The Bioscan 9(4): 1647-1652, 2014 (Supplement on Genetics and Plant Breeding) www.thebioscan.in
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES

GENOTYPE X ENVIRONMENT INTERACTIONS AND STABILITY ANALYSIS IN ELITE LINES OF GARLIC (*ALLIUM SATIVUM* L.)

SANGEETA SHREE*, A. B. SINGH[1] AND NITISH DE[2]
[1]Department of Horticulture (Veg. and Flori.)
[2]Department of Plant Breeding and Genetics
Bihar Agricultural College, Sabour - 813 210, Bhagalpur
e-mail: sangeetashreee@gmail.com

KEYWORDS
Garlic
Genotype x environment interaction
Stability analysis

Received on : 12.05.2014

Accepted on : 13.10.2014

***Corresponding author**

ABSTRACT

Genotype response to changeable environmental factors as ex-pressed through genotype x environment interaction offers important information to growers as end users .Twenty five genotypes of garlic (*Allium sativum* L) were evaluated for their stability, with respect to yield and its contributing traits, in three different nutritional environments created with respect to different fertility levels for two consecutive years. The pooled analysis of variance indicated that genotype x environment interactions were highly significant for the characters viz., number of leaves per plant, length of leaf, yield per plant (weight of bulb), number of cloves per bulb, diameter of clove and average weight of clove and these characters were subjected to stability analysis. Linear as well as non-linear component of GxE interactions were found to be significant for these characters indicating that response of genotypes varied in different environments. In general, all the genotypes did not show any uniform stability and linear pattern for all the traits. Genotypes Bombay White Garlic (27.48,1.0934 and -0.0427), Dholi Garlic-1 (11.50, 1.3196 and -0.4346), Surajgarha Garlic Pink (23.87, 1.2118 and-0.5042) and Munger Garlic White (22.28,0.6110 and -0.1628) had high mean value over population mean, closer to one regression coefficient (b_i) and low and non-significant deviation from regression and was highly stable for yield per plant. These genotypes are likely to perform well in all the six environments.

INTRODUCTION

Garlic (*Allium sativum* L., 2n=16) belongs to the family Amaryllidaceae and is the second most widely used Allium next to onion. It has originated from Central Asia and Southern Europe especially the Mediterranean region. Garlic is among the earliest domesticated plants and is cropped world-wide. Garlic enjoys almost universal cultivation for its valuable bulb. It is well-known for its health benefits. Numerous therapeutic properties have been reported, *i.e.* antifungal, antibacterial, antiviral, antithrombotic, antitumor, hypotensive, hypoglycaemic, hypolipidemic (Augusti, 1996; Sato, 2000). Moreover, therapeutic value related to cardiovascular diseases, cholesterol metabolism, atherosclerosis (Kik *et al.*, 2001), and cancer (Le Bon and Siess, 2000) were recently described. The garlic reproduces vegetatively under the local conditions. In the case of vegetatively reproducing plant species, variability among plants is considered as ecological variability because it is the result of influences of changeable environmental factors. The influence of environmental factors, such as temperature, day length and carbohydrates has been often reported on bulb induction and development in garlic (Takagi, 1990; Nagakubo *et al.*, 1993; Kahane *et al.*, 1997). In onion, light spectrum quality is of primary importance for bulb formation (Lercari, 1982; Kahane *et al.*, 1992). However, environmental factors not only influence bulb formation but also the flavour quality, as observed on onion (Randle, 1997; Randle and Lancaster, 2002). Hence genotype x environment interaction study are of interest to the breeder for several reasons. The need to develop cultivars for specific purpose is determined by an understanding of the interaction of genotypes with predictable environment. Unique cultivars may be required for different rows, different doses of fertilizer, spacings, soil types or planting dates. The responses of genotypes to variable productivity levels among environments provide an understanding of the stability of performance. Genotype x Environment interaction parameters have been reported to be useful for measuring adaptability by various workers (Stoffela *et al.*, 1983 and Poysa *et al.*, 1986). Thus, this work aims at exploring the influence of environmental factors on quantitative characters of twenty five genotypes of garlic bulb. And though, so far there is a lot of work on stability analysis on cereals and other crops (Mosisa *et al.*, 2001 in maize; Hristov *et al.*, 2011 and Hintsa *et al.*, 2011 in wheat, Kumar *et al.*, 2014 in sesame and Shukla *et al.*, 2014 in chickpea), there is virtually no or very little information on stability of vegetable crops particularly on garlic. This experiment was, therefore, conducted to determine the stability of yield and contributing characters in garlic genotypes over different environments.

