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Evaluation of different garlic (*Allium sativum* L.) mutant lines for growth, yield and quality under Chhattisgarh plains condition

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Abstract
The present investigation entitled "Evaluation of different garlic *(Allium sativum* L.) mutant lines for growth, yield and quality under Chhattisgarh plains condition." was carried out at Research cum Demonstration Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) – 492012 during *Rabi* season of 2021-2022. Experiment was laid out in Randomized block design and was replicated thrice with 21 mutant lines. Data were analysed to work out performance of mutant lines. 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}). Mean performance of character under study revealed that IG M-2021-1, IG M-2021-16 were found promising for cultivation under Chhattisgarh plain condition. They recorded maximum marketable yield (t ha^{-1}), total bulb yield (t ha^{-1}) coupled with high equatorial and polar diameter.

Keywords: Mutant, yield, garlic, clove

Introduction
Garlic (*Allium sativum* L), a member of the Alliaceae family, is one of the most aromatic herbaceous annual spices (Kurian, 1995*).* It is the second mostwidely cultivated spice crop, next to onion (Purseglove, 1975). Garlic originated incentral Asia, Mediterranean region from prehistoric time (Thompson and Kelly, 1957). Garlic is cultivated throughout the world mainly utilized as spice and condiment. China, South Korea, Egypt, India, Spain, USA, Thailand and Turkey are the major garlic producing countries of the world. In India, Madhya Pradesh is the leading producer of followed by other states like Rajasthan, Uttar Pradesh, and Gujarat [1]. Whereas in Chhattisgarh it occupies 4,411 ha area with production of around 26,185 MT [2].
Garlic is a frost hardy bulbous perennial with narrow flat leaves and bears small white flowers and bulbils. Critical day length for bulbing is 12hrs. Garlic is sexually sterile diploid. Garlic is normally grown during winter season as this crop needs relatively low temperature for suitable vegetative growth. On other hand this crop requires higher temperature during maturity. The garlic propagating material is known as clove. Required cloves for per hectare ranges from 350-500 kg. The compound bulb consists of 6 to 34 smaller bulblets which is called cloves and is surrounded by a thin white or pinkish papery sheath. Recovery of cloves in garlic bulb ranges from 86-96%.Garlic posses typical pungent flavor which makes it useful mainly as a spice, seasoning and flavouring agent for foodstuffs.

Materials and Methods
The experiment was laid out at Horticulture Research cum Instructional Farm, Department of Vegetable Science, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G) during *Rabi* season 2021-2022. The place were investigation took place is located in the central part of Chhattisgarh . Raipur is a part of Chhattisgarh Plains. Geographically 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. Five competitive and healthy plants from each entry of each replication were randomly selected for recording observations on various traits and their mean values were used in the statistical analysis. Mutant lines were studied for various yield related traits viz., 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}), unmarketable yield (t ha^{-1}), total yield (t ha^{-1}). The data of different parameters collected during the period of experiment were subjected to statistical analysis as per method of analysis of variance by Panse and Sukhatme (1978) [1].

Results and Discussion

The analysis of variance depicted that most of the traits studied under the present experiment exhibited significant mean sum of squares due to treatment (mutant lines). These confirmed the presence of considerable amount of genetic variability among various mutant lines. Similar results with respect to this reported by Siddappa *et al*. (2020) [7], Osman and Moustafa (2009) [6], Kowser *et al.* (2017) [3], Singh and Chand (2003) [9], Tesfaye *et al.* (2021) [10], Singh *et al*. (2012) [8], Zahedi *et al*. (2007) [11]. The data of mean performance of tomato genotypes for yield and yield attributing characteristics depicted in Table 1.

Parameters under study

Plant height recorded significant difference and ranged from 41.55 cm to 58.75 with overall mean of 51.24 cm. The maximum plant height was recorded for IG M-2021-16 (58.75 cm) which was found to be statistically at par with IG M-2021-12 (57.89 cm), IG M-2021-11 (55.91 cm), IG M-2021-1 (55.25 cm), IG M-2021-16 IG M-2021-15 (55.15 cm) and IG M-2021-17 (54.91 cm). Lowest plant height was recorded for IG M-2021-9 (41.55 cm).

Number of leaves recorded overall of 8.69 and ranged from 8.30 to 9.27. The maximum number of leaves was recorded for IG C-2 (9.27) which was at par with IG M-2021-6 (9.07), IG M-2021-16 (9.03), IG C-1 (8.93), IG M-2021-12 (8.87), IG M-2021-2 (8.73), IG M-2021-15 (8.73) and lowest for IG M-2021-14 (8.30).

Collar thickness varied from 2.59 cm to 3.96 cm. The highest collar thickness was recorded for IG M-2021-11 (3.96 cm) whereas lowest thickness of collar was observed in IG C-2. The overall average of collar thickness recorded was 2.97 cm.

