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Evaluation of Garlic Genotypes for Yield and Yield Components in Islamabad, Pakistan Environment

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ABSTRACT

Seven different cultivars of garlic (Allium sativum L.) were evaluated for yield and yield parameters at the vegetable program (HRI), National Agricultural Research Council (NARC) Islamabad in 2014-15 and 2015-16.Yield parameters like survival %age, no of leaves/plant, plant height, no. of cloves/bulb, avg. bulb weight and fresh yield were recorded. In both years, it was observed that Cultivar "NARC-G1" gave the best survival (100%), minimum and wider leaves/plant (10), average plant height (38.2 cm), minimum cloves (8.3) per bulb and comparatively larger bulbs, maximum bulb weight (126.6 gm) and maximum fresh yield (25.6 t/ha), followed by Cultivar " Italian", which gave (22.4 t/ha), while Cultivar "Lehson Gulabi" was noted at the bottom and gave (15.2 t/ha).Hence, "NARC-G1" cultivar could be utilized in term of better yield and as well as industrial use for value addition purposes.

1 Introduction

Garlic (*Allium sativum L.*) is a member of Amaryllidaceae family, the same family as onions, shallots and leeks which are grown for spices/condiment. Majority of the garlic is sold to the fresh market as whole, fresh bulbs, green garlic or escapes. Processed products such as garlic spreads or chopped garlic are also sold but to a lesser extent. It has higher nutritive value than other bulb crops and it is the 2nd most widely used member of the Alliums species [1]. Keeping in view its medicinal value, especially Allicine of garlic which has antibacterial properties [2, 3], garlic is widely used in all households throughout the year. Garlic is used in sauces, soups and for seasoning foods. The cloves are also pickled in vinegar. Garlic is rich in phosphorus, calcium and carbohydrates.

There is a need to explore best garlic genotypes for every area [4]. In Pakistan the present yield of garlic is unsatisfactory due to negligible attention being paid in this direction. This situation can be addressed by changes in agronomical practices [5]. Ennes [6] stated that varieties do not perform equally in all environments, but some tend to be close to the ideal than other. Varietals response can be measured through interaction of genotypes and the environment. Variations in yield parameters have been reported by Pandy and Sing [7] in variety HGI for plant height and number of leaves per plant, and the lowest incidence of infection by purple blotch (*AlternariaPorri*) and stemphylium. Different environ-mental factors effect performance of garlic cultivars and even date of planting plays an important role in yield performance [8]. Performance of garlic cultivars also varies for their medicinal use such as polyphenolic content and antioxidant properties [9]. Wild garlic is also found as weed and needs necessary control in truff grass [10].

According to Fruit, Vegetables and Condiment Statistics of Pakistan (FV& CSP) 2014-15, [11] currently, production of garlic in Pakistan is 72987 tons from an area of 7973 hectares with an average yield of 9.15 tons/hectare. Major garlic producing province is Khyber Pakhtunkhwa (KPK) with an average production of 34167 tons followed by Punjab (25079 tons), Baluchistan (7491tons) and Sindh (6250 tons). Highest yields are obtained in KPK (12.12 T/ha) followed by Baluchistan (8.82 T/ha).The yield of top producing countries in the world is Uzbekistan (26.7 T/ha), Haiti (26.3 T/ha) and China (25.4 T/ha) while of Pakistan is 8.6 T/ha which is 3.5 times less than top yielding countries [12]. This yield gap has resulted in the import of garlic from other countries to cater the demand of garlic in Pakistan. Currently, Pakistan is importing 40303 tons of garlic from China, India and Chile that is worth about 45.71 billions of rupees. This problem could be catered by producing high yielding garlic cultivars on the mainland to cover the international yield gap.

Keeping in view the importance of garlic cultivars, their environmental interactions and performance across the years, the present study was conducted to evaluate garlic cultivars for acclimatization and performance studies at Islamabad.

