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Research Article
Influence of Different Fertilization and Harvest Time on Growth, Head Characters and Nutrition Quality of Endive under Sandy Soil

D.Y. Abd-Elkader and Shimaa M. Hassan

Department of Vegetable, Faculty of Agriculture, Alexandria University, Aflaton Street, 21545 El-Shatby, Alexandria, Egypt

Abstract

Aim: The study aim is to investigate the effect of different fertilization and harvesting time on the growth, head characters and nutrition quality on endive under sandy soil. **Methodology:** A field experiments were carried out during the winter seasons 2013/2014 and 2014/2015 to study the influence of different fertilization like mineral nitrogen and biofertilizer alone or in combination and time of day for harvest on growth, head character and nutritional quality of endive. Growth characters like plant height, number of leaves per plant and leaves dry matter (%) were significantly influenced by different fertilization treatments. However, plant height and number of leaves per plant characters were insignificant differences affected by time of day harvest, in both growing seasons. But the highest leaves dry matter (%) was obtained when plant harvest at midday (in the afternoon) in both growing seasons. Whereas the head weight and head diameter attributing characters were significantly influenced by different fertilization treatments. Significantly maximum head weight (g) and head diameter (cm) were recorded by 100% mineral nitrogen fertilizer followed by 75% mineral nitrogen fertilizer. **Results:** Also, the results reflected that the best time of harvest that gave the significant highest mean value of this characters were given by using the evening harvest, in both growing seasons. The highest nutritional quality parameters like total phenol, TSS and ascorbic acid were obtained when plant received 100% biofertilizer and afternoon harvest, in the both seasons. The data showed that there was significant effect of different fertilization treatments on total chlorophyll content. In both seasons, the highest value was obtained with 100% mineral nitrogen. The data, also indicated that there were no significant effects of all harvesting time treatment on total chlorophyll content.

Key words: Mineral fertilizer, biofertilizer, endive, harvest time, growth, quality

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Corresponding Author: Shimaa M. Hassan, Department of Vegetable, Faculty of Agriculture, Alexandria University, Aflaton Street, 21545 El-Shatby, Alexandria, Egypt

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Endive (*Cichorium endivia* L.), an annual plant, belonging to leafy vegetables group, has become very popular in west European countries, yet it has been relatively less known in Egypt. Endive characterized a considerable nutritive value as well as, distinctive, slightly bitter taste. The plant occurs in two botanical varieties, curly leaves or smooth leaves[1].

Leafy vegetables, rich in vitamins, fiber and minerals are good for human health. Vegetable salads are popular because they contain more vitamins than cooked vegetables and salads are easy to make[2,3].

The nutrition composition of produce and may ultimately play a greater role in food quality. Cultivation the practices likely to affect food quality include humus management technique such as bio-fertilizers, mineral fertilizer, soil management, environmental condition and harvest[4,5].

Nitrogen is usually the most abundant element in plants growth and consequently yield. It has essential role as a constituent of protein, nucleic acids, chlorophyll and growth hormones. Intensive application of fertilizer caused an excess of nitrogen for crops. There is strong evidence that some of the excess nitrogen taken up by the plant is not converted to protein but remains as non-protein nitrogen. This is not only inefficient use of nitrogen by the plant but leads to inefficient use by the animal and the risk of ill effects on human beings eating the plant[6].

Frequently, farmers use excessive rates of fertilizer especially, nitrogen in vegetables and due to increasing of costs of fertilizer and the dangers of increasing soil salinity and pollution of the agriculture environmental as well as significant increase in nitrate accumulation in several vegetable crops especially, leafy vegetables[5,7,8].

Nutrient management involving use of chemical fertilizers combined with bio-fertilizers in balanced proportion may be helpful to increase the productivity of vegetable crops[9].

A further potentially important factor is the time of day that the leaf is harvested. Current farming practice is to harvest leaves at first allowing the crop to be shipped, processed or packed on the same day. However, plant and leaf functional attributes are known to alter diurnally and this could impact on the process ability traits of the leaves[10].

This study aims at investigating the effect of different fertilization and harvesting time on the growth, nutrition quality on endive under sandy soil.

MATERIALS AND METHODS

Two field experiments were conducted during the growing seasons 2013/2014 and 2014/ 2015 at the experimental farm of South Tahrir Horticulture Research Station, at the Ali Mubarak village, El-Bostan region, Behera, Egypt. Physical and chemical properties of the two experimental sites were determined according to methods described by Black[11] and presented in Table 1.

Endive seed cv. Fransawy (curly leaves) were sown on first September and transplanted on first October in soil with three replicates, in both seasons. Transplants were planted with 20 cm apart on both sides of rows with 70 cm width. In the two experiments, the used experimental layout was Randomized Complete Blocks Design (RCBD) in split-plot system with three replications. The fertilizer treatments were, T_1-100% minerals nitrogen fertilizer (80 kg N Fed^{-1}), T_2 100% biofertilizer (2 kg microbien Fed^{-1}), T_3 combination between minerals and biofertilizer microbien (50% mineral nitrogen+50% microbin), T_4 (75% mineral nitrogen+25% microbin) and T_5 (25% mineral nitrogen fertilizer+75% microbin). While, the three harvesting time (i.e., early harvest in the morning, at 7 AM o'clock, mid harvest in the afternoon, at 12 PM o'clock and late harvest in the evening, at 7 PM o'clock from day) were occupied as sub-plot. Root of endive transplants were dipped into the biofertilizer prepared solution (According to the Ministry of Agriculture Recommendation) immediately before transplanting. An additional 2 kg Fed^{-1} of the mean biofertlizer wax mixed with about 25 kg soil and add to the soil at two weeks after transplanting. Phosphorus and potassium fertilizers were fertigated at rates of 70 and 100 kg P_2O_5 and K_2O Fed^{-1}, respectively as ammonium nitrate (33.5% N), phosphoric acid (58%) and potassium sulfate (48%), respectively, according to the recommendations for commercial production of endive plant as outlined by Ministry of Agriculture and Land Reclamation-Arab Republic of Egypt.