Overall average for collar height was 8.69 cm. The collar height ranged from 5.4 cm to 16.38 cm. IG M-2021-16 (16.38 cm) showed maximum collar height and lowest for Local check (5.4 cm).

Fourth leaf length had a overall mean of 33.94 cm . Fourth leaf length ranged from 19.71 cm to 44.41 cm. IG M-2021-16 (44.41 cm) showed maximum fourth leaf length which was at par with IG M-2021-1 (41.60 cm). Lowest fourth leaf length was recorded in IG M-2021-4 (19.71 cm).

Overall mean for fourth leaf width was 1.20 cm. It ranged from 0.93 cm to 1.60 cm. IG M-2021-1 (1.60 cm) showed maximum fourth leaf width which was at par with IG M-2021-16 (1.58 cm), IG M-2021-5 (1.41 cm), IG M-2021-6 (1.35), IG M-2021-7 (1.29), IG M-2021-17 (1.28 cm), IG M-2021-4 (1.28 cm). The lowest fourth leaf obtained for IG C-2 (0.93 cm). The polar diameter of bulb was recorded and it ranged from 2.63 cm to 3.49 cm with an overall mean of 3.20 cm. The maximum polar diameter recorded for IG M-2021-1 (3.49 cm) which was at par with IG C-2 (3.42 cm), IG M-2021-16 (3.41 cm), IG M-2021-11 (3.29 cm) and IG M-2021-15 (3.24 cm).The lowest polar diameter obtained for IG M-2021-5 (2.63 cm).

The equatorial diameter of bulb varied from 2.56 cm to 3.93 cm with an overall mean of 3.24 cm. The result indicated that maximum equatorial diameter was recorded for IG M-2021-15 (3.93 cm) which was statistically at par with IG M-2021-16 (3.74 cm) and lowest equatorial diameter recorded for IG M-2021-8 (2.56 cm).

Neck thickness showed a overall mean of 0.70 cm. Neck thickness for different mutant lines varied from 0.39 cm to 1.18 cm. The maximum neck thickness recorded for IG M-2021-17 (1.18 cm) and lowest for Local check (0.39 cm).

The average weight of ten cloves varied from 3.77 g to 11.43 g. The maximum bulb weight was recorded for IG M-2021-16 (11.43 g) whereas minimum weight of ten outer cloves recorded in IG M-2021-3 (3.77 g).

The number of cloves per bulb were found to be ranging between 19.47 to 28.33 with an overall mean of 23.67. The maximum number of cloves per bulb were obtained in IG M-2021-16 (28.33 g) and minimum number of cloves per bulb Local check (19.47 g).

The average bulb weight for mutant lines varied from 9.27 g to 17.95 g, with overall mean of 13.44 g. The maximum average weight of bulb was obtained for IG M-2021-1 (13.44 g) which was at par with IG M-2021-16 (16.48 g), IG M-2021-6 (15.94 g), IG M-2021-13 (15.66 g), IG M-2021-11 (15.62 g), IG C-1 (15.55 g), IG C-3 (15.38 g) whereas minimum average weight of bulb recorded for Local check (9.27 g). Present finding of result were similar with Osman and Moustafa (2009), Menon and Shibana (2018) [4], Kowser *et al*. (2017).

TSS recorded for different mutant lines varied from 32.26% to 40.22%. The maximum TSS recorded for IG M-2021-1 (40.22%) which was at par with IG M-2021-16 (40.41%), IG M-2021-8 (38.77%), IG M-2021-9 (38.65%), IG M-2021-15 (38.54%), IG M-2021-11 (38.53%). However minimum TSS obtained from Local check (32.26%).

Days to maturity ranged from 130.33 days to 141.33 days. The maximum duration recorded for IG M-2021-16 (141.33 days) and minimum duration required for Local check (130.33 days).

Marketable yield varied from 2.88 t/ha to 10.4 t/ha with an overall mean of 6.51 t/ha. IG M-2021-1 (10.4 t/ha) recorded maximum marketable yield and lowest marketable yield was recorded for Local check (2.88 t/ha).

The total yield among various mutant lines varied from 3.61 t/ha to 10.21 t/ha. The significantly higher yield was obtained from IG M-2021-1 (10.21 t/ha) whereas minimum yield recorded for Local check (3.61 t/ha). Similar finding were reported by Siddappa *et al.* (2020) [7] whose maximum recorded was 9.83 t/ha. Mishra *et al*, (2017) [5] recorded maximum yield of 10.18 t/ha.

