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Genotypic difference of garlic (*Allium sativum* L.) cultivars for growth, bulb yield and yield related attributes at Tigray Province, Northern Ethiopia

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Summary: The experiment was conducted at Ofla district from June to October of 2017 and 2018 cropping season to select high yielding and adaptable garlic cultivar(s). Six garlic cultivars namely Chefe, Tsedey, Holeta local, Kuriftu and Bora-4 and one Ofla Local were evaluated. The experiment was arranged in completely randomized block design (RCBD) with three replications. Different growth, phenology, yield and yield related data were collected. Leaf length, leaf width, bulb diameter and length were significantly ($p<0.05$) influenced by garlic cultivars in both cropping seasons. Bulb weight and number of cloves per bulb were highly significantly ($P<0.01$) influenced by cultivars in both cropping seasons. Also, marketable yield, unmarketable yield and total yield ha^{-1} were highly significantly ($P<0.01$) influenced by cultivars in both seasons. During 2017 and 2018, the highest marketable bulb yield was observed from Ofla Local cultivar with an average value of (8.86 t/ha) and (9.06 t/ha) respectively. During the 2017 cropping year, the maximum and significantly higher total bulb yield of 10.21 t/ha was recorded on the Ofla Local cultivar. Moreover, in 2018, this cultivar provided the maximum total bulb yield of 9.80 t/ha. Therefore, the Ofla Local cultivar showed the greatest performance for growth, yield and yield related attributes. Thus, it is recommended for cultivation in areas having similar agro-ecology. To improve the productivity of garlic, it is important to study and identify the optimum fertilizer level and spacing in the study area.

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Key words: bulb diameter, bulb length, cloves, cropping season, plant height

Introduction

Garlic (*Allium sativum*) is a group of vegetable and belonging to the genus *Allium.* It is popular throughout the world due to its nutritional, medicinal and economic value. The genus *Allium* consists of about 1,000 species, such as leek (*Allium ampeloprasum*), chive (*Allium schoenoprasum*), onion and shallot (*Allium cepa*) (Maab & Klaas, 1995; Kamenetsky et al., 2004; Meredith, 2008; Pacurar & Krejci, 2010). It is used for seasoning foods, and also has medicinal value (Hannan & Sorensen, 2001). It produces an economically important bulb, which is made up of storage leaves known as cloves. Garlic is sterile (not capable to produce fertile botanical seeds); thus, it is propagated using cloves despite some progress in recent years to restore its fertility (Cardelle-Cobas et al., 2010; Shemesh-Mayer et al., 2015).

Garlic occupies the top place in contributing to the maintenance of human health. According to Goldy (2000), garlic cultivation was noticed back to 3200 BC in Egypt and it continues to be a basic constituent of European, Mediterranean and Asian diets as a food item. It also helps as a medicinal plant for treating ailments. It is known for many hundreds of years and was used as a natural antiseptic in the First World War (Gene, 2009). Because of its strength of flavor, it is used mainly as a condiment rather than a bulk foodstuff (Purseglove, 1992). Garlic is produced for its economically important bulbs; which are composed of a tightly attached number of cloves. The bulbs can be used as cooked, fresh, or processed into dehydrated products (Hannan & Sorensen, 2001).

In Ethiopia, garlic is used as an ingredient in local stew. Also, it has an enormous role in the preparation of local medicines. Garlic is one of the most important bulb producing vegetable crops grown by both small and commercial growers for local and export markets (Metasebia & Shimelis, 1998). It has a great contribution to earning foreign currency through export to African countries, Europe, the Middle East and the USA (Kilgori et al., 2007). In the off season, an equal quantity of garlic is usually sold at two to three fold the value of onion (Getachew & Asfaw, 2000).

In Tigray regional state, production and marketing of high value vegetable crops were becoming popular. Garlic is one of the high value vegetables grown meanwhile of the cool season in rotation with pulses (Gebremedhin et al., 2010). In the 2020/2021 cropping year, the area occupied by garlic was about 15,979.54 ha with the total production and productivity obtained from this area 114,944.70 and 7.19 tonnes respectively (CSA, 2021).

