0.70	0.92	103.22	56.45	244.28	237.07	12.28	9.76	2.28
PRO-7	10.20	46.23	1.22	66.38	53.30	47.77	0.65	0.99	109.55	65.87	250.75	240.93	10.80	9.70	2.45
PYO-102	11.07	46.05	1.06	59.90	50.07	49.50	0.41	1.09	110.47	62.53	259.48	252.69	10.25	10.95	2.31
NHRDF Red-2	10.83	38.73	1.48	65.55	53.43	52.92	2.73	1.43	104.22	52.80	228.06	224.93	12.32	11.65	2.45
DoGR-1669	9.83	49.83	1.14	65.63	53.47	52.00	1.25	1.05	108.67	49.49	254.67	246.09	10.22	14.02	2.18
DoGR-1657	10.80	52.21	1.37	63.99	53.57	52.13	1.46	1.56	106.00	50.42	236.13	227.04	11.48	12.16	2.08
Bhima Raj	9.90	47.93	1.07	52.88	50.57	53.31	2.42	1.25	105.78	47.60	216.97	210.72	10.47	12.54	1.90
Bhima Red	7.33	51.34	1.24	50.37	43.50	49.33	1.89	1.62	105.33	53.07	228.25	225.77	9.72	12.34	2.12
ALR	7.35	45.60	1.14	50.63	46.53	51.54	1.06	1.05	103.33	66.07	273.96	267.77	12.36	10.60	1.46
RPG-1	11.30	47.93	1.14	65.55	54.57	53.13	0.51	1.21	101.27	66.49	264.49	266.69	10.63	10.83	1.92
RPG-2	9.90	38.63	1.24	65.11	55.80	46.10	0.49	1.35	105.13	58.40	252.40	247.67	11.16	11.18	2.19
DOGR-1605	9.27	45.46	1.04	54.53	46.00	49.53	0.53	1.00	101.57	72.20	273.34	271.63	12.99	11.43	1.66
DOGR-1606	8.50	31.07	0.89	38.80	41.11	41.57	1.72	1.30	115.67	38.40	179.74	174.23	12.62	11.77	2.54
Mean	9.36	44.80	1.18	58.37	49.79	49.40	1.36	1.20	106.27	57.07	236.80	230.52	11.32	11.82	2.10
S.Em	0.41	2.07	0.05	2.14	1.28	1.52	0.11	0.06	1.07	3.33	12.53	12.64	0.15	0.20	0.04
C.D AT 5%	1.20	6.00	0.10	6.20	3.70	4.40	0.30	0.20	3.10	9.60	36.30	36.60	0.40	0.60	0.10

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 content

Table-2 : Estimates of mean, range, components of variance, heritability and genetic advance as percent of mean for growth, yield and quality parameters.

Sl. No.	Character	SED	Range	GCV (%)	PCV (%)	h^2	GAM
1.	NOL	0.593	6.74-11.30	14.86	16.77	78.56	27.14
2.	LL (cm)	2.931	31.07-52.21	11.51	14.02	67.36	19.46
3.	LD (cm)	0.066	0.89-1.48	12.18	14.00	75.70	21.83
4.	PH (cm)	3.02	38.80-66.38	13.29	14.72	81.48	24.71
5.	PD (mm)	1.808	38.20-55.80	10.61	11.50	85.04	20.15
6.	ED (mm)	2.155	41.44-53.64	7.45	9.17	66.03	12.47
7.	DB (%)	0.161	0.41-2.73	57.93	59.70	94.16	115.80
8.	ND (cm)	0.081	0.92-1.62	17.41	19.29	81.49	32.38
9.	DM (Days)	1.513	101.27-115.67	3.68	4.07	81.67	6.85
10.	WB (g)	4.703	38.40-72.20	14.58	17.74	67.62	24.70
11.	TY (q/ha)	17.573	179.74-273.96	11.34	14.53	60.87	18.22
12.	MY (q/ha)	17.878	174.23-271.63	12.54	15.73	63.55	20.60
13.	TSS (°Brix)	0.265	9.72-12.99	9.75	10.16	92.07	19.26
14.	Dry. M (%)	0.287	9.70-14.45	12.17	12.53	94.38	24.36
15.	PA(μmol/g)	0.051	1.46-2.54	14.30	14.61	95.83	28.83

GV = Genotypic variance, PV = Phenotypic variance, GCV = Genotypic coefficient of variance, PCV = Phenotypic coefficient of variance, h2 = Heritability (%), GAM = Genetic advance (per cent mean).