2 Materials and Methods

Seven promising cultivar/lines namely "NARC-garlic-1, Italian, Iranian, MJ-84, Chinese, GTS-001 and Lehson gulabi (as a Check) were planted for screening and evaluation at the Vegetable Research Area NARC, Islamabad in Mid- October 2014-15, and 2015-16.

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Table 1: Analysis of variance for different yield parameters of seven garlic cultivars.

Factor	DF	Survival %	No. Leaves/pl	Pl Height (cm)	Avg. Bulb Wt (g)	No. Clove/bulb	Fresh Yield (t/ha)
Rep	2	1.26	0.09	1.37	153.49	0.45	29.07
Varieties	6	0.69	9.24 **	183.97 **	4778.14 **	222.3 **	64.34 **
Year	1	0.3	0.29	16.46 **	137.52	54.85 **	18.13 *
Var,s x Year	6	0.29	0.04	0.39	8.7	1.63	0.27
Error	14	0.39	0.39	0.63	95.56	2.45	2.42

Significant at 5% = *, Highly significant at 1% = ** SOV = Source of variation, DF = degree of freedom

Table 2: Mean data on various aspects of garlic cultivars in 2014-15 and 15-16 at Islamabad conditions.

	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Treatment	Survival %age		No. of Leaves/plant		Plant height (cm)		No. of cloves/bulb		Bulb weight (g)		Yield (T/ha)	
Narc-G1	100.00	100.00	10.06 d	9.86 c	38.86 b	38.20 b	10.00 c	8.33 d	118.40 a	126.63 a	24.93 a	25.60 a
Iranian	99.66	99.66	11.73 c	11.53 b	28.40 d	26.36 f	15.33 b	13.33 bc	54.06 d	58.96 c	17.13 bc	18.60 d
MJ-84	99.00	99.53	12.26 bc	11.96 b	30.16 cd	28.53 e	16.00 b	15.00 b	56.13 d	60.13 c	19.60 b	21.46 bc
Italian	99.00	100.00	12.30 bc	12.06 b	36.96 b	36.30 c	14.00 bc	11.66 c	80.10 bc	82.20 b	21.06 ab	22.46 b
Chinese	99.33	99.00	12.06 bc	11.83 b	31.40 c	30.16 d	16.66 b	12.33 bc	44.03 e	45.83 d	18.60 bc	20.33 cd
Lehson gulabi (Check)	100.00	100.00	13.86 a	13.63 a	41.63 a	40.63 a	29.66 a	27.66 a	38.13 e	41.23 d	14.33 c	15.26 e
GTS-01	99.33	99.33	13.30 ab	13.53 a	28.83 d	27.30 f	17.00 b	14.33 b	75.86 c	77.06 b	18.13 bc	19.26 d
LSD at 5%	NS		1.414		2.162		4.588		6.588		4.698	

NS= non-significant, letters a, b, c, d, e and f represent the varieties which are significantly different from each other

Random complete block design with three replications was followed. Row to row and plant to plant spacing was maintained at 25cm and 10 cm respectively. Farm yard manure FYM was applied @ 30 cart load/ha at land preparation. Chemical fertilizers i.e. Nitrogen, Phosphorous and potassium NPK @ 120: 90: 80 kg/ha were applied. Half of the nitrogen and whole of the P and K were applied during land preparation, while rest of the N was applied in two equal doses, two months after planting with monthly intervals. Soil pH was 8.1, EC 0.18 dS/m, organic matter 0.9 % with fine silty, mixed hyperthermic Udic Haplustalf soil type. All cultural practices like weeding, hoeing, irrigations were done according to scheduled programme. Data were recorded on the following parameters, i.e. Survival %age, no. of leaves per plant, plant height in centimeters, no. of cloves per bulb, bulbs weight in gram and fresh yield data (t/ha).Statistical analysis was done using statistical package "R".