Garlic is cultivated in Southern Tigray primarily for its unique flavor and pungency as well as for its health benefits. Despite having great importance, the production and productivity of garlic are low due to different problems. Amongst the productivity limiting factors, lack of improved cultivar (s) is the major one. Consequently, farmers are restricted to growing low yielder garlic landraces which are prone to diseases and insects with traditional agronomic practices. Even though the area is very suitable and the crop is very important for farmers for consumption as well as income generation, production and productivity of the crop are still unsatisfactory. As there will be a variation among the released garlic cultivars with respect to growth, yield, and other important traits, it is important to evaluate the registered garlic cultivars in comparison with local cultivars. Therefore, this research was executed to select adaptable and high yielding garlic cultivar(s).

Materials and methods

Description of the experimental site

An experiment was conducted for two consecutive years (2017 and 2018) under rain fed conditions at Ofla district of the southern zone of Tigray regional state, Ethiopia. This district is geographically located between 13º 89' 8.50" and 13º 97' 5.00" north latitude and 51º 94' 00 and 56º 21' 36" east longitude. The elevation of the district ranges from 1800–2440 m. Long-term meteorological data revealed average annual rainfall between 700–800 mm with mean daily temperature ranging from 10–22 ºC (Tesfay et al., 2014).

Experimental materials

Garlic cultivars namely Chefe, Tsedey, Holeta local, Kuriftu and Bora-4 and one Ofla Local were evaluated for their adaptation and performance at Ofla district under rain fed conditions in 2017 and 2018. Chefe, Tsedey, Holeta local and Kuriftu cultivars were introduced from Debrezeit Agricultural Research Center, while Bora-4 was obtained from Mekelle agricultural research center (Bora-4) and local cultivars were obtained from the farmers. In this case, Ofla Local is a popular garlic variety produced for a long period of time around the study area. This variety is not widely known throughout the country rather it has a popularity and high yielder in Southern Tigray region.

Field preparation, layout, design and planting

The experimental area was plowed, pulverized and leveled properly before planting. A plot size of 1.5 m by 1.5 m (2.25 m^2) was used. The space between blocks was 1.5 m. For the separation of plots within a block, 1 m space was used. Cloves were used as planting material and planted at an inter and intra row distance of 0.3 m and 0.1 m respectively. The experiment was arranged in RCBD with three replications. Cloves were sown with the tip upright and the basal part of the clove down position. Cultivation, weeding, chemical spray and harvesting were done at standard time. During the experimental period, 92 kg ha^{-1} of P_2O_5 and 140 kg ha^{-1} of N were used. P_2O_5 in terms of DAP (diammonium phosphate) was applied during planting. N in the form of urea was applied in split; half at planting time and the remaining half at the mid stage of the crop.

Data collection

Different garlic growth, phenological, and yield component data like days to 50% sprouting, days to physiological maturity, plant height (cm), leaf length (cm), leaf width (cm), bulb diameter (cm), bulb length (cm), bulb weight $plant^{-1}$ (g), number of cloves per bulb, average clove weight (g), total yield $hectare^{-1}$ (kg ha^{-1}), marketable bulb yield $hectare^{-1}$ (kg ha^{-1}) and unmarketable yield $hectare^{-1}$ (kg ha^{-1}) were collected.

Data analysis

The collected data were analyzed using SAS software (9.3 version) with a general linear model procedure. In case ANOVA indicated a significant difference, mean separation was done using LSD at 5% probability level.

Results and discussion

Phonological parameters

Days to 50% emergence

The ANOVA table showed that cultivars exerted a highly significant (*P<0.01*) difference on days to 50% emergence in both the 2017 and 2018 cropping seasons (***Table 1***). Days to 50% emergence ranged from 8 to 16.67 days. Accordingly, the Ofla Local cultivar emerged earlier (8 days) than the other in both years. Bora-4 was the late emerged cultivar with average emergency days of 16.67 and 12.67 from planting in both cropping seasons respectively (***Table 2***). This may be due to the genetic makeup and adaptability of the cultivar to the local area. Garlic germination % was affected by cultivar behavior (Youssef, 2013) and pre- sowing storage temperature (Bizuayehu et al., 2017). A similar result was reported by Tadesse (2015) who found that the cultivar Guahgot local was significantly earlier for days to 50% sprouting.

