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Morphological characterization of garlic grown under the Ecology of Bihar

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Abstract
Morphological characterisation of twenty five genotypes of garlic collected locally as well as from different research centres of the country was done at Permanent Experiment Area of The Department of Horticulture, Bihar Agriculture College, Sabour, Bihar. The results indicated that the genotypes differed significantly as to the different morphological yield and yield attributing traits. The height of plants varied significantly and ranged between 44.20 cm - 66.27cm.Length and breadth of leaves also showed significant variations among different genotypes. As for the yield characters, the number of cloves per bulb ranged from 13.33-32.33 and showed significant variations. The highest bulb yield per plant was obtained in line 650 (28.54 g) which was significantly superior to all other genotypes and was followed by the genotype, BRG-10 (24.23g) which in turn was at par with the genotype, G282 (20.96g) while the lowest bulb yield was found in IC 373010 (9.17g). Thus the genotypes, 610, BRG10, G282 and IC-375107 were the promising genotypes with respect to yield and yield attributing traits in garlic. Considering high yield potential along with other yield attributing characters as a positive trait for selection, genotypes, 610, BRG10, G282 and IC-375107 were found to be promising under ecology of Bihar.

Keywords: Morphological, characterization, Ecology, Bihar, genotypes

Introduction
Garlic (*Allium sativum* L.) is the second most important species in the onion family, Alliaceae (Islah, 2010 and Baghalian *et al*., 2005) [6, 2]. It is used world over for its bulb for seasoning and flavouring food. Sometimes scapes are also used for edible purposes. Fresh and processed garlic may have some health benefits on human health such as anti-carcinogenic, anti-fungal and anti-bacterial properties (Clemente *et al*., 2011) [3]. Evaluation and accountings are important for exploitation of genetic variability for long term human benefits. Evaluation and characterization provide a rapid, reliable and efficient tool of information to augment the utilization of germplasm. For the development of suitable varieties of garlic, it is essential to evaluate the characters of the available germplasm properly and conserve the collected materials for future use. Variability is a yardstick to the breeders to evolve high yielding and stable varieties through selection, either from the existing genotypes or from the segregates of a cross. Since garlic does not produce seed, breeders cannot breed and develop cultivars specific to growing regions. So, garlic can be improved by selection. The selection of the cultivar should take into consideration several different factors and characteristics, some of which include the adaptability of the cultivar to the climate of the growing area, the market demand of the particular cultivar and the resistance or tolerance of the cultivar to various diseases and pests. There are actually many different cultivar strains of garlic. They may differ in pungency, length of storage, colour, size, number of cloves per bulb, hardiness, and suitability for cooking. Some store longer, some are more gourmets in flavour and some mature earlier and others later. Immelman (2006) [5] and StavelIkova (2008) [17] revealed high diversity in garlic genotypes from point of morphological characterizations and reported that the first step of description of garlic genetics resources comprised of morphological characterization. Traits like bulb weight, number of cloves per bulb and clove weight may be used as criterion of selection, for improving agronomical characters of garlic in breeding programme (Fanaei *et al*., 2014) [4]. Growing of inferior genotypes with traditional production practices are considered to be the main causes for low yield of this important spice crops. Moreover 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) [18, 11, 8].

Environmental factors not only influence bulb formation but also the flavour quality, as observed on onion (Randle, 1997; Randle and Lancaster, 2002) [14, 15]. Therefore the present study was intended with the idea of evaluation and characterization of garlic germplasms in the agro ecological condition of Bihar in order to make available efficient tool of information to supplement the utilization of germplasm in further breeding programme as well as to enhance bulb production under the ecology of Bihar.

Materials and Methods

The present study was conducted at Permanent Experiment Area of The Department of Horticulture Bihar Agriculture College, Sabour. The experimental material consisted of twenty five genotypes of garlic. The genotypes were selected out of collections maintained at Bihar, Pusa, BAC Sabour, and some local collections were also taken. There were hundred fifty plants in each plot having area of 1.5m x 1.5m, planted at 15 cm distance between the row and 10 cm distance between plants 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 or 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 data were analyzed statistically according to the method outlined by Panse and Sukhatme (1984) [13].

Results and Discussion

Results indicated that all the treatments varied significantly among themselves with respect to plant height, number of leaves, length of leaves, breadth of leaf, yield of bulb per plant, neck thickness, equatorial diameter of bulb, polar diameter of bulb, length of clove, weight of clove, diameter of clove and number of cloves. The maximum plant height was recorded in genotype IC-372974 (66.27cm) and the minimum (44.20 cm) was observed in the genotype, Phule Basant. The variability for plant height was also observed by Nurzynska-Wierdak (1997) [12], Kohli and Prabal (2000), Jogdande *et al*. (2004) [7] and Sengupta *et al*. (2007) [16]. The maximum leaf length (54.10cm) was observed in line IC 141151. However, the lowest leaf length was noted in Phule Basant (32 cm). The highest (12.67) leaves/plant was exhibited in line IC-372974, while it was the lowest, 5.67leaves/plant in WG-323. The highest leaf width was found in genotype 650 (1.9 cm) and narrow in genotype 638(0.5 cm). Similar findings were observed by Kohli and Prabal (2000), Jogdande *et al*. (2004) [7] and Sengupta *et al*. (2007) [16] in garlic.

