Effect of Applying Different Alfalfa and Moringa Leaf Extract Concentration Rates on Yield and Quality of Onion (*ALLIUM CEPA* L.)

Shambel Abebe [1*], Biniam Abebe [1]

[1]Department of Plant Science, College of Agriculture and Environmental Science, Arsi University, P.O. Box 193, Asella, Ethiopia

[*]**Corresponding Author**: Shambel Abebe Email: lamshamb@gmail.com

ABSTRACT

A field experiment was conducted at practical site of College of Agriculture and Environmental Science, Arsi University, during main season of 2017 to evaluate the effect of alfalfa and moringa leaf extract concentration application at different rates on onion growth, yield and yield quality attributes. The treatments consisted of four rates of alfalfa leaf extract (control, 2%, 3% and 4%) and four rates of moringa leaf extract (control, 2%, 3% and 4%). The experiment was laid out as a randomized complete block design in a factorial arrangement and replicated three times. The results revealed that combined application of alfalfa and moringa leaf extract application had significantly influenced leaf number per plant, plant height, leaf length, root length, root number, days to maturity, mean bulb weight, marketable yield, unmarketable yield, total yield and total soluble solid of onion crop. The combination of alfalfa and moringa leaves extract at the rate of 4% resulted in maximum leaf number per plant (12.76), plant height (89.18 cm), leaf length (68.71cm), root length (14.23cm), root number (63.02) and days to maturity (122.66), which increased by 48.04, 43.26, 48.87, 39.84, 48.22 and 89.92%, respectively, as compared to the values obtained from plants grown in the control /without application. Moreover, combined alfalfa and moringa leaf extract application at the rate of 4% each had a significantly increased the yield and on quality parameters like

marketable yield (88.16Q/ha), unmarketable yield (19.29Q/ha), mean bulb weight (94.55gm/bulb), total bulb yield (88.26 Q/ha) and total soluble solid (8.92%) which was improved by 21.88%, 457.73%, 37.18%, 31.14% and 45.74%, respectively as compared to the control. Therefore, the results of this study indicated that, combined alfalfa and moringa leaf extract application at the rate of 4% led to optimum growth and yields of the onion crops. Thus, it was recommended that, application of growth hormone obtained from leaf extract of alfalfa and moringa at 4% concentration was assured the growth, yield and quality attributes of onion product can be improved.

Key words: Alfalfa, Leaf extracts, moringa, onion yield, onion quality

INTRODUCTION

In Ethiopia onion (*Allium cepa* L.) is produced as a cash crop by both small-scale farmers and commercial growers, especially under irrigated condition. Onion (*Allium cepa* L.) is one of the bulb crops belonging to the family Alliaceae (Hanelt, 1990) and a highly important vegetable crop in the Ethiopian daily diet (Anchal *et al.*, 2006). Onion production opens job opportunity for many citizens as it is a source of income for producers, brokers, transporters, wholesalers and retailers. But, statistics indicated that, the production of onion in Ethiopia during 2016/2017 growing season was in about 33,603.39 ha of land yielding a total production of 3,274,752.45qu. with an average yield (97.45 Q/ha) (CSA, 2017) which is too low as compared to the world average of 193.1Q/ha (FAOSTAT, 2017).

It is, therefore, highly important to look for ways of improving onion yield and quality both in size and bulbs uniformity (Lemma and Shimeles, 2003 and Alemu *et al*., 2004). To this end, the application of synthetic plant growth regulators and extracts of some plant parts seems promising (Tafesse, 2015).However, availability and use of such plant growth regulators in

Ethiopia is not well known, and/or limited to the horticulture industries, due to lack of companies who import plant growth regulators and also due to their high cost. Another plant growth regulator that has been used to stimulate growth in many plants is Triacontanol (TRIA); which was first discovered by Ries *et al.* (1977) in alfalfa (*Medicago sativa* L.) leaves. Triacontanol (TRIA) has been reported to promote the yield of different horticultural and field crops such as asparagus, dry beans, lettuce, onion, tomatoes (Biernbaum *et al*., 1988), and many others. Triacontanol is a potential plant growth regulator which has been reported to significantly affect plant growth and development (Verma *et al*., 2009; Shahbaz *et al*., 2013). Triacontanol (TRIA) is known for increasing chlorophyll content (Giridhar *et al*., 2004) and plays a positive role in enhancing growth, yield, photosynthesis, nitrogen fixation, enzymes activities, free amino acids, reducing sugars, and soluble protein of plants (Ries *et al*. 1993; Borowski *et al*. 2000; Naeem *et al.* 2009; Aftab *et al.* 2010; Naeem *et al.* 2010, Naeem *et al.* 2011). In general, very small concentration of triacontanol, ranging from nano-gram per liter to 10 g/l, was shown to promoting the yield and dry matter content of many crops (Biernbaum *et al*., 1988).

