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GENOTYPIC RESPONSE OF GARLIC (*ALLIUM SATIVUM* L.) IN DIFFERENT NUTRITIONAL ENVIRONMENTS

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ABSTRACT

Twenty five genotypes of garlic collected locally as well as from different research centres and universities of the country were evaluated in three nutritional environments for yield and morphological traits in order to study the genotypic response of garlic in these artificially created environments. The work was done at Permanent Experiment Area of The Department of Horticulture, Bihar Agriculture College, Sabour in 2000-2001.Design of experiment was RBD and observations were recorded on three randomly selected competitive plants per replication for each entry on yield and morphological traits, viz. plant height, collar thickness, number of leaves per plant, length of leaves, breadth of leaves, diameter of bulb, ,length of clove, diameter of clove, average weight of cloves and yield per plant or average weight of bulb. The results indicated that the germplasms differed significantly with respect to the different morphological and yield attributes in different environments. Most of the characters in general was nutrient responsive. Genotype Bombay White Garlic had higher potential and Farka Pink was the least potent genotypes with respect to different yield and yield attributing characters.

Key words : *Genotypic response, garlic, different nutritional environments.*

Garlic (*Allium sativum* L.) is an important member of genus Allium, known to be derived from *Allium longicuspis.* It has its origin in Central Asia and Southern Europe. It belongs to the family Amaryllidaceae. Garlic is a diploid species (2n = 2x = 16) and it reproduces is vegetatively (McCollum, 1987; Figliuolo *et al.,* 2001; Ipek *et al.,* 2003). Garlic is considered as one of the most important species in the onion family (Baghalian *et al.,* 2005). It has been widely used throughout history as a food additive for both its flavour and medicinal effects. Recent research indicated that fresh and processed garlic may have some health benefits on human health such as anti-carcinogenic, anti-fungal and anti-bacterial properties. It is currently used for its unique flavour as a food ingredient as well as a dietary supplement (Khanum *et al.,* 2004). Furthermore, a liquid garlic spray has been used as an insect repellent for other crops. Thus garlic being very important crop, breeding for its improvement becomes imperative.In the case of vegetatively reproducing plant species, genotypic variability among plants is considered as ecological variability because it is the result of influences of changeableenvironmental factors. The influence of environmental factors,such as temperature, day length and carbohydrates has beenoften reported on bulb induction and development in garlic(Takagi, 1990; Nagakubo *et al.,* 1993; Kahane *et al.,* 1997). Environmental factors not only influence bulb formation butalso the flavour quality, as observed on onion (Randle, 1997; Randle and Lancaster, 2002). Hence study on the response of genotype in different environments is of interest to the breeder for several reasons.The need to develop cultivars for specific purpose is determined by an understanding of the response of genotypes with predictable environment. Unique cultivars may be required for different rows, different doses of fertilizer, spacing, soil types or planting dates. The responses of genotypes to variable productivity levels among environments provide an understanding of their morphological and yield performance in better way. Thus, this work aims at exploring the influence of different nutritive environmentalfactors on quantitative characters of twenty five genotypes of garlic bulb.

MATERIALS AND METHODS

The experiment was conducted at Permanent Experiment Area of The Department of Horticulture Bihar Agriculture College, Sabour for two years. The experimental material consisted of twenty five genotypes of garlic, collected locally and also fromresearchcentres and universities of the country.The genotypes evaluated under varying environments were, Faizabad Garlic-6/22, Faizabad Garlic-5, Faizabad Garlic-6/1 I, Faizabad Garlic- 20/2, Faizabad Garlic-6, Akola Garlic-46, Bombay White Garlic and Akola Garlic-43, Jamuna Safed and Dholi

Garlic-9, Dholi Garlic-8, Dholi Garlic-6, Dholi Garlic-3, Dholi Garlic-I, Dholi Garlic-2, Dholi Garlic- 11, Dholi Garlic- 1 0, Dholi Garlic-5, B adshah Garlic, Dholi Garlic-7, Farka White, Farka Pink, Munger Garlic White, Surajgarha Garlic Pink and RAUGarlic-5.

