To estimate genetic variability and genetic advance for bulb yield and its components of different mutant lines of Garlic (*Allium sativum L.*) under Chhattisgarh plains

ABSTRACT

This study aims**to study aims toevaluate the genetic variability and genetic advance for bulb yield and components of different mutant lines of Garlic (*Allium sativum L.*) under Chhattisgarh plains** The experiment was laid out in Randomized Block design with three replications 21 mutant lines *viz.*, IG C-1, IG C-2, IG C-3, local check, IG M-2021-1, IG M-2021-2, IG M-2021-3, IG M-2021-4, IG M-2021-5, IG M-2021-6, IG M-2021-7, IG M-2021-8, IG M-2021-9, IG M-2021-10, IG M-2021-11, IG M-2021-12, IG M-2021-13, IG M-2021-14, IG M-2021-15, IG M-2021-16, IG M-2021-17.Data were analyzed to work out performance of mutant lines, to assess genetic variability, heritability, genetic advance. The character taken under study include plant height (cm), number of leaves, collar height (cm), collar thickness (cm), fourth leaf length (cm), fourth leaf width (cm), polar diameter (cm), equatorial diameter (cm), neck thickness (cm), number of cloves, average weight of bulb (g), TSS, days to maturity, weight of ten outer cloves (g), marketable yield (t ha^{-1}), total yield (t ha^{-1}). Estimates of genetic parameters for various character under study revealed that high genotypic co-efficient of variation was found in general compared to phenotypic co-efficient of variation.Heritability estimates under present investigation ranged from moderate to high. High heritability estimates recorded for collar height, weight of outer ten cloves, marketable yield, total yield. High heritability coupled with high genetic advance was recorded for collar height, marketable yield and bulb yield.

Key words: Heritability, genetic advance, mutant lines etc.

INTRODUCTION

Garlic (*Allium sativum* L.) is an annual aromatic herbaceous spice that belongs to the Alliaceae family (Kurian, 1995). After onion, it is the second most widely cultivated spice crop (Rubatzky and Yamaguchi, 1997). Garlic dates back to prehistoric times in Central Asia and the

Mediterranean region (Thompson and Kelly, 1957).Before 2000 B.C., garlic cultivation was discovered in Egypt, and nearly 5000 years ago in India (Kamenetsky and Rabinowitch, 2001). Garlic is produced worldwide. It is consumed as spice, flavouring agent and also has pharmaceutical benefits."*Allium*" is the widest and the most diverse representative genus of the Alliaceae. It is spread across in North Africa,North America, Europe and Asia and contains around 700 different species (Tsiaganis*et al.,* 2016). China is the leading producer of garlic and accounts for 20.7 million tons of production, followed by India with production of 2.9 million. In India, Madhya Pradesh is the leading producer of followed by other states like Rajasthan, Uttar Pradesh, and Gujarat (Anon., 2021a). Whereas in Chhattisgarh it occupies 4,411 ha area with production of around 26,185 MT (Anon., 2021b).In recent years, mutation breeding has gained popularity as a convenient tool for crop development and as a way to complement current germplasm for cultivar improvement in breeding programmes (Acharya*et al.,* 2011). Furthermore, Mutation aredefined as a sudden heritable changes in gene. It can be either spontaneous or induced. It can be induced either in seed or propagating material.

MATERIAL AND METHOD

The studywas conducted in Rabi season 2021-2022 at Research cum Demonstration Farm, College of Agriculture, Indira Gandhi KrishiVishwavidyalaya, Raipur (C.G.) - 492012. . It lies between $21^0$16'N latitude and $81^0$36'E longitude at an altitude of 289.56 meters above mean sea level.