Recently, application of moringa leaf extract (MLE) for increasing agricultural productivity is getting attention in different parts of the world, due to its effect on plant growth and development (Abedin *et al*., 2016). Several findings revealed that moringa leaf extract (MLE) increased productivity of sugarcane and vegetable crops (Foidle *et al*., 2001). Furthermore, While Fuglie, 2000 and Foidle *et al*., 2001, was also reported that, applying of moringa leaf extract (MLE) produced a 20 to 35% increase in the yield of peanut (*Arachis hypogaea* L.), onion (*Allium cepa* L.) and tomato (*Lycopersicon esculentum* [L.] Mill.). Moreover, prevention of premature leaf senescence resulting in more leaf area with higher

photosynthetic pigments following foliar application of moringa leaf extracts (MLE) (Bashir *et al*., 2014). Moringa has attained enormous attention being rich in cytokinin, antioxidants and macro–micro nutrients in its leaves (Makkar *et al*., 2007). Cytokinins are one of the plant growth regulators that are important for chlorophyll development and hence delay leaf senescence. Cytokinin available in moringa leaf extract was even more effective in comparison with artificial cytokinin source i.e benzyl amino purine (BAP) under normal as well stress conditions (Basra *et al*., 2011b). Leaf and twig, 2009 showed that extracts of moringa can be recommended to be used effectively by farmers as a bio-organic fertilizer for various crops due to its high productivity, high nutritive value, antioxidant effect, easy preparation, low cost and environmentally friendly nature (Culveri *et al.,* 2012). Fuglie (1999) and Foidle *et al*. (2001) suggested that the effectiveness of moringa leaf extract (MLE) could be due to its richness in zeatin, ascorbic acid, Ca^{2+}, and K^{+}, which are involved in improving several plant growth and development processes.

The use of plant growth regulators (PGRs) that are known to increase growth rate of plants would be of high importance, to improve both vegetative growth and bulb yield of onion, and this has been suggested by several authors (Mathur, 1971). Unlike their profound effect on productivity of horticultural crops, the use of plant growth regulators (PGRs) in Ethiopian agriculture is limited to the horticulture industries. There are only a few numbers of experimental outputs that dealt with plant growth regulators (PGRs) and there is no continuity and give priority in the research so as to recommend to growers (farmers). Synthetic growth regulators are expensive and not available in many countries like Ethiopia, particularly when Ethiopian farmers are considered. In addition, the price of most of the plant growth regulators (PGRs) is expensive and it is hard to get locally, hence

they are not easily available for both small scale and commercial onion growers. In order to alleviate such problems, the use of plant extracts that are believed to be growth stimulators seems to be a better alternative. For instance, foliar application of alfalfa (*Medicago sativa*) and Moringa (*Moringa oleifera* Lam.) leaf extract on different crops have shown promising results and they can be made easily available for growers. Therefore, the objective of this research was to evaluate the effect of alfalfa and moringa leaf extract application at different concentration rates on yield and quality attributes of onion**.**

MATERIALS AND METHODS

Description of the Study Area

A field experiment (2017 rainy season) was conducted at demonstration site of Arsi University, College of Agriculture and Environmental Science located in the Oromia, Ethiopia. The site is geographically located at a distance of 175 km South East of Addis Ababa with an altitude of 2430 m.a.s. l 7^0 57, N latitude and 39^0 7, E longitude, representing a high altitude and high rain fall environment. The annual mean rainfall of the area is 831 mm with a mean maximum temperature of 20.8 ^{0}c and a mean minimum temperature of 7.9 ^{0}c (KARC, 2008).

Experimental Materials and Field Management

Seed of onion variety bombay red, which was preferred as common variety by most of the growers in the onion growing regions as well as in the country, which was obtained from market and the variety was released by Melkassa Agricultural Research Centre in 1980 (EARO, 2004). Seeds were sown on a well-prepared 1 m x 2 m on nursery bed following recommended cultural practices by Selamawit *et.al* (2013) at Arsi University, College of Agriculture and Environmental Science on demonstration site. The growth plot size was 2 m x 1.2 m = 2.4 m^2 with a total of 40 plants per plot. Field

layout and treatments assigning were done according to treatments combinations. The onion seedlings were transplanted at 45 days after sowing in single row of 30 cm x 10 cm, spacing between rows and plants, respectively and when seedlings were attained proper stage for transplanting at 3 or 4 leaves stage estimated around 12 to 15 cm height. Seedlings were transplanted on fine soil which was prepared following the recommended tillage practice for the crop. Water was applied regularly as demand without stressing the plants and when the rainfall was come it was stopped. Although, all management practices (cultivation, transplanting, weeding and others) were applied uniformly to all plots as per required. Moreover**,** Ridomil Gold at a rate of 3.25 kg ha^{-1} in 700 liters of water was uniformly applied every three days to control disease. Each experimental plot had six single rows. During data collection the middle four single rows were considered for recording all data excluding the two border rows as well as those plants at both ends of each row to avoid edge effects.

Treatments and Experimental Design

A number of leaf extract was done on alfalfa and moringa as reported by Azra, (2011) and Tafesse, (2015), respectively. Accordingly, the treatments were designed as follows. The treatments were consisted four levels of alfalfa leaf extract (ALE) (Control/without application, 2%, 3% and 4%), and four levels of maringa leaf extract (MLE) (Control/without application, 2%, 3% and 4%), and was applied after the seedlings were transplanted. The experiments were laid out as a randomized complete block design (RCBD) in a 4 x 4 factorial arrangement and replicated three times. The treatments were assigned to each plot randomly.

Soil Chemical Analysis

The soil samples were air-dried and ground to pass through a 2 mm sieve to exclude non-soil particles for analysis**.** The analysis of the soil was made

done using the standard methods at Kulumsa Agricultural Research Center Soil Laboratory and JIJE Labo-glass PVT. Limited Company of Soil Laboratory. Accordingly, soil pH was measured potentiometrically using a pH meter in the supernatant suspension of 1:2.5 soils to water ratio after stirring with automatic stirrer for 30 minutes. Soil particle size distribution was determined by the hygrometer method following the procedure described by Day (1965) and organic carbon was determined following the wet digestion method as described by Walkley and Black (1934). The modified Kjeldhal procedure was used for determining of total nitrogen of soil as described by Jackson (1958) and available soil phosphorus was extracted by Olsen (Olsen *et al*., 1954) extraction method and then determined using spectrophotometer following the procedure described by Murphy and Riley (1962).