MATERIALS AND METHODS

The present study was conducted at Permanent Experiment Area of The Department of Horticulture Bihar Agriculture College, Sabour for two years. The data of both the years were pooled and analyzed. The experimental material consisted of twenty five genotypes of garlic. The genotypes were selected out of collections maintained at TCA, Dholi campus, RAU, Bihar, Pusa, BAC Sabour and some local collections were also taken. 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 for over two years. Hence total number of environments were six i.e. three during the first year (E_1, E_2 and E_3) and another three (E_4, E_5 and E_6) during the second year of experiment. 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 eleven yield and yield attributing traits viz. plant height (cm), collar thickness (cm), number of leaves per plant, length of leaves (cm), breadth of leaves (cm), yield per plant/average weight of bulb (g), diameter of bulb (cm), number of cloves per bulb, length of clove (cm), diameter of clove (cm), and average weight of clove (g). The genotype (G) x environment (E) interaction was calculated by the pooled analysis of variance. The mean value of genotypes for different traits under different environments were used for this analysis. The analysis of stability parameters was estimated by the model suggested by Eberhart and Russel (1966).

Table 1: Pooled analysis of variance for eleven characters of garlic for genotypes x environment interaction

Source of variation	d.f.	Plant height (cm)	Collar thickness (cm)	No. of leaves/ plant	Length of leaf (cm)	Breadth of leaf (cm)
Environment	5	273.2859**	1.1958**	69.7333**	466.0500**	0.8435**
Genotypes	24	665.4235**	0.3131**	18.1069**	186.8601**	0.2589**
Genotypes x Environemnt	2.5612	0,0059	0.5824**		72.0826**	0.0009
Pooled error	12.289	0.0071	0.2253		5.604	0.0052

Table 1: Cont............

Source of variation	Yield per plant (g)	Diameter of bulb (cm)	No. of cloves per bulb	Length of clove (cm)	Diameter of cloves (cm)	Av. Wt. of clove (g)
Environment	378.4201**	17.2706**	1280.3286**	9.6743**	.5087**	2.1621**
Genotypes	337.4358**	4.0627**	999.5860**	2.47074**	.3625**	1.0229**
Genotypes x Environemnt	0.8195*	0.0776	7.844**	0.0191	0066**	0.0125**
Pooled error	0.628	0.0642	3.0256	0 0463	0.0035	0.0022

Table 2: Stability analysis for yield and yield components over six environments (Mean squares)