Days to maturity

Non-significant (P≥0.05) effect was observed among garlic cultivars on days to maturity during the 2017 cropping seasons. However, in the 2018 production year, a significant (p<0.05) difference was observed among cultivars (***Table 1***). The highest days to maturity were recorded on Bora-4 (124.67 days) cultivar, which is significantly similar to Tsedey (124.33 days), Kuriftu (124.33 days) and Holeta Local (123.33 days) in the 2018 cropping season. While the earliest days to maturity were noted from the local cultivar (119) followed by Chefe (120.67) (***Table 2***). This character is highly affected by cultivar genetic constituents and the environmental condition of the study area that existed during the experimental period. This result was in line with the study of Getahun and Getaneh (2019) who found that Adis zemene local and Chefe (94 days) were early maturing at Woreta, South Gonder zone.

Table 1. Mean squares of phonological traits of six garlic cultivars evaluated during 2017 and 2018 cropping season.

SOV	DF	Days to emergence		Days to maturity	
		2017	2018	2017	2018
Block	2	1.56	0.60	29.17	17.82
Cultivars	5	28.86**	5.85**	7.43ns	15.79*
Errors	10	1.09	0.91	12.30	2.43
CV (%)		9.83	9.65	3.63	1.27

*and **=significant at P≤0.05, and p≤0.01 probability levels respectively; ns=not significant, DF=Degree of freedom; SOV=Source of variation

Growth parameters

Plant height

Regardless of the degree of significance, plant height was significantly (p<0.05) influenced by garlic cultivars in both the cropping seasons (***Table 3***). In both cropping seasons, the maximum plant height was recorded on Ofla Local. During the 2017 production year, the minimum plant height was obtained from Chefe (43.52 cm) which is non-significant from Tsedey (45.9 cm), Holeta local (46.29 cm), and Kurifu (46.71cm). During the 2018 production year, Holeta local gave the shortest plant height (54.75 cm), which is significantly at par with Bora-4 (***Table 4***). The result indicated that not only do inherent characteristics of the cultivars affect the plant height; but also, the season of production has the greatest effect on it. The maximum plant height recorded on Local cultivars might be attributed to the wider adaptability of the cultivars to the local area. The current finding is in agreement with the finding of Ayalew et al. (2015) who reported that plant height is significantly affected by cultivars.

Leaf length and width

Leaf length and width were statistically significantly (p<0.05) influenced by garlic cultivars in both cropping seasons (***Table 3***). In 2017, the longest leaf length (41.05 cm) was obtained from Bora-4, which is statistically the same with Ofla Local and Kuriftu cultivar. While the shortest leaf length was recorded from Chefe (31.41 cm) cultivar in the 2017 cropping season (***Table 4***). In 2018, the maximum leaf length was recorded from Kuriftu (50.38 cm) cultivar followed by Tsedey (48.86 cm) and Ofla Local (47.72 cm); however, the minimum leaf length (42.05 cm) was obtained on Holeta local (***Table 4***). In 2017, the maximum leaf width was recorded on Bora-4 (1.8 cm) cultivar, which is significantly similar with an Ofla Local (1.72 cm) and Tsedey (1.53 cm). In the 2018 production year, Tsedey gave the maximum leaf width (2.15 cm). The minimum leaf width was recorded on Holeta local in both cropping seasons (***Table 4***). This may be attributed to the inherent characteristics of the cultivars and the season of production. In agreement with this finding, Yeshiwas et al. (2017) reported a significance different among garlic genotypes in leaf width and length.