Table 1. Soil chemical analysis of the site

	Parameters				
	PH%	Available phosphorus ($mg/kg_)$	Total nitrogen (%)	Organic carbon (%)	Organicmatter (%)
Block 1	5.27	31.23	0.42	6.03	10.4
Block 2	5.28	37.39	0.39	5.00	9.65
Block 3	5.26	29.83	0.42	6.00	10.45

Preparation of Moringa and Alfalfa Leaf Extract

Moringa seedlings were raised at Melkassa Agricultural Research Center and when the seedlings were attained 45 days the leaves were brought to Arsi University, College of Agriculture and Environmental Science laboratory for processing. One kilo-gram fresh green moringa and alfalfa leaves were grinded, separately by using conventional mortar and pistil and soaked in distilled water for 24hrs for extract. The extract was purified by filtering

twice through (Whatman No. 1) filter paper. The concentrations were prepared from the crude extract of 20, 30 and 40 ml and diluted with 980 ml, 970 ml and 960 ml with distilled water to reach at the concentration of 2%, 3% and 4% respectively, according to (Bashir *et al.,* 2014), and control treatment was used with water as foliar spray.

Data Collection and Measurements

Data on some growth parameters were recorded without lifting the plants while for other parameters that need destructive sampling, previously tagged plants was lifted and the necessary data were recorded.

Plant height (PH): it was measured from the longest mature leaf at physiological maturity (50 % leaf fall) randomly from 10 plants with ruler.

Root Length (RL): it was measured from the tip of the longest root from ten randomly sampled plants.

Number of roots per plant: The total number of under-ground root was counted from ten randomly sampled plants.

Number of leaves per plant (LN): The total numbers of leaves were counted at physiological maturity from ten randomly sampled plants.

Days to maturity (MD): It was recorded date of maturity when approximately the leaves of 70% plants senesce or fall off.

Mean bulb weight (MBW): The average weights (g) of mature bulb after curing were determined from 10 randomly selected plants by dividing for 100.

Marketable bulb yield: It was measured by sensitive balance gram which can be recognized as clean marketable bulbs that had >60gm (Lemma and Shimeles, 2003).

Unmarketable bulb yield: - It was measured by sensitive balance gram which can be recognized as unmarketable bulbs that had <20gm, diseased, decayed and disordered bulbs.

Total bulb yield: the total bulb yield (kg) per plot were recorded by taking the weight of cured bulbs and total bulb yield per ha was obtained by extrapolation (Lemma and Shimeles (2003).

Total soluble sugars content (TSS): The TSS was determined at harvesting time from ten randomly selected bulbs using the procedures described by (Waskar *et al*., 1999). Scales from randomly selected bulbs was macerated for juice extraction and TSS of the juice was determined by using a hand refractometer (Erma Japan) 0 to 32 percent range. The values were expressed as percent TSS of the bulbs (Anon., 1984).

Data Analysis

Data were subjected to analysis of variance (ANOVA) using SAS statistical package **(**SAS, 2010**)** version 9.2. All significant pairs of treatment means were compared using the fishers Least Significant Differences (F-LSD) test at 5% level of significance.

RESULTS AND DISCUSSION

Growth parameters

Leaf Number per Plant and Plant Height

The results of the experiment showed that there was a significant interaction effect of alfalfa and moringa leaves extract on leaf number per plant and highest plant height of onion (Table 2). Many leaf numbers per plant (12.76) and highest plant height (89.18cm) was recorded at 4% concentration of alfalfa and moringa leaf extract application and the lowest was observed for the control treatment, respectively (Table 2). Moreover, when the alfalfa and moringa leaves extract was applied at highest concentration, the growth response of leaf number per plant and plant height is increased, which was

improved by 48.04% and 43.26%, respectively (Table 2). Moringa accelerated growth of young plants, strengthened plants, improved resistance to pests and diseases, prolonged life span, increased number of roots, stem and leaves, produced more and larger fruits and generally increased yield by about 20-30% Fugile. (2001). Similar result were obtained by, Nagar *et al*., 2006 and Anwar *et al*., 2007 who reported Zeatin is one form of the most common forms which is naturally occurring cytokinin in plants playing an important role in cell division and cell elongation that led to promote the growth of plants Sale *et al*. (2015) reported that pot treated of tomato with moringa leaf extract (MLE) at 100 ml/pot gave plant with the greatest most number of leaves for moringa leaf extract (MLE) at different levels of application. (Foidle *et al*., 2001 and Shahbaz *et al*., 2013). The result was supported by Fugile, 2001, who was reported, moringa leaf extract was accelerates growth of young plants, strengthens plants, stems and leaves. Although, Sale *et al*., 2015, reported that, pot treated of tomato with moringa leaf extract (MLE) at 100 ml/pot gave plant with the highest number of leaf at different levels of application. In addition, Mohammed, 2013 was observed that moringa extract at concentrated 50% of ratio (1:2) showed the highest effect on plant height and number of leaves per plant of onion 48.43cm and 11.95 and the lowest were obtained from the control 38.12cm and 7.17, respectively. Furthermore, Azra, 2011**,** found that spraying wheat, peas and tomato with moringa *oleifera* extract at 3.5% increased all growth parameters. Similarly, the current result also supported by Giridhar *et al*., 2004; Verma *et al*., 2009, Aftab *et al.* 2010; Naeem *et al.* 2010, Naeem *et al.* 2011 ware also reported, triacontanol is a potential plant growth regulator which has been reported to significantly affect plant growth and development.