Source of variation	Df	Plant height (cm)	Collar thickness (cm)	No. of leaves/ plant	Length of leaf (cm)	Breadth of leaf (cm)
Genotypes (g)	24	223.8600**	0.1044**	6.0374**	62.2629**	0.0860**
Environment (E) + (GxE)	125	8.578**	0.0178**	1.1099**	6.4593**	0.0126*
Env. (Linear)	1	953.0868**	1.9928**	115.6442**	776.6773**	1.4141**
G x E (Linear)	24	1.8758**	0.0043	0.2111NS	0.7302**	0.0025**
Pooled deviation	100	0.7414	0.0013	0.01803	0.1321	0.0011
T_1		0.5483	0.0002	0.0745	0.0311	0.0004
T_2		0.2801	0.0023	0.128	0.1829	0.0007
T_3		0.0326	0.0005	0.0147	0.0306	0.0006
T_4		0.0771	0.0007	0.6075**	0.0374	0.0003
T_5		0.3602	0.0022	03052**	0.1755	0.0025
T_6		0.2349	0.0006	0.1114	0 0783	0.0006
T_7		4.7529	0.0052	0.24 37*	0.1780	0.0002
T_8		0.5927	0.1517	0.1537	0.2281	0.0008
T_9		0.0583	0.0016	0.0746	0.2984	0.0009
T_{10}		0.0746	0.0005	0.0045	0.0282	0.0002
T_{11}		0.048	0.0003	0.0656	0.0431	0.0003
$T1_2$		0.0672	0.0002	0.0733	0,1118	0.0007
T_{13}		2.2977	0.0039	0.2560*	0.4694	0.0081**
T_{14}		3.5590	0.0023	0.1423	0.2194	0.0010
T_{15}		0.2148	0.0011	0.2041*	0.0904	0.0010
T_{16}		0.4470	0.0010	0.0346	0.0134	0.0006
T_{17}		0.1741	0.0006	0.0731	0.0526	0.0010
T_{18}		0.1066	0.0019	I .0576**	0.1810	0.0004
T_{19}		0.6233	0.0010	0.1446	0.0587	0.0012
T_{20}		0.1372	0.0004	0.0733	0.0717	0.0007
T_{21}		0.9420	0.0011	0.082	0.0613	0.0009
T_{22}		0.3043	0.0009	0,0914	0.1945	0.0021
T_{23}		1.5012	0.0017	0.2555*	0.2658	0.0011
T_{24}		1.0339	0.0013	0.1479	0.0812	0.0005
T_{25}		0.0666	0.0008	0.0891	0.1208	0.0006
Pooled Error		4.0962	0.0024	0.0751	1.8680	0.0017

Table 2: Cont......................................

Source of variation	Yield per plant (g)	Diameter of bulb Icm)	No. of cloves per bulb	Length of clove (cm)	Diameter of cloves (cm)	Average Wt. of clove (g)
Genotypes (g)	112.422**	1.3511	382.8008**	0.7868**	0.1206**	0.03417**
Environment (E) + (GxE)	5.3161**	0.2556**	19.5999**	0.1329**	0.00889**	0.0342**
Env. (Linear)	631.7902**	28.8248	2136.5179**	15.6239**	0.8470**	3.5850**
G x E (Linear)	0.8777**	0.0494	8.6146**	0.0179**	0.0052**	0.0260**
Pooled deviation	0.1165	0.0194	1.0666	0.0056	0.0014	0.0007
T_1	0.0032	0.0055	0.4926	0.0016	0.0020	0.0006
T_2	0.0482	0.0598*	0.1642	0.0055	0.0014	0.0004
T_3	0.0273	0.0074	1.7210	0.0014	0.0005	0.0004
T_4	0.0007	0.0090	1.3028	0.0035	0.0001	0.0003
T_5	0.0385	0.0500*	0.5339	0.0088	0.0011	0.0006
T_6	0.0197	0.0211	0.2942	0.0081	0.0002	0.0016
T_7	0.1667	0.0059	15.1340**	0.0131	0.0005	0.0009
T_8	0.1076	0.0175	0.1138	0.0266	0.0008	0.0021
T_9	0.0176	0.0206	0.0711	0.0011	0.0008	0.0004
T_{10}	0.0054	0.0079	0.3130	0.0029	0.0005	0.0003
T_{11}	0.0031	0.0082	0.0891	0.0016	0.0005	0.0006
$T1_2$	0.0961	0.0052	1.2102	0.0010	0.0003	0.0003
T_{13}	0.1875	0.0015	0.2662	0.0025	0.0008	0.0001
T_{14}	0.0497	0.0240	0.1312	0.0012	0.0008	0.0001
T_{15}	0.0024	0.0263	0.3628	0.0072	0.0004	0.0002
T_{16}	0.0482	0.0120	1.4509	0.0046	0.0000	0.0008
T_{17}	0,0578	0.0158	0.0894	0.0040	0.0000	0.0011
T_{18}	0.1481	0.0447	0.0656	0.0049	0.0014	0.0002
T_{19}	0.6439	0.0428	0.7982	0.0112	0.0211**	0.0022
T_{20}	0.1984	0.0063	0.8618	0.0010	0.0004	0.0004
T_{21}	0.0328	0.0206	0.2949	0.0095	0.0002	0,0017
T_{22}	0.0494	0.0257	0.1671	0.0110	0.0010	0.0001
T_{23}	0.0465	0.0133	0.6062	0.0037	0.0005	0.0027
T_{24}	0.7135	0.0168	0.0855	0.0016	0.0009	0,0001
T_{25}	0.2093	0.0173	0.0463	0.0017	0.0008	0.0010
Pooled Error	0.2093	0.0214	1.0085	0.0156	0.0012	0.00074