Yield and yield components

Bulb diameter and bulb length

Both bulb diameter and length were significantly affected (P<0.05) by garlic cultivars during both Cropping seasonsCropping seasons regardless of the degree of significance (***Table 5***). Accordingly, the highest bulb diameter was obtained on the Ofla Local (4.67 cm) and Kuriftu (5.60 cm) during the both cropping seasons, respectively. However, Kuriftu was not significantly different from Ofla Local in 2018. All the remaining cultivars were statistically similar to each other in the 2017 cropping season. In 2018, the minimum bulb diameter was recorded by Holeta local (4.63 cm) followed by Bora-4 (4.72 cm) and Chefe (4.85 cm) (***Table 6***). The bulb size, which is the garlic yield determinant character is highly affected by the soil type/condition, inherent characters of the cultivars and the agronomic practice (particularly spacing). So, inherent characteristics of the cultivars determine the bulb size and yield of garlic. Similar results were noted by Shah et al. (2018) who found that a significance variation among cultivars on bulb diameter, length and yield. Khatun et al. (2014) reported that bulb size was statistically significantly influenced by cultivars whereby the highest bulb length was obtained from BAU Roshon 2 in the two successive years.

Average bulb weight

Average bulb weight showed a highly significant (P<0.01) difference in both cropping seasons (***Table 5***). The highest average bulb weight was obtained from Ofla Local (36.59 gm) in 2017; in the 2018 cropping season, the maximum bulb yield (48.88 gm) was recorded from the Kuriftu cultivar. Whereas, the minimum bulb diameter was recorded on the Chefe cultivar, which is significantly the same as Kuriftu and Tsedey in 2017. In the 2018 cropping season, the lowest bulb weight was observed on Holeta Local, but Holeta Local was not significantly different from Chefe and Ofla Local (***Table 6***). From this finding, bulb weight is highly associated with bulb diameter and length; that means the highest bulb diameter and length result in the highest bulb yield. This might be attributed to the wider adaptability and genetic constituent of the cultivars. Ayalew et al. (2015) found that significantly the highest bulb weight (49.72 g) per plant was obtained from the local cultivar followed by Kuriftu (35.36 g). Besides, Khatun et al. (2014) reported that the maximum bulb weight per plant was attained from BAU Roshon 2 in two successive years.

Number of cloves per bulb

The results showed that the number of cloves per bulb were highly significant (P<0.01) influenced by garlic cultivars during both cropping seasons (***Table 7***). Kuriftu gave the highest number of cloves per bulb (13.13), which is significantly identical to Bora-4 and Ofla Local in 2017 cropping season. The rest cultivars were significantly the same and considered the lowest. Also, Kuriftu gave the maximum value (27.73) in the 2018 cropping year which is statistically similar with the Tsedey cultivar (***Table 8***). The number of clove bulb^{-1} is highly influenced by genotype; in most of the cases, cultivars gave smaller sized large number of cloves bulb^{-1}; in the other cases, some cultivars produces large sizes with a small number of cloves. Shah et al. (2018) reported that a greater number of cloves bulb^{-1} (12.7) was noted on Garlic-1 followed by Buner Local and Swat White. Khatun et al. (2014) also reported a significance different among garlic cultivars in number of cloves per bulb. This is also in agreement with the finding of Mishra & Vikram (2017) who found a significance variation among garlic genotypes on this character

Marketable bulb yield

Marketable bulb yield was highly significantly (P<0.01) influenced by garlic cultivars in both 2017 and 2018 cropping seasons (***Table 7***). In both years, the highest marketable bulb yield was noted from the Ofla Local cultivar with mean values of (8.86 t/ha) and (9.06 t/ha), respectively. However, Ofla Local is significantly at par with Kuriftu in the 2018 cropping season (***Table 8***). Whereas, the minimum bulb yield was recorded in 2017 (5.97 t/ha) and 2018 (4.25 t/ha) on Chefe and Holeta Local, respectively (***Table 8***). This result is highly due to the genetic potential of the cultivar to produce the highest bulb weight, bulb length and width, which are strongly associated with bulb yield. The current finding is in line with Ayalew et al. (2015), who reported that the highest bulb yield (16.56 t/ha) was recorded from a local cultivar at the Dabat district Northern Ethiopia. A similar result was also reported by Getahun & Getaneh (2018), who found the local Adis Zemen cultivar gave the highest mean yield of 37.15 quintals/hectare at Angot kebele South Gonder Zone, Ethiopia.