Table 1: Some soil physical and chemical properties of the experimental sites, during the two winter seasons of 2013/2014 and 2014/2015

	Seasons	
Properties	2013/2014	2014/2015
Physical		
Sand (%)	92.90	92.75
Texture	Sandy	Sandy
Chemical		
pH	8.21	8.10
EC (dS m^{-1})	0.59	0.55
N (%)	0.06	0.05
P (ppm)	4.14	3.88
K (meq/100 g soil)	14	12

Table 2: Influence of different fertilization, harvest time and their interaction on growth characters of endive during the winter season 2013/2014

	Winter season of 2013/2014		
Seasons and treatments	Plant height (cm)	No. of leaves per plant	Leaves dry matter content (%)
Different fertilization (%)			
80 kg N/Fed 100	23.11[a]	21.33[a]	16.52[a]
Biological fertilization 100	19.14[d]	18.33[c]	17.08[a]
50% kg N/Fed+Bio 50	19.82[c]	19.88[b]	14.96[b]
25% kg N/Fed+Bio 75	19.41[cd]	19.22[c]	15.23[b]
75% kg N/Fed+Bio 25	21.94[b]	21.00[a]	13.81[c]
Harvesting time			
Morning (M)	20.64[a]	19.73[a]	15.27[b]
Afternoon (A)	20.82[a]	19.86[a]	16.50[a]
Evening (E)	20.59[a]	20.26[a]	14.79[c]
Different fertilization × harvesting time			
80 kg N/Fed 100% × (M)	23.23[a]	20.66[bcd]	15.91[c]
80 kg N/Fed 100% × (A)	22.93[b]	21.33[ab]	18.22[a]
80 kg N/Fed 100% × (E)	23.16[a]	22.00[a]	15.42[cd]
Biological fertilization 100% × (M)	19.00[h]	18.33[gh]	16.95[b]
Biological fertilization 100% × (A)	19.33[g]	18.00[h]	18.39[a]
Biological fertilization 100% × (E)	19.10[h]	18.66[fgh]	15.89[c]
50% kg N/Fed+Bio 50% × (M)	19.70[f]	19.66[def]	14.61[de]
50% kg N/Fed+Bio 50% × (A)	20.10[e]	20.00[cde]	15.66[c]
50% kg N/Fed+Bio 50% × (E)	19.66[f]	20.00[cde]	14.62[de]
25% kg N/Fed+Bio 75% × (M)	19.50[fg]	19.33[efg]	13.81[ef]
25% kg N/Fed+Bio 75% × (A)	19.36[g]	19.00[efgh]	16.97[b]
25% kg N/Fed+Bio 75% × (E)	19.36[g]	19.33[efg]	14.93[cd]
75% kg N/Fed+Bio 25% × (M)	21.76[d]	20.66[bcd]	15.07[cd]
75% kg N/Fed+Bio 25% × (A)	22.40[c]	21.00[abc]	13.27[f]
75% kg N/Fed+Bio 25% × (E)	21.66[d]	21.33[ab]	13.08[f]

Values followed by the same alphabetical letter(s) in common, within a particular group of means in each character, do not significantly differ, using revised LSD test at 0.05 level of probability

The recommended agriculture practices for commercial endive production were followed. Endive were harvested 70 days after transplanting.

Vegetative growth characteristics: The sample were taken at harvest stage, in both seasons. Five plant were taken from each sub plot, to measure plant height (cm), number of leaves per plant and dry matter of leaves (%) was determined after drying the leaves at 70°C for 72 h.

Head characters: The sample were taken at harvest stage, in both seasons. Five plant were taken from each sub plot, to measure head fresh weight (g) and head diameter (cm).

Nutritional quality: The total soluble solids were measured in the juice of the leaves using a portable digital refract meter (Atago Co. Ltd., Tokyo, model PR-1). The nitrates were determined according to Cataldo *et al.*[12].Total soluble phenols were determined according to Scalbert *et al.*[13] and expressed as mg g^{-1} fresh weight. Leaves vitamin C was measured by titration with iodide potassium[14]. Nutrient content, phosphorus was determined calorimetrically; using spectrophotometer at 650 nm, according to Murphy and Riley[15] and potassium was determined by flam photometer as described by Cottenie *et al.*[16] of the leaves were expressed as a percentage on the dry weight basis.

Statistical analysis: Treatment means were separated and compared using the LSD test at 0.05 level of significance according to Snedecor *et al.*[17]. The statistical analysis was performed using Co-Stat software package for windows.

RESULTS AND DISCUSSION

Vegetative growth characteristics: Regarding the effects of different fertilizer on plant height character of endive in sandy soil, the results of Table 2 and 3 revealed that use of the different fertilization treatments showed that the plant height of endive were produced with application of 100% of mineral nitrogen fertilizer compared with other treatments, in both growing seasons. Meanwhile, when the inoculation with biofertilizer was amended with 75 or 50% mineral nitrogen not significant differences were obtained. On the other hand, it is clear that application of biofertilizer solely significantly decreased plant height compared with the other treatments. Also, the data are shown in Table 2 and 3. Plants were

Table 3: Influence of different fertilization, harvest time and their interaction on growth characters of endive during the winter season 2014/2015