RESULTS AND DISCUSSION

G x E interaction is a category coming from quantitative genetics and it is used in plant breeding. It reflects genotype adaptability and stability. Variation of the genotype in different environments is manifested as a change in phenotype (Kang, 2002). Changes in the phenotypic values result from the reaction of the genotype to the prevailing environmental conditions. In the present study, the pooled analysis of variance for genotypes x environment interaction showed that there is significant difference between the genotypes, environment and G x E interaction (Table 1) indicating the inconsistent performance of genotypes across the environments. This result was in line with the findings of Singh *et al.* (2000) in garlic, Mosisa *et al.* (2001) in maize, Hintsa *et al.* (2011) in wheat and Alemu Dessa Derebe (2014) in shallot. However, genotypes x environment interaction was found to be highly significant only for the characters viz., number of leaves per plant, length of leaf, yield per plant (weight of bulb), number of cloves per bulb, diameter of clove, length of clove and average weight of clove. The analysis of variance for stability parameters in respect of different characters (Table 2) implicated that linear genotypic variance were highly significant for all the characters except diameter of bulb. The variance due to environment plus genotypes x environment were found to be highly significant for all the characters. The linear environmental variances were highly significant for all the characters except diameter of bulb. The linear component of genotypes x environment were found to be highly significant for all the characters except number of leaves per plant and diameter of bulb. Magnitude of variance due to environment (linear) for all the characters over G x E (linear) were high which might be the reason for higher adaptation in relation to yield and other characters which is in accordance with the observations of Mohanty and Prusti (2001) in onion. Partitioning the genotype x environment interaction into linear and non-linear components suggested that both linear and non-linear components were significant for all the characters except number of leaves per plant (for which only non linear component was significant) indicating that response of genotypes varied in different environments Similar findings were also reported by Khar *et al.* (2005).

The analysis for stability parameters was carried out for only those characters where the genotype x environment interactions were significant in the pooled analysis of variance (Table 1). These characters were number of leaves per plant, length of leaf, yield per plant (weight of bulb), number of cloves per bulb, diameter of clove, length of clove and average weight of clove. Rest of the characters which were non-significant were excluded from the stability analysis. The stability analysis was done following the model of Eberhart and Russell (1966) which suggested two stability parameters (i) linear regression and (ii) deviation from such regression. According to them a stable variety will have high mean performance, regression

Table 3: Stability parameter of garlic genotypes for characters under study tested in six environment.