2.10. The highest pyruvic acid content was found in DOGR-1606 (2.54)[13].

Genetic variability, heritability and genetic advance : The extent variations observed due to genetic factors were worked out for fifteen genotypes for *late kharif* are presented in Table-2. The PCV and GCV for all the traits are varied from 4.073 to 59.701% and 7.447 to 57.931 %, respectively. The results indicated that the value of phenotypic coefficient of variation (PCV) were higher in magnitude than that of genotypic coefficient of variation (GCV) for all the characters indicating that the environmental had a great role in influencing the expression of characters (12, 13). The moderate PCV and GCV were recorded for number of leaves. The Leaf length, leaf diameter, plant height, polar diameter, neck diameter, bulb weight, total yield, marketable yield, dry matter content and pyruvic acid content. However highest GCV and PCV were recorded for doubles bulb percentage. The high value showed responsiveness of the attributes for making further improvement by selection (14, 15). While, low PCV and GCV were observed for equatorial diameter, days to maturity and total soluble solid (TSS) content of bulb (15, 16).

Most of the traits viz. number of leaves leaf diameter, leaf diameter plant height, polar diameter, double bulb percent, neck diameter, days to maturity, total soluble solid, dry matter content and pyruvic acid content in bulb exhibiting very high heritability whereas equatorial diameter, weight of bulb, total yield and marketable yield exhibited high heritability. High heritability for these traits indicatedpresence of additive gene action. The heritability and genetic advance as percentage of mean were varied from 60.87% (total yield) to 95.82 % (pyruvic acid content in bulb) and 6.85% (days to maturity) to 115.80 % (double bulbs %) respectively.

The high heritability andhigh genetic advance over mean were recorded for characters viz. number of leaves per plant, plant height, leaf diameter, polar diameter, neck diameter,percentage of double bulb, average bulb weight, marketable yield dry matter content, and pyruvic acid content in bulb. However, high genetic advance as percentage of mean were exhibited for all the traits except days to maturity which was low (6.74%).

High heritability (> 60%) but medium genetic advance as percentage of mean (10-20%) was exhibited for character like equatorial diameter, total yield and TSS. However, high heritability (85.76%) and low genetic advance as percentage of mean (6.74%) were exhibited in days to maturity character. The results revealed that high heritability for these traits in onion was mainly under genetic control and is less influenced by environment.

Estimates of genotypic coefficient of variation (11.34% and 12.54%) and phenotypic coefficient of variation (14.53 and 15.73%) were moderate and noticed high heritability (60.87% and 63.55%) for both total yield and marketable yield were recorded. Whereas moderate GAM (18.22%) was noticed for total yield while high GAM (20.60%) was noticed for marketable yield trait. High heritability coupled with high genetic advance, indicated the influence of additive gene action (11, 12, 15, 17).

Studies on character associationship : For determining the relationship between different characters in late kharif onion, genotypic and phenotypic correlation coefficients were calculated. The correlation coefficients with their magnitude and direction are shown in Table-3. The

