RESEARCH PAPER

Evaluation of garlic (*Allium sativum* L.) genotypes for yield and yield attributing traits under semi arid zone of Haryana (Hisar)

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ABSTRACT : The investigation was carried out at Research Farm of the Department of Vegetable Science, C.C.S. Haryana Agricultural University, Hisar during spring *Rabi* season of 2014-15. The data exhibited significant variation in 25 genotypes for different characters. The maximum plant height (95.5 cm) was recorded in genotype HG 4 and lowest recorded (63.23 cm) in HG 8. The maximum number of leaves per plant was observed in GRS 1349 and minimum in CGSD 1249. The minimum polar diameter of the bulb was recorded with the genotype GRS 1330 and maximum polar diameter of bulb with genotype HG 2. The highest and lowest equatorial diameter of bulb was recorded with genotype BGSD 1232 and HG 6, respectively. The bulbs of genotype BGSD 1230 (51.6 g) were heaviest among the genotypes and HG 5 produced the lightest bulbs (18.5 g). Number of cloves per bulb ranged from 21.9-44.4 and general mean was 33.7. The genotype GRS 1340 produced the maximum number of cloves per bulb (44.4) and the minimum number of cloves per bulb was recorded with genotype GRS 1349 (21.9). Average weight of cloves was recorded maximum in genotype GRS 1349 (108.8 g) and minimum in genotype CGSD 1232 (30 g). The highest yield was recorded with genotype GRS 1349 (140.27 q), while the minimum yield was observed in genotype GRS 1328 (55.13 q).

KEY WORDS : Garlic, Genotype, Bulb yield

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Garlic (*Allium sativum* L.) is a member of Alliaceae family and is the second most important widely cultivated bulbous crops after onion. It is originated from the progenitor *Allium longicuspis* and its center of origin is Central Asia (Mc Collum, 1976). Of the two botanical varieties, *sativum* and *ophioscorodon*, former is of commercial importance and characterized by a bulb with many white or pink blushed cloves along with weak and sterile flower stalk, if it bolts at all (Jones and Mann, 1963). It exhibits a wide range of diversity in morphological, reproductive and quality traits (Senula and Keller, 2000) because of its apomictic nature, which leads to the existence of extensive spontaneous mutations (Ata, 2005).

Garlic is a rich source of carbohydrates (29%), proteins (6.30%), minerals (0.30%), and essential oils (0.1-0.4%) and a fair source of fat, vitamin C and sulphur (Memane *et al.,* 2008). Its nutritive value is very high among bulbous crops (Pandey, 1997). Its unique characteristic flavour and pungency is due to the presence of diallyl disulphide, which is an odoriferous sulphur compound (Natale *et al.*, 2005). Besides, it has several medicinal properties such as antibacterial (Arora and Kaur, 1999), antifungal (Hughes and Lawson, 1991),

antiviral (Meng *et al.*, 1993), antiprotozoa properties (Reuter *et al.*, 1996) and antioxidant and anticancer properties (Harris *et al.*, 2001). Therefore, its medicinal significance has increased to the extent that its oil capsules are now marketed through pharmacies and health food stores (Rahim and Fordham, 1994). Much of the literature on garlic as medicine has been cited in most of the religious epics and Vedas.

India ranks second to China in area and production of garlic but ranks 74th in terms of productivity. In India, the area under garlic during the year 2013–14 was 2.31 lakh hectares and production of 12.52 lakh tonnes with average productivity of 5.4 t/ha. Among different states in India, Madhya Pradesh followed by Rajasthan, Gujarat and Uttar Pradesh are the leading states where Madhya Pradesh alone accounts for more than 27 per cent of the area and 21 per cent of the production with an average yield of 4.5 t/ha (Anonymous, 2014).