Genotypes	Number of leaf per plant			Length of leaf (cm)			Yield per plant/weight of bulb (g0			No. of cloves/bulb		
	X	bi	Sd²	X	bi	Sd²	X	bi	Sd²	X	bi	Sd²
T_1	6.06	1.1177	-0.0006	32.1	0.9114	-1.8369	15.47	1.0305	-0.2061	22.48	0.8999	-0.5159
T_2	5.33	1.1329	0.0528	28.63	1.0850	-1.6852	13.44	0.9635	-0.1611	15.91	0.6722	-0.8443
T_3	5.94	1.2033	-0.0604	31.67	0.8258	-1.8374	15.25	1.0780	-0.182	21.15	0.8656	0.7125
T_4	6.28	1.2082	0.5324	33.23	0.9989	-1.8306	16.24	1.0266	-0.2086	25.92	1.3724	0.2943
T_5	5.56	1.0557	0.2301	28.00	0.9357	-1.6730	12.38	1.1339	-0.1708	14.77	0.893	-0.4746
T_6	7.00	0.7569	0.0363	34.08	1.0424	-1.7897	17.08	0.8619	-0.1896	28.86	1. 2925	-0.7143
T_7	8.28	0.4931	0.1686	39.35	1.2743	-1.6900	27.48	1.0934	-0.0427	37.18	1.456	14.1255
T_8	7.55	0.6549	0.0785	35.13	1.1391	-1.6399	19.49	0.8889	-0.1017	30.91	1. 2462	-0.8947
T_9	5.50	1.2682	-0.0005	29.72	o.8497	-1.5696	14.28	1.0140	-0.1917	18.29	0.5163	-0.9374
T_{10}	6.51	1.1218	-0.0706	32.81	1.0259	-1.8398	16.06	1.0236	-0.2039	23.64	I 0778	-o 6955
T_{11}	6.11	1.1051	-0.0095	32.41	0.9649	-1.8249	15.68	1.0619	-0.2062	23 19	1.0584	-0.9195
$T1_2$	5.83	1.2666	-0.0018	31.41	0.8068	-1.7562	14.96	0,9499	-0.1132	19.95	0.8023	0.2017
T_{13}	8.91	0.5822	0.1809	37.19	1.2735	-1.3986	20,87	1.5685	-0.0218	32.97	1.168	-0.7423
T_{14}	5.45	1.2807	0.0609	29.31	0.9502	-1.6486	14.12	1.0468	-0.1596	17.70	0.5434	-0.8773
T_{15}	7.39	0.7505	0.1289	34.70	1.0635	-1.7776	18.55	0.8477	-0.2069	30.44	1.2242	-0.6458
T_{16}	6.67	1.0817	-0.0405	33.48	1.0237	-1.8546	16.22	0.9462	-0.1611	26.63	1.5515	0.4424
T_{17}	6,83	0.9164	-0.0020	33.73	1.1070	-1.8354	16.77	0.8958	-0.1515	27.95	1.4024	-0.9191
T_{18}	5.45	0.9215	0.9824	28.99	0.9989	-1.687	13.81	0.9133	4.0612	16.98	0.5134	-0.9429
T_{19}	5.11	1.2794	0.0695	27.54	0.9310	-1.8093	11.50	1.3196	-0.4346	13.00	0.7976	-0.2103
T_{20}	5.83	1.2666	-0.0018	30.21	0.5314	-1.7963	14.73	0.9613	-0.0109	19.55	0.7595	-0.1467
T_{21}	7.17	0.6678	0.0069	34.43	1.0792	-1.8067	18.09	0.8309	-0.1765	29.26	1.2177	-0.7136
T_{22}	5.00	1.2080	0.0163	26.98	0.9303	-1.6735	8.97	0.7559	-0.1599	6.48	0.7768	-0.8414
T_{23}	7.78	0.5821	0.1804	35.59	1.1240	-1.6022	22.28	0.6110	-0.1628	32.03	1.2279	-0.4023
T_{24}	8.00	0.5059	0.0728	36.41	1.1457	-1.7868	23.87	1.2118	-0.5042	32.61	1.1616	-0.9230
T_{25}	5.67	1.2082	0.0140	29.73	0.9437	-1.7472	14.60	0.9649	-0.0067	18..49	0.5031	-0.9622
G. Mean	6.4133	0.9854		32.274	0.9997		16.6996	0.9999		23.4467	0.9999	
SEm ±	0.1899	0.1974		0.1625	0.0652		0.1526	0.0679		0.46)9	0.1117	

Table 3: Cont....................................

