

PERFORMANCE STUDY OF VARIOUS GARLIC GENOTYPES (*ALLIUM SATIVUM* L.) IN SUBTROPICAL LUCKNOW CONDITIONS

KANARAM SODH, SUTANU MAJI*, SANJAY KUMAR, GOVIND PRAJAPATI AND KAMAL RAM MEENA

Department of Applied Plant Science (Horticulture),

Babasaheb Bhimrao Ambedkar University (A Central University), Vidya-Vihar, Rae Bareli Road, Lucknow - 226 025

e-mail: majisutanu@gmail.com

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***Corresponding author**

ABSTRACT

The present study was conducted with the objective of evaluating performance of selected genotypes of garlic and to select suitable variety performing well in the subtropical dry climate like Lucknow of Uttar Pradesh, India. Sixteen genotypes namely, Yamuna Safed (G-1), Yamuna Safed-2 (G-50), Yamuna Safed-3 (G-282), Yamuna Safed-4 (G-323), Yamuna Safed-5 (G-189), Agrifound White (G-41), Yamuna Safed-8 (G-384), JWR-G-1, JWR-G-2, JWR-G-3, JWR-G- Local, Chomu KVK-Local, B-1 (Local), B-2 (Local), B-3 (Local), B-4 (Local) were collected from various parts of country and tested for their performance at Lucknow condition. Among the tested genotypes the performance of genotype Yamuna Safed-3 (G-282) was found better in respect of bulb yield (maximum 39.64 g bulb fresh weight and 264.32 t/ha bulb yield) and as well as bulb quality (32.83 cloves/bulb) followed by Yamuna Safed-8 (G-384) as compared to the others. Similarly, bulb quality was also better in these two genotypes which were also reflected on physical and chemical characteristics of clove and bulb among the all genotypes tested. Therefore, Yamuna Safed-3 (G-282) and Yamuna Safed-8 (G-384) might be suggested for subtropical dry climate region like Lucknow for better yield and quality.

INTRODUCTION

Garlic (*Allium sativum* L.) has major position between the spices, medicinal and vegetable crops just after onion in the Alliaceae family (Damse *et al.*, 2014). Kazakhstan (Central Asia) is assumed as primary centre of origin and Mediterranean and Caucasus zones are as secondary (Govind *et al.*, 2015). Garlic is apomixes type and reproduces vegetatively by clove (Ipek *et al.*, 2005). India is the second largest producer in the world having 2.02 lakh ha area, 1251.88 lakh mt production and 5.43 t/ha productivity just after China (Anon., 2013-14) and has good export potential as fresh bulb as well as in dehydrated form (Singh *et al.*, 2012 & 2013). Fresh garlic bulb (100 g) contain moisture - 62.8%, protein - 6.3%, fat - 0.1%, fiber - 0.8%, carbohydrates - 29%, energy-145 calories and is good source of selenium, phosphorous, manganese, copper, iron, zinc, calcium, thiamine, riboflavin (Gupta and Singh, 1998). Garlic extract contains the bactericidal and fungicidal properties (Pandey, 1997) with reducing cholesterol effect in human body due to presence of Allicin (Shankaracharya, 1974). There are various types of garlic found in India and grown in different places. The importance of genetic variability is well known in crop plant. The development of an effective plant breeding programme is dependent on the existence of genetic variability and performance pattern in a specific locality. To make the collection useful for plant breeders, morphological and molecular evaluation of the germplasms is necessary (Soni *et al.*, 2013a, b; Singh *et al.*, 2013 and Kumar *et al.*, 2013). It may be said that the variation in garlic occurred due to only random

or induced mutation (Burba, 1993), through somaclonal variation (Novak, 1990) and agro-climatic adaptability. New cultivars are generated through clonal selection (Jones and Mann, 1963), induced mutation (Rubatzky and Yamaguchi, 1997), and by somaclonal variation or genetic engineering (Robinson, 2007). India has wide variations in the garlic germplasms for its various agro-climatic situations. But, the performance of different garlic germplasms is variable in different region. The Lucknow is a sub-tropical climatic area and the soil of experimental area is alkaline with high pH (8.2). Keeping these views the present investigation was aimed to see the performance of various garlic germplasms collected from various parts of country under subtropical dry climatic area like Lucknow.