Table 2. Mean performance of garlic cultivars for phonological traits during 2017 and 2018 cropping season at Ofla district.

Cultivars	Days to 50% emergence			Days to maturity		
	2017	**2018**	**Mean**	**2017**	**2018**	**Mean**
Chefe	9.00[bc]	9.00[bc]	9.00	96.00	120.67[bc]	108.34
Tsedey	10.00[b]	10.00[b]	10.00	96.67	124.33[a]	110.50
Holeta-local	10.67[b]	10.33[bc]	10.50	94.67	123.33[ab]	109.00
Kuriftu	9.33[bc]	9.33bc	9.33	95.67	124.33[a]	110.00
Bora-4	16.67[a]	12.67[a]	14.67	96.67	124.67[a]	110.67
Ofla Local	8.00[c]	8.00[c]	8.00	99.33	119.00[c]	109.17
Mean	10.61	9.89		96.50	122.72	
LSD $_{(0.05)}$	1.90	1.76		ns	2.88	

Means within columns followed by different letter (s) for each variable are significantly different at ($p<0.05$)

Table 3. Mean squares of growth traits of garlic cultivars during 2017 and 2018 cropping season.

SOV	DF	Plant height (cm)		Leaf length (cm)		Leaf width (cm)	
		2017	2018	2017	2018	2017	2018
Block	2	54.94	7.95	40.66	11.75	0.10	0.13
Cultivars	5	74.81*	55.92**	46.06*	26.23**	0.12*	0.10**
Errors	10	13.78	8.22	12.93	3.81	0.02	0.01
CV (%)		7.67	4.84	10.11	4.18	9.90	5.23

*, and **, significant at $P\leq0.05$, $p\leq0.01$ probability levels respectively; ns= not significant, DF= Degree of freedom; SOV= Source of variation

Table 4. Mean performance of garlic cultivars for growth traits during 2017 and 2018 cropping season at Ofla district.

Cultivars	Plant height (cm)			Leaf length (cm)			Leaf width (cm)		
	2017	**2018**	**Mean**	**2017**	**2018**	**Mean**	**2017**	**2018**	**Mean**
Chefe	43.52[c]	62.99[abc]	53.26	31.41[c]	45.13[cd]	38.27	1.33[c]	1.76[cd]	1.55
Tsedey	45.9[bc]	60.45[bc]	53.18	31.29[bc]	48.86[ab]	40.08	1.53[abc]	2.15[a]	1.84
Holeta-local	46.29[bc]	54.75[d]	50.52	32.19c	42.05[d]	37.12	1.31[c]	1.69[d]	1.50
Kuriftu	46.71[bc]	65.14[bc]	55.93	34.83[abc]	50.38[a]	42.61	1.49[bc]	2.09[ab]	1.79
Bora-4	50.29[b]	58.49[cd]	54.39	41.05[a]	45.69[bc]	43.37	1.8[a]	2.04[ab]	1.92
Ofla Local	57.55[a]	66.72[a]	62.14	39.54[ab]	47.72[abc]	43.63	1.72[ab]	1.91[bc]	1.82
Mean	48.38	61.42		35.55	46.64		1.53	1.94	
LSD(0.05)	6.75	5.49		6.54	3.60		0.28	0.19	

Means within columns followed by different letter (s) for each variable are significantly different ($p<0.05$)

Table 5. Mean squares for yield attributors of garlic cultivars evaluated during 2017 and 2018 cropping season.

SOV	DF	Bulb diameter (cm)		Bulb length (cm)		Bulb weight (gm)	
		2017	**2018**	**2017**	**2018**	**2017**	**2018**
Block	2	0.17	0.02	0.04	0.13	2.04	44.20
Cultivars	5	0.50*	0.44**	2.14**	0.09[ns]	163.51**	190.36**
Errors	10	0.09	0.05	0.04	0.04	1.89	20.96
CV (%)		7.86	4.27	5.53	4.79	6.36	13.04

* and **significant at $P\leq0.05$and $p\leq0.01$ probability levels respectively; ns= not significant, DF= Degree of freedom; SOV= Source of Variation

Table 6. Mean performance of garlic cultivars for yield and yield components during 2017 and 2018 cropping season at Ofla district (Adigolo FTC).

