



GENOTYPIC DIFFERENCE IN GROWTH AND YIELD RELATED TRAITS OF ONI (*ALLIUM CEPA* L.) VARIETIES AT SOUTHERN TIGRAY

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ABSTRACT

Onion (*Allium cepa* L.) is the most common member of the family Amaryllidaceae (Alliaceae) which grows as a herbaceous biennial vegetable crop with cross pollinated and monocotyledonous behavior having diploid chromosomes number $2n=16$. In order to identify Genotypic difference in growth, yield and yield related traits of Onion varieties, the field experiment was carried out at the research station of Mehoni Agricultural Research Center, southern, Ethiopia in the 2013 and 2014 cropping season under irrigation condition. The experiment was consisted of varieties of onion arranged in completely randomized block design with four replications. In 2013 cropping season, days to 50% maturity, bulb diameter and unmarketable were significantly affected by varietal difference. On the other hand, marketable yield, unmarketable yield and total yield were also influenced through varietal effect in 2014. The highest marketable yield (318.52 q ha^{-1}) was obtained from Adama red variety; which, however, it was statistically on par with the marketable yield (289.26 q ha^{-1}) at Nafis variety whereas the lowest marketable yield (222.41 q ha^{-1}) was recorded at Nasik red variety in 2014 cropping season.

Keywords: *Allium cepa*, Marketable yield, Unmarketable yield, Total yield, Yield, Yield related traits.

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Contribution/Originality

The paper's primary contribution is finding that to study genotypic difference in growth and yield related traits of onion (*Allium cepa* L.) varieties at southern Tigray, Ethiopia. Then, it provides concrete information on the best adaptable varieties to the specific agro-ecology for onion growers particularly in the specific study area.

1. INTRODUCTION

Onion (*Allium cepa* L.) is the most common member of the family Amaryllidaceae (Alliaceae). It is widely grown herbaceous biennial vegetable crop with cross pollinated and monocotyledonous behavior having diploid chromosomes number $2n=16$ [1]. It is grown from seeds, transplants or sets, for both green and dry bulbs [2]. Onions exhibit particular diversity in the eastern Mediterranean countries, through Turkmenistan, Tajikistan to Pakistan and India, which are the most important sources of genetic diversity and believed to be center of origin [3] however, the leading onion producer countries are China, India, USA and Turkey [4].

Onion is an important vegetable crop whose distinctive flavour is appreciated by people throughout the world. One of the advantages of onion is that the bulbs can be harvested and sold either 'green' in salads, while the mature bulbs are cooked or eaten raw as a vegetable [5]. It contains some important vitamins (A, B, and B2, thiamine, riboflavin and niacin) and minerals (Ca, P, Fe, Cu and Zn) in addition to some soluble sugars and nicotinic acid [6].

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According to this guy it also contains a phyto-chemical called quercetin which is effective in reducing the risk of cardiovascular disease, anticancer and has an antioxidant effect.

Onion bulbs varying in size (small, medium and large), colour (white, yellow and red) and shape (flattened, round and globular) and they are grouped into short days and long days depending on the day length requirements [7]. According to the authors onion bulbs acquiring day length of (15-16 hrs) categorized in to short day group and those take 14 hrs or more for bulb formation fell into long day group (>17 hrs) types; while, numerous varieties of onion have different characteristics and yield. Onion also requires varying day length and temperature for the purpose they produced. A relatively high temperature and long photoperiod are required for bulb formation and for seed production; temperature is an immense importance than day length [8].

Recently, onion crops are the most important cultivated crops in the agricultural community of Ethiopia and it is rapidly becoming a popular vegetable among producer and consumer [9]. According to the Central Statistics Agency [10] report, the volume of root crops produced and the area under root crop production in the country are about 4.5 million quintals and 169,343 hectares respectively. Out of this volume, onion takes the share of 1,759,192 quintals and 16,578 hectares. Onion is considerably important in the daily Ethiopian diet, mostly used as seasonings or as vegetables in stews [11].

For proper productivity and production of onion, good management and cultural practices, development of new varieties and evaluation of the available onion varieties are the sustainable strategies. The development of new varieties is a long and expensive process which also needs expert scientists especially, plant breeders. However, the evaluation of the existing and available onion varieties for their adaption and productivity in the climatic conditions of Ethiopia, particularly to Raya area is a faster way to improve the onion production potential.

Farmers in the area choose onion variety for planting depending on a number of factors which include production potential, market demand, regional adaptability and availability of seeds and their prices. One of the major onion production problems in the area is lack of high quality seeds and improper agronomic practices used by farmers. Such seeds are usually of low quality (viability, vigor and genetic purity) but very expensive and usually are low productive and susceptible to different environmental stresses.