MATERIALS AND METHODS

This experiment was carried out at the Horticultural Research Farm (PragyaVatika) of the Department of Applied Plant Science, Babasaheb Bhimrao Ambedkar University, Lucknow, Uttar Pradesh, India. The experimental material was consisted of 16 genotypes (Table 1) of garlic collected from the different reputed research stations and institutions of the country. The research material (cloves of garlic) was sown with 16 treatments and 3 replications under Randomized Block Design (RBD). Planting of cloves was done at the spacing of 15 x 15 cm in first fortnight of November 2014. Agro-practices like watering, weeding etc. were carried out according to the requirement. No chemical fertilizers were applied, it was grown organically.

Each plot (0.9 x 0.9 m²) consists of 36 plants. The observations were recorded from selected nine plants per plot. Observations were taken for vegetative growth, yield and quality characters e.g. plant height (cm), number of leaves per plant, maximum length of leaves (cm), length of fifth leaf (cm), width of fifth leaf (cm), basal diameter of pseudostem (mm), bulb yield per plot (g), bulb yield per ha (t), equatorial diameter of bulb (cm), polar diameter of bulb (cm), fresh weight (g), dry weight (g), bulb height (cm), basal diameter of stem (mm), number of cloves per bulb, fresh and dry weight of 10 cloves (g), length and width of cloves (cm), moisture content of bulb and cloves (%), dry matter of bulb (%), pH of garlic bulb, TSS (^oB) and vitamin C (mg/100g). The quality parameters were analyzed following the standard methods of AOAC (2000). The recorded data were statistically analyzed at 5 % level of significance following the standard process as stated by Panse and Sukhatme (1985).

RESULTS

Vegetative growth characters

The data presented in Table 2 showed that there was significant variation in plant height, Genotype G-282 (Yamuna Safed-3) which was positioned under treatment T₃ showed maximum plant height (21.12 cm, 32.05 cm, 59.10 cm and 62.80 cm) at different days of observation *i.e.* 30, 60, 90 and 120 DAS (Days after sowing), respectively followed by G-384 (Yamuna Safed-8). Number of leaves per plant was recorded higher (4.75, 7.23, 9.12 and 10.62) in the genotype G-384 at all stages of observations *i.e.* 30, 60, 90 and 120 DAS, respectively. It was found that the maximum length of leaves significantly increased (19.13, 28.12, 47.47 and 39.58 cm, respectively) in the genotype G-282 which was signed as T₃. Similar tendency was also found in case of circumference of pseudostem (basal girth) of garlic plant which was maximum significantly (4.94, 7.49, 13.21 and 13.56 mm, respectively) under the genotype G-282 followed by treatment T₁₁ (at 30, 60, 90 and 120 DAS, respectively). Length and width of fifth leaf was significantly greater (44.74 and 2.03 cm, respectively) in the genotype G-282 at the 90 DAS (Table 3). The bulb neck thickness was measured and found that the genotype G-282

(T₃) had significantly maximum neck thickness (8.00 mm) among all the genotypes tested.

Bulb yield

After harvesting the fresh weight of bulb of selected plant was measured and the average bulb weight was multiplied with the number of accommodated plants per plot to get the yield per plot and per ha accordingly (Table 4). It was calculated that the yield varied due to different genotypes under same condition ranging from 306.90 g/plot (minimum under T₁₆-B-4) to 792.98 g/plot which was maximum under T₃ (G-282). Similarly, the maximum yield of 264.32 t/ha was estimated under T₃ followed by T₇ (Yamuna safed-3 (G-384)) and minimum under T₁₆ (B-4) *i.e.* 102.29 t/ha.

Physico-chemical characters

The physical characteristics in respect of bulb length, diameter, weight, number of cloves and fresh and dry weight of cloves were determined and found significant variation among them except polar diameter of bulb. The data presented in Table 3 and 4 clearly showed that the length of bulb was maximum (37.72 mm) under the treatment T₇, whereas, the basal diameter of stem was found significantly maximum (10.15 mm) under treatment T₃ (G-384). The highest equatorial diameter (51.57 mm) recorded in the genotype G-282 whereas, the polar diameter was found maximum (32.85 mm) under the treatment T₇ (G-384). Both the fresh and dry weight of bulb were significantly higher (39.64 g and 13.94 g, respectively) under the treatment T₃ (G-282) and number of cloves per bulb was also found maximum (32.83) in the same genotype G-282 followed by T₇ and T₉. Regarding the clove character it was found that maximum length was recorded in the genotype G-282 (T₃) followed G-384 (T₇). Similarly maximum clove diameter (14.39 mm) was found under T₃ and minimum was found under T₁₆.