Table 1: Mean performance of garlic mutant lines for characters under study

Mutant lines	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
IG C -1	54.84	8.93	9.27	2.96	35.72	1.17	3.21	3.55	0.66	9.17	21.53	15.55	35.1	136.33	8.15	8.67
IG C -2	51.37	9.27	6.76	2.59	31.42	0.93	3.42	3.3	0.59	8.63	19.73	13.5	35.48	141	7.51	8.4
IG C -3	56.62	8.4	6.8	3.02	36.18	1.18	3.01	2.78	0.68	10.13	23	15.38	35.12	134	7.76	8.56
Local check	46.11	8.27	5.4	2.87	30.21	0.99	3.16	3.14	0.39	3.93	19.47	9.27	32.26	130.33	2.88	3.61
IG M-2021-1	55.25	8.53	7.05	3.18	41.6	1.18	3.49	3.14	0.71	11.43	22	17.95	40.22	141.33	10.04	10.31
IG M-2021-2	50.48	8.73	7.26	2.81	32.63	1.03	2.63	2.85	0.61	5.97	23.2	13.46	38.09	134.67	8.27	8.45
IG M-2021-3	52.91	8.8	8.64	2.81	30.91	1.2	3.49	3.56	0.59	3.77	22.13	7.81	32.33	136.67	2.9	3.1
IG M-2021-4	45.95	8.07	6.98	2.69	19.71	1.28	3.21	3.55	0.55	5.71	24.4	12.47	35.42	137.67	5.25	5.8
IG M-2021-5	50.02	9.4	11.71	3.14	38.46	1.41	3.53	3.17	0.56	7.07	25.73	15.94	33.44	133	6.38	6.72
IG M-2021-6	48.11	9.07	7.51	2.97	32.24	1.35	3.23	3.55	0.64	9.17	24.33	14.12	34.68	135.33	7	7.91
IG M-2021-7	43.33	9	6.81	2.97	31.15	1.29	2.87	3.35	0.6	9.23	24.4	15.31	32.41	131.33	7.58	8.45
IG M-2021-8	43.03	8.6	6.86	2.73	31.05	1.04	2.76	2.56	0.51	4.53	25.4	9.75	38.77	133	3.71	4.63
IG M-2021-9	41.55	8.53	6.65	2.97	29.01	1.19	2.95	3.26	0.76	4.17	21.73	9.8	38.65	135	3.73	5.21
IG M-2021-10	49.97	8.47	6.27	2.95	29.01	1.13	2.93	3.21	0.75	3.93	22.4	10.19	34.05	135	2.9	5.23
IG M-2021-11	55.91	8.8	14.42	2.91	40.66	1.01	3.29	3.54	0.89	10.83	23.07	15.62	38.53	135.67	8.06	8.06
IG M-2021-12	57.89	8.87	8.12	3.09	40.27	1.34	3.21	3.59	0.65	8.63	24.33	14.56	37.33	139	7.74	7.89
IG M-2021-13	50.08	8.33	9.2	3.01	34.49	1.16	3.33	3.41	0.85	10.3	24.13	15.66	35.67	136.67	7.95	8.42
IG M-2021-14	53.71	8.3	8.69	2.9	29.87	1.13	3.21	3.27	0.66	6.17	23.6	14.29	37.45	139	7.01	8.11
IG M-2021-15	55.15	8.73	13.89	3	34.58	1.26	3.24	3.93	0.94	4.71	27	10.92	38.64	139	5.76	5.86
IG M-2021-16	58.75	9.03	16.38	3.96	44.41	1.58	3.41	3.74	0.89	10.87	28.33	16.48	40.04	139.67	8.61	8.85
IG M-2021-17	54.91	8.4	7.74	2.8	39.26	1.28	3.53	3.6	1.18	6.92	27.13	14.31	38.31	138.33	7.64	8.3
Grand mean	51.24	8.69	8.69	2.97	33.94	1.20	3.20	3.34	0.70	7.39	23.67	13.44	36.29	136.29	6.52	7.17
SEm±	1.45	0.22	0.52	0.1	1.22	0.13	0.1	0.11	0.08	0.94	0.63	1.03	0.66	1.39	0.37	0.41
CD(0.05)	4.15	0.628	1.5	0.29	3.49	0.37	0.28	0.31	0.23	2.68	1.79	2.93	1.89	3.99	1.06	1.18
CV %	6.54	5.84	13.92	7.8	8.3	25.06	7.00	7.62	26.98	29.26	6.11	17.63	4.20	2.36	13.12	13.26

1. Plant height (cm)	5. Fourth leaf length (cm)	9. Neck thickness (cm)	13. TSS
2. Number of leaves	6. Fourth leaf width (cm)	10. Weight of ten outer cloves (g)	14. Days to maturity
3. Collar height (cm)	7. Polar diameter (cm)	11. Number of cloves	15. Marketable yield (t/ha)
4. Collar thickness (cm)	8. Equatorial diameter (cm)	12. Average weight of bulb (g)	16. Total yield (t/ha)

Conclusion

On the basis of mean performance for IG M-2021-1, IG M-2021-16 were found to be superior for cultivation under Chhattisgarh plains condition. It recorded maximum polar diameter (cm), TSS, marketable yield (t/ha) and total yield (t/ha).

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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