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

		NOL	LL	LD	PH (cm)	PD	ED	DB (%)	ND	DM (Days)	WB (g)	TY	MY	TSS	Dry. M (%)	PA
NOL																
LL	G	0.185^{NS}														
	P	0.214^{NS}														
LD	G	0.281^{NS}	0.315^{NS}													
	P	0.269^{NS}	0.266^{NS}													
PH (cm)	G	0.692**	0.384^{NS}	0.674**												
	P	0.570**	0.380^{NS}	0.535**												
PD (mm)	G	0.541**	0.146^{NS}	0.393^{NS}	0.572**											
	P	0.421^{NS}	0.198^{NS}	0.342^{NS}	0.555**											
ED (mm)	G	0.411*	0.688**	0.481*	0.306^{NS}	0.641**										
	P	0.339^{NS}	0.436*	0.328^{NS}	0.266^{NS}	0.565**										
DB (%)	G	-0.115^{NS}	-0.043^{NS}	0.448*	-0.145^{NS}	-0.295^{NS}	0.127^{NS}									
	P	-0.088^{NS}	-0.027^{NS}	0.377^{NS}	-0.156^{NS}	-0.268^{NS}	0.129^{NS}									
ND (cm)	G	0.213^{NS}	0.106^{NS}	0.445*	-0.052^{NS}	-0.038^{NS}	0.114^{NS}	0.396^{NS}								
	P	0.168^{NS}	0.065^{NS}	0.294^{NS}	-0.031^{NS}	-0.058^{NS}	0.053^{NS}	0.324^{NS}								
DM (Days)	G	0.030^{NS}	-0.383^{NS}	-0.386^{NS}	-0.224^{NS}	-0.492*	-0.748**	0.122^{NS}	0.066^{NS}							
	P	0.004^{NS}	-0.297^{NS}	-0.325^{NS}	-0.209^{NS}	-0.441*	-0.547*	0.133^{NS}	0.013^{NS}							
WB (g)	G	0.138^{NS}	0.370^{NS}	0.127^{NS}	0.367^{NS}	0.255^{NS}	0.328^{NS}	-0.607**	-0.530*	-0.686**						
	P	0.073^{NS}	0.198^{NS}	0.076^{NS}	0.284^{NS}	0.220^{NS}	0.249^{NS}	-0.487*	-0.423^{NS}	-0.464*						
TY (q/ha)	G	0.267^{NS}	0.481*	-0.077^{NS}	0.379^{NS}	0.545*	0.518*	-0.819**	-0.259^{NS}	-0.632**	0.780**					
	P	0.167^{NS}	0.203^{NS}	-0.018^{NS}	0.236^{NS}	0.390^{NS}	0.338^{NS}	-0.645**	-0.211^{NS}	-0.388^{NS}	0.584*					
MY (q/ha)	G	0.274^{NS}	0.411^{NS}	-0.102^{NS}	0.320^{NS}	0.515*	0.522*	-0.807**	-0.205^{NS}	-0.648**	0.755**	1.000**				
	P	0.178^{NS}	0.215^{NS}	-0.035^{NS}	0.227^{NS}	0.388^{NS}	0.333^{NS}	-0.638**	-0.150^{NS}	-0.406*	0.571*	0.981**				
TSS (°Brix)	G	-0.250^{NS}	-0.566**	-0.046^{NS}	-0.388^{NS}	0.073^{NS}	0.066^{NS}	0.011^{NS}	-0.254^{NS}	-0.315^{NS}	0.175^{NS}	-0.008^{NS}	-0.009^{NS}			
	P	-0.222^{NS}	-0.449*	-0.007^{NS}	-0.344^{NS}	0.065^{NS}	0.025^{NS}	0.014^{NS}	-0.196^{NS}	-0.242^{NS}	0.130^{NS}	0.020^{NS}	0.040^{NS}			
Dry M(%)	G	-0.006^{NS}	0.282^{NS}	0.267^{NS}	0.100^{NS}	-0.335*	0.008^{NS}	0.655**	0.147^{NS}	0.187^{NS}	-0.436^{NS}	-0.614**	-0.630**	-0.264^{NS}		
	P	-0.022^{NS}	0.192^{NS}	0.201^{NS}	0.081^{NS}	-0.331^{NS}	0.022^{NS}	0.622**	0.132^{NS}	0.215^{NS}	-0.340^{NS}	-0.496*	-0.517*	-0.253^{NS}		
PA(µmol/g)	G	0.223^{NS}	-0.473**	0.119^{NS}	0.057^{NS}	0.282^{NS}	-0.241^{NS}	0.114^{NS}	0.197^{NS}	0.499*	-0.493*	-0.407^{NS}	-0.394^{NS}	-0.013^{NS}	-0.132^{NS}	
	P	0.202^{NS}	-0.378*	0.085^{NS}	0.068^{NS}	0.256^{NS}	-0.184^{NS}	0.110^{NS}	0.175^{NS}	0.451*	-0.369^{NS}	-0.282^{NS}	-0.287^{NS}	-0.021^{NS}	-0.132^{NS}	