The production and productivity not only depend on area and cultural practices but also depend on improved high yielding genotypes and environmental conditions (Lawande *et al.,* 2009). The lack of genotypes with high yield with better storage potential is the main constraint limiting the productivity in India, which is why, the average productivity of garlic in India is very low compared to other countries. Therefore, the present investigations were undertaken to select genotypes having high bulb yield with large sized cloves per bulb.

RESEARCH METHODS

The experimental materials consisted of 25 genotypes of garlic maintained at research farm and laboratory of the Department of Vegetable Science, C.C.S. Haryana Agricultural University, Hisar. The genotypes were planted on last week of October 2014 in Randomized Block Design (RBD) with three replications. The cloves were planted manually in flat beds of 3x2 m size at a spacing of 15x10 cm. The bulbs were harvested on last week of April. The observations were recorded at maximum growth stage on randomly selected 10 plants in each replications for all the characters *viz.*, plant height (cm), number of leaves per plant, leaf length (cm), leaf width (cm), pseudostem length (cm), polar and equatorial diameter of bulb (cm), average bulb weight (g), number of cloves per bulb, average weight of cloves (g), total yield (q/ha) and marketable yield (q/ha). The statistical analysis was carried out by using OPSTAT statistical analysis tool (*www.hau.ernet.in*).

Table A : List of genotypes evaluated during the study

Sr. No.	Genotype	Sr. No.	Genotype
1.	HG 1	14.	GRS 1340
2.	HG 2	15.	GRS 1345
3.	HG 3	16.	GRS 1349
4.	HG 4	17.	BGSD 1222
5.	HG 5	18.	BGSD 1225
6.	HG 6	19.	BGSD 1230
7.	HG 7	20.	BGSD 1232
8.	HG 8	21.	CGSD 1232
9.	HG 17	22.	CGSD 1247
10.	HG 27	23.	CGSD 1249
11.	GRS 1328	24.	CGSD 1252
12.	GRS 1330	25.	CGSD 1265
13.	GRS 1332		

RESEARCH FINDINGS AND DISCUSSION

Significant variations were observed for different characters. The mean performance of different genotypes for growth and yield attributing characters are presented in Table 1 and 2. The plant height ranged from 63.23 to 95.5 cm with overall mean value of 78.16 cm. The maximum plant height (95.5 cm) was recorded in genotype HG 4 followed by HG 2 (86.73 cm) and GRS 1349 (86.80 cm). The lowest plant height was recorded (63.23 cm) in HG 8 followed by CGSD 1249 (65.93 cm) and HG 7 (68.26 cm). The number of leaves per plant ranged from 7 to 14.3 with a mean value of 10.77. The maximum number of leaves per plant was observed in GRS 1349 and minimum in CGSD 1249. The remaining genotypes were having 9 to 12 leaves per plant. Significant differences were recorded among the genotypes with respect to leaf length, which ranged from 29.53 (genotype BGSD 1222) to 42.16 (genotype HG 7) cm. The range for leaf width was 1.36-3.55 cm with general mean 2.24 cm. The maximum leaf width was recorded with genotype GRS 1349 (3.55 cm), while the minimum leaf width (1.36 cm) with genotype CGSD 1249 followed by the genotype BGSD 1225 (1.86 cm) and BGSD 1230 (1.89 cm). The pseudostem length ranged from 16.7-38.08 cm. The genotype BGSD 1230 had the maximum pseudostem length (38.08 cm), followed by the genotype BGSD 1222 (34.16 cm), while the minimum pseudostem length was registered with the genotype HG 5 (16.7 cm) followed by HG 8 (17.26cm) and HG6 (18.6 cm). The general mean for pseudostem length was 28.60

cm.