Genotypes	Length of clove (cm)			Diameter of clove (cm)			Av. Weight of clove (g)		
	X	bi	Sd²	X	bi	Sd²	X	bi	Sd²
T_1	2.85	0.9837	-0.0138	0.82	0.9823	-0.001	0.52	0.9059	-0.0001
T_2	2.60	0.9614	-0.0099	0.71	1.2448	0.0002	0.35	0.9233	-0.0003
T_3	2.83	0.9816	-0.0140	0.80	1.0059	-0.0007	0.51	0.9205	-0.0004
T_4	2.97	0.9517	-0.0119	0.85	0.8879	-0.0012	0.56	0.9491	-0.0004
T_5	*2.55*	1.0731	-0.0067	0.69	1.3038	-0.000!	0.34	0.9093	-0.0001
T_6	3.05	0.9400	-0.0073	0.99	0.7758	-0.0011	0.65	1.0656	0.0009
T_7	3.71	0.7764	-0.0024	1.07	0.5988	-0.0007	1.37	2.5328	0.0001
T_8	3.13	0.5988	0.0112	0.94	0.6578	-0.0004	0.75	0.9512	0.0013
T_9	2.73	0.8973	-0.0144	0.75	1.1091	-0.0005	0.41	1.0662	-0.0003
T_{10}	2.91	0.9467	-0.0125	0.84	1.0383	-0.0007	0.55	0.9400	-0.0004
T_{11}	2.88	0.9741	-0.0139	0.83	1.0118	-0.0007	0.55	0.9358	-0.0001
$T1_2$	2.82	0.9602	-0.0144	0.78	1.0324	-0.0009	0.50	0.8905	-0.0004
T_{13}	3.56	1.2098	-0.0130	1.03	0.7286	-0.0004	0.93	0.6492	-0.0006
T_{14}	2.70	0.8192	-0.0143	0.73	1.1711	-0.0004	0.40	1.0662	-0.0006
T_{15}	3 14	1.0194	-0.0082	0.92	0.5870	-0.0008	0.72	0.9163	-0.0005
T_{16}	3.00	0.9560	-0.0109	0.86	0.8997	-0.0012	0.60	1.1736	0.0000
T_{17}	3.01	0.9355	-0.0114	0.88	0.8289	-0.0012	0.62	1.2266	0.0004
T_{18}	2.63	0.9632	-0.0105	0.72	1.2124	0.0001	0.38	1.0941	-0.0005
T_{19}	2.38	1.2884	-0.0042	1.32	2.5192	-0.0198	0.30	0.7824	0.0015
T_{20}	2.79	0.9826	-0.0145	0.77	1.1121	-0.0008	0.40	0.8654	-0.0003
T_{21}	3.08	0.9786	-0.0059	0.90	0,6991	-0.0010	0.68	0.9073	0.0000
T_{22}	2.07	1.3361	-0.0045	0.68	1.2183	-0.0003	0.26	0.7573	-0.0006
T_{23}	3.35	1.1082	-0.0117	0.95	0.4985	-0.0007	0.76	1.0028	0.0020
T_{24}	3.46	1.3892	-0.0138	0.99	0.6785	-0.0003	0.86	0.5572	-0.0006
T_{25}	2.77	0.9713	-0.0137	0.78	1.1829	0.0004	0.45	1.0112	-0.0006
G. Mean	2.9214	1.0001		0.864	0.9994		0.5790	0.9999	
SEm ±	0.0335	0.0947		0.0167	0.2032		0.0118	0.0699	

coefficient (b1) near unity, and deviation from regression (Sd²) close to zero. Therefore, all the three parameters *i.e.*, mean, linear regression and non-linear responses seems to be equally important.

The stability parameters high mean, $b_i = 1$ and $Sd^2 = 0$) for number of leaves per plant (Table 3), showed that out of 25 genotypes, four genotypes namely, Akola Garlic-46 (7.00, 0.7569 and 0.0363), Dholi Garlic-10 (6.67, 1.0817 and -0.0405), Dholi Garlic-5 (6.83, 0.9164 and-0.0020) and Farka White (7.17, 0.6678 and .0069) were found to be stable over different environments. In case of length of leaf, genotypes, Bombay White Garlic (39.35, 1.2743, -1.6900), Dholi Garlic-1 (37.19, 1.2735,-1.3986), Munger Garlic White (35.59, 1.1240,-1.6022) and Akola Garlic-43 (35.13, 1.1391,-1.6399) having high mean performance, average regression (b_i near unity) and low deviation from regression, were found to be very stable while genotypes, Faizabad Garlic-5, Faizabad Garlic-6,Dholi Garlic-9, Dholi Garlic-2 and Badshah Garlic were poor performers but stable genotypes.