As for the bulb characters, the line BRG-10 recorded maximum equatorial bulb diameter while the minimum equatorial bulb diameter was found in line IC-49387. The maximum polar diameter of bulb was recorded in genotype 650, and the minimum in IC 373010. The maximum number of cloves per bulb was recorded in genotype 650(32.33) and minimum was in M-118(13.33). The maximum average weight of cloves was recorded in BRG-10, while the minimum average weight of cloves was exhibited in RG482.The highest bulb yield per plant was obtained in line 650(28.54 g) which was significantly superior to all other genotypes and was followed by the genotype, BRG-10(24.23g) which in turn was at par with the genotype, G282 (20.96g) while the lowest bulb yield was found in IC 373010 (9.17g). These findings are quite similar to those of Lammerink (1989) [10], Nurzynska Wierdak (1997) [12], Kohli and Prabal (2000), Jogdande *et al*. (2004) [7] and Anonymous (2006-07b). Similar, results have been reported by Heredia *et al.* (1991), Perez and Lopez (2002), Pandey *et al.* (1996), Kohli and Prabal (2000), Shree (2002-2003) and Jogdande *et al*. (2004) [7] in garlic. Higher bulb yield may be attributed to cumulative effects of number of leaves per plant, polar and equatorial diameter of bulb, number of cloves per bulb and average weight of cloves. These results might be due to the genetic variations among garlic cultivars and their capability for exploiting the environmental resources particularly, light, CO2, water and nutrients (Abdel-Razzaak and El-Sharkawy, 2013).

Based on results it can be concluded that there was significant variation in garlic genotypes grown under the environmental conditions of Bihar specially. The genotypes varied with respect to various morphological and yield characters. These traits may be used as criterion of selection, for improving agronomic characters of garlic in breeding programs. The genotypes, 610, BRG10, G282 and IC-375107 were the promising genotypes with respect to yield and yield attributing traits in garlic.

Table 1: Genotypes of Garlic used under investigation

S.N.	**Genotypes**	**Source**
1.	IC344844	Collection from DOGR maintained at BAU, Sabour
2.	G50	Collection from DOGR maintained at BAU, Sabour
3.	BRG-1	Local collection maintained at BAU, Sabour
4.	Phule Basant	Collection from DOGR maintained at BAU, Sabour
5.	WG 22	Collection from DOGR maintained at BAU, Sabour
6.	IC-337433	Collection from DOGR maintained at BAU, Sabour
7.	BRG-10	Local Collection maintained at BAU, Sabour
8.	BRG-13	Local Collection maintained at BAU, Sabour
9.	RG-482	Collection from DOGR maintained at BAU, Sabour
10.	W-323	Collection from DOGR maintained at BAU, Sabour
11.	IC-374951	Collection from DOGR maintained at BAU, Sabour
12.	RG-61	Collection from DOGR maintained at BAU, Sabour
13.	IC 37506	Collection from DOGR maintained at BAU, Sabour
14.	638	Collection from DOGR maintained at BAU, Sabour
15.	G-282	Collection from DOGR maintained at BAU, Sabour
16.	IC 141151	Collection from DOGR maintained at BAU, Sabour
17.	IC 373010	Collection from DOGR maintained at BAU, Sabour

18.	IC-372974	Collection from DOGR maintained at BAU, Sabour
19.	G-323	Collection from DOGR maintained at BAU, Sabour
20.	IC-15642	Collection from DOGR maintained at BAU, Sabour
21.	M-118	Collection from DOGR maintained at BAU, Sabour
22.	IC-375107	Collection from DOGR maintained at BAU, Sabour
23.	M-90	Collection from DOGR maintained at BAU, Sabour
24.	650	Collection from DOGR maintained at BAU, Sabour
25.	BRG-6	Local collection maintained at BAU, Sabour

Table 2: Meteorological data during crop period

Month	Temperature(^{0}C)		Relative Humidity (%)		
	Max.	Min.	Max.	Min.	Rainfall(mm)
October-2014	32.2	20.3	87.0	69.0	3.2
November-2014	29.0	14.4	86.0	49.0	-
December-2014	21.5	9.1	94.0	67.0	0.4
January-2015	20.6	8.8	93.0	67.0	39.3
February-2015	23.9	8.2	87.0	53.0	4.7
March-2015	29.9	15.5	78.0	51.0	3.27
April-2015	32.5	19.4	80	52	70.9
May-2015	36.1	25.2	76	54	27.2

