
Adaptation Trail of Garlic (*Allium sativum* L.) Varieties in the High Land of Eastern Hararghe Zone, Oromia, Ethiopia

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Abstract: Garlic (*Allium sativum* L.) belongs to the family Alliaceae and is the second most widely used *Allium* next to onion. Eastern Hararghe has a considerable potential agro ecology which is suitable for garlic production. However, lack of improved and adaptable varieties of this crop is the major production constraints to study area. A field experiment was conducted for two consecutive years (2019 and 2020) during the cropping season on farmers' land at Kombolcha and Gursum districts. The objective of the study was to identify adaptable, high yielding and diseases tolerant garlic varieties for study area and similar agro ecology. The treatments arranged in randomized complete block design with three replications. The treatments were consisted of five garlic varieties (Chelenko I, Kuriftu, Tsedey 92, HL and Chefe) and one local check. The result of the study showed significant differences among varieties for all the recorded traits except days to maturity. Among the varieties, Tsedey 92 provided about 54.3% and 13.3% yield advantages over the local and standard check, respectively. Also Tsedey 92 was tolerant to rust disease than other varieties and local cultivar. Therefore, for sustainable garlic production and productivity in study area Tsedey 92 was recommended and need to be demonstrated.

Keywords: Adaptation, Bulb Yield, Diseases, Garlic, Varieties

1. Introduction

Garlic (*Allium sativum* L.) belongs to the family Alliaceae and is the second most widely used *Allium* next to onion [14]. Garlic is among the most important bulb vegetable crops used as a seasoning or condiment of foods because of its pungent flavor. Garlic adds a taste to foods as well as helps to make them more palatable and digestible [7]. Garlic has higher nutritive value than other bulb crops in addition to containing antibiotics like garlicin and allistatin [9]. In Ethiopia, the area coverage of garlic during the 2017/18 main cropping season was 19,412.49 ha, and total production was about 178, 22.19 tonnes with an average productivity of 9.1 t ha⁻¹ [2]. This far below the world average yield of 16.71 t ha⁻¹ [3] and neighboring country like Egypt produced 309,155 tonnes with productivity of 24.34 t/ha [4]. The low yield of this crop due to many biotic and abiotic factors such as lack of high yielding varieties, non-availability of quality seeds, imbalanced fertilizer use, lack of irrigation facilities, lack of proper disease

and insect pest management and other agronomic practices, low storability, and lack of proper marketing facilities [5, 11]. Eastern Hararghe has a great potential to produce garlic under rain fed and irrigation. However, due to lack of improved and adaptable garlic varieties with their improved agronomic practices the farmers use only the local cultivar with their own traditional production. Even if the area is very suitable and the crop is very important commercially, farmer's income generation from garlic and productivity is still unsatisfactory. There are no any research efforts made in relation to adaptability of garlic varieties in study area. Therefore, objective of this study was to identify adaptable, high yielding and diseases tolerant garlic varieties for study area and similar agro ecology.

2. Materials and Methods

2.1. Description of Experimental Site

The experiment was conducted under rain fed for two

consecutive years (2019 and 2020) at Kombolcha and Gursum districts on farmers' land, Eastern Hararghe zone, Oromia region state, Ethiopia. Kombolcha is located at 17 km far away from Harar town. The altitude of district ranges from 1200 to 2460 meters above sea level. The district receives a mean annual rainfall of 600-900 mm, which is bimodal and erratic in distribution. The small rainy season starts in February/March and extends to mid-May, while the main rainy season stretches between July and August. The

mean annual minimum and maximum temperatures are 13.8 and 24.4°C, respectively [8]. Gursum is located at 75km far away from Harar town. The altitude of the district ranges from 1200 to 2938 m above sea level with the annual rain fall of 650 to 750 mm and the mean annual minimum and maximum temperature of 18 and 25°C, respectively. The area has short rainy season March to April and long rainy season June to August [13]

2.2. Experimental Materials

Table 1. Description of five garlic varieties and one local check selected for the trial.

No	Varieties	Year of released	Breeder/Maintainer
1	Chefe	2015	Debre Zeit Agricultural Research center
2	Kuriftu	2010	Debre Zeit Agricultural Research center
3	Tsedey 92	1999	Debre Zeit Agricultural Research center
4	Holeta	2015	Debre Zeit Agricultural Research center
5	Chelenko I(Standard check)	2014	Haramaya University
6	Local	-	Farmers of study area

Source =Ministry of Agriculture and Natural Resources (10)

2.3. Treatments and Experimental Design

The treatments were consisted of five garlic varieties and one local check (Table 1). The trial was carried out in randomized complete block design (RCBD) having three replicates in a gross plot size of 3.6m² (1.8m and 2m) with a spacing of 1m between replicates and 0.5m between plots. All treatments were assigned randomly to the experimental plots. The experimental field was prepared following the conventional tillage practice using oxen plow. Cloves of medium sized (2 -3 g) were planted by hand in rows 30 cm apart and with 10 cm between plants with in rows. N was split applied in the form of Urea half at planting and the other half at 30 days after planting while all the NPS was applied at time of planting.

2.4. Data Collection

Data were recorded on plant height, leaves length, bulb diameter, number of cloves per bulb and bulb weight from a sample of 10 representative plants while days to maturity and bulb yield were collected on plot base. Also disease data were collected by scale (1 to 5).

2.5. Data Analysis

Analysis of variance were carried out using GenStat discovery 15th edition software for the parameters studied following the standard procedures [6]. Means that showed significant difference were compared using Least Significant Difference (LSD) test at 5% significant level.