Despite the diverse advantages of onion have, research works in Ethiopia, particularly in the Raya Valley on this plant has been limited. This lack of information on evaluating of best performing variety is considered to be among the major hindrance to embark on mass production and utilization of this economically important crop in the country. Thus, it is believed necessary to evaluate suitable agronomical conditions that would enable to maximize growth and yield of onion. Therefore, the objective of this study was to determine the growth and yield of onion varieties under Raya Valley.

2. MATERIALS AND METHODS

The field experiment was carried out at the research station of Mehoni Agricultural Research Center (MeARC) in 2013 and 2014 cropping season under irrigation conditions. The center is situated at about 678 km north of the capital, Addis Ababa. Geographically it is located at 12° 41' 50" North latitude and 39° 42' 08" East longitude with an altitude of 1578 m.a.s.l. The site receives mean annual rainfall of 750 mm with an average minimum and maximum temperature of 18 and 25°C, respectively. The soil textural class of the experimental area is clay loam with pH of 7.9.

Treatments were arranged in randomized complete block design (RCBD) with four replications. Seeds of three onion varieties namely; Nafis, Nasik red and Adama red were sown in seedbeds and grown at the nursery for 50 days. Uniformly grown seedlings were selected, hardened and transplanted to the experimental field after attaining 13-15 cm height or 50 days of sowing in the nursery. Seedlings of onion taken from the nursery were transplanted to experimental field having a plot size of 3 m width and 3.5 m length. During the experiment seedlings were planted at 40x20x10 cm between double row, single row and plants, respectively. A spacing of 2 m and 1.5 m was

also maintained between replications and rows. Plants in the 3 middle rows out of the 5 rows per plot constituted the net plot used as the sampling unit. Ten plants from the middle rows were taken for sampling and data analysis. All appropriate agronomic practices such as weeding, watering and hoeing were conducted uniformly both at the nursery and experimental field.

Data on establishment percentage, plant height (cm), days to 50% maturity, leaf number, bulb length (cm), bulb diameter (cm), marketable yield ($q\ ha^{-1}$), unmarketable yield ($q\ ha^{-1}$) and total yield ($q\ ha^{-1}$) was collected and analyzed.

Data on agronomic and yield components were subjected to analysis of variance (ANOVA) using SAS PROC GLM (2002) at $P < 0.05$. If there exists a significant difference among the treatment means the Least Significant Difference (LSD) Test was used to compare the mean separations at $P < 0.05$.

3. RESULTS AND DISCUSSION

3.1. Growth Characters

3.1.1. Establishment Percentage (%)

Establishment percentage was not significantly ($P > 0.05$) affected by varietal effect in both cropping season (Table 1). Even though there was no significant difference among the three varieties; slightly higher establishment percentage (87.18% and 80.32%) was obtained from those varieties of Nasik red and Adama red in 2013 and 2014 cropping season, respectively. Whereas the lowest establishment percentage (85.19% and 76.54%) was recorded at Adama red and Nafis varieties in both 2013 and 2014 cropping seasons (Table 3).

3.1.2. Days To 50% Maturity

Analysis of variance Table 1 indicated that day to 50% maturity was significantly ($P < 0.05$) influenced by the varieties of onion plant in 2013 cropping year; Whereas in 2014 cropping season variety was not exerted any significant ($P > 0.05$) effect on days to 50% maturity. In 2013, Nafis produced significantly higher days to 50% maturity (93.50) while Adama red was produced lower value (90.50); however it was not statistically different with Nasik red. This revealed that both Adama red and Nasik red was matured earlier than that of Nafis variety. On other hand, in 2014 even though it was no indicated any significant different to some extent the higher (98.75) and lower (89.50) days to 50% maturity was attained at Adama red and Nasik red varieties, respectively (Table 3).

3.1.3. Leaf Number

The effect of variety on leaf number per plant did not indicate any significant difference ($P > 0.05$) in both 2013 and 2014 cropping season (Table 1). As Table 3 indicated that, even though there is no significant difference slightly higher (10.50 and 12.75) leaf number per plant was observed at the variety Nasik red in both cropping seasons; however, the lower leaf number per plant (9.50) at Adama red and (11.75) at Nafis in 2013 and 2014 cropping year, respectively.

3.1.4. Plant Height

Plant height was not significantly influenced ($P > 0.05$) by varietal effect in 2013 and 2014 cropping years (Table 1). However, somewhat higher plant height (57.40 cm) was recorded at Nafis and (66.26 cm) at Nasik red in 2013 and 2014 cropping year, respectively. Whereas to some extent the lower value (54.65 cm) and (62.16 cm) was also obtained at the varieties of Nasik red and Nafis in both corresponding seasons. As compared from both seasons Nasik red was the tallest variety than those other onion varieties (Table 3).