There was wide variation in chemical quality parameters of cloves as compared to the physical parameters (Table 5). It was seen that the TSS of garlic was significantly better (41.13 ^oB) in the genotype Chomu KVK-Local under treatment T₁₂ (Table 4). The determination of pH of clove extract revealed that the variation of pH due to different genotypes was non-significant, however, maximum pH (6.63) was recorded under

Table 1: Genotypes and their source of collection

S.No.	Name of genotypes	Source of collection
1.	Yamuna Safed (G-1)	NHRDF, Sub. Centre Karnal
2.	Yamuna Safed-2 (G-50)	NHRDF, Sub. Centre Karnal
3.	Yamuna Safed-3 (G-282)	NHRDF, Sub. Centre Karnal
4.	Yamuna Safed-4 (G-323)	NHRDF, Sub. Centre Karnal
5.	Yamuna Safed-5 (G-189)	NHRDF, Sub. Centre Karnal
6.	Agrifound White (G-41)	NHRDF, Sub. Centre Karnal
7.	Yamuna Safed-8 (G-384)	NHRDF, Sub. Centre Karnal
8.	JWR-G-1	CH & F Jhalawar Rajasthan
9.	JWR-G-2	CH & F Jhalawar Rajasthan
10.	JWR-G-3	CH & F Jhalawar Rajasthan
11.	JWR-G- Local	CH & F Jhalawar Rajasthan
12.	Chomu KVK-Local	Chomu KVK Jaipur
13.	B-1 (Local)	West Bengal
14.	B-2 (Local)	West Bengal
15.	B-3 (Local)	West Bengal
16.	B-4 (Local)	West Bengal

Table 2: Vegetative characters of different genotypes of garlic

Treatments	Plant height (cm)				Number of leaves				length of leaves (cm)				Basal diameter (mm)			
	30 DAS	60 DAS	90 DAS	120 DAS	30 DAS	60 DAS	90 DAS	120 DAS	30 DAS	60 DAS	90 DAS	120 DAS	30 DAS	60 DAS	90 DAS	120 DAS
T ₁	18.02	28.37	50.75	58.66	4.08	6.33	8.04	9.46	16.41	25.57	39.29	41.90	3.90	5.83	9.42	10.42
T ₂	17.52	26.82	49.81	61.21	4.04	6.46	8.25	9.41	16.38	24.27	37.68	39.58	3.82	5.79	9.31	10.80
T ₃	21.12	32.05	59.10	62.80	4.67	7.08	8.87	10.16	19.13	28.12	47.47	45.58	4.94	7.49	13.21	13.56
T ₄	18.11	29.13	52.71	62.82	4.21	6.37	8.50	10.04	16.55	26.75	39.14	42.09	4.34	5.93	9.85	11.42
T ₅	16.35	26.56	49.62	62.18	3.96	6.21	7.86	9.03	14.92	24.19	37.36	39.61	3.85	5.95	9.69	10.51
T ₆	14.38	25.49	44.18	48.92	3.29	5.79	8.28	8.93	12.75	21.49	31.09	34.09	3.66	5.20	7.74	7.86
T ₇	19.83	31.42	55.23	59.81	4.75	7.23	9.12	10.62	18.41	29.16	45.87	44.57	4.74	6.89	11.06	12.17
T ₈	18.10	29.21	48.70	56.88	4.50	6.66	8.58	9.22	16.87	27.04	38.62	41.06	4.51	6.62	9.68	10.25
T ₉	18.28	30.09	54.96	59.46	4.54	7.06	8.40	10.12	17.43	28.36	44.86	41.54	4.61	6.82	10.65	11.67
T ₁₀	16.07	28.46	51.63	59.91	4.29	6.33	7.79	8.93	15.40	25.72	40.30	41.23	4.21	6.31	9.98	10.14
T ₁₁	18.08	28.50	53.72	58.14	4.37	6.70	8.04	9.21	16.64	26.00	39.87	44.85	4.27	6.62	10.20	10.64
T ₁₂	18.13	28.59	51.16	59.65	3.78	6.41	8.62	8.25	17.37	25.67	39.91	43.15	4.37	6.43	10.33	10.95
T ₁₃	15.82	28.43	49.29	55.97	4.12	6.54	8.16	9.33	13.97	26.00	38.45	40.61	4.48	6.56	9.75	10.31
T ₁₄	15.59	23.11	42.27	51.05	3.46	6.54	7.87	9.41	13.75	21.05	32.33	36.95	3.13	5.24	8.81	9.42
T ₁₅	15.11	25.91	37.91	46.34	3.66	6.29	7.54	9.09	14.91	24.37	31.93	35.37	3.90	5.96	9.37	9.96
T ₁₆	13.58	23.72	42.78	46.42	3.75	6.04	6.94	6.96	13.28	21.74	34.30	36.56	3.46	5.38	8.55	9.12
SEm (±)	1.049	2.297	5.577	7.115	0.291	0.151	0.643	0.347	0.781	2.544	4.750	6.822	0.159	0.944	1.250	1.230
CD (p = 0.05)	2.141	4.686	11.376	14.515	0.593	0.309	1.313	0.708	1.594	5.190	9.690	NS	0.325	NS	2.551	2.509