	Winter season of 2014/2015		
Seasons and treatments	Plant height (cm)	No. of leaves per plant	Leaves dry matter content (%)
Different fertilization (%)			
80 kg N/Fed 100	23.23^{a}	21.77^{a}	16.76^{b}
Biological fertilization 100	19.27^{d}	18.66^{d}	17.62^{a}
50% kg N/Fed+Bio 50	20.02^{c}	20.22^{b}	15.67^{c}
25% kg N/Fed+Bio 75	19.51^{d}	19.44^{c}	15.31^{d}
75% kg N/Fed+Bio 25	22.17^{b}	21.33^{a}	14.28^{e}
Harvesting time			
Morning (M)	20.76^{a}	20.06^{b}	15.93^{b}
Afternoon (A)	20.97^{a}	20.20^{ab}	16.85^{a}
Evening (E)	20.79^{a}	20.60^{a}	15.00^{c}
Different fertilization × harvesting time			
80 kg N/Fed 100% × (M)	23.40^{a}	21.33^{b}	16.21^{ef}
80 kg N/Fed 100% × (A)	23.00^{ab}	21.66^{ab}	18.37^{b}
80 kg N/Fed 100% × (E)	23.30^{a}	22.33^{a}	15.71^{g}
Biological fertilization 100% × (M)	19.13^{g}	18.66^{gh}	17.72^{c}
Biological fertilization 100% × (A)	19.40^{fg}	18.33^{h}	18.91^{a}
Biological fertilization 100% × (E)	19.23^{g}	19.00^{fgh}	16.24^{e}
50% kg N/Fed+Bio 50% × (M)	19.80^{def}	20.00^{de}	15.64^{g}
50% kg N/Fed+Bio 50% × (A)	20.26^{d}	20.33^{cd}	16.54^{e}
50% kg N/Fed+Bio 50% × (E)	20.00^{de}	20.33^{cd}	14.82^{h}
25% kg N/Fed+Bio 75% × (M)	19.56^{efg}	19.33^{efg}	14.20^{i}
25% kg N/Fed+Bio 75% × (A)	19.53^{efg}	19.33^{efg}	16.94^{d}
25% kg N/Fed+Bio 75% × (E)	19.43^{fg}	19.66^{def}	14.80^{h}
75% kg N/Fed+Bio 25% × (M)	21.93^{c}	21.00^{bc}	15.87^{fg}
75% kg N/Fed+Bio 25% × (A)	22.60^{b}	21.33^{b}	13.52^{j}
75% kg N/Fed+Bio 25% × (E)	22.00^{c}	21.66^{ab}	13.44^{j}

Values followed by the same alphabetical letter(s) in common, within a particular group of means in each character, do not significantly differ, using revised LSD test at 0.05 level of probability

harvested at three times, early time (morning), mid time (afternoon) and late time (evening) there were insignificant differences affected by harvest time, in both growing seasons.

The interactions in between different fertilization and harvest time are presented in Table 2 and 3. The results indicated that the interaction between 100% mineral fertilizer with early or late harvest time were significantly higher than other interactions and gave the highest endive plants, in the first season Table 2. While, the interactions 100% mineral nitrogen fertilizer with any harvest time gave the highest mean value in plant highest, in second season Table 3.

Regard to the number of leaves per plant, in both growing seasons, the obtained results in Table 2 and 3 indicate that the 100% mineral nitrogen fertilizer or 75% mineral nitrogen fertilizer inoculation with 25% of biofertilizer significantly resulted in the highest values of leaves number per plant as compared to other tested treatments. However, there were no significant differences among the treatments of inoculation with biofertilizer either solely or coupled with half dose of minerals nitrogen fertilizer treatment. The number of leaves per plant was not affected by harvest time in Table 2 and 3, in both growing seasons.

The interactions between different fertilizer and harvest time are presented, also in Table 2 and 3. Data indicated that there were significantly differences among the interactions, in both growing seasons. When plants receive 100% mineral nitrogen fertilizer the highest mean values were obtained from late harvest (evening), in two studied seasons.

The effect of different fertilization on leaves dry matter% of endive plants in sandy soil are presented in Table 2 and 3. The results presented that there was significantly differences among each different fertilization treatments in this trait. The highest leaves dry matter% was obtained when plant received 100% mineral nitrogen fertilizer or 100% biofertilizer gave the highest mean value in the first season. While, the highest leaves dry matter% value was determined in 100% biofertilizer treatment (17.62%) in the winter 2014 and 2015.

From the aforementioned results, under the present conditions, it could be concluded that vegetative growth of endive plants expressed as plant height, leaves number per plant and dry matter of leaves%, it could be concluded that the increase in vegetative growth may be attributed to the beneficial effects of non-stimulating the meristmatic activity for producing more tissues and organs and N play major roles

Table 4: Influence of different fertilization, harvest time and their interaction on head characters of endive during the two winter season 2013/2014 and 2014/2015

