

Registration of 'Chelenko I' Garlic (*Allium sativum* L.) Variety

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Abstract: *Chelenko I* (G-147-2/94) garlic variety was released in 2013 for mid to high altitude garlic growing areas of eastern and western Hararghe Zones in Ethiopia. The variety was developed through selection from a collection of 252 cultivars/genotypes obtained from Debre-Zeit Agricultural Research Centre in central Ethiopia and Haramaya district in the eastern part of the country. The released garlic variety was shown to have superior yielding ability and other desirable traits over the standard check 'Tsedey' cultivar. Moreover, the yield of the new variety was found to be stable over seasons and locations in the eastern highlands of the country. Therefore, the variety could be cultivated sustainably by smallholder farmers in the area and other places with similar.

Keywords: Bulb yield; Bulb weight; Stability test; Yield trials; *Tsedey* variety; Haramaya

1. Introduction

Garlic (*Allium sativum* L.) is one of the main *Allium* vegetable crops known worldwide with respect to its production and economic value. It belongs to the family Alliaceae, genus *Allium* and originated in Central Asia (Brewster, 1994). It is used for seasoning in many foods as well as for medicinal and religious purposes (Hannan and Sorensen, 2001). It is widely cultivated throughout the world including Ethiopia. Total area under cultivation in the world was 1,199,929 ha with a production of 17674893 tonnes (FAO, 2012). In Ethiopia, 16411.19 ha of land was under garlic cultivation with a production of about 159093.58 tonnes (CSA, 2014).

Garlic is a high value crop. However, its production and productivity are very low 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 (Getachew and Asfaw, 2010; Mohamed *et al.*, 2014). In line with this, 252 garlic cultivars/genotypes were evaluated over locations and seasons to select the most promising genotype with respect to yield and disease reaction for the eastern highlands of Ethiopia.

2. Varietal Origin/Pedigree and Evaluation

Chelenko I with the collection name of G-147-2/94 developed through selection from a collection of 252 cultivars/genotypes obtained from Debre-Zeit Agricultural Research Centre in the central part and Haramaya district in the eastern part of the country. The variety along with other test genotypes and standard check (*Tsedey*) were evaluated across three locations (Haramaya, Kulubi, and Chelenko) for two years (2011 and 2012).

3. Agronomic and Morphological Characteristics

The released variety *Chelenko I* exhibited congenial morphological and agronomic characteristics compared to the standard check (*Tsedey*). It has deep green foliage, with vigorous growth, and a medium time of maturity. It is also moderately susceptible to garlic rust. The variety produces large-sized bulbs and cloves that are white-skinned and creamy in flesh colour (Table 1).

4. Yield

Chelenko I (G-147-2/94) showed superior yielding ability, producing a mean bulb yield of 9.33 t ha⁻¹ and a mean bulb weight of 49.15 g. In fact, the bulb yield of the new variety exceeded that of the standard check (*Tsedey*) variety by about 14.39% while its mean bulb weight exceeded that of the standard check by about 18.18% (Table. 1).

5. Yield Stability Test

The stability of the released variety along with seven other garlic genotypes which included the commercial standard check variety (*Tsedey*) were tested for bulb yield and bulb weight stability during the regional variety trials. Additive Main Effects and Multiplicative Interaction (AMMI) (Zobel *et al.*, 1988) model was used to test the stability of the genotypes since it combines the analysis of variance with principal component analysis. In addition, AMMI stability value (ASV) was calculated as proposed by Purchase (1997) and Purchase *et al.* (2000). The AMMI analysis of variance revealed that mean square for genotype x environment interaction was significant for bulb yield but not for the bulb weight (Table 2).

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Table1. Agronomic and morphological characteristics of 'Chelenko I' (G-147-2/94) garlic variety as compared to standard check 'Tsedey'.

Character	<i>Chelenko I (G-147-2/94)</i>	<i>Tsedey</i>
Adaptation area		
Altitude	2000 to 2400 m above sea level (Mid to high altitude garlic grown areas of eastern and western Hararghe)	1800-2500 m above sea level (Medium to high altitude)
Rainfall	760-1010 mm	760-1010 mm
Planting		
Planting season	Year-round under both rain-fed and irrigated conditions	Year-round under both rain-fed and irrigated conditions
Planting date	At the start of the main rainy season (June) and at any time with irrigation considering the frost period	At the start of the main rainy season (June) and at any time with irrigation considering the frost period
Seeding rate (t ha ⁻¹)	0.8 – 1.0	0.8 – 1.0
Row spacing (cm)	30	40
Spacing between plants (cm)	10	10
Fertilizer rate (kg ha ⁻¹)	92 kg P ₂ O ₅ (200 kg DAP), 105 kg N (69 kg N from 150 kg Urea and 36 kg N from the 200 kg DAP)	92 kg P ₂ O ₅ (200 kg DAP), 105 kg N (69 kg N from 150 kg Urea and 36 kg N from the 200 kg DAP)
Fertilizer application time	Whole phosphorus through DAP (200 kg) plus half N through DAP plus 36 kg urea ha ⁻¹ at planting and half N (114 kg urea) at active vegetative growth stage	Whole phosphorus through DAP (200 kg) plus half N through DAP plus 36 kg urea ha ⁻¹ at planting and half N (114 kg urea) at active vegetative growth stage
Fertilizer application method	Drilling in rows just before planting	Drilling in rows just before planting
Days to maturity	132	133
Crop pest reaction	Moderately susceptible to garlic rust	Moderately susceptible to garlic rust
Leaf		
Leaf length (cm)	44.42	40.60
Foliage colour	Green	Green
Ability to produce scape	Absent	Absent
Yield (tha ⁻¹)		
Bulb yield (tha ⁻¹)	9.3	8.13
Bulb weight per plant (g)	49.15	41.59
Clove weight (g)	3 (2 to 4)	2.29
Number of cloves per bulb	13 (11 to 15)	13
Release year	2014	1999/00
Breeder/Maintainer	Haramaya University	DZARC/EIAR