Thephenotypic and genotypic variancecomponents, and coefficients of phenotypicand genotypic coefficients of variation werecalculated by the methods suggested by Burton and Devane, 1953 is illustrated below:

1) Genotypic coefficient of variation (GCV) –

$$GCV\ (\%) = \frac{\sqrt{\sigma^2 g}}{\bar{X}} \times 100$$

Where,

σ^2 g = genotypic variance

$\bar{X}$ = Mean of characters

2) Phenotypic coefficient of variation (PCV) –

$$PCV\ (\%) = \frac{\sqrt{\sigma^2 p}}{\bar{X}} \times 100$$

Where,

σ^2 p = phenotypic variance

$\bar{X}$ = Mean of characters

Heritability

Heritability with reference to broad sense (h^2b) is defines as proportion of genotypic variance to total variance (phenotypic variance). It was estimated by using Hansen et al., (1956) formula:

$$h^2 b = \frac{\sigma^2 g}{\sigma^2 p} \times 100$$

The heritability was classified into low, moderate and high as suggested by Robinson (1966):

<50%	=	Low
50-70%	=	Moderate
>70%	=	High

Genetic advance

It was calculated as per method given by Johnson et al., (1955)

$GA = k\ \sigma p h^2$

Where,

k = Selection intensity at 5% i.e. 2.06 (constant)

σp = Phenotypic standard deviation

h^2 = Heritability in broad sense

Genetic advance was classified into high, moderate and low as suggested by Johnson *et al.* (1955) >20% = High

10-20% = Moderate

Genetic advance as percentage of mean –

It was estimated by the formula –

$$\mathbf{GA\ (\%) = \frac{GA}{X} \times 100}$$

Where, GA = Genetic advance

$\bar{X}$ = Mean of character

PARAMETERS UNDER STUDY

The estimates of PCV and GCV were classified as low (<10%), moderate (10-12%) and high (>20%) according to Sivasubramanian and Madhavamenon (1973). Data presented in table-1 indicated highest range of variation (17.73-42.94) for fourth leaf width followed by plant height (14.55-58.75). For neck thickness the range of variation was very narrow (0.36-1.18). The Genotypic coefficient variation (GCV) and Phenotypic coefficient variation (PCV) garlic mutant lines are depicted in Figure no. 1 and Figure no. 2. High magnitude of genotypic as well as phenotypic coefficient of variation were recorded for traits *viz.,* Collar height (33.41 and 35.00), Weight of ten outer cloves (33.26 and 39.84), Marketable yield (32.31 and 33.77), total yield (26.22 and 28.01) and average weight of bulb (19.18 and 23.31) suggests the substantial improvement can be achieved through selection of these traits. Moderate PCV and GCV was recorded for fourth leaf length (16.12 and 17.28), this suggest existence of considerable variability in the population. Selection based on thesetraits will contribute in improvement in genotype. Remaining character had low PCV and GCV. Lowest PCV and GCV recorded for number of leaves (5.37 and 3.11). The result of the present study were found to be close to the findings of Islam *et al.* (2004), Zahedi *et al.*(2007), Tsega *et al.(*2010), Singh *et al.(*2012), Kumar *et al*. (2015), Vatsayan*et al.(*2015) and Sharma *et al*.(2016). They recorded high PCV and GCV for Plant height, average weight of bulb, number of cloves per bulb and marketable yield.

The genetic advance as percentage of mean ranged from 3.20 to 65.70. Highest genetic advance as percentage of mean was recorded for Collar height (65.70%) followed by marketable yield (63.68%), weight of ten outer cloves (57.19%) total yield (50.58%). The genetic advance as percentage of mean was found to moderate to high for all characters except number of leaves (3.72%), fourth leaf width (8.37%), days to maturity (3.20%). The high value of genetic advance for the traits under study revealed that these characters are governed by additive genes and selection will be rewarding for further improvements in future. Moderate genetic advance for traitssuggesths that both additive and non-additive variance are operating in these traits . Furthermore the traits showing low genetic advance indicates significance of non-additive gene effects. The genetic advance as percentage of mean is presented in Table 2 and Figure no. 2. The findings are in close associations with reports of Tsega *et al.* (2010), Sonkiya*et al.* (2012), Singh *et al.(*2012), Sable *et al.(*2020).