	Winter season of			
Seasons and treatments	2013/2014 Weight of head (g)	2014/2015 Weight of head (g)	2013/2014 Diameter of head (cm)	2014/2015 Diameter of head (cm)
Different fertilization (%)				
80 kg N/Fed 100	399.22^{a}	422.33^{a}	20.83^{a}	20.23^{a}
Biological fertilization 100	263.22^{d}	291. 00^{e}	13.16^{e}	13.38^{e}
50% kg N/Fed+Bio 50	285.77^{c}	325.00^{d}	15.33^{d}	14.66^{d}
25% kg N/Fed+Bio 75	274.77^{cd}	367.22^{c}	16.77^{c}	15.77^{c}
75% kg N/Fed+Bio 25	348.88^{b}	391.88^{b}	19.50^{b}	17.94^{b}
Harvesting time				
Morning (M)	313.46^{b}	364.73^{a}	17.26^{ab}	16.40^{b}
Afternoon (A)	303.66^{b}	344.46^{b}	16.26^{b}	15.60^{c}
Evening (E)	326.00^{a}	369.26^{a}	17.83^{a}	17.20^{a}
Different fertilization × harvesting time				
80 kg N/Fed 100%×(M)	406.00^{ab}	429.66^{a}	21.00^{a}	20.36^{a}
80 kg N/Fed 100%×(A)	381.66^{bc}	417.33^{ab}	20.16^{ab}	19.66^{ab}
80 kg N/Fed 100%×(E)	410.00^{a}	420.00^{ab}	21.33^{a}	20.66^{a}
Biological fertilization 100%×(M)	254.66^{g}	293.00^{f}	13.00^{g}	13.33^{ij}
Biological fertilization 100%×(A)	256.66^{g}	271.66^{g}	13.00^{g}	12.50^{j}
Biological fertilization 100%×(E)	278.33^{fg}	308.33^{f}	13.50^{fg}	14.33^{hi}
50% kg N/Fed+Bio 50%×(M)	285.66^{f}	328.33^{e}	15.66^{def}	14.66^{gh}
50% kg N/Fed+Bio 50%×(A)	283.33^{f}	308.33^{f}	14.33^{efg}	13.66^{hij}
50% kg N/Fed+Bio 50%×(E)	288.33^{f}	338.33^{e}	16.00^{de}	15.66^{efg}
25% kg N/Fed+Bio 75%×(M)	271.00^{fg}	373.33^{d}	17.33^{cd}	16.00^{ef}
25% kg N/Fed+Bio 75%×(A)	265.00^{fg}	360.00^{d}	15.50^{def}	14.83^{fgh}
25% kg N/Fed+Bio 75%×(E)	288.33^{f}	368.33^{d}	17.50^{cd}	16.50^{de}
75% kg N/Fed+Bio 25%×(M)	350.00^{de}	399.33^{c}	19.33^{abc}	17.66^{cd}
75% kg N/Fed+Bio 25%×(A)	331.66^{e}	465.00^{d}	18.33^{bc}	17.33^{d}
75% kg N/Fed+Bio 25%×(E)	365.00^{cd}	411.33^{bc}	20.83^{a}	18.83^{bc}

Values followed by the same alphabetical letter(s) in common, within a particular group of means in each character, do not significantly differ, using revised LSD test at 0.05 level of probability

in structural proteins and other several macromolecules related with growth plants on onion and lettuce, respectively[18,19]. However, leaves dry matter% improvement when used 100% biofertilizer. Also, the improving in plant growth associated with decrease in N level. The decrease of N application with used mineral fertilizer with bio-fertilizer was reported in many investigation such as, Shehata *et al.*[7] on celery plant and Shahein *et al.*[20] on amaranths plant).

The results presented that there was significantly differences among each of harvest time treatments in this trait. The highest leaves dry matter% was obtained when plant harvest at midday (afternoon), in both seasons of study Table 2 and 3.

As for the interaction effects between the different fertilization and harvest time on leaves dry matter% character, the results presented in Table 2 and 3 demonstrated generally that the comparisons among the mean values of leaves dry matter% for the different treatments that gave the highest mean values was the combinations between application of 100% mineral fertilizer at mid harvest (afternoon) in the first season and 100% biofertilizer treatment at mid harvest, in the second season.

Head character: The results concerning the effects of different fertilization on head fresh weight of endive under sandy soil in Table 4 indicated significantly increases in the weight due to use of the different fertilization treatments, through the two seasons. The obtained results clarified that the significant highest mean value of head fresh weight (399.22 and 422.33) was given by application of fertilizer at 100% minerals nitrogen, followed by 75% minerals nitrogen+25% biofertilizer, in both growing seasons.

According the results in Table 4 there were significant differences among the three studied harvest time in relation to their effects on head fresh weight character, in both growing seasons. The results reflected that the best harvest time that gave the significant highest mean value of this character was given by using the evening harvest (326 g), in the first season and the evening harvest (369.26 g), followed by morning harvest (364.26 and 364.63 g), in the second season.

The application of different fertilization to the grown endive plants, the obtained results, in the two seasons, cleared that using the mineral fertilizer at 100% mineral nitrogen gave significantly higher head diameter mean values (20.83 cm)

Table 5: Influence of different fertilization, harvest time and their interaction on nutritional quality of endive during the winter season 2013/2014

	Winter season of 2013/2014		
Seasons and treatments	Total phenol (%)	TSS (%)	Ascorbic acid (mg 100 g^{-1} FW)
Different fertilization (%)			
80 kg N/Fed 100	12.90^{d}	3.70^{e}	12.04^{e}
Biological fertilization 100	15.79^{a}	4.74^{a}	14.40^{a}
50% kg N/Fed+Bio 50	14.95^{c}	4.34^{c}	13.53^{c}
25% kg N/Fed+Bio 75	15.39^{b}	4.54^{b}	13.95^{b}
75% kg N/Fed+Bio 25	12.82^{d}	3.94^{d}	12.94^{d}
Harvesting time			
Morning (M)	14.091^{b}	4.33^{a}	13.53^{b}
Afternoon (A)	14.932^{a}	4.31^{a}	13.70^{a}
Evening (E)	14.096^{b}	4.12^{b}	12.89^{c}
Different fertilization × harvesting time			
80 kg N/Fed 100%×(M)	12.74^{fgh}	3.70^{g}	12.20^{g}
80 kg N/Fed 100%×(A)	13.37^{f}	3.66^{g}	12.23^{fg}
80 kg N/Fed 100%×(E)	12.59^{gh}	3.73^{g}	11.70^{h}
Biological fertilization 100%×(M)	15.33^{bcd}	4.73^{ab}	14.33^{b}
Biological fertilization 100%×(A)	16.50^{a}	4.90^{a}	14.76^{a}
Biological fertilization 100%×(E)	15.56^{bc}	4.60^{bc}	14.10^{bc}
50% kg N/Fed+Bio 50%×(M)	14.52^{e}	4.60^{bc}	13.76^{cd}
50% kg N/Fed+Bio 50%×(A)	15.60^{bc}	4.26^{de}	14.26^{b}
50% kg N/Fed+Bio 50%×(E)	14.73^{de}	4.16^{ef}	12.56^{f}
25% kg N/Fed+Bio 75%×(M)	15.29^{bcd}	4.63^{bc}	14.20^{b}
25% kg N/Fed+Bio 75%×(A)	15.89^{ab}	4.53^{bc}	14.06^{bc}
25% kg N/Fed+Bio 75%×(E)	14.98^{cde}	4.46^{cd}	13.60^{d}
75% kg N/Fed+Bio 25%×(M)	12.56^{h}	4.00^{f}	13.16^{e}
75% kg N/Fed+Bio 25%×(A)	13.28^{fg}	4.20^{ef}	13.16^{e}
75% kg N/Fed+Bio 25%×(E)	12.61^{gh}	3.63^{g}	12.50^{fg}