Table 3: Physical characters of garlic leaves and bulbs

Treatments	Fifth leaf		Neck thickness (mm)	Bulb length (mm)	Basal diameter of stem (mm)	Diameter (mm) of bulb		Weight of bulb(g)	
	length (cm)	width (cm)				Equatorial	Polar	Fresh	Dry
T ₁	36.00	1.77	6.47	35.06	7.45	42.46	22.14	27.17	8.65
T ₂	35.02	1.43	6.71	34.90	7.71	42.75	24.68	21.43	7.25
T ₃	44.74	2.03	8.00	37.14	10.15	51.57	31.13	39.64	13.94
T ₄	38.53	1.57	6.63	33.76	8.15	47.27	28.95	30.98	10.90
T ₅	35.66	1.47	6.74	31.99	7.58	42.40	25.14	23.47	8.43
T ₆	29.81	1.47	6.11	31.70	7.30	37.72	26.50	18.41	7.02
T ₇	44.37	2.00	7.49	37.72	9.08	49.95	32.85	33.60	11.45
T ₈	37.68	1.67	6.09	31.75	7.16	40.71	25.39	21.05	8.18
T ₉	43.00	1.53	6.99	36.01	8.28	47.70	30.60	33.57	11.23
T ₁₀	39.23	1.67	5.49	32.27	7.23	41.77	23.70	22.54	8.16
T ₁₁	40.80	1.63	5.75	30.32	6.26	40.40	22.50	22.63	8.36
T ₁₂	38.20	1.53	5.85	31.77	6.82	40.63	25.27	21.81	8.39
T ₁₃	36.98	1.47	4.41	32.09	6.73	40.49	23.45	20.13	7.25
T ₁₄	30.74	1.37	5.15	29.83	6.71	37.16	25.04	19.91	8.44
T ₁₅	30.43	1.30	6.13	30.44	7.33	40.93	29.91	20.67	7.23
T ₁₆	32.77	1.47	5.35	29.17	6.58	38.44	26.10	15.34	5.44
SEm (±)	5.073	0.133	0.121	2.426	0.980	3.728	5.625	1.617	0.647
CD (p = 0.05)	10.349	0.271	0.246	4.949	1.999	7.605	NS	3.299	1.319

Table 4: Physical characters and yield of garlic

Treatments	Number of cloves/bulb	Weight of 10 clove(g)		Diameter of cloves (mm)		Yield Per plot (g)	Per ha (t)
		Fresh	Dry	Length	Width		
T ₁	30.83	13.11	4.87	26.14	9.90	543.60	181.08
T ₂	29.22	11.01	4.48	25.81	9.32	428.58	142.87
T ₃	32.83	16.58	6.36	33.14	14.39	792.98	264.32
T ₄	21.66	12.11	4.37	31.56	9.74	619.45	206.47
T ₅	27.18	11.90	4.62	27.08	11.33	469.55	156.53
T ₆	23.99	10.33	4.50	29.92	10.59	368.34	122.77
T ₇	31.77	15.22	5.53	32.57	11.72	672.09	224.02
T ₈	20.76	8.70	3.71	25.06	8.39	421.17	140.38
T ₉	31.74	16.08	6.06	31.94	11.59	671.12	223.70
T ₁₀	26.03	10.35	4.01	25.53	9.09	450.97	150.31
T ₁₁	27.19	12.27	4.87	28.83	11.22	452.61	150.86
T ₁₂	19.86	12.11	5.02	31.23	9.27	436.22	145.40
T ₁₃	25.55	13.23	5.31	28.30	10.88	402.72	134.22
T ₁₄	25.90	9.52	4.08	23.16	11.18	398.26	132.75
T ₁₅	23.70	11.63	4.32	28.90	8.56	413.57	137.85
T ₁₆	23.16	7.55	2.77	24.84	6.90	306.90	102.29
SEm (±)	1.959	1.478	0.665	1.611	0.927	32.310	10.743
CD (p = 0.05)	3.995	3.015	1.356	3.286	1.890	65.913	21.915

Table 5: Quality characters of garlic.