There was significant difference among the genotypes for polar diameter of the bulb, which ranged from 2.85 to 5.38 cm with a mean value of 4.05 cm. The minimum polar diameter of the bulb was recorded with the genotype GRS 1330 and maximum polar diameter of bulb with genotype HG 2. The equatorial diameter of bulb ranged from 3.02-4.96 cm and the general mean for equatorial diameter of bulb was 4.09 cm. The highest equatorial diameter of bulb was recorded with genotype BGSD 1232 (4.96 cm), followed by genotype BGSD 1222 (4.91 cm) and GRS 1340 (4.74 cm), whereas, the minimum equatorial diameter of bulb was observed in genotype HG 6 (3.02 cm). The range and general mean for average bulb weight was recorded 18.5-51.6 g, respectively. The bulbs of genotype BGSD 1230 (51.6 g) were heaviest among the genotypes, followed by GRS 1349 (50.7 g) and HG 27 (48.7 g). The genotype HG 5

produced the lightest bulbs (18.5 g), followed by the genotype GRS 1328 (20.4 g) and CGSD 1247 (20.43 g). Number of cloves per bulb ranged from 21.9-44.4 and general mean was 33.7. The genotype GRS 1340 produced the maximum number of cloves per bulb (44.4) followed by the genotype HG 17 (43.1) and BGSD 1232 (41.8). The minimum number of cloves per bulb was recorded with genotype GRS 1349 (21.9) followed by the genotype GRS 1328 (22.2) and CGSD 1232 (25.9). Average weight of cloves was recorded maximum in genotype GRS 1349 (108.8 g) and minimum in genotype CGSD 1232 (30 g) followed by the genotype CGSD 1247 (32.5 g), GRS 1330 (33.7 g), BGSD 1230 (34 g) and BGSD 1225 (35.7 g). The range and general mean for average weight of clove was observed as 30-108.8 g and 52.5 g, respectively.

There was significant variation among the genotypes for total yield and marketable yield. The

Table 1 : Mean performance of 25 garlic genotypes for growth characters					
Genotypes	Plant height (cm)	No. of leaves per plant	Leaf length(cm)	Leaf width (cm)	Pseudo-stem length (cm)
HG1	73.733	9.800	31.933	2.420	24.533
HG2	86.733	9.300	33.033	1.943	31.600
HG3	82.167	10.333	36.333	2.327	23.467
HG4	95.500	9.867	32.333	2.680	31.567
HG5	76.900	9.733	36.367	2.393	16.700
HG6	70.567	10.500	38.900	1.743	18.600
HG7	68.267	10.933	42.167	2.147	21.200
HG8	63.233	9.667	37.133	2.830	17.267
HGuu 17	77.933	11.067	33.833	2.187	24.800
HG27	82.067	11.733	35.233	2.200	33.433
GRS 1328	74.133	9.733	33.733	1.983	30.500
GRS 1330	88.933	11.267	38.833	2.223	29.700
GRS 1332	84.300	11.400	37.900	2.187	31.167
GRS 1340	75.167	10.167	36.933	2.150	33.833
GRS 1345	79.100	12.733	40.633	2.307	33.667
GRS 1349	86.800	14.300	41.833	3.557	31.700
BGSD 1222	84.467	12.433	29.533	2.067	34.167
BGSD 1225	72.667	8.467	35.233	1.867	28.800
BGSD 1230	85.467	12.700	31.233	1.893	38.067
BGSD 1232	80.267	10.967	30.967	2.367	29.600
CGSD 1232	74.933	10.233	32.067	1.933	31.500
CGSD 1247	67.800	9.967	32.700	2.370	33.300
CGSD1249	65.933	7.000	31.600	1.367	26.867
CGSD 1252	79.367	12.233	41.867	2.393	30.200
CGSD 1265	77.767	12.933	39.433	2.467	28.900
Mean	78.168	10.779	35.671	2.240	28.605
C.D. (P=0.05)	5.217	2.066	4.135	0.203	4.894
CV (%)	4.051	11.638	7.039	5.514	10.389