** and * significant at 1% and 5% respectively, NS – Non significant

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 content

Table-4 : Direct or indirect effect of different characters on bulb yield of late kharif onion genotype.

	Correlation (P)With yield	NOL	LL (cm)	LD (cm)	PH (cm)	PD (mm)	ED (mm)	DB (%)	ND (cm)	DM (Days)	WB (g)	MY (q/ha)	TSS (°Brix)	Dry. M (%)	PA (µmol/g)
NOL	0.167NS	-0.0137	-0.0137	0.0326	-0.0359	-0.0038	0.0263	0.0098	-0.0152	0.0001	-0.0009	0.1684	0.0156	-0.0007	-0.0019
LL(cm)	0.203NS	-0.0029	-0.0643	0.0322	-0.0239	-0.0018	0.0339	0.0031	-0.0059	-0.0098	-0.0024	0.2036	0.0315	0.0064	0.0035
LD(cm)	-0.018NS	-0.0037	-0.0171	0.1212	-0.0337	-0.0031	0.0254	-0.0422	-0.0267	-0.0108	-0.0009	-0.0331	0.0005	0.0067	-0.0008
PH (cm)	0.236NS	-0.0078	-0.0244	0.0649	-0.0629	-0.0050	0.0207	0.0175	0.0028	-0.0069	-0.0035	0.2148	0.0242	0.0027	-0.0006
PD (mm)	0.390**	-0.0057	-0.0127	0.0415	-0.0349	-0.0090	0.0439	0.0301	0.0052	-0.0146	-0.0027	0.3668	-0.0046	-0.0110	-0.0024
ED (mm)	0.338*	-0.0046	-0.0281	0.0397	-0.0168	-0.0051	0.0776	-0.0144	-0.0048	-0.0181	-0.0030	0.3152	-0.0018	0.0007	0.0017
DB (%)	-0.645**	0.0012	0.0018	0.0457	0.0098	0.0024	0.0100	-0.1120	-0.0293	0.0044	0.0059	-0.6034	-0.0010	0.0207	-0.0010
ND(cm)	-0.211NS	-0.0023	-0.0042	0.0357	0.0019	0.0005	0.0041	-0.0363	-0.0906	0.0004	0.0052	-0.1423	0.0138	0.0044	-0.0016
DM (Days)	-0.388**	0.0001	0.0191	-0.0394	0.0132	0.0040	-0.0425	-0.0149	-0.0012	0.0331	0.0057	-0.3847	0.0170	0.0071	-0.0041
WB (g)	0.584**	-0.0010	-0.0127	0.0092	-0.0179	-0.0020	0.0193	0.0546	0.0383	-0.0154	-0.0122	0.5407	-0.0092	-0.0113	0.0034
MY(q/ha)	0.981**	-0.0024	-0.0138	-0.0042	-0.0143	-0.0035	0.0259	0.0714	0.0136	-0.0135	-0.0070	0.9464	-0.0028	-0.0172	0.0026
TSS (°Brix)	0.020NS	0.0030	0.0288	-0.0009	0.0217	-0.0006	0.0020	-0.0015	0.0177	-0.0080	-0.0016	0.0376	-0.0703	-0.0084	0.0002
Dry. M (%)	-0.496**	0.0003	-0.0124	0.0243	-0.0051	0.0030	0.0017	-0.0696	-0.0119	0.0071	0.0041	-0.4893	0.0178	0.0332	0.0012
PA(µmol/g)	-0.282NS	-0.0028	0.0243	0.0103	-0.0043	-0.0023	-0.0143	-0.0124	-0.0159	0.0149	0.0045	-0.2718	0.0015	-0.0044	-0.0092