This suggested the need to conduct further stability analysis for bulb yield but not for bulb weight to identify the most stable or widely adaptable and high yielding genotype. The stability analysis showed that the released variety (*Chelenko I*) had the lowest ASV values and the highest bulb yield of 9.33 tonnes ha⁻¹ among

the tested genotypes (Table 3). In addition, *Chelenko I* variety had the heaviest bulbs and cloves among all the genotypes. As a whole, the newly released variety was found to be stable and high yielding, and could be recommended for cultivation in a wide range of environment in the eastern highlands of Ethiopia.

Table 2. AMMI analysis of variance for bulb yield and bulb weight of eight garlic genotypes tested at three locations for two cropping seasons (2011 & 2012).

Source of variation	Bulb yield t ha ⁻¹				Bulb weight (g)				
	Degree of freedom	Sum squares	Mean squares	Sum of square explained	Sum squares	Mean squares	Sum of square explained	% total	%G x E
Treatment	47	1085.9	23.1**	81.83	8186	174.2**	59.30		
Genotype	7	58.2	8.32**	5.36	1448	206.8**	17.69		
Environment	5	894.9	178.99**	82.41	5496	1099.3**	67.14		
Rep within E	12	54.2	4.52	4.99	1628	135.7	19.89		
G x E	35	132.7	3.79*	12.22	1241	35.5	15.16		
IPCA 1	11	92.2	8.38**		666	60.6		53.67	
IPCA 2	9	23.5	2.61		275	30.6		22.16	
Residuals	15	17	1.14		300	20		24.17	
Error	84	187.1	2.23	14.10	3992	47.5	28.92		
Total	143	1327.1	9.28		13805	96.5			

* and **, significant at P<0.05 and P<0.01, respectively. Rep within E = replication within environments; G x E = genotype by environment interaction; IPCA 1 and 2 = interaction principal component axis one and two, respectively.

Table 3. AMMI stability parameters for bulb yield (t ha⁻¹) from AMMI model analysis of eight garlic genotypes tested at three locations and two cropping seasons (six environments).

Genotype	2011 cropping season			2012 cropping season			Pooled Mean & Rank	AMMI model stability parameters			
	Haramaya	Chelenko	Kulubi	Haramaya	Chelenko	Kulubi		IPCA 1	IPCA 2	ASV	
G-147-2/94	8.446	9.056	4.364	13.100	9.482	9.859	9.05 (2)	0.69	0.26	1.11	4
Chelenko I	7.710	11.661	4.280	12.190	10.865	9.249	9.33 (1)	-0.06	-1.31	0.01	1
G-66-1/94	7.260	11.816	2.718	9.850	5.659	7.514	7.47 (8)	-1.53	0.10	5.89	8
G-71-2/94	7.407	7.009	3.247	12.290	8.298	8.909	7.86 (5)	1.04	0.57	1.41	6
G-83-2/94	8.758	11.542	4.021	11.670	6.664	9.106	8.63 (3)	-0.97	0.73	1.12	5
G-88-1/94	7.051	8.404	2.953	11.420	7.887	8.321	7.67 (7)	0.35	0.13	0.56	3
Tsedey	7.281	10.213	3.298	11.280	8.309	8.405	8.13 (4)	-0.22	-0.34	0.18	2
G-65-2/94	6.896	7.996	3.041	11.720	8.788	8.467	7.82 (6)	0.72	-0.15	1.58	7
Env Mean	9.71	7.60	3.49	8.24	11.69	8.73					
IPCA1	-1.92	-0.23	0.01	1.10	0.72	0.31					

Env = environment; IPCA 1 and 2 = interaction principal component axis one and two, respectively; ASV = AMMI stability value. Numbers in parenthesis represent pooled mean characteristics of genotypes in a descending order. ASV = rank of genotypes in ascending order.

6. Conclusion

The newly released variety *Chelenko I* was found to be superior to the commercial variety (*Tsedey*), which was used as a standard check, in terms of both bulb yield and clove weight. The bulb yield of the variety was also found to be stable over seasons and locations. It is, thus, concluded that the *Chelenko I* garlic variety could be cultivated sustainably and profitably by smallholder farmers in the eastern highlands of the country as a cash crop to enhance household income and livelihoods.

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