3. Results and Discussion

Combined analysis of variance showed the presence of highly significant ($P \leq 0.01$) differences among the varieties for the plant height, number of cloves per plant, bulb diameter and yield; significant difference ($P \leq 0.05$) for leave length and bulb weight. The presence of significant differences among varieties indicates the presence of genetic variability for each of the characters among the tested varieties. There was also highly significant ($P \leq 0.01$) differences among treatments for maturity date; significant difference ($P \leq 0.05$) for plant height due to the environmental variation. Only bulb weight was significant ($P \leq 0.05$) differences among treatments due to the Genetic-environment interaction.

Table 2. The mean squares for different sources of variation and the corresponding CV (%) for parameter studied.

S.V	DF	PH	DM	LL	NCPB	BD	BW	BY
Rep	2	14.73	0.26	32.62	0.306	0.53	35.97	81.79
Variety	5	244.44**	4.88	68.84*	26.8**	202.8**	120.54*	2939.78**
Environment	1	206.72*	2900.7**	53.13	0.038	94.35	117.86	172.33
V * E	5	37.69	9.41	4.41	2.095	12.71	39.8*	133.45
Error	58	50.96	66.1	21.47	4.102	15	49.99	90.08
Total	71							
CV (5%)		14.7	5.8	13.8	19.6	15.4	33.9	15

Keys: *, **: significant at 5% and 1% respectively, S.V=source of variation, E=environment, V * E=variety verses environment, CV=coefficient of variation, DF=degree of freedom DM=days to maturity, PH=plant height, LL=leaf length, NCPB= number of clove per bulb, BD=bulb diameter, BW=bulb weight, BY=bulb yield

Table 3. Combined mean of yield and yield parameters of garlic varieties over years and locations.

Varieties	DM	PH(cm)	LL(cm)	BD(mm)	NCPB	BW(g)	BY(t/ha)	RDS
Tseday 92	140.4	48.98b	35.44ab	31.20a	10.08b	26.18a	8.45a	1
Chelenko I	139.9	55.29a	36.51a	27.46b	10.17b	22.50ab	7.46b	2
Kuriftu	140	46.9bc	31.54b	26.72b	11.11b	20.98ab	7.00b	2
Chafe	139.6	46.02bc	31.32b	25.16bc	9.47bc	18.96b	5.17c	3
Local	140.1	51.52ab	35.28ab	22.98c	12.75a	19.54b	5.47c	3
HL	138.6	42.37c	31.47b	23.37c	8.36c	17.14b	4.34d	4
LSD (5%)	NS	5.90	3.70	2.71	1.61	5.78	0.79	
CV (%)	7.4	14.9	13.5	12.7	19.1	33.9	15.4	

Keys: NS= Not significant, CV=Coefficient of Variation, LSD= Least Significant Difference. Means followed by different letters within columns are significantly different by Duncan's new multiple range test (P = 0.05). DM=days to maturity, PH=plant height, LL=leaf length, NCPB= number of clove per bulb, BD=bulb diameter, BW=bulb weight, BY= bulb yield, RDS= Rust disease score (1-5)

3.1. Maturity Date

The current result showed that there was no significance difference among varieties, but HL variety was early matured (138.6 day) followed by Chafe (139.6) while Tseday 92 variety was late maturity date(140.4 days) compared to other varieties and local.

3.2. Plant Height and Leaf Length

The current study revealed that the type of variety affected the plant height and leaf length. The highest plant height (55.29cm) was recorded from Chelenko I followed by local (51.52cm) and Tseday (48.98cm) while the lowest plant height (42.37cm) was recorded from HL. On the other hand, a significant the highest leaf length (36.51cm) was recorded from Chelenko I followed by Tseday (35.44cm) and local check (35.28a) while the lowest leaf length was recorded from Chafe variety (31.32cm). In contrast to current finding research reported that the highest pseudo stem length was recorded from local cultivar (28.80 cm) followed by Kuriftu (24.53 cm) [1]. This might be variation between the two environments.

3.3. Bulb Diameter and Number of Cloves Per Bulb

Significantly the highest bulb diameter was recorded from Tseday 92 (31.2mm) followed by Chelenko I (27.46mm) while the lowest bulb diameter (22.98mm) was recorded from local check. On the other hand the highest number of clove per bulb was recorded from local check (12.75) while the lowest from HL variety (8.36). This result is in line with [1] who reported that the highest number of cloves per bulb was recorded from local among tasted garlic varieties.

3.4. Bulb Weight and Yield

The current result showed that the bulb weight and yield were affected by the variety. Significantly the highest bulb weight (26.18g) and yield (8.45t/ha) were recorded from Tseday 92 variety while the lowest bulb weight (17.14g) and yield (4.34t/ha) from HL variety. The current result showed the possibility of bulb yield increment by 54.3% and 13.3% via use of Tseday 92 variety over local and standard check (Chelenko I), respectively. However, overall yield was lower

compared to the national average yield. Similarly, [12] reported that the maximum bulb weight (26.07g) and yield (8.067t/ha) recorded from Tseday 92 as compared to five garlic varieties. However, this result varies from the study conducted by [1] reported that the highest tuber yield were recorded 16.16, 11.78 and 5.57t/ha from local, Kuriftu and Tseday 92 varieties respectively. This might be variation between the two environments.

4. Conclusion and Recommendation

As indicated in the result there was significant differences among the varieties for all parameters, except days to maturity. Among the varieties, Tseday 92 provided about 54.3% and 13.3% yield advantages over the local and standard check, respectively. Also Tseday 92 was tolerant to rust disease than other varieties and local cultivar. Therefore, for sustainable garlic production and productivity in study area Tseday 92 was recommended and need to be demonstrated.

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