RESULT AND DISCUSSION

Table-1**Genetic parameter of variation for bulb yield and its components in garlic**

S.No.	Parameters	Range		Mean	Coefficient of variation (%)		h^2 (b)	Genetic advance	G.A as % of mean
	Characters	Minimum	Maximum		Genotypic	Phenotypic			
1	**Plant height (cm)**	41.55	58.75	51.723	10.109	13.174	58.883	8.265	15.980
2	**Number of leaves**	8.3	9.27	8.692	3.116	5.375	33.593	0.323	3.720
3	**Collar height (cm)**	5.4	16.38	8.686	33.417	35.009	91.111	5.708	65.707
4	**Collar thickness (cm)**	2.59	3.96	2.965	8.463	10.290	67.651	0.425	14.340
5	**Fourth leaf length (cm)**	17.73	42.94	33.945	16.126	17.286	87.029	10.519	30.990
6	**Fourth leaf width (cm)**	0.58	1.40	1.217	9.355	21.529	18.882	0..102	8.374
7	**Polar diameter (cm)**	2.63	3.49	3.197	7.387	9.063	66.426	0.396	12.402
8	**Equitorial diameter (cm)**	2.56	3.93	3.336	9.284	10.902	72.528	0.543	16.288
9	**Neck thickness (cm)**	0.36	1.18	0.699	22.149	29.998	54.515	0.235	33.688
10	**Weight of 10 outer cloves (g)**	3.77	11.43	7.394	33.261	39.849	69.668	4.229	57.190
11	**Number of cloves**	19.47	28.33	23.670	9.241	10.314	80.272	4.037	17.055
12	**Average bulb weight (g)**	9.27	17.95	13.446	19.189	23.315	67.737	4.374	32.533
13	**TSS**	32.26	40.22	36.286	6.753	7.452	82.131	4.575	12.608
14	**Days to maturity**	130.33	141.33	136.397	2.043	2.687	57.807	4.364	3.199
15	**Maretable yield (t/ha)**	2.88	10.04	6.513	32.31	33.774	91.528	4.148	63.68
16	**Total yield (t/ha)**	3.61	10.31	7.170	26.228	28.015	87.649	3.627	50.584

Table-2: Summary of Genotypic coefficient of variation (GCV), Phenotypic coefficient of variation (PCV), heritability (h2b) and genetic advance as percent of mean of bulb yield and its components in garlic

S.No.	Characters	GCV %	PCV (%)	h2(b) (%)	Genetic advance as % of mean
1	Plant height (cm)	M	M	M	L
2	Number of leaves	L	L	L	L
3	Collar height (cm)	H	H	H	H
4	Collar thicness (cm)	L	M	M	L
5	Fourth leaf length (cm)	M	M	H	M
6	Fourth leaf width (cm)	L	H	L	L
7	Polar diameter (cm)	L	L	M	L
8	Equitorial diameter (cm)	L	M	H	L
9	Neck thicness (cm)	H	H	M	M
10	Weight of 10 outer cloves (g)	H	H	M	H
11	Number of cloves	L	M	H	L
12	Average bulb weight (g)	M	H	M	M
13	TSS	L	L	H	L
14	Days to maturity	L	L	M	L
15	Maretable yield (t/ha)	H	H	H	H
16	Total yield (t/ha)	H	H	H	H

