



Growth and essential oil of peppermint (*Mentha piperita* L.) plants as influenced by compost and some biostimulants

Abd-El-kader E. H.*, Ali A. F., Tawfik O. H.

Department of Horticulture, Faculty of Agriculture, Al-Azhar University, Assiut, Egypt

Abstract

This investigation was conducted during the two experimental seasons of 2019 and 2020 to explore the impact of compost as organic fertilization and some biostimulants, as well as, their interactions on the plant growth parameters and essential oil of peppermint (*Mentha piperita* L.) plants. Compost fertilizer was added to the soil of peppermint plants at the levels of 0, 8, 16 and 24/acre. Biostimulants were ascorbic acid (Asc) at 50, 100 ppm and yeast extract (YE) at 5 g /l, 10 g /l. The plants were sprayed with these biostimulants as follows: Control (no sprayed plants), Asc at 50, 100 ppm, YE at 5 g /l, 10 g /l, Asc at 50 ppm + 5g /l YE and Asc at 100 ppm + 10 g /l YE. The given results indicated that the application of compost at all levels and also foliar spray with the two examined biostimulants at all concentrations, either single or mixed resulted a significant increase in plant growth traits in terms of plant height, branch number /plant, herb fresh and dry weights /plant, leaves fresh and dry weight / plant, as well as, essential oil %, among the three cuts except for the low level of compost (8 m³/acre) concerning compost levels and, also Asc at 50 ppm regarding biostimulant concentrations, in some cases, as compared to untreated plants. Obviously, treating the plants with compost at the high level (24 m³/acre) registered the highest values of these studied characteristics, among all cuts. Also, foliar spray with the combined treatment (100 ppm Asc + 10 g /l YE) proved to be more effective in augmenting the previous studied traits in all cuts. All tested parameters were significantly affected by the interaction treatments in all cuts. In this concern, most combined treatment significantly augmented all examined aspects in all cuts. Moreover, the addition of compost at the high level (24 m³/acre) plus 100 ppm Asc + 10 g /l YE was the most effective treatment, among all cuts.

Keywords: peppermint, *Mentha piperita*, compost, ascorbic acid, yeast extract.

*Corresponding author: Abd-El-kader E. H.,
E-mail address: eh754304@gmail.com

1. Introduction

Peppermint or mint (*Mentha piperita* L.) is one of the most important medicinal and aromatic plants, it is a perennial herb, belongs to Lamiaceae (Labiatae) and it is a natural hybrid between spearmint (*Mentha spicata* L.) and watermint (*Mentha aquatic* L.) (Khalil *et al.*, 2015; Spring and Daniels, 2001). It is propagated by stolons. The genus contains about 25 species. Peppermint is cultivated all over the world, whereas it has been utilized for flavor, fragrance, medicinal and pharmaceutical industries (Iskan *et al.*, 2002). This plant believing to be cultivated in ancient Egyptian. Peppermint plant has been applied in folk remedies and traditional medicine in order to the treatment of digestive disorders and nervous system actions due to its antitumor and antimicrobial roles, chemopreventive potential, its renal actions, antiallergenic influence, as well as, for lessening cramping, digestive complaints, nausea, diarrhea and anorexia (Keifer *et al.*, 2007; Saeidnia *et al.*, 2005). The oil of peppermint plays several therapeutically actions such as, treating irritable bowel syndrome, vlcervative colitis, Crohn's disease, gallbladder and biliary tract disorders and liver complaints (Blumenthal, 1998; Felming, 1998). Organic farming is one of the most agricultural practices. Thus, organic fertilizers act primarily cast effective and easily available from locality products than those of mineral fertilizers (Solomon *et al.*, 2012). Organic manures are important roles in promoting microbial biomass (Suresh *et al.*, 2004). So, the basis of soil fertility was due to the

presence of organic matter (Aboudrare, 2009). The beneficial influence of organic manures on increasing the plant growth aspects were explained by Sakr (2001) and Abdou *et al.* (2012) on *Mentha piperita*, Khalil and El-Sherbeny (2003) on *Mentha species* and Sukhmal *et al.* (2006) on *Mentha arvensis*, Biasi *et al.* (2009) and Marzok (2011) on *Ocimum gratissimum*, Abdou *et al.* (2014) on marjoram, Hassan *et al.* (2015) on rosmmary, Rekaby (2013), Acimovic (2013), Abdullatif (2019) on Coriander, Ali *et al.* (2017) and Hamed (2017) on anise, and Mahmoud *et al.* (2021) and Mahmoud (2021) on roselle. The role of organic manures in enhancing essential oil was detected by Sakr (2001) and Abdou *et al.* (2012) on *Mentha piperita*, Khalil and El-Sherbeny (2003) on *Mentha species* and Sukhmal *et al.* (2006) on *Mentha arvensis*, Moradi *et al.* (2011) and Ali *et al.* (2016) on fennel, Rekaby (2013) on coriander and Ali *et al.* (2017) on anise. Ascorbic acid (vitamin C) is biostimulant, antioxidant that canable protecting the plants against damage due to aerobic metabolism and a range of pollutants. Also, it plays necessity role as enzyme co-factor. Additionally, ascorbic acid resulted a significant effect on plant resistance against many plant pathogens like, bacteria, fungi, nematode and parasitic plants (Mahdy, 1994; Oertli, 1987). It is involved in a wide range of beneficial roles as antioxidant defense, photoprotection, as well as, regulating the growth and photosynthesis (Blokhdina *et al.*, 2003). Many investigators concluded that the application of ascorbic acid led to an augment in the growth and essential oil of different plants, such as, Sakr (2001),