All the genotypes were grown in three different nutritional environments created with respect to different fertility levels viz. N:P:K: :100:40:60, N:P:K: :125:50:70, N:P:K: :150:60:80 applied in the form of urea, DAP and murate of potash in the year 2000-2001. Hence total number of environments were three, viz. E1, E2 and E3. There were hundred plants in each plot having area of 1.5m x1.5m, planted at 15cm distance between the row and 10 cm distance within row in a Randomized Block Design,with three replications. Observations were recorded on three randomly selected competitive plants per replication for each entry on yield and morphological traits, viz. plant height (cm), collar thickness (cm), number of leaves per plant, length of leaves (cm), breadth of leaves (cm), diameter of bulb (cm), length of clove (cm), diameter of clove (cm) average weight of cloves (g)and yield per plant or average weight of bulb (g), The statistical analysis of the data noted in all observations was carried out by the method of analysis of variance as suggested by Panse and Sukhatme (1984).Comparison of the genotypes was made with the help of critical differences (C.D.).

RESULTS AND DISCUSSION

The results indicated that all the genotypes differed significantly with respect to different morphological characters (Table-1) as well as with respect to yield characters (Table-2).

All the genotypes differed significantly with respect to plant height. It was also observed that the plant height of the genotypesincreased with the increasing fertility levels.Genotypes, Bombay White Garlic, Dholi Garlic-1, Surajgarha Garlic Pink and Munger Garlic White had taller plants, while genotypes Farka Pink, Dholi Garlic-7, Faizabad Garlic-6 and Faizabad Garlic-5 had shorter plants as compared to other genotypes under investigation. The differences in plant heights among different genotypes in a particular set of environment might be due to their genetical make up. Significant difference due to environments indicated that environment created by varying dose of different fertilizers affected this trait in garlic in a linear manner. Mathur *et al.* (1975) and Buwalda (1986) also recorded greater plant height in higher dose of nitrogen fertilization in garlic.

Similarly, collar thickness of different genotypes differed significantly in all the environments. Increasing trend was also noticed in all the genotypes with the increased level offertilzers in the form of urea, di-amonium phosphate and murate of potash. The difference in collar thickness might be due to genetical ability of particular genotype.

Significant difference in leaf number was also exhibited by different genotypes in all thethree environments. Genotype, Bombay White Garlic had the maximum number of leaves andwas statististically comparable to genotypes Dholi Garlic-1, Surajgarha Garlic Pink, Munger Garlic White, Akola Garlic-43 and Dholi Garlic-11 in all the three environments. Significant difference in number of leaf among different genotypes in different environments was also recorded by Singh (1981) as well as by Mehta and Patel (1985) in garlic.As regardas the length of leaf, significant difference among different genotypes were observed in all the environments. Here also Bombay White Garlic had the longest leaf which was statistically at par with Dholi Garlic-1 and Surajgarha Garlic Pink and all these genotypes except Surajgarha Garlic Pink in E2 and E3 had significantlylonger leaves than their respective general means. It may be noticed from the Table-1 that as the doses of fertilizer increased, the length of leaf also increased. Thus, it can be said that levels of fertilizers affected this trait in a linear manner.

Breadth of leaf also recorded significant difference among the genotypes in all the three environments. This reflects that different genotypes differed significantly in having leaf breadth (Table-1) and were very much influenced by different doses of NPK application.

Similarly, diameter of bulb also differed significantly among themselves in all the environments (Table-2). Largest diameter was found in the genotype Bombay White Garlic followed by Dholi Garlic-1 and these two genotypes were statistically comparable in all the environments. Minimum bulb diameter was noticed in genotype, Farka Pink. Greater diameter of bulb might be attributed to presence of more number of cloves.

Significant variation among different genotypes under different environments was recorded with

Table-1 : Mean performance of garlic over different nutritional environment for morphological characters during 2000-2001.