Values followed by the same alphabetical letter(s) in common, within a particular group of means in each character, do not significantly differ, using revised LSD test at 0.05 level of probability

than other different fertilizer treatments, followed by 75% mineral nitrogen +25% biofertilizer (20.23 cm), in both two seasons. Table 4 showed also that the harvest time reflected significant increments in head diameter character with the three tested harvest time, in both seasons. The highest mean values of this character was obtained by evening harvest (17.83 and 17.23 cm), in the two seasons.

Concerning the results in Table 4 the interaction effects between the different fertilization and harvest time on head characters, generally, the endive plant was received 100% mineral nitrogen fertilizer with evening harvest time gave the highest mean value of head characters compare other treatments, in both growing seasons.

The present results, in general are in agreement with those obtained by Shehata *et al.*[7], Hosseny and Ahmed[19] and Shahein *et al.*[21].

Nutritional quality: Total soluble solid, total phenol contentand ascorbic acid were affected by different fertilization Table 5 and 6. The highest nutritional quality was obtained when plant received 100% biofertilizer, in the both growing seasons. Also, the data shown in Table 5 and 6 the highest mean values of this characters were obtained by afternoon harvest, in the two seasons.

As for the interaction effects between the different fertilization and harvest time on nutritional quality characters, the results presented in Table 5 and 6 the mean values of nutritional quality for the different treatments that gave the highest mean values was the combinations between application of 100% biofertilizer at mid harvest (afternoon), in the two seasons.

The effect of different fertilization application on vitamin C found in this study, has also been demonstrated in reviewer[22,23]. Nitrogen fertilizers especially at high rates, seem to decrease the concentration of vitamin C in many fruit and vegetables. Plant growth is generally enhanced by the nitrogen fertilization, so that a relative dilution effect may occur in the plant tissues. Nitrogen fertilizers are also known to increase plant foliage and thus may reduce the light intensity and accumulation of vitamin C in shaded parts.

Table 6: Influence of different fertilization, harvest time and their interaction on growth characters of endive during the winter season 2014/2015

	Winter season of 2014/2015		
Seasons and treatments	Total phenol (%)	TSS (%)	Ascorbic acid (mg 100 g^{-1} FW)
Different fertilization (%)			
80 kg N/Fed 100	12.31^{c}	3.68^{d}	11.82^{e}
Biological fertilization 100	14.32^{a}	4.60^{a}	14.20^{a}
50% kg N/Fed+Bio 50	13.29^{b}	4.24^{b}	13.30^{c}
25% kg N/Fed+Bio 75	13.22^{b}	4.51^{a}	13.81^{b}
75% kg N/Fed+Bio 25	11.94^{c}	3.97^{c}	12.83^{d}
Harvesting time			
Morning (M)	13.05^{ab}	4.18^{b}	13.38^{b}
Afternoon (A)	13.24^{a}	4.37^{a}	13.59^{a}
Evening (E)	12.77^{b}	4.05^{c}	12.60^{c}
Different fertilization × harvesting time			
80 kg N/Fed 100%×(M)	12.55^{efg}	3.63^{i}	12.06^{e}
80 kg N/Fed 100%×(A)	12.17^{g}	3.86^{h}	12.13^{e}
80 kg N/Fed 100%×(E)	12.22^{fg}	3.56^{i}	11.26^{f}
Biological fertilization 100%×(M)	13.94^{abc}	4.56^{bc}	14.00^{b}
Biological fertilization 100%×(A)	14.73^{a}	4.93^{a}	14.60^{a}
Biological fertilization 100%×(E)	14.30^{ab}	4.30^{e}	14.00^{b}
50% kg N/Fed+Bio 50%×(M)	13.33^{cde}	4.26^{ef}	13.63^{c}
50% kg N/Fed+Bio 50%×(A)	13.54^{bcd}	4.36^{de}	14.06^{b}
50% kg N/Fed+Bio 50%×(E)	13.02^{def}	4.10^{fg}	12.20^{e}
25% kg N/Fed+Bio 75%×(M)	13.65^{bcd}	4.53^{bcd}	14.06^{b}
25% kg N/Fed+Bio 75%×(A)	13.83^{bc}	4.60^{b}	14.00^{b}
25% kg N/Fed+Bio 75%×(E)	12.19^{g}	4.40^{cde}	13.36^{cd}
75% kg N/Fed+Bio 25%×(M)	11.78^{g}	3.93^{gh}	13.16^{d}
75% kg N/Fed+Bio 25%×(A)	11.92^{g}	4.10^{fg}	13.16^{d}
75% kg N/Fed+Bio 25%×(E)	12.12^{g}	3.90^{h}	12.16^{e}

