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Studies of genetic variability components for two seed production conditions of onion in West Bengal

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Abstract
The present investigation was carried out at CRF Gayeshpur, BCKV employing 14 varieties of onions for seed production in two different conditions without storing of bulbs following randomized block design with three replications. High GCV coupled with high broad sense heritability and high genetic advance was registered for seed yield/sq.m and moderate GCV coupled with high heritability and moderate to high genetic advance was recorded for leaves/plant, scapes/plant and seeds/umbel suggesting early generation selection for improving these characters. Low GCV coupled with heritability and moderate genetic advance was recorded for length of scape and 1000 seed weight. Simple selection will not be effective to improve these characters because of their probable conditioning by non-additive gene action. Important selection indices have been framed from the studies of genetic variability and character associationship. Seed yield/sq.m itself emerged as an important selection index for improving seed yield/plant. Among the seed yield components, scapes/plant, seeds/umbel and 1000 seed weight were the most prominent characters which need to be considered during selection of genotypes for high seed yield.

Keywords: Genetic variability, heritability, ganetic advance, path coefficient, character associationship, selection indices

Introduction
Onion is one of the important vegetable crops grown in this country in large areas both for local consumption as well as for export purposes. Though India ranks second in area and production in the world after China and third in export after Netherlands and Spain average productivity of onion in India is very low (10.6 t/ha) compared to even world average (16.5 t/ha). Onion varieties are generally classified by day length (short, intermediate and long) required for bulbing. Almost all onion cultivars grown in India, may it belong either to "Kharif", "Early Rabi" or "Rabi" are basically short day cultivars. These "Kharif" and "Early Rabi" group of onion cultivars have expanded the span of onion cultivation in the plains of India. However, very little work has done in respect to both varietal evaluation and seed production of onion under West Bengal condition. The best possible growing condition in the "Early Rabi" season under tropical-humid conditions of the Gangetic plain of West Bengal was determined through varietal evaluation of growth, bulb characters and bulb yield of the onion varieties under varied temperature and photo-periodic regimes. The bulbs which have harvested during December are replanted without storing to determine seed production potential of the onion varieties and its genetic variability components.

Materials and Methods
In the present investigation, the 14 varieties of onion are used out of which 13 varieties of onion viz Agrifound Dark Red, Arka Kalyan, Arka Pragati, Agrifound Rose, Pusa Red, N-53, Gujarat White, Fursangi Local, Phule Samarth, Phule Safed, Baswant-780, Nasik Red, Agrifound Light Red were collected from Project Directorate of Onion & Garlic, Pune & Sukhasagar (local adaptive cultivar of West Bengal). The varietal evaluation for their seed production potential was done in two consecutive years following randomized block design with 3 replications through framing a new method where bulbs have been produced by transplanting the seedlings during first week of September. The bulbs are harvested during last week of December prematurely and after few days of curing have been re-planted during late December as rabi seed crop in both open field condition and under insect proof net cage at Central Research Farm of Bidhan Chandra Krishi Viswavidyalaya, West Bengal. In open field condition, pollination was accomplished by different pollinator insects, mainly honey bees and in net cage condition, mass hand selfings have been done for seed set because it is basically a cross-pollinated crop mainly due to protandry.

The mean values from each open pollinated variety in each replication in two seed production condition (caged and open) were used for statistical analyses

Components of genetic variability

The genotypic (GCV) and phenotypic (PCV) coefficients of variations were calculated as per Burton (1952) [4] and Burton and De Vane (1953) [5].

Heritability in broad sense (h^2) was estimated by the formula suggested by Hanson *et al.* (1956).

Correlation coefficient(r)

Phenotypic and genotypic correlation coefficients for all possible combinations were worked out utilizing the pooled data over two years as per Al-Jibouri *et al.* (1958) [3].

Path Co-efficient analysis

Data on Phenotypic correlation coefficients were utilized to estimate the direct and indirect effects of different characters of bulb and seed yield as per Dewey and Lu (1959) [7].