Scavroni *et al.* (2005) and Abdou *et al.* (2012) on *Mentha piperita*, Khalil and El-Sherbeny (2003) on *Mentha* species and Sukhmal *et al.* (2006) on *Mentha arvensis*, Abdou *et al.* (2012) on mint, Khalil *et al.* (2010) and Marzok (2017) on *Ocimum basilicum*, Ahmed (2005) on marjoram, Youssef and Talaat (2003) on rosemary, Shala (2012) on Caraway, Said *et al.* (2014) on Coriander, Helmy (2016) on cumin and Ali *et al.* (2016) and Abo kutta (2016) on fennel. Yeast (*Saccharomyces cerevace*) is one of biofertilizers which acts important roles in improving the growth, productivity and chemical constituents of horticultural plants may be due to the positive, physiological and biological roles of yeast which were explained as follows: Yeast extract is a good source of several nutritional elements (P, K, S, Ca, Mg and No), a lot of vitamin B, natural growth substances like cytokinins, proteins, nucleic acids, lipids and carbohydrates (Nagodawithana, 1991). Many studies showed that treating some different medicinal and aromatic plants with yeast extract led to an increase in the growth and essential oil such as, Ali *et al.* (2009) and Khaled *et al.* (2014) on marjoram (*Majorana hertensis*), Salman (2006), Nassar *et al.* (2015), El-Naggar *et al.* (2015) and Marzok (2017) on basil (*Ocimum basilicum*) and Abd-El-Satar (2020) on *Anethum graveolens*. Therefore, the objective of this investigation was to determine the impact of compost and some biostimulants (ascorbic acid and yeast extract), as well as their interactions on the plant growth

traits and essential oil of peppermint (*Mentha piperita* L.) plants to find out the most suitable treatment for enhancing these characteristics.

2. Materials and methods

2.1 Experimental site and treatments description

The present research was conducted during the two successive seasons of 2019 and 2020 at Kom Ombo, Aswan governorate, Egypt to investigate the effect of compost and some biostimulants (ascorbic acid and yeast extract), as well as their interactions on the plant growth traits and volatile oil of peppermint (*Mentha piperita* L.) plants. A split plot design was executed with three replicates, in this study. Compost as organic manure was occupied as the main plots (A) included four treatments, meanwhile the seven biostimulant treatments (B) were assigned to the sub-plots, therefore, the interaction treatments (A×B) were 28 treatments. Stolons of peppermint were cultivated on February 15th, for both seasons, in 1.5×1.8 m plot included 3 rows, 60 cm apart, the row contained 6 plants spaced at 25 cm. Thus, the experimental unit was 18 plants. The physical and chemical characteristics of the used soil were according to Jackson (1973) and are listed in Table (1). Compost levels at 0, 8, 16 and 24 m³/acre were added during the preparation of soil to the cultivation, in the two seasons.

Table (1): The physical and chemical properties of the experimental soil.

Characters	Value		Characters	Value	
	2019	2020		2019	2020
Clay (%)	48.21	47.81	CaCO ₃ (%)	2.53	2.41
Silt (%)	35.12	36.20	PH (1:2.5)	7.43	7.37
Sand %	13.61	13.12	E.C m/mhos/cm	1.31	1.37
			Total N (%)	0.15	0.13
Organic matter (%)	2.45	2.61	Available P (%)	2.78	3.05
			Exchange K (mg/100 g soil)	2.28	2.17
Texture	Clay loam	Clay loam	Exchange Ca++ (mg/100 g soil)	35.3	33.10
			Exchange Na (mg/100 g soil)	2.22	2.31

Physical and chemical properties of the applied compost were determined according to Black *et al.* (1965) and are shown in Table (2). Biostimulant substance treatments were as follows: Control (no sprayed plants), ascorbic acid (Asc) at 50 ppm, 100 ppm, yeast extract (YE) at 5 g/l, 10 g/l, ASC at 50 ppm + YE at 5 g/l and Asc at 100 ppm + YE at 10 g/l. The chemical analysis of yeast (*Saccharomyces cerevisiae*) extract according to Khedr and Farid (2000) is shown in Table (3). The plants were

foliar sprayed with the two tested biostimulants, either separately or in combination three times as follows, March 15th May 31st and August 14th for the first, second and third sprays, respectively, in the two seasons. The plants were foliar sprayed till run off. All other agricultural practices were performed as usual. During the growing seasons, the plants were harvested three times as follows: May 1st, July 15th and September 28th the first, second and third cuts, respectively, in both seasons.

Table (2): The physical and chemical properties of the used compost.