Leaf Height and Root Length

Leaf height and root length of onion were significantly affected by the concentration of alfalfa and moringa leaf extract at $p<0.05$ (Table 2). The tallest leaf and root length of onion were recorded at 4% of alfalfa and moringa leaf extract concentration which was recorded 94.19 cm and 14.23 cm, respectively. When the concentration of the extracts was increased from zero (control) to 4% leaf height and root length parameters were increased by 48.87% and 39.84%, respectively (Table 2). The greater height of leaves and root length with the application of 4% alfalfa and moringa leaf extract concentration might be linked with the efficiency of photosynthetic apparatus (Foidle *et al*., 2001 and Shahbaz *et al*., 2013). The recent finding was supported by Fugile, 2001, which was reported that, moringa leaf extract was increased root length and leave height of onion. Similarly, Tefase, 2015, also reported that when the amount of alfalfa shoot extract was further increased to 0.5µg/l, the leaf height was increased by 13.7%.

Root Number per Plant and Days to Maturity

Root number and days to maturity of onion were significantly affected by the concentration of alfalfa and moringa leaves extracts at $p<0.05$ (Table 2). Many root number (63.02) was recorded at the combined application of 4% of alfalfa and moringa leaves extract application each root number and the many days to maturity (126 days) was recorded at the interaction concentration rate of on 3% alfalfa and 4% moringa leaves extract concentration. Although, the lower number of roots number per plant and days to maturity was recorded at the control (30.39) and (110.30), respectively (Table 2). In addition, when the concertation amount of alfalfa and moringa leaf extract was increased from control to 4% of the root number per plants was increased by 48.22% and when the concentration of alfalfa and moringa was increased from control to 3% and 4%, respectively,

days to maturity was increased by 87.53% (Table 2). The current result was supported by Hanaa *et al*., 2008 and Rehman and Basra, 2010, which was reported that, the foliar application of moringa leaf extract may stimulate earlier cytokinin formation thus preventing premature leaf senescence and resulting in more leaf area with higher photosynthetic pigments. Similarly, The result is concordant with Ogbuehi *et al*., 2017, who reported that, the highest (45.50) mean number of roots per plant of onion at 2 WAP was recorded from the 20% MLE treated plots while the lowest (35.00) from control. Moringa prolonged life span, increased number of roots, stem and leaves, produced more and larger fruits and generally increases yields of onion by about 20-30% (Fugile, 2001).

Table 2. Effect of alfalfa and moringa leaf extracts on leaf number per plant (LNPP), plant height (PH) (cm), leaf height (LH) (cm), root length (RL) (cm) and days to maturity (DM) of onion

Treatments	Growth parameters					
	LNPP	PH (cm)	LH (cm)	RL (cm)	RN	DM
Control (0%)	6.13^{e}	38.58^{g}	33.58^{e}	5.67^{f}	30.39^{d}	110.3^{d}
ALE2%	8.43d	58.55^{cdef}	48.53^{cde}	9.1b^{cde}	44.3^{bcd}	121.66^{abc}
ALE3%	8.93^{bcd}	53.96^{f}	45.53^{de}	9.6b^{cde}	45.35^{bcd}	111.66^{cd}
ALE4%	8.4^{d}	73.63^{b}	51.25^{abcde}	7.26^{ef}	53.33^{ab}	116.66^{abcd}
MLE2%	10.73^{b}	72.7^{b}	57.5^{abcd}	9.46^{bcde}	40.73^{bcd}	111.66^{cd}
MLE3%	8.90^{bcd}	58.24^{def}	64.6^{abc}	10.08^{bcde}	52.63^{ab}	118.33^{abcd}
MLE4%	9.8^{bcd}	64.92^{bcdef}	53.63^{abcd}	10.46^{bcd}	31.53^{cd}	121^{abcd}
ALE2%*MLE2%	9.70^{bcd}	59.99^{bcdef}	49.96^{bcde}	10.6^{bc}	46.2^{bcd}	118.33^{abcd}
ALE2%*ML	9.33^{bcd}	68.63^{bcde}	56.5^{abcd}	9.46^{bcde}	43.53^{bcd}	113.33^{bcd}

E3%						
ALE2%*ML E4%	8.83^{cd}	60.14^{bcdef}	50.6b^{cde}	10.06^{bcde}	42.6^{bcd}	120^{abcd}
ALE3%*ML E2%	9.33^{bcd}	67.7^{bcdef}	49.16^{bcde}	7.53^{ef}	41.73^{bcd}	115.66^{abcd}
ALE3%*ML E3%	9.26^{bcd}	70.7^{bcd}	66.64^{ab}	7.66^{ef}	47.8^{abc}	116.66^{abcd}
ALE3%*ML E4%	9.83^{bcd}	55.59^{ef}	53.93^{abcd}	8.26^{cdef}	46.47^{bcd}	126^{a}
ALE4%*ML E2%	10.46^{bc}	72.15^{bc}	60.43^{abcde}	11.66^{ab}	49.13^{ab}	123.33^{ab}
ALE4%*ML E3%	9.53^{bcd}	72.15^{bc}	94.19^{abc}	9.56^{bcde}	43.96^{bcd}	121.66^{abc}
ALE4%*ML E4%	12.76^{a}	89.18^{a}	68.71^{a}	14.23^{a}	63.02^{a}	122.66^{ab}
CV%	9.98	12.74	19.77	18.26	21.6	5.50
LSD (0.05%)	1.87	13.77	18.02	2.82	16.27	10.83