Genotypes	Plant height (cm)			Collar Thickness (cm)			Number of leaves/plant			Length of leaf (cm)			Breadth of leaf (cm)		
	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3
Faizabad Garlc-6/2	45.87	46.01	49.90	1.12	1.22	1.32	6.67	7.00	7.33	29.77	32.50	34.71	0.94	1.11	1.17
FaizabadGarlc-5	41.90	44.20	45.80	1.03	1.14	1.25	6.00	6.33	6.67	25.60	29.73	31.81	0.85	1.01	1.09
FaizabadGarlc-6/11	44.37	46.80	49.80	1.12	1.21	1.31	6.33	7.00	7.33	29.60	32.27	33.83	0.94	1.10	1.14
FaizabadGarlc-20/2	47.00	50.10	53.10	1.15	1.22	1.38	7.00	7.33	8.00	30.44	33.77	35.87	1.00	1.11	1.20
FaizabadGarlc-6	40.00	43.70	45.23	1.03	1.12	1.22	5.67	6.33	6.67	25.27	29.17	30.30	0.83	0.98	0.96
Akola Garlic-46	49.57	54.00	58.00	1.17	1.31	1.43	7.00	7.33	8.00	31.53	34.33	37.00	1.03	1.15	1.24
Bombay White Garlic	59.37	65.77	68.80	1.28	1.61	1.86	7.67	8.67	9.00	35.54	40.40	42.53	1.26	1.34	1.42
Akola Garlc-43	51.67	56.67	59.40	1.19	1.34	1.46	7.33	8.00	8.33	32.23	35.17	83.73	1.09	1.20	1.33
Dholi Garlic-9	43.00	45.43	47.97	1.07	1.20	1.28	6.00	6.67	7.00	27.80	30.60	32.40	0.86	1.08	1.11
Dholi Garlc-8	46.17	49.13	52.33	1.15	1.22	1.38	6.67	7.33	8.00	29.90	33.17	35.80	0.99	1.11	1.19
Dholi Garlic-6	46.03	48.37	51.76	1.13	1.22	1.37	6.67	7.00	7.33	29.77	32.60	35.30	0.95	1.10	1.18
Dholi Garlic-3	43.80	46.67	48.76	1.09	1.21	1.30	6.33	7.00	7.33	29.10	32.07	33.33	0.94	1.09	1.13
Dholi Garlic-1	46.80	57.46	64.07	1.25	1.43	1.62	7.67	8.33	9.00	33.83	36.97	41.03	1.22	1.26	1.38
Dholi Garlic-2	42.30	40.53	47.66	1.06	1.10	1.27	6.00	6.67	7.00	26.64	30.57	32.07	0.85	1.07	1.11
Dholi Garlic-11	51.67	56.03	59.03	1.18	1.33	1.44	7.00	8.00	8.33	32.00	34.90	37.67	1.07	1.16	1.30
Dholi Garlic-10	48.13	52.03	54.83	1.15	1.23	1.40	7.00	7.33	8.00	30.60	34.17	36.27	1.02	1.12	1.21
Dholi Garlic-5	48.80	52.90	56.67	1.17	1.28	1.40	7.00	7.33	8.00	30.60	34.17	36.70	1.03	1.13	1.22
Badshah Garlic	42.00	44.23	46.00	1.04	1.17	1.26	6.00	6.67	7.00	26.50	30.13	31.83	0.86	1.05	1.11
Dholi Garlic-7	39.03	43.50	45.13	0.96	1.09	1.18	5.67	6.33	6.67	24.84	28.00	30.00	0.81	0.96	1.09
JamunaSafed	43.56	46.67	48.67	1.08	1.20	1.30	6.33	7.00	7.33	28.90	30.13	31.83	0.90	1.09	1.12
Farka White	51.63	54.52	58.50	1.17	1.32	1.43	7.00	7.67	8.00	31.73	34.83	37.54	1.03	1.16	1.30
Farka Pink	38.21	42.00	44.57	0.95	1.04	1.12	5.33	6.00	6.67	24.17	28.00	29.20	0.79	0.91	1.09
Munger Garlic White	56.36	56.27	61.43	1.21	1.38	1.47	7.33	8.00	8.67	32.67	35.53	39.00	1.09	1.21	1.33
Surajgarha Garlic Pink	56.63	57.17	61.83	1.24	1.41	1.52	7.67	8.33	8.67	33.22	36.77	39.80	1.13	1.24	1.35
RAU Garlic-5	43.27	46.00	48.43	1.08	1.20	1.29	6.00	6.67	7.33	26.90	30.73	32.47	0.86	1.08	1.12
G.M.	47.09	49.85	53.11	1.12	1.25	1.37	6.61	7.21	7.67	29.57	32.83	35.08	0.97	1.11	1.20
S.Em+-	1.89	2.089	2.28	0.04	0.05	0.05	0.26	0.30	0.28	01.16	01.44	01.24	0.04	0.05	0.04
C.D.	5.36	5.95	6.48	0.12	0.15	0.15	0.74	0.87	0.81	03.30	04.11	03.53	0.11	0.14	0.13
CV%	6.94	7.23	7.43	6.59	7.54	6.73	6.84	7.32	6.44	06.81	07.62	06.14	6.75	7.48	6.40