3 Results and Discussion

Analysis of variance (Table 1) indicated the importance of garlic cultivars for their performance across the years for yield and yield parameters. All varieties have shown significant results for all parameters except survival percentage which could be due to highest germination % of all genotypes studied. Yield of any crop is based on number of plant in unit area. This trait is very important to obtain the prescribed yield of specific crop, i.e.ifplant population is complete in the unit area then the production should also be on indices. Sood et al. [13] also reported significant variation in garlic genotypes for agronomic traits. Variations in plant height, number of cloves per bulb and fresh yield were found to be significant which indicates the interaction of environment i.e these parameters could change by changing the environmental conditions of the crop. Compatible environment could produce a better yield, greater number of cloves and higher plant height which will be useful in enhancing the production of garlic cultivars and this depends on the genetic ability of any cultivars to exploit environmental conditions particularly, light, CO_2, water and nutrients [14]. Similar results have been reported by StavelIkova et al. [15], Noorbakhshian et al. [16] and Panthe et al. [17].

Table 2 shows the findings of this study. In the first year (2014-15) maximum survival (100 %) were recorded in cultivars "NARC-G1, Italian and Lehson gulabi (check)", while minimum survival (99.0 %) were noted in cultivar "Chinese". The same pattern has been observed in next year for survival % age which was insignificant for all

the cultivars studied (Table 2). Average performance for survival %age of all cultivars for two years trial has been shown in Fig. 1. The results reveal that maximum germination %age maybe due to genetic make-up and as sufficient food stuff or emergence was available in all studied genotypes [2]. Moreover, the presences of allicin components also play an essential role in theprotection of seedlings from fungal and bacterial diseases, ensuring high survival %age [18]. Figliuolo et al. [19] also reported genetic variations in agronomic traits in studied cultivars.

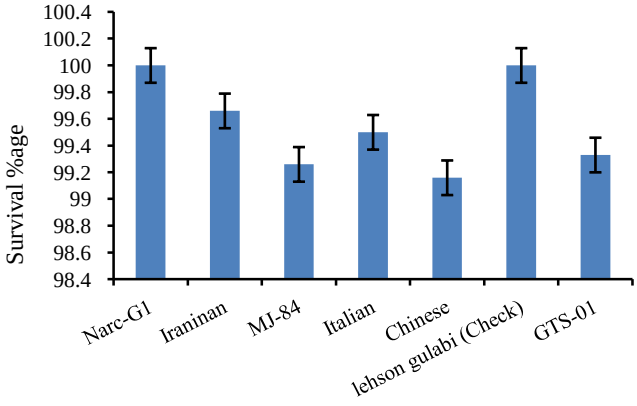

Fig. 1: Combined plot of survival %age of seven garlic cultivars for the years 2014-15 & 2015-16.

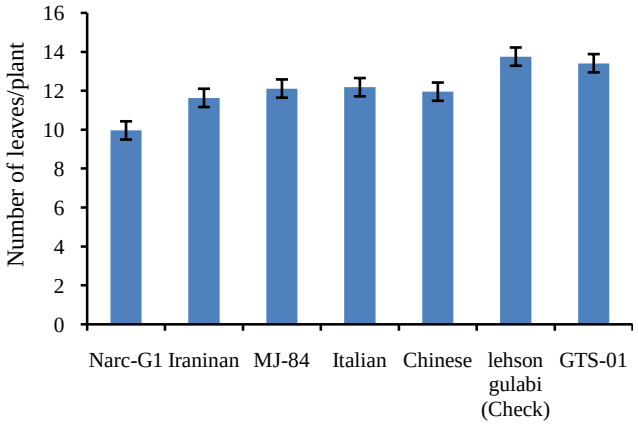

Fig. 2: Combined plot of No. of leaves/plant in seven garlic cultivars for the years 2014-15 & 2015-16.