^{abc} Means on the same column with different superscripts differ significantly ($p>0.05$), Where, ALE = alfalfa leaf extract and MLE = moringa leaf extract

Mean Bulb Weight and Total Yield

All foliar application of alfalfa and moringa leaf extract concentration was affected mean bulb weight of yield components of onion significantly (Table 3). The highest mean bulb weight (94.55gm/bulb) was observed at the application of alfalfa and moringa leaf extract concentration rate of 4%. Combined alfalfa and moringa leave extract application of 4% was the best treatment and gave significant increases of mean bulb weight (94.55gm/bulb) and exceed form control (35.16gm/bulb) by 37.18% (Table 3). This finding is in conformity with Muhammad *et al.,* 2013, who reported

application of foliar moringa extract with concentration of 50% produced heavier bulb yield of 76.87gm while lowest 10.39gm were obtained from the control. A significantly superior yield of onion (88.26 Q/ha) was observed with the combined application of 4% alfalfa and moringa leaf extract concentration rate and at the lowest were at control 27.49 Q/ha (Table 3). The increment in yield with application of 4% of alfalfa and moringa leaf extract concentration was about 31.15% over control (Table 3). Plots applied with 4% of alfalfa and moringa leaf extract concentration was produced maximum yield 88.26 Q/ha followed by combined application of 4% of alfalfa and 3% of moringa was producing yield of 67.53 Q/ha (Table 3) which was lower from combined application of 4% of alfalfa and moringa leaf extract by 76.51%. Although, application of alfalfa and moringa leaf extract exceed the production of Arsi zone (50.99 Q/ha) with 57.77%, Oromia region (75.60 Q/ha) by 85.65% whereas Ethiopia production (97.45 Q/ha) exceed the current experiment with 90.56% (CSA, 2017).The increase in bulb yield of onion with application of higher level of alfalfa and moringa leaf extract concentration might be due to increased triacontanol and cytokinins available in alfalfa and moringa leaf extract, respectively (Culver *et al.,* 2012 and Ozobia, 2014). Hala *et.al*; 2017, reported that as different moringa extract concentration on fruit yield of pepper showed that significant increases as compared to the control treatment. Similarly, Jason, 2013, showed that, application of moringa leaf extract contains plant growth hormone, called zeatin which has been increase yields by 25 to 30%. The same results were reported by Bashir *et al.,* 2014, Oluwagbenga and Odeghe, 2015, and Aluko, 2016, on onion, tomato, eggplant, and pepper, respectively.

Marketable and Unmarketable Bulbs Yield

Alfalfa and moringa leaves extract concentration significantly affecting the weight of marketable bulb yield. Application of 4% concentrated rate of alfalfa and moringa leaves extract significantly increased the weight of marketable bulbs (88.16Q/ha) exceed by 21.88% as compared to the control (19.29Q/ha) treatment (Table 3). The result obtained might be due to the fact that different concentrations of alfalfa and moringa leaves extract have increased protein content and carbohydrate when compared with untreated onion (control) (Muhammad *et al.,* 2013). The greater number of leaves produced on the combined application of 4% alfalfa and moringa leaf extract might be, linked with the efficiency of photosynthetic apparatus, which leads to increase in number of bulbs produced (Muhammad *et al.,* 2013). Similarly, Alfalfa and moringa leaf extract interaction showed that significant effect on unmarketable bulbs of onion (Table 3). The highest unmarketable bulbs (8.20Q/ha) were obtained from control whereas the lowest unmarketable bulbs were produced by the control treatment applied with the combined application of 4% alfalfa and moringa leaf extract concentration (0.10Q/ha) (Table 3). The funding was in line with the finding of Mohammed *et.al*, 2013; that showed the application of foliar extract with concentration 50% of moringa extract application produced a greater number of onion bulbs, heavier bulb yield and longer bulb diameter while lowest number of bulbs obtained from the control.

Table 3. Effect of alfalfa and moringa leaf extract on mean bulb weight (MBW), marketable yield (MY), unmarketable yield (UMY), total yield (TY) and total soluble solid (TSS) of onion