general mean for total yield was 106.01 q and it ranged from 55.13 to 140.27 q. The highest yield was recorded with genotype GRS 1349 (140.27 q), while the minimum yield was observed in genotype GRS 1328 (55.13 q) followed by CGSD 1249 (66.6 q) and CGSD 1232 (70.3 q). The general mean for marketable yield was 103.9 q and it ranged from 53.4 to 138.5 q. The highest marketable yield was recorded in genotype GRS 1349 (138.5 q), while the minimum yield was observed in genotype GRS 1328 (53.4 q) followed by CGSD 1249 (64.9 q) and CGSD 1232 (68.3 q). These results are in agreement with findings of Futane *et al.* (2006) and Singh and Chand (2003) who evaluated the performance of garlic genotypes for plant height, number of leaves per plant, bulb fresh weight, bulb diameter, number of cloves per bulb, 100 cloves weight, clove length, clove thickness,

total soluble solids and bulb yield. The results are also in consonance with the finding of Singh and Tiwari (1995) and Zahedi *et al.* (2007) who showed that all of the morphological characters in garlic genotypes were different from each other and differ significantly for bulb yield.

After studying growth and yield attributing characters of different garlic genotypes, it can be concluded that there was wide variation for different traits and genotype GRS 1349 may be promising one for the farmers of Hisar as well as semi arid region of Haryana. Beside, the other germplasm like HG 27 and BGSD 1230 have shown great promise for this region. Hence, there is a great possibility of improvement in attributes of this valuable vegetable crop.

Table 2 : Mean performance of 25 garlic genotypes for yield attributing characters							
Genotypes	Polar diameter of bulb (cm)	Equatorial diameter of bulb (cm)	Average bulb weight (g)	Number of cloves per bulb	Average weight of cloves (g)	Total yield (q/ha)	Marketable yield (q/ha)
HG1	3.683	3.566	30.700	30.567	54.400	100.933	98.633
HG2	5.380	4.063	41.333	40.833	43.867	113.000	111.367
HG3	4.136	3.723	36.367	34.033	43.433	104.733	102.400
HG4	4.183	3.766	24.067	28.567	64.067	89.800	86.867
HG5	4.023	3.643	18.500	28.933	72.667	93.200	91.300
HG6	3.543	3.020	22.767	30.667	74.800	101.200	99.000
HG7	3.856	3.160	26.967	31.833	61.100	96.400	94.900
HG8	3.953	3.396	19.600	31.433	76.033	92.067	89.967
HG17	4.026	4.593	40.400	39.733	41.567	120.200	117.733
HG27	4.156	4.733	48.767	43.133	40.933	132.000	129.000
GRS 1328	4.193	3.550	20.400	22.267	51.933	55.130	53.440
GRS 1330	2.856	3.656	24.933	39.500	33.767	122.843	120.567
GRS 1332	3.560	3.896	24.100	33.900	36.900	124.110	122.167
GRS 1340	3.573	4.740	23.367	44.400	84.333	108.373	106.667
GRS 1345	4.053	4.403	25.933	34.033	42.467	122.037	120.333
GRS 1349	5.206	4.396	50.733	21.900	108.867	140.270	138.500
BGSD 1222	4.423	4.060	42.200	30.700	39.833	121.333	119.167
BGSD 1225	3.626	4.916	39.100	28.267	35.733	112.067	109.767
BGSD 1230	4.526	4.823	46.967	31.233	34.067	131.400	128.800
BGSD 1232	4.300	4.960	51.600	41.800	41.633	117.467	115.800
CGSD 1232	4.123	4.650	40.367	25.933	30.000	70.333	68.333
CGSD 1247	3.323	4.046	20.433	32.433	32.500	99.057	96.700
CGSD1249	3.573	4.150	40.733	37.100	44.500	66.633	64.933
CGSD 1252	4.596	4.330	32.333	39.900	60.900	109.267	106.433
CGSD 1265	4.560	4.096	31.433	40.433	64.300	106.467	105.000
Mean	4.056	4.093	32.964	33.741	52.584	106.013	103.911
C.D. (P=0.05)	4.069	2.606	4.318	4.311	4.524	8.229	7.856
CV (%)	6.091	3.866	7.955	7.758	5.225	4.714	4.591

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