Values followed by the same alphabetical letter(s) in common, within a particular group of means in each character, do not significantly differ, using revised LSD test at 0.05 level of probability

Data obtained in Table 7 and 8 showed that there was significant effect of different fertilization treatments on total chlorophyll content. In both seasons, the highest value was obtained with 100% mineral nitrogen fertilizer gave 1.866 and 1.856 in the first and second seasons, respectively. Also, the application of biofertilizer 100% significantly decrease the content of total chlorophyll compared with other treatments similar finding was gained by Migahed *et al.*[24] and Shehata *et al.*[7]. on celery, Muzafar[23] on globe artichoke From the data in two seasons, it is clear that there were not significant effects of all harvesting time treatment on chlorophyll content.

Data in Table 7 and 8 indicate that, during the two seasons, the highest values of nitrate content in the leaf tissues were obtained from 100% mineral nitrogen fertilizer (80 kg Fed^{-1}). Whereas, the lowest values of nitrate content in the leaf tissues biological fertilization100%. These results are confirmed by Migahed *et al.*[24] and Hassan *et al.*[25] on globe artichoke. Also, in this respect Hosseny and Ahmed[19], Shahein *et al.*[21] and Boroujerdnia *et al.*[26] reported that reduced nitrogen fertilizer with biofertilizer decrease nitrate accumulation in lettuce and Shehata *et al.*[7] in celery plant. Also, Ahmed *et al.*[27] found that significant decreases in nitrate accumulation when the lettuce plant treated with all studied bio-fertilizers, especially those plants treated with nitrogen.

The effect of harvesting time on nitrate accumulation was significant and amount was lower in afternoon in comparison to another harvest time. Because, during day trough solar radiation increasing nitrate reeducates activity and nitrate assimilation and thereby decreasing nitrate content of plants explained the rate of NO_3 up take is substantially higher in day time than in night time[28,29]. This is apparently due to higher soluble sugar content of the during day time than in night. In this case similar result has been reported by Boroujerdnia *et al.*[26] on lettuce.

Data in the same tables show that the highest values of P and K were recorded in leaves in two seasons, the highest values of P and K content in the leaf tissues were obtained from 100% mineral fertilizer of N 80 kg Fed^{-1}. Whereas, the leaf P and K content were not significant in the second season but in the first season the highest value of P content were obtained from the evening treatment and the highest value of K content were obtained from the morning treatment. These results were agreement with Levander[30], who found the different leaf mineral concentration were mainly dictated by species and to a lesser degree were due to effect of light intensity at the time of harvest.

Table 7: Influence of different fertilization, harvest time and their interaction on total chlorophyll, nitrate content, phosphorus and potassium in leaves, during the winter season 2013/2014

	Winter season of 2013/2014			
Seasons and treatments	Total chlorophyll (mg g^{-1} FW)	Nitrate content (mg kg^{-1} FW)	P (%)	K (%)
Different fertilization (%)				
80 kg N/Fed 100	1.856^{a}	254.44^{a}	0.0608^{a}	2.650^{a}
Biological fertilization 100	1.370^{e}	158.22^{d}	0.0337^{e}	2.600^{b}
50% kg N/Fed+Bio 50	1.553^{c}	208.66^{c}	0.0442^{c}	2.620^{ab}
25% kg N/Fed+Bio 75	1.515^{d}	211.00^{c}	0.0366^{d}	2.620^{ab}
75% kg N/Fed+Bio 25	1.714^{b}	236.88^{b}	0.0581^{b}	2.640^{ab}
Harvesting time				
Morning (M)	1.605^{a}	229.33^{a}	0.0456^{b}	2.640^{a}
Afternoon (A)	1.601^{a}	192.66^{c}	0.0458^{b}	2.610^{b}
Evening (E)	1.600^{a}	219.53^{b}	0.0487^{a}	2.630^{ab}
Different fertilization × harvesting time				
80 kg N/Fed 100%×(M)	1.856^{a}	278.00^{a}	0.0620^{a}	2.640^{abc}
80 kg N/Fed 100%×(A)	1.856^{a}	227.33^{d}	0.0606^{b}	2.646^{abc}
80 kg N/Fed 100%×(E)	1.856^{a}	258.00^{b}	0.0600^{bc}	2.670^{a}
Biological fertilization 100%×(M)	1.363^{d}	169.33^{f}	0.0330^{j}	2.636^{abc}
Biological fertilization 100%×(A)	1.366^{d}	145.33^{g}	0.0313^{k}	2.590^{bc}
Biological fertilization 100%×(E)	1.380^{d}	160.00^{f}	0.0370^{h}	2.583^{c}
50% kg N/Fed+Bio 50%×(M)	1.570^{c}	223.33^{d}	0.0390^{g}	2.656^{ab}
50% kg N/Fed+Bio 50%×(A)	1.550^{c}	184.33^{e}	0.0460^{f}	2.603^{abc}
50% kg N/Fed+Bio 50%×(E)	1.530^{c}	218.33^{d}	0.0476^{e}	2.606^{abc}
25% kg N/Fed+Bio 75%×(M)	1.510^{c}	225.00^{d}	0.0363^{h}	2.646^{abc}
25% kg N/Fed+Bio 75%×(A)	1.520^{c}	188.66^{e}	0.0340^{i}	2.590^{bc}
25% kg N/Fed+Bio 75%×(E)	1.520^{c}	219.33^{d}	0.0396^{g}	2.643^{abc}
75% kg N/Fed+Bio 25%×(M)	1.690^{b}	251.00^{bc}	0.0576^{d}	2.650^{abc}
75% kg N/Fed+Bio 25%×(A)	1.700^{b}	217.66^{d}	0.0573^{d}	2.626^{abc}
75% kg N/Fed+Bio 25%×(E)	1.740^{b}	242.00^{c}	0.0593^{c}	2.666^{b}