Treatments	Yield components, Yield and Quality Parameters				
	MBW (gm)	MY (Q/ha)	UMY (Q/ha)	TY (Q/ha)	TSS (%)
Control (0%)	35.16^{f}	19.29^{e}	8.20^{a}	27.49^{f}	4.08^{f}
ALE2%	68.43^{bcd}	61.88^{b}	4.10^{acde}	65.98^{ab}	7.38^{abcd}
ALE3%	57.39^{de}	33.28^{cde}	3.40^{bcde}	36.68^{def}	6.89^{abcde}
ALE4%	78.67^{abc}	50.89^{cde}	8.00^{ab}	58.89^{bcde}	6.20^{bcdef}
MLE2%	70.21^{bcd}	58.94^{bc}	2.50^{de}	61.44^{bc}	5.29^{def}
MLE3%	38.27^{ef}	40.21^{abe}	7.10^{abc}	47.31^{bcdef}	8.32^{ab}
MLE4%	67.99^{bcd}	56.57^{cde}	3.70^{abcde}	60.27^{bcd}	6.07^{bcdef}
ALE2%*MLE2%	74.09^{abcd}	58.47^{bc}	5.70^{cde}	64.17^{b}	6.70^{abcde}
ALE2%*MLE3%	71.61^{bcd}	53.97^{bcd}	2.80^{cde}	56.77^{bcde}	7.39^{abcd}
ALE2%*MLE4%	57.25^{de}	30.19^{de}	5.10^{abcd}	35.29^{ef}	5.55^{cdef}
ALE3%*MLE2%	63.80^{cd}	53.53^{bcd}	3.30^{cef}	56.83^{bcde}	7.26^{abcd}
ALE3%*MLE3%	71.51^{bcd}	40.48^{bc}	3.60^{bcde}	44.08^{bcdef}	7.92^{abc}
ALE3%*MLE4%	55.13^{def}	34.01^{de}	5.60^{abcd}	39.61^{cdef}	7.65^{abcd}
ALE4%*MLE2%	75.59^{abcd}	44.41^{bcd}	4.60^{abcd}	49.01^{bcdef}	4.61^{ef}
ALE4%*MLE3%	85.66^{ab}	61.43^{bc}	6.10^{abcd}	67.53^{ab}	8.46^{ab}
ALE4%*MLE4%	94.55^{a}	88.16^{a}	0.10^{e}	88.26^{a}	8.92^{a}
CV%	18.85	28.69	58.59	26.36	21.65
LSD (0.05)	20.95	2.37	0.45	23.61	2.45

^{abc} Means on the same column with different superscripts differ significantly ($p>0.05$), Where ALE = alfalfa leaf extract and MLE = moringa leaf extract

Total Soluble Solid

Total soluble solids were revealed significant differences among the interactions of the treatments. The highest percent of total soluble solid was observed in bulbs treated with combined 4% of alfalfa and moringa leaf extract concentration 8.92% while the lowest was recorded from the control (4.08%) (Table 3). Combined application of alfalfa and moringa leaves extract of 4% was gave significantly improved total soluble solid (8.92%) and exceed form zero (control) (4.08%) by 45.73%The possible reason for increasing the total soluble solids with higher application of alfalfa along with moringa leaf extract might be higher plant growth regulator content which increased the chlorophyll content and dry weight per plant (Brady, 1985). Consistent with the results of this study, Naik and Hosamani, 2003, also showed that maximum TSS was recorded for higher concentration rates of moringa. Similarly, the result concordant with Morsy *et al*., 2012, who stated that the application of alfalfa leaf extract rates increased TSS values.

CONCLUSIONS AND RECOMMENDATION

This experiment was conducted during the 2017 cropping season in Arsi University, College of Agriculture and Environmental Science on the demonstration site with the objective to evaluate the effect of alfalfa and moringa leaf extract application rates on yield and quality attribute of onion**.** The experiment was laid out in randomized complete block design in factorial arrangement with four levels of alfalfa and moringa leaf extract concentration rate for each (0%, 2%, 3%, 4%), respectively. The interaction effect of alfalfa and moringa leaf extract was significant on all parameters of growth, yield and quality attributes of onion. In most of alfalfa and moring leaf extract application with the concentration rate of 4% was brought significant effect as compared to the zero (control) treatment (water

sprayed). Therefore, the result of the study was indicated that, application of 4% of alfalfa and moringa leaf extract application was improved growth, yield and quality attributes of onion. Thus, it was recommended that application of growth hormone obtained from leaf extract of alfalfa and moringa was assured as the growth, yield and quality of onion product can be improved. A recommended concentration rate of 4% of moringa and alfalfa leaf extract has been found to give the best yield for onion.

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REFERENCES

Aftab T, Khan MMA, Idrees M, Naeem M, Singh M, Ram M. (2010). Stimulation of crop productivity, photosynthesis and artemisinin production in Artemisia annua L. by tria contanol and gibberellic acid application. J. Plant Interact. doi: 10.1080/1742914100364 7137

AK Biswas, TS Hoque, MA Abedin, (2016). Effects of moringa leaf extract on growth and yield of maize., Department of Soil Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Alawady, A. (2003). Moringa Tree: Nature's Pharmacy. Retrieved October 20, 2007, from http://www.islamonline.net/english/Science/2003/02article06.shtml

Aluko, M., (2016). Moringa leaf extract on the growth and yield of pepper (*Capsicum annuum* L). ARPN Journal of Agricultural and Biological Science, 11(3): 107-109.

Alemu D, Deressa A, Desalegne L, Anchala C., 2004. Domestic vegetable seed production and marketing. Research Report (Ethiopia).

Amin A. A., EL-Sh. M. Rashad and H.M.H. EL-Abagy (2007) Physiological Effect of Indole - 3 - Butyric Acid and Salicylic Acid on Growth, Yield and Chemical Constituents of Onion Plants, Dokki, Cairo, Egypt, Journal of Applied Sciences Research, 3(11): 1554-1563.

Amirigbal, M., Nadeemakbar, A., Abbas, R., Khan, H., & Maqsood, Q. (2014). Response of Canola to foliar application of Moring (Moringa olifera L.) and Brassica (*Brassica napus* L.) water extracts. International J. Agric. and Crop Sci., 14(7), 1431-1433.