Cultivars	Bulb diameter (cm)			Bulb length (cm)			Bulb weight (gm)		
	2017	2018	Mean	2017	2018	Mean	2017	2018	Mean
Chefe	3.77b	4.85cd	4.31	3.14c	3.91b	3.53	17.91d	28..95c	23.43
Tsedey	3.72b	5.15bc	4.44	3.00c	3.96b	3.48	18.16cd	38.26b	28.21
Holeta-local	4.02b	4.63d	4.33	3.14c	3.85b	3.50	18.75b	27.35c	23.05
Kuriftu	3.55b	5.60a	4.58	3.27c	4.35a	3.81	18.04d	48.88a	33.46
Bora-4	3.66b	4.72d	4.19	5.21a	3.91b	4.56	20.39b	29.04c	24.72
Ofla Local	4.67a	5.44ab	5.06	3.87b	3.99b	3.93	36.59a	37.18b	36.89
Mean	3.55	5.06		3.00	3.99		17.91	35.11	
$LSD_{(0.05)}$	3.90	0.40		3.60	0.35		2.50	8.46	

Means within columns followed by different letter (s) for each variable are significantly different (p<0.05)

Table 7. Mean squares for yield parameters of garlic cultivars evaluated during 2017 and 2018 cropping season.

SOV	DF	Number of cloves per bulb		Marketable yield (t/ha)		Unmarketable yield (t/ha)		Total yield (t/ha)	
		2017	2018	2017	2018	2017	2018	2017	2018
Block	2	14.84	2.41	0.23	0.71	0.01	0.02	0.17	0.60
Cultivars	5	24.76**	81.42**	3.79**	11.05**	0.18**	0.13**	5.15**	12.08**
Errors	10	3.03	3.76	0.21	0.65	0.01	0.01	0.24	0.61
CV (%)		17.85	9.53	6.89	12.15	9.43	25.80	6.34	11.14

** Significant at p≤0.01 probability levels; DF= Degree of freedom; SOV= Source of variation

Table 8. Mean performance of garlic cultivars evaluated during 2017 and 2018 cropping season.

Cultivars	Number of cloves per bulb			Marketable yield (t/ha)			Unmarketable yield (t/ha)			Total yield (t/ha)		
	2017	2018	Mean	2017	2018	Mean	2017	2018	Mean	2017	2018	Mean
Chefe	6.60b	16.53de	11.57	5.97c	5.10cd	5.54	0.73d	0.44b	0.59	6.70c	5.54de	6.12
Tsedey	7.80b	24.47ab	16.14	6.05c	7.16b	6.61	1.03bc	0.25c	0.64	7.08c	7.41bc	7.25
Holeta-local	7.20b	13.53e	10.37	6.25b	4.25d	5.25	1.16ab	0.22c	0.69	7.41c	4.47e	5.94
Kuriftu	13.13a	27.73a	20.43	6.01c	8.41ab	7.21	0.89cd	0.22c	0.56	6.90c	8.63ab	7.77
Bora-4	12.33a	21.27bc	16.8	6.80bc	5.93cd	6.37	1.32a	0.40bc	0.86	8.11bc	6.33cd	7.22
Ofla Local	11.47a	18.60cd	15.04	8.86a	9.06a	8.96	1.35a	0.75a	1.05	10.21a	9.80a	10.01
Mean	6.60	20.36		6.66	6.65		1.08	0.38		6.70	7.03	
$LSD_{(0.05)}$	3.17	3.58		0.83	1.49		0.18	0.18		0.89	1.45	

Means within columns followed by different letter (s) for each variable are significantly different (p<0.05)

Unmarketable bulb yield

The result indicated, a highly significant (P<0.01) variation among cultivars on unmarketable bulb yield in both cropping seasons (***Table 7***). Accordingly, Ofla Local gave the highest unmarketable yield in both seasons with respective mean values of (1.35 t/ha) and (0.75 t/ha). However, an Ofla Local is not significantly different from Bora-4 and Holeta local cultivars in 2018 (***Table 8***). While the minimum results (0.73 t/ha) and (0.22 t/ha) were recorded from Holeta local in 2017 and 2018, respectively (***Table 6***).