As far as yield is concerned, the genotypes, Bombay White Garlic (27.48, 1.0934 and -0.0427), Dholi Garlic-1 (20.87, 1.5685 and -0.0218), Surajgarha Garlic Pink (23.87, 1.2118 and -0.5042) and Munger Garlic White (22.28, 0.6110 and -0.1628) had high mean value over population mean, closer to one regression coefficient (b_i) and low and non-significant deviation from regression which suggested that they have high stability and adaptation to unfavourable environments. Among the genotypes, having mean weight of bulb below population mean and having average regression (b_i near unity) and low deviation from regression were Dholi Garlic-3, Jamuna Safed, Dholi Garlic-9, Badshah Garlic and Faizabad Garlic-5 which were poor performers but stable genotypes.

Both linear as well as non-linear component of GxE interactions for number of cloves per bulb were found to be significant suggesting that response of genotypes differed significantly in different environments. The genotypes, Munger Garlic White (32.03,1.2279 and -0.4023), Dholi Garlic-8 (23.64, 1.0778 and -0.6955), Surajgarha Garlic Pink (32.61, 1.1616 and -0.9230), Dholi Garlic-1 (32.97, 1.168 and -0.7423), Dholi Garlic-11 (30.44, 1.2242 and -0.6458) and Akola Garlic-43 (30.91,1.2462 and -0.8947) had high mean value over population mean, closer to one regression coefficient (b_i) and low and non-significant deviation from regression which indicated that they have high stability and adaptation to unfavourable environments. Among the genotypes having mean number of cloves per bulb below population mean and having average regression (b_i near unity) with low deviation from regression were Faizabad Garlic-6/2, Faizabad Garlic-6 and Dholi Garlic-3. These were poor performers but stable genotypes. Similar results were also reported by Jindal *et al.*(1986) in fennel, Sastry *et al.* (1989) in tomato, Romanenko and Savchuk (1990) in coriander, Kalloo *et al.* (1998) in tomato, Dhar and Ram (1999) in French Bean and Pan and Prasad (2000) in garden pea.

The genotypes, Akola Garlic-46 (0.99, 0.7758 and -0.0011), Dholi Garlic-10 (0.86, 0.8997 and -0.0012) and Dholi Garlic-5 (0.88, 0.8289 and -0.0012) were highly stable in respect of diameter of cloves over all the environments as they had average response of regression coefficient (b_i approimately unity) and low and non-significant deviation from regression (Sd^2 below zero) with higher average mean value than the population mean (Table 3), which indicated that they have high stability and adaptation to unfavourable environments.

The stability parameters for average weight of clove exhibited that out of 25 genotypes only five genotypes namely Akola Garlic-46, (0.65, 1.0656 and 0.0009), Akola Garlic-43 (0.75, 0.9512 and 0.0013), Dholi Garlic-11 (0.72, 0.9163 and -0.0005), Dholi Garlic -10 (0.60, 1.1736 and 0.0001) and Munger Garlic White (0.76, 1.0028 and 0.0020) were highly stable over all environments as they had high mean value over population mean, closer to one regression coefficient (b_i) and low and non-signifcant deviation from regression (Sd^2 around zero). From the findings and discussions made so far it may be said that any generalization regarding stability of a cultivar for all the characters is too difficult. The gnotypes studied did not exhibit uniform stability and response pattern for all the characters. Similar observation was also made by Dhadukt *et al.* (2011). However, out of the twenty five genotypes studied so far, genotypes, Bombay White Garlic, Dholi Garlic -1 , Surajgarha Garlic Pink and Munger Garlic White had high mean value over population mean, closer to one regression coefficient (b_i) and low and non-signifcant deviation from regression and was highly stable for yield per plant. These genotypes are likely to perform well in all the six environments.

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