3.1.5. Bulb Length

Variety did not exerted any significant difference influence ($P>0.05$) on plant height of the onion plant (Table 1). From the mean comparison table slightly higher bulb length (5.08 cm and 5.93 cm) was recorded from these varieties of Nafis and Adama red in the first and second cropping year, respectively. Table 3 also revealed that lower plant height (4.60 cm and 5.73 cm) was indicated at Nasik red and Nafis varieties in 2013 and 2014 consecutively.

3.1.6. Bulb Diameter

Bulb diameter was significantly ($P<0.01$) affected by varietal effect in 2013 cropping season; which, however, it has not affected in the year of 2014 (Table 2). In 2013 cropping year, significantly higher bulb diameter (5.38 cm) was recorded at Nafis variety which was statistical at par with the bulb diameter of Adama red variety (5.11 cm) (Table 4).

3.2. Yield Related Traits

3.2.1. Marketable Yield

In 2014 cropping, season, marketable yield was significantly influenced ($P<0.05$) by varietal effect of the onion plant; conversely, in 2013 cropping year variety did not exert any significant effect on marketable yield (Table 2). In the first cropping season even though there was no significant difference among the varieties slightly higher and lower marketable yield (218.29 q ha⁻¹) and (209.72 q ha⁻¹) was recorded at Nafis and Nasik red varieties consequently. On the other hand, the highest marketable yield (318.52 q ha⁻¹) was obtained from Adama red variety; which however, it was statistically on par with the marketable yield (289.26 q ha⁻¹) at variety Nafis. Whereas the lowest marketable yield (222.41 q ha⁻¹) was recorded at Nasik red variety (Table 4).

3.2.2. Unmarketable Yield

Unmarketable yield was very highly significantly ($P<0.001$) influenced by the varieties of onion plant in 2013 cropping year. Similarly it was also significantly ($P<0.05$) affected in the second cropping season (Table 2). In 2013, Nafis variety was produced significantly higher unmarketable yield (12.04 q ha⁻¹) while Adama red was produced significantly lower unmarketable yield value. Conversely, Nasik red was produced significantly higher unmarketable yield (11.59 q ha⁻¹) in 2014 cropping year, but significantly lower unmarketable yield (8.07 q ha⁻¹) was recorded at the variety of Adama red (Table 4).

3.2.3. Total Yield

The analysis of variance (ANOVA) Table 4 indicated that in 2013 cropping season total yield was not significantly ($P>0.05$) affected by varietal effect of the onion plant. However, it was significantly influenced ($P<0.05$) in the 2014 cropping year (Table 2). In 2014, Adama red variety provided the highest total yield (326.59 q ha⁻¹); however, it was statistically at par with Nafis variety (299.44 q ha⁻¹). On the other hand, Nasik red variety produced significantly lower total yield (239 q ha⁻¹) (Table 4). Conversely, although there was no significant difference in 2013, slightly higher (230.32 q ha⁻¹) and lower (217.36 q ha⁻¹) total yield was obtained at those varieties of Nafis and Nasik red, respectively.

Table-1. Mean square for (2013) and (2014) cropping season analysis of variance for the performance of onion varieties under irrigation condition

SOV	DF	Establishment age (%)		Days to 50% maturity		Leaf number		Plant height (cm)		Bulb length (cm)	
		2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Replication	3	7.39	167.52	0.97	2.08	0.75	2.11	29.88	5.01	0.05	0.004
Variety	2	4.67 ^{ns}	14.52 ^{ns}	11.58*	77.08 ^{ns}	1.08 ^{ns}	1.08 ^{ns}	7.68 ^{ns}	17.29 ^{ns}	0.24 ^{ns}	0.048 ^{ns}
Error	6	34.64	36.68	1.14	35.42	0.42	1.19	37.31	7.04	0.08	0.006
CV (%)		6.81	7.71	2.81	6.34	6.51	8.98	10.92	4.12	5.95	5.07

ns; not significant at P< 0.05, * significant at P< 0.05; ** significant at P<0.01 and *** significant at P< 0.001 probability level.

Table-2. Mean square from the first year (2013) and second year (2014) analysis of variance for the performance of onion varieties under irrigation condition (Continued)

SOV	DF	Bulb diameter (cm)		Marketable yield (q/ha)		Unmarketable yield (q/ha)		Total yield (q/ha)	
		2013	2014	2013	2014	2013	2014	2013	2014
Replication	3	0.02	0.21	673.37	1375.10	1.45	0.05	695.73	1376.29
Variety	2	0.35**	0.34 ^{ns}	74.80 ^{ns}	8655.33*	45.41***	12.551*	207.96 ^{ns}	8042.01*
Error	6	0.02	0.16	2126.70	960.64	1.52	0.14	2210.76	948.12
CV (%)		2.62	6.14	21.58	11.13	14.76	3.72	21.18	10.68

ns; not significant at P< 0.05, * significant at P< 0.05; ** significant at P<0.01 and *** significant at P< 0.001 probability level.