Results and Discussions

Estimated genetic variability components varied widely in two seed production conditions for three characters viz., scapes /plant, seeds/umbel and seed yield/sq.m indicating high influence of entomophilies open pollination for effective seed production of onion. Mean genetic variability components over two seed production conditions have been used to present the results.

Coefficient of variation (CV): Mean coefficient of variation over two seed production conditions for the seven characters was low for all the characters (Table 1), which indicated less environmental influence on all the 14 varieties for expression of the seed production potential.

Genetic component of variation

Studies on the variability using genetic parameters like genotypic coefficient of variation, heritability and genetic advance is essential for initiating an efficient selection programme for any crop.

Genotypic coefficient of variation: Both phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) showed appreciable differences for three characters viz., scapes /plant, seeds/umbel and seed yield/sq.m which indicated marked interaction between genotype x seed production condition for the expression of these characters. However, close correspondence was recorded for PCV and GCV estimates for respective environment indicating stable expression of the characters under the particular seed production condition. In this investigation, average GCV was very high for seed yield/sq.m (71.20%) (Table 1) indicating high genetic variation among the varieties for seed production potential. However, average GCV was moderate for leaves/plant, scapes/plant, flowers/umbel and seeds/umbel while it was low for length of scape and 1000 seed weight. The present findings clearly suggested the worth of seed yield itself along with leaves/plant, scapes/plant, flowers/umbel and seeds/umbel for the study of genetic variability in onion.

Heritability in broad sense: Close correspondence between PCV and GCV estimates was reflected on the broad sense heritability estimates that were very high (more than 90%) for all the characters. However, this broad sense heritability values are likely to be over estimated as in this calculation it was not possible to exclude variation due to different genetic component and their interrelation.

Genetic advance (GA): In the present investigation genetic advance as percentage of mean indicated few significant traits. Mean genetic advance over two seed production conditions was moderately high for seed yield/sq.m, leaves/plant and seeds/umbel while it was moderate to moderately high for scapes/plant, length of scape, flowers/umbel and 1000 seed weight.

Joint consideration of GCV, heritability and GA

In the present investigation, high GCV coupled with high broad sense heritability and high genetic advance was registered for seed yield/sq.m and moderate GCV coupled with high heritability and moderate to high genetic advance was recorded for leaves/plant, scapes/plant and seeds/umbel.

Moderate to high heritability, genotypic coefficient of variation and genetic gain for the number of seed stalks per plant, flowers per umbel, seed yield, diameter of umbel and 1000-seed weight as recorded earlier by Mohanty (2001) [8] supported the present findings.

Generally high GCV coupled with high broad sense heritability and genetic advance is attributable to additive gene action controlling the concerned characters so early generation selection would be helpful for improving these characters. Simple selection will be rewarding for improving the character like, seed yield/sq.m registering this sort of combinations of genetic parameters. However, simple selection will also be effective in terms of improving other characters viz., leaves/plant, scapes/plant and seeds/umbel registering moderate GCV, coupled with high heritability and moderately high to moderate genetic advance. Although, selection will not be as effective as in case of the characters showing high GCV coupled with high broad sense heritability and genetic advance.

Low GCV coupled with high heritability and moderate genetic advance was recorded for length of scape and 1000 seed weight. Simple selection will not be effective to improve these characters because of their probable conditioning predominantly by non-additive gene action.

Character associationship for seed yield components in two conditions

Information generated from the studies of character association serve as the most important indicator (plant character) that ought to be considered in the selection programme. Such studies would also help us to know the suitability of multiple characters for indirect selection, because selection for one or more traits results in correlated response in several other traits (Searle, 1965).

Correlation coefficient

Genotypic (G), phenotypic (P) and environmental (E) correlation coefficients among the pair of characters in both the seed production conditions have been presented in Table 2. The correlation coefficients in most of the pair of characters did not wide variations with open and caged condition which indicated less influence of the seed production condition on the correlated expression of the pair of characters in the genotype, the major difference in seed production having recorded due to exclusion of pollinators under caged condition. However, consistent phenotypic

correlation coefficients between pair of characters in both the seed production conditions have been utilized to study the character associationship. All the seed yield components established highly significant positive correlations with seed yield in both the seed production conditions (Table 2).