H- HIGH M- MEDIUM L-LOW

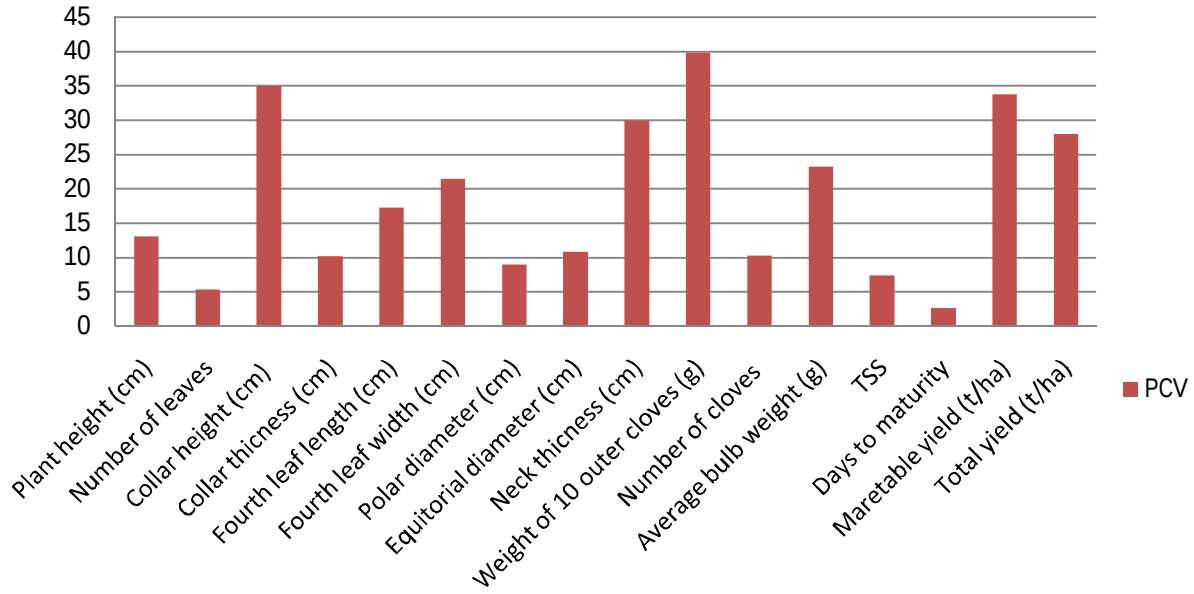

Fig 1: Graphical representation of GCV of bulb yield and its component in garlic

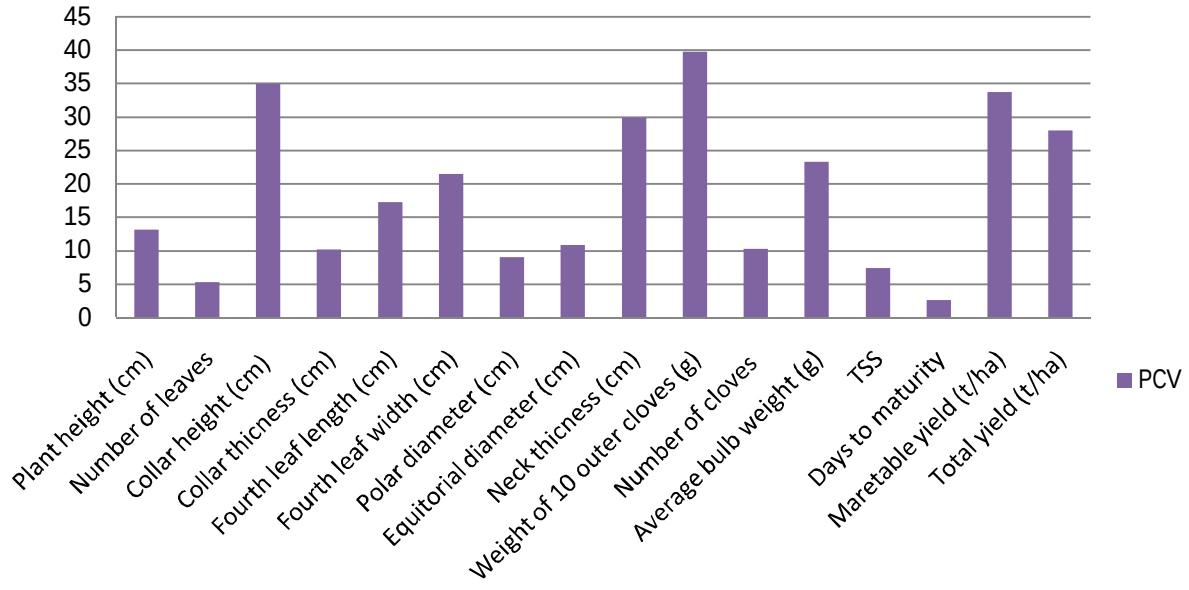

Fig 2: Graphical representation of GCV of bulb yield and its component in garlic

Heritability estimates for most of the character ranged between moderate to high except number of leaves and fourth leaf width (cm). High heritability coupled with high genetic advance were recorded for collar height (cm), marketable yield (t ha^{-1}) and total yield (t ha^{-1}) whereas moderate level of heritability with moderate level of genetic advance was observed for fourth leaf length (cm), neck thickness (cm), average weight of bulb (g). Selection of these traits would be rewarding towards higher bulb yield. Occurrence of high heritability coupled with high genetic advance for marketable yield in tonnes per hectare, total yield of bulb in tonnes per hectare, collar height indicating preponderance of additive genetic variance in the genetic control of these traits. Selection would be more effective for these characters towards the improvement of total bulb yield in garlic.

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