Anchal C, Deressa A, Deselagn L., (2006). Farmers participatory onion seed production in the Central Rift Valley of Ethiopia: achievement, constraints and its implication for the national seed system. In The Conference of the Crop Science Society of Ethiopia, 11, Addis Abeba (Ethiopia),

Andrews, D. (2006). Nutraceutical Moringa composition. Image analysis. Principles and Practice. A Technical Handbook produced by Joyce-Loebl, A Vickers Company. Short Run Press, Exeter, 250 pp.

Anwar F.; S. Latif; M. Ashraf and A. H. Gilani (2007). *Moringa oleifera*: A food plant with multiple medicinal uses. Phytother. Res. 21:17-25.

Azra Y. (2011). Exploring the Potential of Moringa (*Moringa Oleifera*) Leaf Extract as Natural Plant Growth Enhancer. Ph.D. Faculty of Agriculture, University of Agriculture, Faisalabad, Pakistan.

Bashir, K.A., J.A. Bawa and I. Mohammed, 2014. Efficacy of leaf extract of drumstick tree (*Moringa oleifera* L.) on the growth of local tomato (*Lycopersicon esculentum*), Journal of Pharmacy and Biological Sciences, 9(4): 74-79.

Basra, S.M.A., Z. Ali, H. Munir, A. Mahmood and S. Yousaf, 2011b. Mitigation of drought stress in maize by natural and synthetic growth promoters. J. Agric. Soc. Sci., 7: 56–62

Biernbaum, J.A., W. Carlson, C. Shoemaker, and R. Heins. 1988. Low PH causes iron and manganese toxicity. Greenhouse Grower 6(3):92-97.

Borowski, E., Blamowski, Z.K. and Michalek, W. (2000) Effects of Tomatex/ Triacontanol on chlorophyll fluorescence and tomato (Lycopersicon esculen- tum Mill.) yields. Acta Physiol. Plant. 22: 271–274

Bremner, J.M. and C.S. Mulvaney, 1982, Nitrogen-total. *In* Methods of soils analysis Part 2, 2 ed. American Society of Agronomy, Inc., Madison, Wisconsin.

Culver, M., T. Fanuel1 and A.Z. Chiteka, 2012. Effect of moringa extract on growth and yield of tomato. Greener Journal of Agricultural Sciences, 2(5): 207-211.

Day, R.P. 1965. Pipette method of particle size analysis. In: Methods of soil analysis. Agronomy 9. ASA USA. p. 553-562.

Emongor, V. E. (2002). Effect of benzyldenine and gibberellins on growth and yield components of common bean. UNISWA Res. J. Agr. Sci. Tech., 6(1), 65-72.

EARO (Ethiopian Agriculture Research Organization). 2004. Directory of Released Crop Varieties and their Management. Addis Ababa, Ethiopia.

Foidl N, Makkar HPS, Becker K (2001).The potential of *Moringa oleifera* for agricultural and industrial uses. In: *Proceedings of the International.*

Fuglie, L.J. (1999) The Miracle Tree: Moringa oleifera: Natural Nutrition for the Tropics. Church World Service, Dakar, 68.

Giridhar P., Indu E.P., Ravishankar G.A., Chandrasekar A. 2004. Influence of TRIA on somatic embryogenesis in Coffea arabica L. and Coffea canephora P. EX FR. In vitro Cell Dev Biol Plant 40:200-203.

Hala, H. Abou El-Nour and Nabila, A. Ewais, 2017, .Effect of *Moringa oleifera* Leaf Extract (MLE) on Pepper Seed Germination, Seedlings Improvement, Growth, Fruit Yield and its Quality. Egypt, ISSN2077-4605.

Hanaa, H., A. El-Baky, M.M. Hussein and G.S. El-Baroty. 2008. Algal extracts improve antioxidant defense abilities and salt tolerance of wheat plant irrigated with sea water. EJEAF Che. 7(4):2812-832.

Hanelt P. 1990, Taxonomy, evolution, and history. In Onions and allied crops. CRC Press.

Jackson , M.L. 1958 . Soil chemical analysis . Prentice-Hall , Englewood Cliffs , N.J . 498 p.

Jason, P., 2013. Pepe's Fruit Trees, www.pepesplants.com

KARC., 2008. Kulumsa Agricultural Research Center. Annual Report of KARC, Asella, Ethiopia. p. 6.

Lemma D, Shimeles A., 2003. Research Experience in Onion Production, Ethiopia.

Marschner, H., 1995. *Mineral Nutrition of higher plants*. 2nd Ed. Academic Press, San Diego, CA. pp. 889.

Makkar, H.P.S., G. Francis and K. Becker. 2007. Bioactivity of phytochemicals in some lesser-known plants and their effects and potential applications in livestock and aquaculture production systems. Animal 1: 1371-1391.

Mathur, M.M., 1971. Response of *Allium cepa*. L. transplants to different plant growth regulators. Indian J. Hortic., 28: 296-300.

Mohammed, R; Olorukooba, M.M; Akinyaju, J.A and Kambai, E.A,2013, Evaluation of Different Concentrations And Frequency of Foliar Application of *Moringa, Extract* on Growth & Yield of Onion, *Allium*

cepa Lam, Forestry Research Institute of Nigeria, Federal College of Forestry Mechanization, P.M.B 2273, Afaka, Kaduna,Nigeria.

Morsy, M.G. Marey, R.A. Karam, S.S. and Abo-Dahab, A.M.A. 2012. Productivity and storability of onion as influenced by the different levels of alfalfa leaf extract. Journal of Agricultural Research Kafer El-Sheikh University, 38(1):171-186.