Earlier reports of positive and significant genotypic and phenotypic correlation of seed yield/plant with the number of seed stalks per plant, flower per umbel, diameter of umbel and 1000-seed weight (Mohanty, 2001) [8]; between mean seed yield and scape height (Villanueva and Havey, 2001) [11]; between mean seed yield and number of fertilized florets (Dehdari *et al*., 2002) [6]; between mean seed yield and with number of flower stalks per plant, number of seeds and flowers per umbel and umbel size (Aklilu *et al*., 2002; Aklilu and Kataria, 2003) [2, 1] amply supported the present findings on the study of correlations.

Path coefficient

Three characters viz., scapes/plant, seeds/umbel and 1000 seed weight had consistently high and positive direct effect on seed yield in both the conditions (Table 3). It emerged that not the flowers/umbel but how many seeds have been set in the umbel through effective pollination (seeds/umbel) was the prime character determining seed yield. Direct effects of all the other characters were very low in magnitude. Mean residual effect over two seed production conditions was 0.07 suggesting the inclusion of major seed yield components in this study.

Mohanty (2000) [9] working out the path analysis suggested that 1000-seed weight and the number of seed stalks per plant had high positive direct effect, while each of these characters had relatively high and positive indirect effect, on seed yield which agreed well to the present findings.

Important selection indices for seed yield

Important selection indices have been framed from the studies of genetic variability and character associationship. Seed yield itself emerged as an important selection index for improving seed yield/plant. Among the seed yield components, scapes/plant, seeds/umbel and 1000 seed weight were the most prominent characters which need to be considered during selection of genotypes for high seed yield.

Table 1: Genetic variability parameters for different seed yield components in two seed production conditions

Characters	Condition	Mean	Coefficient of variation (C.V.)%	Phenotypic Coefficient of variation (PCV)%	Genotypic Coefficient of variation (GCV)%	Heritability%(H)	Genetic Advance (GA)	Genetic Advance (GA)% of Mean
No. of leaf/plant	Open	24.02	1.33	29.61	27.58	96.8	14.62	60.88
	Cage	22.11	1.78	29.05	26.00	96.6	11.40	59.65
	Mean	23.06	1.56	29.33	26.79	96.7	13.01	60.27
No. of Scape/plant	Open	3.31	0.57	26.93	24.92	94.5	1.84	55.59
	Cage	3.10	6.00	21.08	20.21	91.9	1.24	40.00
	Mean	3.21	3.29	24.01	22.56	93.2	1.54	47.80
Length of scape (cm)	Open	62.17	0.07	15.18	13.18	93.6	19.44	31.27
	Cage	58.79	2.37	12.02	11.79	96.1	13.99	23.80
	Mean	60.48	1.22	13.60	12.48	94.8	16.715	27.54
No. of flowers/umbel	Open	342.67	0.09	20.77	19.77	95.3	146.63	42.79
	Cage	345.51	0.41	20.38	18.38	95.1	145.00	41.97
	Mean	344.09	0.25	20.58	19.07	94.9	145.82	42.38
No. of seeds/umbel	Open	558.72	0.03	44.40	41.40	96.3	510.98	91.46
	Cage	366.30	3.42	31.43	30.24	98.8	234.36	63.98
	Mean	462.51	1.73	37.92	35.82	97.6	372.67	77.72
1000 Seed wt.(g)	Open	2.70	0.68	14.06	13.05	97.8	0.78	28.89
	Cage	2.65	0.42	11.45	10.64	96.9	0.62	23.40
	Mean	2.67	0.55	12.76	12.14	95.8	0.70	26.15
Seed yield/sq.m (kg)	Open	26.60	1.31	84.07	82.06	94.3	46.05	173.12
	Cage	17.25	0.14	63.34	60.34	95.2	22.50	130.44
	Mean	21.93	0.73	73.71	71.20	94.7	34.28	151.78

Table 2: Genotypic (G), Phenotypic (P) and Environmental (E) Correlation coefficients among pair of characters