Treatments	TSS (°B)	pH	Moisture of bulb(%)	Moisture of clove (%)	Vitamin-C (mg/100g)	dry matter content (g)
T ₁	36.90	5.94	67.98	62.92	13.31	32.02
T ₂	36.53	6.02	66.15	59.39	17.30	33.66
T ₃	36.30	6.41	64.83	61.06	25.30	35.13
T ₄	35.07	6.08	64.84	63.69	17.41	35.15
T ₅	36.47	6.19	62.92	61.18	16.02	36.08
T ₆	40.87	6.46	61.83	56.44	24.01	38.25
T ₇	30.23	6.49	65.87	63.53	26.64	34.12
T ₈	37.07	6.37	61.14	57.09	18.60	38.85
T ₉	36.03	6.31	66.52	63.06	21.31	33.48
T ₁₀	38.27	6.63	63.79	61.32	20.00	36.20
T ₁₁	37.60	6.54	63.06	60.27	14.65	36.94
T ₁₂	41.13	6.44	61.48	58.61	17.23	38.51
T ₁₃	36.87	6.53	63.98	59.74	13.38	36.01
T ₁₄	36.73	6.10	57.93	57.14	20.35	42.36
T ₁₅	38.10	6.26	65.00	62.88	16.55	35.40
T ₁₆	36.20	6.09	64.52	61.55	19.72	35.47
SEm(±)	0.733	0.970	0.870	1.095	0.320	0.815
CD (p = 0.05)	1.495	NS	1.774	2.233	0.653	1.662

T₁₀(JWR-G-3). A significant amount of vitamin C in terms of ascorbic acid was determined in clove extract of various genotypes. Among them genotype G-384 showed maximum amount of vitamin C (26.64 mg/100g fresh weight) followed by G-282 (25.30 mg/100 g fresh weight) and the lowest vitamin C content (13.31 mg/00 g fresh weight) was found in genotype G-1.

Moisture percentage of bulb and cloves was recorded maximum (67.98 % and 63.53 % respectively) in the genotypes Yamuna Safed (G-1) and G-384 Dry matter of the garlic bulb was recorded significantly maximum (42.36 g) under the treatment T₁₄ (B-2-Local).

DISCUSSION

In the present investigation, significant differences among the genotypes were obtained for all the characters, suggesting thereby the presence of significant variation among the genotypes for these traits. Based on the mean values with respect to yield characters, the genotype Yamuna Safed-3(G-282) was the highest yielder followed by Yamuna Safed-8 (G-384), JWR-G-2 and Yamuna Safed-4 (G-323). The genotype Yamuna Safed-3(G-282) was also among the top genotypes for the economic traits such as plant height, number of leaves, length & width of fifth leaf, basal diameter of pseudo stem, polar bulb diameter, equatorial bulb diameter, fresh bulb weight, number of clove, length of clove, TSS, dry matter content. These results are in conformity with the previous results as reported by many workers (Randhawa *et al.*, 1974; Patil *et al.*, 1986, Saha *et al.*, 1990; Singh *et al.*, 1995; Mohanty, 2001 a,b). Similar results were also reported in garlic by Lopez *et al.* (1997), Agrawal and Tiwari (2004) and Singh and Chand (2004) during their study on germplasm evaluation in garlic.

Moderate heritability was obtained for width of clove, polar diameter of bulb, dry matter content in bulb, length of fifth leaf, thickness of stem, pseudo stem diameter, plant height bulb height and low value of heritability was recorded for

maximum length of leaf. Similarly, high heritability for fresh weight of bulb in onion and number of cloves/ bulb in garlic were also reported by Padma *et al.* (1973), Doruchowski (1986), Patil *et al.* (1986) and Agrawal (1999). Mohanty (2001a, b) have been reported.

Similarly, a considerable variation in bulb yield and its attributes like bulb weight (Singh *et al.*, 1995 and Agarwal, 1999), bulb diameter (Rajalingam and HariPriya, 1998), bulb yield (Dewangan and Sahu, 2012) and genotype Yamuna Safed -3 (G-282) (T₃) produced maximum bulb yield followed by Yamuna Safed-8 (G-384) (T₇) whereas, B-4 (T₁₆) collected from West Bengal (grown as local) showed the lowest yield in Lucknow condition. Poor performance of T₁₆ (B-4 Local collection from West Bengal) might be due to unfavourable agro-climatic condition of Lucknow (subtropical dry climate).

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