Values followed by the same alphabetical letter(s) in common, within a particular group of means in each character, do not significantly differ, using revised LSD test at 0.05 level of probability

Table 8: Influence of different fertilization, harvest time and their interaction on total chlorophyll, nitrate content, phosphorus and potassiumin leaves, during the winter season 2014/2015

	Winter season of 2013/2014			
Seasons and treatments	Total chlorophyll (mg g^{-1} FW)	Nitrate content (mg kg^{-1} FW)	P (%)	K (%)
Different fertilization				
80 kg N/Fed 100%	1.866^{a}	261.00^{a}	0.0585^{a}	2.790^{a}
Biological fertilization 100%	1.394^{d}	157.55^{e}	0.0342^{e}	2.690^{d}
50% kg N/Fed+Bio 50%	1.574^{c}	212.77^{d}	0.0433^{c}	2.720^{c}
25% kg N/Fed+Bio 75%	1.533^{c}	222.11^{c}	0.0380^{d}	2.710^{c}
75% kg N/Fed+Bio 25%	1.737^{b}	243.00^{b}	0.0562^{b}	2.750^{b}
Harvesting time				
Morning (M)	1.621^{a}	234.20^{a}	0.0464^{a}	2.740^{a}
Afternoon (A)	1.620^{a}	199.66^{c}	0.0455^{a}	2.730^{a}
Evening (E)	1.623^{a}	224.00^{b}	0.0462^{a}	2.720^{a}
Different fertilization × harvesting time				
80 kg N/Fed 100%×(M)	1.866^{a}	284.66^{a}	0.0610^{a}	2.793^{a}
80 kg N/Fed 100%×(A)	1.866^{a}	234.66^{cd}	0.0573^{b}	2.786^{ab}
80 kg N/Fed 100%×(E)	1.866^{a}	263.66^{b}	0.0573^{b}	2.790^{a}
Biological fertilization 100%× (M)	1.386^{d}	167.66^{g}	0.0313^{h}	2.693^{g}
Biological fertilization 100%×(A)	1.400^{d}	145.00^{h}	0.0353^{g}	2.690^{g}
Biological fertilization 100%×(E)	1.396^{d}	160.00^{g}	0.0360^{g}	2.703^{fg}
50% kg N/Fed+Bio 50%×(M)	1.586^{c}	223.33^{e}	0.0420^{e}	2.733^{d}
50% kg N/Fed+Bio 50%×(A)	1.576^{c}	191.66^{f}	0.0456^{d}	2.733^{d}

Table 8: Continue

Seasons and treatments	Winter season of 2013/2014 Total chlorophyll (mg g^{-1} FW)	Nitrate content (mg kg^{-1} FW)	P (%)	K (%)
50% kg N/Fed+Bio 50%×(E)	1.560^{c}	223.33^{e}	0.0423^{e}	2.720^{de}
25% kg N/Fed+Bio 75%×(M)	1.540^{c}	235.00^{cd}	0.0380^{f}	2.726^{de}
25% kg N/Fed+Bio 75%×(A)	1.530^{c}	201.00^{f}	0.0383^{f}	2.716^{ef}
25% kg N/Fed+Bio 75%×(E)	1.530^{c}	230.33^{de}	0.0376^{f}	2.703^{fg}
75% kg N/Fed+Bio 25%×(M)	1.723^{b}	260.33^{b}	0.0600^{a}	2.773^{b}
75% kg N/Fed+Bio 25%×(A)	1.726^{b}	226.00^{de}	0.0510^{c}	2.753^{c}
75% kg N/Fed+Bio 25%×(E)	1.763^{b}	242.66^{c}	0.0576^{b}	2.723^{de}

Values followed by the same alphabetical letter(s) in common, within a particular group of means in each character, do not significantly differ, using revised LSD test at 0.05 level of probability

CONCLUSION

Consequently, the results of this study suggest that cultivated endive had increased the growth and head characteristics with the application of different fertilization and harvest time. On the other hand, the lowest nitrate accumulation and highest of nutrition value such as vitamin C, TSS% and total phenol were determined in biological fertilization 100% application when compared with other different fertilization. When considering the nutrition and nitrate accumulation in leafy vegetables are harmful for human health, therefore, the usual fertilizer of NPK 50%+Bio 50% or NPK 75%+Bio 25% is firstly suggested that it should be applied to not only have better yield and agronomic traits but also produce healthy crops for human nutrition in cultivated endive. The combination of mineral fertilizer and biological fertilizer of nitrogen under sandy soil give the similar obtained in head weight and quality in other soils.