Table-3. Mean performance of onion varieties from the first year (2013) and second year (2014) under irrigation condition

Variety	Establishment percentage (%)			Days to 50% Maturity			Leaf number			Plant height (cm)			Bulb length (cm)		
	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean
Adama red	85.19	80.32	82.76	90.50b	98.50	94.50	9.50	12.00	10.75	55.72	64.78	60.25	4.78	5.93	5.36
Nasik red	87.18	78.83	83.01	91.00b	89.75	90.38	10.50	12.75	11.63	54.65	66.26	60.46	4.60	5.75	5.18
Nafis	86.92	76.54	81.73	93.50a	93.50	93.50	9.75	11.75	10.75	57.40	62.16	59.78	5.08	5.73	5.41
LSD _{0.05}	ns	ns		1.85	ns		ns	ns		ns	ns		ns	ns	

Means followed by the same letter in the same column are not significantly different at 5% level of probability.

Table-4. Mean performance of onion varieties from the first year (2013) and second year (2014) under irrigation condition (Continued)

Variety	Bulb diameter (cm)			Marketable yield (q/ha)			Unmarketable yield (q/ha)			Total yield (q/ha)		
	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean
Adama red	5.11a	6.28	5.70	212.96	318.52a	212.96	5.42c	8.07c	6.75	218.38	326.59a	272.49
Nasik red	4.71b	6.38	5.55	209.72	227.41b	209.72	7.64b	11.59a	9.62	217.36	239.00b	228.18
Nafis	5.38a	6.83	6.11	218.29	289.26a	218.29	12.04a	10.19b	11.12	230.32	299.44a	264.88
LSD _{0.05}	0.23	ns		ns	53.63		2.14	0.64		ns	53.28	

Means followed by the same letter in the same column are not significantly different at 5% level of probability.

4. CONCLUSIONS

From this field experiment variety was exerted significant influence on days to 50% maturity and unmarketable yield q ha⁻¹ in 2013. Similarly it was also affected marketable yield, unmarketable yield and total yield of onion plant in the 2014 cropping season. Based on this research output significantly higher marketable yield (318.52 q ha⁻¹) was obtained at Adama red variety; which however, it was statistically on par with Nafis variety (289.26 q ha⁻¹) whereas significantly lower marketable yield (222.41 q ha⁻¹) was recorded at Nasik red variety in the second cropping year.

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REFERENCES

- [1] M. J. Bassett, *Breeding vegetable crops*. West Port. Connecticut: AVI Publishing Co. Inc, 1986.
- [2] D. R. Decoteau, *Vegetable crops*. New Jersey, USA: Prentice- Hall, Inc, 2000.
- [3] J. L. Brewster, *Onions and other vegetable alliums*, 2nd ed. North America: CAB International, 2008.
- [4] J. L. Brewster, *Onion and other vegetable alliums*. Wallingford, UK: Cab International, 1994.
- [5] G. D. Lannoy, *Vegetable crops in tropical Africa*. In: Raemaeks R. H. (Editor). *Crop production in tropical Africa*. Belgium: Directorate General for International Cooperation DGIC, 2001.
- [6] S. P. Baliyan, "Evaluation of onion varieties for productivity performance in Botswana," *World Journal of Agricultural Research*, vol. 3, pp. 129-135, 2014.
- [7] N. D. Costa, G. M. Resende, and C. S. Dias, "Evaluation of onion cultivars at Petrolina," *Horticulture Brasileira*, vol. 18, pp. 57-60, 2000.
- [8] A. F. Baloch, *Vegetable crops*. Horticulture: National Book Foundation Islamabad, 1994.
- [9] A. Geremew, A. Teshome, T. Kasaye, and C. Amenti, "Effect of intra-row spacing on yield of three onion (*Allium Cepa* L.) varieties at Adami Tulu agricultural research center mid rift valley of Ethiopia," *J. Hort. Forest*, vol. 2, pp. 7-11, 2010.
- [10] CSA, *Central statistics authority report on socio-economic characteristics of the population in agricultural households, land use, Area and production of crops* vol. 1. Addis Ababa, Ethiopia: Statistical Bulletin of Agricultural Survey, 2005.
- [11] MoARD, "Report of Federal Democratic Republic of Ethiopia," Ministry of Agriculture and Rural Development Report on Animal and Plant Health Regulatory Directorate: Crop Variety Register, Addis Ababa, Ethiopia, 2009.

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