Table-1 : Contd .....

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Genotypes	Diameter of bulb(cm)			Length of cloves (cm)			Width of cloves (cm)			Average weight of cloves (g)			Average weight of bulb (g)		
	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3
Faizabad Garlc-6/2	3.07	3.66	3.84	2.50	2.84	3.30	0.76	0.85	0.94	0.36	0.50	0.70	13.00	15.40	18.20
FaizabadGarlc-5	2.65	3.26	3.70	2.20	2.67	2.97	0.70	0.78	0.87	0.19	0.40	0.52	11.00	13.60	15.80
FaizabadGarlc-6/11	2.99	3.64	3.81	2.48	2.84	3.27	0.76	0.84	0.94	0.35	0.55	0.69	12.60	15.39	18.00
FaizabadGarlc-20/2	3.14	3.60	4.08	2.67	3.07	3.44	0.80	0.90	0.95	0.40	0.56	0.75	13.80	16.20	19.00
FaizabadGarlc-6	2.54	3.26	3.39	2.10	2.60	2.97	0.67	0.76	0.87	0.15	0.40	0.50	9.82	12.00	15.50
Akola Garlic-46	3.21	3.71	4.28	2.77	3.20	3.50	0.84	0.92	0.97	0.47	0.63	0.90	15.00	17.20	19.50
Bombay White Garlic	4.10	4.30	4.61	3.62	3.70	4.13	1.01	1.10	1.12	0.89	1.40	1.85	25.20	27.00	30.60
Akola Garlc-43	3.44	3.93	4.38	2.93	3.33	3.17	0.87	0.96	1.00	0.55	0.82	0.90	17.60	19.00	22.00
Dholi Garlic-9	2.78	3.54	3.73	2.46	2.77	3.10	0.72	0.83	0.88	0.20	0.47	0.60	11.80	14.30	17.00
Dholi Garlc-8	3.13	3.69	4.05	2.57	2.90	3.37	0.80	0.92	0.97	0.40	0.56	0.75	13.60	16.10	18.73
Dholi Garlic-6	3.10	3.67	4.02	2.54	2.87	3.33	0.78	0.86	0.97	0.40	0.55	0.72	13.20	15.60	18.60
Dholi Garlic-3	2.98	3.62	3.80	2.47	2.83	3.23	0.74	0.84	0.92	0.35	0.52	0.67	12.60	15.30	17.30
Dholi Garlic-1	3.87	4.29	4.60	3.13	3.67	4.13	0.96	1.07	1.10	0.80	0.95	1.05	21.80	26.20	29.79
Dholi Garlic-2	2.77	3.33	3.70	2.45	2.73	3.03	0.71	0.81	0.88	0.20	0.44	0.60	11.50	14.30	16.80
Dholi Garlic-11	3.42	3.78	4.37	2.80	3.27	3.67	0.87	0.94	0.98	0.55	0.75	0.90	16.60	18.44	20.80
Dholi Garlic-10	3.51	3.70	4.09	2.70	3.10	3.47	0.82	0.91	0.97	0.40	0.59	0.85	14.40	16.20	19.20
Dholi Garlic-5	3.19	3.70	4.16	2.73	3.10	3.47	0.83	0.92	0.97	0.40	0.62	0.90	14.80	16.40	19.40
Badshah Garlic	2.72	3.32	3.70	2.23	2.70	3.00	0.71	0.79	0.88	0.19	0.43	0.60	11.40	14.20	16.00
Dholi Garlic-7	2.49	3.18	3.36	1.93	2.27	2.97	1.02	1.43	1.54	0.12	0.38	0.42	8.80	10.40	15.40
Jamuna Safed	2.95	3.62	3.78	2.47	2.80	3.20	0.73	0.82	0.92	0.34	0.50	0.65	12.20	15.23	17.00
Farka White	3.33	3.72	4.34	2.77	3.24	3.57	0.86	0.93	0.97	0.55	0.65	0.89	16.00	18.20	20.30
Farka Pink	2.41	2.98	3.29	1.53	2.10	2.60	0.66	0.74	0.84	0.12	0.29	0.40	7.00	9.20	10.90
Munger Garlic White	3.57	3.98	4.44	2.97	3.46	3.83	0.91	0.96	1.01	0.55	0.83	0.92	21.00	22.00	24.00
Surajgarha Garlic Pink	3.66	4.02	4.54	2.47	3.47	4.07	0.92	1.02	1.05	0.75	0.88	0.97	21.60	22.80	27.59
RAU Garlic-5	2.84	3.58	3.74	2.58	2.77	3.17	0.73	0.82	0.92	0.26	0.48	0.65	12.00	15.20	17.00
G.M.	3.10	3.65	3.99	0.13	2.97	3.36	0.81	0.91	0.98	0.40	0.61	0.77	14.34	16.63	19.38
S.Em+-	0.11	0.16	0.19	0.36	0.13	0.12	0.25	0.04	0.03	0.01	0.02	0.04	0.62	0.55	0.95
C.D.	0.32	0.46	0.54	8.62	0.38	0.33	0.07	0.10	0.08	0.04	0.06	0.11	1.76	1.57	2.71
CV%	6.32	7.64	8.30	2.84	7.89	5.97	5.55	8.10	5.32	6.01	6.44	8.76	7.50	5.77	8.53