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REFERENCES

1. Adamczewska-Sowinska, K. and C.M. Uklanska, 2010. The effect of form and dose of nitrogen fertilizer on yielding and biological value of endive. Acta Sci. Polonorum, 9: 85-91.
2. Fu, J., 2008. Effects of different harvest start times on leafy vegetables (lettuce, pakchoi and rocket) in a reaping and regrowth system. M.Sc. Thesis, Faculty of Agriculture, University of Lincoln, England.
3. Mhaske, M.G., S. Ziauddin, B.M. Kalalbandi and Y.S. Saitwal, 2011. Effect of organic and inorganic sources of nitrogen and biofertilizers on growth and yield of cabbage (*Brassica oleraceae* var. capitata). Int. J. Agric. Sci., 7: 133-135.
4. Hassan, F.A.S., E.F. Ali and S.A. Mahfouz, 2012. Comparison between different fertilization sources, irrigation frequency and their combinations on the growth and yield of coriander plant. Aust. J. Basic Applied Sci., 6: 600-615.
5. Tsouvaltzis, P., A. Koukounaras and S. Anastasios, 2014. Application of amino acids improves lettuce crop uniformity and inhibits nitrate accumulation induced by the supplemental inorganic nitrogen fertilization. Int. J. Agric. Biol., 16: 951-955.
6. Marschner, H., 1994. Mineral Nutrition in Higher Plants. Jovaovish Publisher, San Diego, pp: 6-74.
7. Shehata, S.M., H.S. Abdel-Azem, A. El-Yazied and A.M. El-Gizawy, 2010. Interactive effect of mineral nitrogen and biofertilization on the growth, chemical composition and yield of celeriac plant. Eur. J. Sci. Res., 47: 248-255.
8. Doifode, V.D. and P.B. Nandkar, 2014. Influence of biofertilizers on the growth, yield and quality of brinjal crop. Int. J. Life Sci., 2: 17-20.
9. Sarkar, A., A.R. Mandal, P.H. Prasad and T.Y. Maity, 2010. Influence of nitrogen and biofertilizer on growth and yield of cabbage. J. Crop Weed, 6: 72-73.
10. Clarkson, G.J.J., S.D. Rothwell and G. Taylor, 2005. End of day harvest extends shelf life. HortScience, 40: 1431-1435.
11. Black, C.A., 1965. Method of soil Analysis. American Society of Agronomy, Madison, WI., USA.
12. Cataldo, D.A., M. Haroon, L.E. Schrader and V.L. Youngs, 1975. Rapid colorimetric determination of nitrate in plant tissue by nitration of salicylic acid. Soil Sci. Plant Anal., 6: 71-80.
13. Scalbert, A., B. Monties and G. Janin, 1989. Tannins in wood: comparison of different estimation methods. J. Agric. Food Chem., 37: 1324-1329.
14. Ranganna, S., 1986. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. 2nd Edn., McGraw-Hill Publishing Co. Ltd., New Delhi, Pages: 1112.
15. Murphy, J. and J.P. Riley, 1962. A modified single solution method for the determination of phosphate in natural waters. Analytica Chimica Acta, 27: 31-36.
16. Cottenie, A., M. Verloo, L. Kiekens, G. Velghe and R. Camerlynck, 1982. Chemical Analysis of Plants and Soils. IWONL, Brussels, pp: 63.

17. Snedecor, G.W. and W.G. Cochran, 1980. Statistical Method. 7th Edn., Iowa State University Press, Ames, Iowa, USA., pp: 507.
18. Yaso, I.A., H.S. Abdel-Razzak and M.A. Wahab-Allah, 2007. Influence of biofertilizer and mineral nitrogen on onion growth, yield and quality under calcareous soil conditions. J. Agric. Environ. Sci. Alex. Univ. Egypt, 6: 245-264.
19. Hosseny, M.H. and M.M.M. Ahmed, 2009. Effect of nitrogen organic and biofertilization on productivity of lettuce (cv. Romaine) in sandy soil under Assiut conditions. Ass. Univ. Bull. Environ. Res., 12: 79-93.
20. Kavitha, S. Sivagami and Ranjini, 2013. Individual and combined effect of biofertilizer, chemical fertilizer and vermicompost on *Amaranthus tristis*. Int. J. Pharm. Sci. Rev. Res., 20: 190-195.
21. Shahein, M.M., S.A.E. Hassan and A.A. Ragab, 2013. Reduction of mineral fertilizers in lettuce production by using microbial inoculation, potassium humate and potassium silicate. Hortsci. J. Suez Canal Univ., 1: 77-84.
22. Lee, S.K. and A.A. Kader, 2000. Preharvest and postharvest factors influencing vitamin C content of horticultural crops. Postharvest Biol. Technol., 20: 207-220.
23. Mozafar, A., 1993. Nitrogen fertilizers and the amount of vitamins in plants: A review. J. Plant Nutr., 16: 2479-2506.
24. Migahed, H.A., E.A. Amal and F. Bouthaina, 2004. Effect of different bacterial strains as biofertilizer agents on growth, production and oil of Apium *Graveolensunder* calcareous soil. Arab Univ. J. Agric. Sci. Ain. Shams. Cairo., 12: 511-525.
25. Hassan, A.H., A.H. Khreba, M.S. Emam and S.A. Atala, 2006. Effect of biofertilizers, organic fertlizers and their interaction on the vegetative growth, yield and quality of artichoke flower head. Egypt. J. Apple Sci., 21: 185-200.
26. Boroujerdnia, M., N.A. Ansari and F.S. Dehcordie, 2007. Effect of cultivars, harvesting time and level of nitrogen fertilizer on nitrate and nitrite content, yield in romaine lettuce. Asian J. Plant Sci., 6: 550-553.
27. Ahmed, A.H.H., J.F. Mishriky and M.K. Khalil, 2000. Reducing nitrate accumulation in lettuce (*Lactuca sativa* L.) plants by using different biofertilizers. Proceedings of the International Conference on Economics, Humanity and Management, September 9-12, 2000, Cairo University, Egypt, pp: 509-517.
28. Bose, B. and H.S. Srivastava, 2001. Absorption and accumulation of nitrate in plants: Influence of environmental factors. Indian J. Exp. Bio., 39: 101-110.
29. Santamaria, P., 2006. Nitrate in vegetables: Toxicity, content, intake and EC regulation. J. Sci. Food Agric., 86: 10-17.
30. Levander, O.A., 1990. Fruit and vegetable contributions to dietary mineral intake in human health and disease. HortScience, 25: 1486-1488.