Table 3: Physical Status of the soil of the experimental plot

S.N	Soil status	Percentage	Method of determination
1	Sand %	72.54	Hydrometer method (Bonyoucos, 1962)
2	Silt %	13.20	
3	Clay %	12.55	
4	Texture class	Sandy loam	Triangular method Sigmoid, 1928

Table 4: Mean performance for morphological characters of 25 genotypes under study

Genotypes	PH (cm)	LL(cm)	BL(cm)	NL/P	NT(cm)	ED(cm)	PD(cm)	Y/P(g)	WC(g)	LC(cm)	DC(cm)	NC/B
IC 344844	62.00	50.47	0.80	10.67	1.12	3.18	2.65	12.11	0.86	1.28	0.61	14.00
G50	51.37	43.57	0.80	7.67	1.15	3.58	2.90	18.71	1.05	1.42	0.80	15.67
BRG-1	56.33	49.43	0.78	10.00	0.99	3.66	2.95	18.47	0.95	1.82	0.93	19.00
Phule Basant	44.20	32.00	0.80	8.33	1.08	3.87	2.64	18.50	0.70	1.56	0.81	25.67
WG 22	45.30	33.03	0.51	10.00	1.10	3.43	2.74	15.43	0.63	1.38	0.71	24.00
IC-337433	52.63	40.33	0.59	10.00	1.04	3.10	2.40	11.62	0.57	1.53	0.68	19.33
BRG-10	62.03	50.97	0.83	10.33	1.05	4.47	3.53	24.23	1.22	1.85	0.97	23.00
BRG-13	54.70	43.60	0.65	8.00	0.92	3.18	2.48	10.49	0.60	1.41	0.80	16.00
RG482	49.60	41.37	1.37	10.00	0.96	3.10	2.65	12.69	0.51	1.24	0.77	24.67
WG-323	49.30	37.93	0.65	5.67	1.13	4.06	2.47	10.19	0.69	1.75	0.90	13.67
IC-49387	45.60	33.40	0.53	6.33	0.94	2.36	2.84	18.11	0.58	1.33	0.64	30.67
RG 61	60.33	51.10	0.82	8.00	1.19	3.56	2.45	9.24	0.61	1.48	0.70	14.67
IC-37506	66.00	52.67	0.70	8.00	0.98	2.77	3.14	19.61	0.76	1.16	0.63	24.33
638	48.00	38.20	0.50	6.33	1.18	3.67	2.77	13.09	0.55	2.23	1.06	23.33
G282	52.20	46.47	1.20	11.33	0.92	3.68	3.33	20.96	0.82	1.70	0.82	24.67
IC 141151	54.73	54.10	0.91	10.00	1.31	3.50	3.32	19.13	1.09	1.68	0.84	17.00
IC 373010	53.63	39.77	0.71	8.00	0.91	3.91	2.12	9.17	0.53	1.56	0.76	16.00
IC-372974	66.27	48.33	0.97	12.67	0.86	2.81	2.69	18.08	0.90	1.43	0.77	19.33
G 323	48.30	41.00	1.14	8.00	0.84	2.82	2.64	15.35	0.67	1.55	0.73	22.33
IC-15642	50.00	40.10	0.70	9.00	1.12	3.40	3.03	18.74	0.83	1.37	0.79	20.67
M-118	56.17	42.30	0.70	9.67	1.06	3.81	2.54	11.53	0.73	1.68	0.80	13.33
IC-375107	53.67	44.50	1.40	7.33	1.18	2.91	3.05	20.43	0.75	1.41	0.71	26.33
M-90	51.63	39.53	1.57	12.00	1.01	4.06	2.88	16.86	0.87	1.75	0.92	19.33
650	61.07	51.13	1.90	7.33	1.13	4.23	3.85	28.54	0.74	1.32	0.73	32.33
BRG-6	61.67	52.87	1.48	9.67	0.91	2.75	2.77	15.86	0.70	1.12	0.82	22.33
Mean	54.27	43.93	0.92	8.97	1.04	3.43	2.83	16.28	0.76	1.52	0.79	20.87
C.V.	6.85	6.23	13.29	10.66	8.03	8.19	9.43	12.75	7.17	11.87	10.53	5.86
S.E.	2.15	1.58	0.07	0.55	0.05	0.16	0.15	1.20	0.03	0.10	0.05	0.71
C.D. 5%	6.10	4.49	0.20	1.57	0.14	0.46	0.44	3.41	0.09	0.30	0.14	2.01
C.D. 1%	8.14	5.99	0.27	2.09	0.18	0.62	0.59	4.55	0.12	0.40	0.18	2.68

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