Characters			No. of leaf/plant	No. of Scape/plant	Length of scape(cm)	No. of flowers/umbel	No. of seeds/umbel	1000 Seed wt.(g)	Seed yield/sq.m (kg)
No. of leaf/plant	Open	P	1.000	0.853**	0.233	0.738**	0.592**	0.296	0.702**
		G	1.000	0.854	0.233	0.739	0.593	0.297	0.703
		E	1.000	0.146	-0.004	-0.061	0.044	0.001	-0.150
	Cage	P	1.000	0.766**	0.333*	0.700**	0.361*	0.031	0.640**
		G	1.000	0.804	0.339	0.701	0.364	0.031	0.641
		E	1.000	0.217	-0.148	-0.023	0.008	0.326*	-0.421**
No. of Scape/plant	Open	P		1.000	0.173	0.728**	0.687**	0.291	0.786**
		G		1.000	0.173	0.728	0.687	0.292	0.787
		E		1.000	-0.315	0.138	0.189	-0.320	-0.900
	Cage	P		1.000	0.205	0.524**	0.470**	0.159	0.755**
		G		1.000	0.190	0.543	0.489	0.168	0.787
		E		1.000	0.459	0.593	0.126	-0.218	0.641
Length of scape(cm)	Open	P			1.000	0.068	0.432**	0.193	0.383*
		G			1.000	0.068	0.432	0.193	0.383

		E			1.000	0.183	-3.333	0.903	0.197
	Cage	P			1.000	0.103	0.247	0.319*	0.343*
		G			1.000	0.103	0.251	0.325*	0.349*
		E			1.000	0.364	0.145	-0.033	0.285
No. of flowers/umbel	Open	P				1.000	0.673**	0.360*	0.687**
		G				1.000	0.673	0.360	0.687
		E				1.000	1.826	-0.168	-0.056
	Cage	P				1.000	0.565**	0.126	0.640**
		G				1.000	0.569	0.126	0.640
		E				1.000	-0.112	0.541	0.496
No. of seeds/umbel	Open	P					1.000	0.484**	0.893**
		G					1.000	0.485	0.893
		E					1.000	-0.242	-0.071
	Cage	P					1.000	0.642**	0.879**
		G					1.000	0.647	0.884
		E					1.000	-0.196	0.082
1000 Seed wt.(g)	Open	P						1.000	0.639**
		G						1.000	0.640
		E						1.000	0.197
	Cage	P						1.000	0.543**
		G						1.000	0.543
		E						1.000	-0.145
Seed yield/sq.m (kg)	Open	P							1.000
		G							1.000
		E							1.000
	Cage	P							1.000
		G							1.000
		E							1.000

* Significant at 5% level, ** Significant at 1% level

Table 3: Phenotypic path coefficient Analysis for seed yield in two conditions

Component	Condition	No. of leaf/plant	No. of Scape/plant	Length of scape (cm)	No. of flowers/umbel	No. of seeds/umbel	1000 Seed wt. (g)	Phenotypic correlation with Yield/plant
No. of leaf/plant	**Open**	0.055	0.285	0.010	-0.029	0.295	0.086	0.702
	Cage	0.129	0.263	0.018	0.013	0.214	0.003	0.640
No. of Scape/plant	Open	0.047	0.334	0.008	-0.028	0.342	0.084	0.786
	Cage	0.099	0.343	0.011	0.010	0.279	0.013	0.755
Length of scape(cm)	Open	0.013	0.058	0.044	-0.003	0.215	0.056	0.383
	Cage	0.043	0.070	0.054	0.002	0.147	0.027	0.343
No. of flowers/umbel	Open	0.041	0.243	0.003	-0.039	0.335	0.104	0.687
	Cage	0.090	0.180	0.006	0.018	0.335	0.011	0.640
No. of seeds/umbel	Open	0.033	0.229	0.019	-0.026	0.498	0.140	0.893
	Cage	0.046	0.161	0.013	0.010	0.593	0.054	0.879
1000 Seed wt.(g)	Open	0.016	0.097	0.009	-0.014	0.241	0.290	0.639
	Cage	0.004	0.055	0.017	0.002	0.381	0.084	0.543

Residual= 0.0791, Residual= 0.0613(Mean Residual =0.0702)

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