Number of leaves per plant are an important trait for fixation of photosynthates in cloves and bulb, ultimately acting as major contributor for yield potential [17]. The results revealed that maximum leaves (13.8) were noted in cultivar "Lehson gulabi" (check), while minimum leaves per plant (10.06) were noted in NARC-G1. In the 2nd year, similar results were obtained. Leaves/plant in both years for all cultivars has been shown in Fig. 2. Although, the numbers of leaves in NARC-G1 are less than Lehson gulabi, but they are wider; exposing more surface area for photosynthetic process which plays an active role in enhancing yield.

For plant height as indicated in Fig. 3, maximum plant height (41.63 cm) was recorded in cultivar "Lehson gulabi (check)" followed by "NACR-G1" (38.86 cm) and Italian (36.96), while minimum plant height (28.40 cm) was noted in cultivar "Iranian". The same sequence of cultivar response/ behavior was observed in both years for plant height. These results agree with the results reported by Al-Otayk et al. [2] who observed variation up to 70 cm in plant height of garlic cultivars. Hussein et al. [20] also reported plant height variation among garlic cultivars indicating that it is a genetic characteristic which varies from variety to variety and is also influenced by agronomic practices. Omer and Abou-Hadid [21] reported maximum plant height (105.5 cm) in Egyptian cultivars in comparison to Chinese garlic.

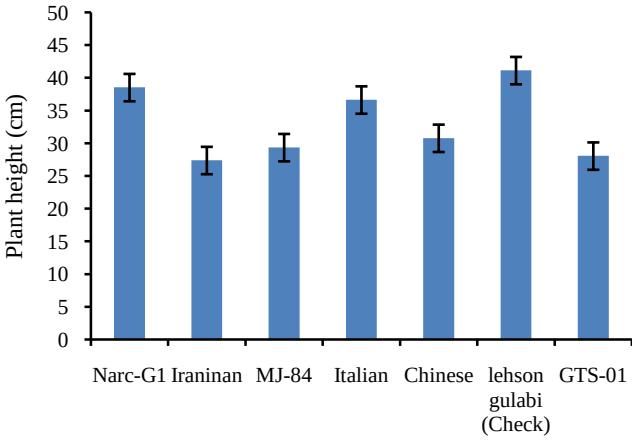

Fig. 3: Combined plot of plant height (cm) of seven garlic cultivars for the years 2014-15 & 2015-16.

Number of cloves per bulb act as seed yield index in any garlic genotype [16] and are also helpful in completing plant population in the field. However, greater number of cloves never means high yield in term of weight, as in this study, maximum cloves/bulb (29.66) were noted in cultivar "Lehson gulabi (check)".Minimum cloves/bulb (10.0) were recorded in cultivar "NARC-G1".However, the bulb weight was the higher in NARC-G1 than in Lehson gulabi (see Figs. 4 and 5).

The results obtained in the current study for both years revealed that highest bulb weight (118.40 g) was recorded in cultivar 'NARC-G1", followed by Italian cultivar (80.10g), while minimum bulb weight (38.13g) was obtained in cultivar " Lehson gulabi" (check). The results for both years were similar. Bulbs weight (g) has maximum positive effect on yield and maybe used for enhancing garlic production [16]. Panthe et al. [17] have also reported variations in garlic genotypes based on bulb weight, a major contributing trait in garlic yield.

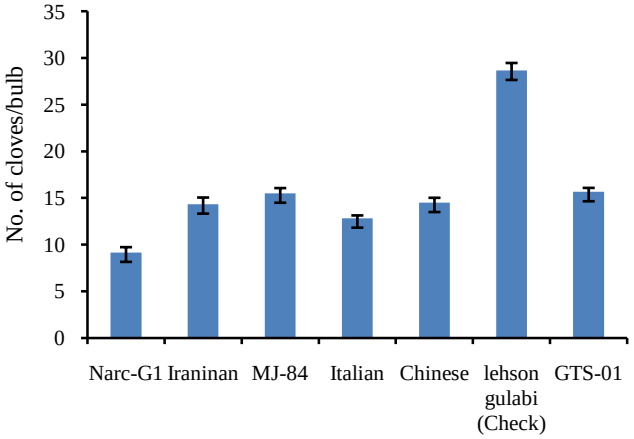

Fig. 4: Combined plot of no. of cloves/bulb in seven garlic cultivars for two years (2014-15 & 2015-16).