respect to average weight of clove. Further, it was revealed that genotype Bombay White Garlic had significantly heavier cloves ascompared to rest of the genotypes in all the environments whereas genotype Farka Pink possessed minimum clove weigh in all the environments. Average weight of clove of all the genotypes increased with increasing levels of NPK application. Differential response of the genotypes to three nutritional environments is also in agreement with the findings of Singh (1981) and Mehta and Patel (1 985) in garlic.

Significant differencein clove length was also observed among different genotypes inall the environments. Further it was also revealed that the clove length increased with the increased level of NPK application. Genotype Bombay White Garlic had the longest clove while Farka Pink had the shortest clove length in all the environments.

Width of clove, which differed significantly among different genotypes in all the environments, evinced that increasing levels of NPK increased width of clove in all genotypes. Significant variation in width of clove of garlic was also recorded by Singh (1981) as well as Mehta and Patel (1 985). It may also be noticed fromTable-2 that as thenutrition level increased width of clove also increased. Increase in the width of clove with increased level of nutrient levelwas observed by Singh and Tiwari (1968).

Significant difference among genotypes with respect to average weight of bulb (yield per plant) was observed in all the three environments. The genotype, Bombay White Garlic had significantlyhigher weight of bulb in all the three environments during both the year of experimentation except genotype Dholi Garlic-I with which it was statistically at par and both these genotypes were statistically superior to their respective general means in all the three environments (E1, E2, and E3). Genotype, Farka Pink was found to have the minimum average weight of bulb in all environments. Significant difference in average weight of bulb amongst differentgenotypes was reported by Singh (1981) as well as Mehta and Patel (1985). It may also be noticed from the Table-2 that as the level of NPK increased, the yield perplant increased correspondingly. Higher yield at higher level of P was also reported by Singh *el al.* (1961), Choudhary (1 967) and Maurya and Bhuyan (1982).

Success of any plant breeding programme depends on the variability present in the material. Thus we have observed that significant difference was present among the genotypes with respect to different yield and yield attributing traits in all the environments. Most of the characters in general and the yield per plant (weight of bulb) in particular was nutrient responsive. Genotype Bombay White Garic had higher potential and Farka Pink was the least potent genotypes.

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