Residual effect = 0.02490

genotypic correlation coefficients were higher than corresponding phenotypic correlation coefficients for most of the characters (Table-3). It is suggested that there was inherent association among the traits but the environment minimized the phenotypic association (10). The genotypic correlation coefficients were higher than their corresponding phenotypic ones for the most of the characters reflecting predominant role of heritable factors (12, 18). The genotypic correlation coefficients for leaf length (0.481), polar diameter (0.545), equatorial diameter (0.518) and average weight of bulb (0.78) were significantly and positively correlated with total yield. The result indicated that simultaneous improvement of these characters is possible (19, 20). However, traits like leaf diameter, double bulb percent (10), neck diameter, days to maturity, dry matter content (21) and total soluble solid (17), and pyruvic acid content (12) of bulbs were exhibited negative association with total bulb yield.

Path coefficient analysis : The marketable bulb yield exhibited a very high magnitude of direct effect (0.9464) on total yield followed by equatorial diameter (0.0776), leaf diameter (0.121) , days to maturity (0.033) and dry matter content of bulb (0.0332). The direct selection for these characters could be beneficial for yield improvement of onion since these characters also showed positive correlation with bulb yield. Whereas, the high negative indirect effect via leaf diameter (-0.0042), percentage of double bulb (-0.0144), neck diameter (-0.0906), TSS (--0.0703) and pyruvic acid content (-0.0092) on total bulb yield (Table-4.). The similar results of high direct effect via bulb weight, equatorial diameter, plant height and number of leaves were also reported several workers (10,14,19). The equatorial diameter and dry matter content of bulb had strong positive effect on yield which corroborates the findings of previous workers (12,17).

References

1. Tripathi P.C.and Lawande K.E. (2013). Effect of storage environments and packing methods on storage losses in onion. *Indian Journal of Horticulture,* 70(3): 455-458.

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

3. 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.

4. 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.

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

6. 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.

7. Tripathy P., Sahoo B.B., Priyadashini S.K. and Dash D.K. (2016). Evaluation of rabi onion genotype under western zone of Odisha. *International Journal of Farm Science,* 6(3): 216-222.

8. Bal S.K., Maity T. andMaji A. (2020). Evaluation of onion genotypes for growth, yield and quality traits under gangetic-alluvial plains of West Bengal. *International Journal of Chemical Studies,* 8(4): 2157-2162.

9. Upadhyay A., Dube A.K., Pandey P., Singh V. and Dixit S. (2020). Evaluation of onion (*Allium cepa*L.) accessions for yield attributes and yield for central Uttar Pradesh. *Journal of Pharmacognosy and Phytochemistry,* 9(3): 1457-1459.

10. Singh R.K., Dubey B.K., BhondeS.R. and Gupta R.P. (2011). Genetic variability in late kharif (Rangada) onion (*Allium cepa* L.) *Journal of Applied Horticulture,* 113 (1): 74-78.

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

12. 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*, 5(5): 145-149.

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

14. 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): 115-119.

15. Parmar V.K., Jivani L.L., Patel S.S. and Mavadia V.V. (2018). Genetic variability, heritability and genetic advance in onion (*Allium cepa* L.). *Journal of Pharmacognosy and Phytochemistry,* 7(6): 576-578

16. 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): 43-49.

17. Ram R.B., Navaldey B., Meena M.L., Rubee L. and Mukesh B. (2011). Genetic variability and correlation studies in onion (*Allium cepa* L.) *Vegetos,* 24(1):152-156.

18. Narayan R., Singh D.B., Kishor A. and Singh M. (2019). Studies on Genetic Variability, Heritability and Genetic Advance in Long Day Onion (*Allium cepa* L.) Genotypes. *Progressive Horticulture,* 51(1): 263 138.

19. Hosamani R.M., Patil B.C. and Ajjppalavara P.S. (2010). Genetic variability and character association studies in onion (*Allium cepa* L.). *Karnataka J. Agric. Sci.,* 23(2): 302-305.

20. 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.

21. 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.