Muhammed, R., M.M. Olorukooba, J.A. Akinyaju and E.A. Kambai, 2013. Evaluation of different concentrations and frequency of foliar application of moringa extract on growth & yield of onion, (*Allium cepa* L). Agrosearch, 13(3): 196-205.

Murphy, J. and J.P. Riley, 1962. Amodified Single Solution Method for the Determination of Phosphate in natural waters. *Anal.Chim*. Acta. 27:31-36.

Naeem M, Idrees M, Aftab T, Khan MMA, Moinuddin. 2010. Changes in photosynthesis, enzyme activities and production of anthraquinone and sennoside content of coffee senna (Senna occidentalis L.) bytriacontanol. Internat J Plant Develop Biol. 4:535

Naeem M, Khan MMA, Moinuddin, Idrees M, Aftab T. 2011. Triacontanol-mediated regulation of growth and other physiological attributes, active constituents and yield of Mentha arvensis L. Plant Growth Regul 65:19520

Naeem M, Khan MMA, Moinuddin, Siddiqui MH. 2009. Triacontanol stimulates nitrogen-fixation, enzyme activities, photosynthesis, crop productivity and quality of hyacinth bean (Lablab purpureus L.). Sci Hort 121:389396a

Naik, B.H and Hosamani, R.M. 2003. Effect of spacing and nitrogen levels on growth and yield of Kharif onion. Karnataka Journal of Agriculture. Science, 16 (1):98-102.

Nagar P. K.; R. I. Leyer and P. K. Sircar (2006). Cytokinins in developing fruits of Moringa pterigosperma Gaertn. Physiol. Plant 55:45-50.

Ogbuehi H.C., Emeribe E.O. and Asagwara I.O. 2017, Soil Application of Moringa Leaf Extract on Root Development and Root Exudates of Soybean (Glycine max L.), Department of Crop Science and Biotechnology, Faculty of Agriculture and Vet. Medicine Imo State University, P.M.B. 2000 Owerri, Nigeria, Volume 6, Issue 2, ISSN (Online) 2319-147.

Olsen, S.R., C.V. Cole, F.S. Watanabe and L.A. Dean, 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. United States, Department of Agriculture Circ., pp: 939.

Oluwagbenga, D. and O.T. Odeghe, 2015. Responce of sweet bell pepper to moringa leaf extract and oregano bio-degradable fertilizer. Asian J Agri. Biol., 3(4): 117-123. Aluko, 2016.

Osman, H., & Abohassan. (2015). Moringa: The strategic tree for the third Century (1st ed., p. 287). King Abdulaziz University Publishing Center.

Ozobia A.P., 2014. Comparative assessment of effect of moringa extracts, NPK fertilizer and poultry manure on soil properties and growth performance of *Solanium menlongina* in Abuja, North Central Region of Nigeria. Journal of Agricultural and Crop Research, 2(5): 88-93.

Rehman, H and S.M.A. Basra. 2010. Growing Moringa oleifera as a multipurpose tree; some agro physiological and industrial perspectives. American Chronicle. ht tp://www.americanchronicle.com/articles/view/159447. May 28 Revenga

Price, M. (2007). The Moringa Tree. ECHO Tech. Note, eBook. Retrieved from http://miracletrees.org / moringa-doc/ebook Moringa.pdf.

Ries S, Savithiry S, Wert V, Widders I (1993). Rapid induction of ion pulses in tomato, cucumber, and maize plants following a foliar application of L(+)-adenosine. Plant Physiol 101: 49–55.

Ries SK, Wert VF, Sweelev CC, Leavitt RA. 1977. Triacontanol: a new natural occurring plant growth regulator. Science 195:13391341.

Ries, S.K. 1985. Regulation of plant growth with triacontanol. CRC. *Crit. Rev*. *Plant Sci*., 2: 239-285.

Sale F.A, Sani, B.A and Akande, I.S, 2015, Evaluation Of *Moringa* Leaf Extract And Leaf Mulch On Growth And Development Of Tomato (*Lycopersicon Esculentum Mill*), Kogi State University, Anyigba, Kogi State.

Selamawit Ketema, Lemma Dessalegn, Buzuayehu Tesfaye 2013 Effect of Planting Methods on Maturity and Yield of Onion (Allium cepa var cepa) in the Central Rift Valley of Ethiopia, Ethiop. J. Agric. Sci. 24:45-55

Shahbaz, M., Solarin, S. A., Mahmood, H., & Arouri, M. (2013). Does financial development reduce CO2 emissions in Malaysian economy? A time series analysis. Economic Modelling, 35, 145-152.

Taiz, H., & Zieger, E. (2002). Plant Physiology (3rd ed., pp. 423-558). Sinauer Associates, Inc.The Federal Democratic Republic of Ethiopia Central Statistical Agency Agricultural Sample Survey, 2017.

Verma, S.P., Díaz-González, L., González-Ramírez, R., 2009, Relative efficiency of single-outlier discordancy tests for processing geochemical data on reference materials: Geostandards and Geoanalytical Research, 33(1), 29-49.

Walkley, A. and C. A. Black, 1934. Determination of organic matter in the soil by chronic acid digestion. *Soil Sciences*, 63: 251-264

Waskar, D.P. Khedkar, R.M. Garande, V.K. 1999. Effect of post-harvest treatments on shelf life and quality of pomegranate in evaporative cool chamber and ambient conditions. Journal of Food Science Technology, 36(2), 114-117.