Total bulb yield

Significant (P<0.01) difference in total bulb yield among garlic cultivars in both cropping seasons (***Table 7***). In the 2017 cropping season, the maximum and significantly different total bulb yield (10.21 t/ha) was obtained from the Ofla Local cultivar. Also, this cultivar provided the maximum total bulb yield (9.80 t/ha), which is statistically significantly the same as Kuriftu (***Table 8***). Whereas, the minimum (6.70 t/ha) total bulb yield was recorded from Chefe cultivar in the 2017 cropping year, which is not significantly different from the rest of the cultivars, except the Ofla Local. In 2018, the lowest total bulb yield (4.47 t/ha) was noted from Holeta local (***Table 6***). This result was in line with the work of Khatun et al. (2014), who found that the highest yield was obtained from BAU Roshun 2, which was significantly different from other cultivars.

Conclusions

From the experimental data on days to 50% sprouting (emergence), days to 50% physiological maturity, leaf length, leaf width, plant height, bulb diameter, bulb length, bulb weight per plant, number of cloves $bulb^{-1}$, average clove weight, total yield, marketable bulb yield and unmarketable yield were collected and analyzed using SAS software.

The length and width of the leaf were significantly ($p<0.05$) affected by garlic cultivars in both cropping seasons. Similarly, both bulb diameter and length were significantly ($P<0.05$) affected by garlic cultivars during the 2017 and 2018 cropping seasons. Mean of garlic bulb weight was highly significantly ($P<0.01$) influenced by cultivars in both cropping seasons. The number of cloves per bulb was highly significant ($P<0.01$) affected by garlic cultivars during 2017 and 2018. All marketable, unmarketable and total bulb yields per hectare were highly significantly ($P<0.01$) influenced by cultivars in both the 2017 and 2018 cropping seasons.

Ofla Local cultivar emerged earlier (8 days) than the others in both years. The maximum days to maturity were noted on Bora-4 (124.67 days) cultivar, which is significantly at par with Tsedey (124.33), Kuriftu (124.33) and Holeta Local (123.33 days) in the 2018 cropping season. In both cropping seasons, the tallest plant height was observed on Ofla Local. In 2017, the longest leaf length (41.05 cm) was obtained from Bora-4, which is statistically identical with Ofla Local and Kuriftu cultivars. In 2018, the maximum leaf length was recorded from Kuriftu (50.38 cm) cultivar followed by Tsedey (48.86 cm) and Ofla Local (47.72 cm). In 2017, the maximum leaf width was recorded on Bora-4 (1.8 cm) cultivar. In 2018, Tsedey gave the maximum leaf width (2.15 cm). The widest bulb diameter was recorded from Ofla Local (4.67 cm) and Kuriftu (5.60 cm) during the 2017 and 2018 cropping seasons, respectively.

In both 2017 and 2018, the highest marketable bulb yield was observed on Ofla Local cultivar with mean values of (8.86 t/ha) and (9.06 t/ha) respectively. Ofla Local gave the highest unmarketable yield in both 2017 and 2018 cropping seasons, with respective mean values of (1.35 t/ha) and (0.75 t/ha). In the 2017 cropping season, the maximum and significantly different total bulb yield (10.21 t/ha) was obtained from the Ofla Local cultivar. Also, in 2018, this cultivar provided the maximum total bulb yield (9.80 t/ha).

Generally, the Ofla Local, which gave a relatively high yield, is recommended to be used around this study area and other areas having similar agroecological conditions. Further, it is important to study and come up with an appropriate/optimum agronomic practice like spacing and fertilizer level to obtain a high yield with good quality.

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