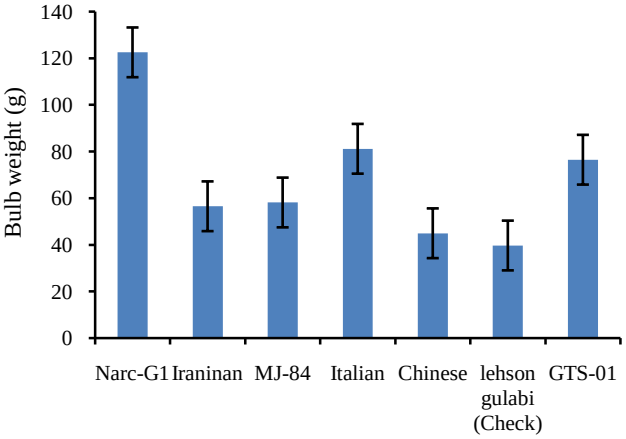

Fig. 5: Combined plot of bulb weight(g) of seven garlic cultivars for the years 2014-15 & 2015-16.

Fresh yield data (t/ha) were also highly significant at 5% level of probability and follow the same pattern as bulbs weight in (g) data (Fig. 6). The statistical results revealed that maximum fresh bulbs yield (24.93 t/ha) was recorded in cultivar "NARC-G1", followed by cultivar "Italian" (21.06 t/ha). The minimum fresh bulbs yield (14.33 t/ha) wascontained in cultivar "Lehson gulabi (check)". All other parameters/treatments were in between regarding fresh yield. Similar results were obtained in both years Sood et al. [13], Panther et al. [17], Noorbakhshian et al. [16, 22] have also reported variations in cultivars regarding yield parameter. Environmental conditions of both years have a profound effect on yield which resulted in variation as indicated in Table 1 and 2. These results are in accordance with Anon [23] and Hussein [20] who stated that the difference in agro-climatic conditions for garlic cultivation would create variation in the experiment.

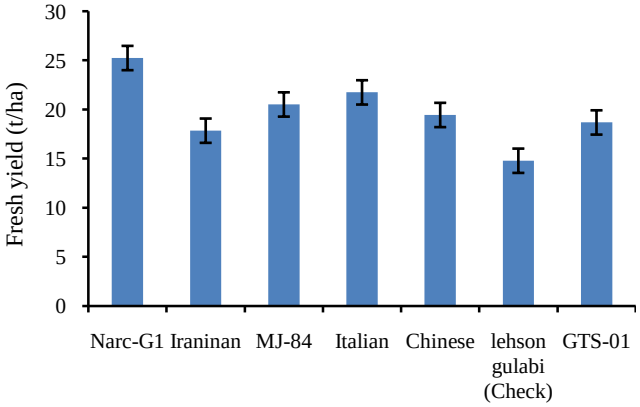

Fig. 6: Combined plot of fresh yield (t/ha) of seven garlic cultivars for the year 2014-15 & 2015-16.

4 Conclusion

Based on results it can be concluded that there are variations in garlic genotypes especially in the number of leaves per plant, plant height, number of cloves per bulb, bulb weight and fresh bulb yield. These traits may be used as criteria for selection, for improving agronomic characteristics of garlic in breeding programmes. Among genotypes, NARC-G1 was found to be the best across the years on the basis of growth, development and yield performance than other garlic genotypes. So this cultivar may be considered for replacement with local varieties i.e. Lehson gulabi and Iranian cultivars in Islamabad, Pakistan.

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