Properties	Value		Properties	Value	
	2019	2020		2019	2020
Dry weight of 1 m ³	450 kg	450	Total N %	1.5	1.6
Moisture (%)	25-30	25-30	Total P (%)	0.9	0.88
pH (1:10)	7.6	7.8	Total K (%)	1.4	1.31
E.C. (m mhose/cm)	2-3.5	2-3.6	Fe (ppm)	290	297
Organic matter (%)	37	38.6	Mn (ppm)	29.2	30.3
Organic carbon (%)	19.8	21.5	Cu (ppm)	150	151
C/N ratio	14.2	13.9	Zn (ppm)	152	175

Table (3): The chemical properties of yeast extract (weight /100g d.w.).

Minerals	Amino acids (mg)		Vitamins (mg)		Enzymes (mg)	Carbohydrates (mg)			
N	34.39 g	Tryptophan	0.45	Vitamin B1 (Thiamine)	2.23	Oxidase	0.29	Carbohydrates	23.2
P ₂ O ₅	7.23 g	Methionine	0.72	Vitamin B2	1.31	Cytochrome	0.35	Glucose	13.33
K ₂ O	51.68 g	Cysteine	0.23	Vitamin B6 (Pyrodoxine)	2.9				
Mg	5.76 mg	Tyrosine	1.49	Vitamin B8	1.25				
CaO	3.05 mg	Phenylalanine	2.01	Vitamin B12	153				
NaCl	0.30 mg	Histidine	2.63	Riboflavin	4.96				
Zn	335.6 mg	Leucine	3.09	Nicotinic acid	39.88				
Mn	81.3 mg	Isoleucine	2.31	Folic acid	4.36				
B	175.6 mg	Arginine	1.99	P.amino benzoic acid	9.23				
FeO	0.92 mg	Lysine	2.95	Panthenic acid	19.56				
Al	650.2 mg	Threonine	2.09	Biotin	0.09				
Co	67.8 mg	Valine	2.19	Inositol	2.3				
Pb	438.6 mg	Glutamic acid	2.0						
Sn	223.9 mg	Serine	1.59						
SiO ₂	1.55 mg	Asparatic acid	1.33						
So ₂	0.49 mg	Proline	1.53						
Cl	0.06 mg								

The harvesting was done by cutting the plants at 10 cm above the surface of soil. The following data were recorded for each cut as follows: Plant height (cm), branch number /plant, herb fresh weight (g) /plant, herb dry weight (g) /plant, leaves fresh weight (g) /plant and leaves dry weight (g) /plant, as well as, essential oil percentage in the air dried leaves was determined according to the method of British Pharmacopoeia (1963). All obtained data were tabulated and statistically analyzed according to MSTATE-C (1986) using the L.S.D. test at 5% to know the differences among all treatments according to Mead *et al.* (1993).

3. Results and Discussion

3.1 Plant height (cm)

The presented data in Table (4) showed that plant height of peppermint was significantly increased by the application of compost as organic fertilization at all levels, among the three cuts, in both seasons, in relative to unfertilized plants. It could be noticed that such trait was gradually significantly augmented with increasing the levels of compost in all cuts, during the two experimental seasons. Therefore, the use of the high level of compost (24 m³/acre) gave the longest plants, in all cuts, as ranged 32.9 and 32.8 %, in the first cut, 22.5 and 25.0 % in the second cut and 27.9 and 36.6 % in the third one over the check treatment,

during both seasons, respectively. The effectiveness of organic manures on augmenting plant height was also revealed by Sakr (2001) on *Mentha piperita*, Khalil and El-Sherbeny (2003) on three *Mentha species*, El-Gendy *et al.* (2001) on basil, Kandeel *et al.* (2002) on *Ocimum basilicum*, Marzok (2011) on *Ocimum gratissimum*, Hassan *et al.* (2015) on rosemary, Shehata (2013) on guar, Hemdan (2008) on anise and Abdou *et al.* (2014) on marjoram. Concerning biostimulant treatments, the data in Table (4) proved that spraying peppermint plants with the two examined biostimulants at all concentrations, either single or together, in all cuts, for the two seasons, led to a significant increase in plant height, except for Asc at 50 ppm, in the first, second and third cuts, mostly, during both seasons, as compared to no sprayed ones. Clearly, foliar spray with the combined treatment (100 ppm Asc + 10 g/ l YE) proved to be more effective in increasing plant height in all cuts, than those obtained by other treatments and control, in the two seasons. Numerically, this previous superior treatment augmented such aspect by 23.1 and by 22.9 % in the first cut, by 28.9 and by 27.3 % and in the second cut and by 30.3 and by 25.0 % in the third one over control, for both seasons, respectively. The promoting effect of Ascorbic acid on plant height was also claimed by Abdou *et al.* (2012) on *Mentha piperita*, Youssef and Talaat (2003) on rosemary, Abo kutta (2016) on fennel.

Table (4): The impact of utilizing compost and some biostimulant treatments, as well as, their interactions on plant height (cm.) of peppermint (*Mentha piperita* L.) plants during 2019 and 2020 seasons.

Biostimulant treatments (B)	Compost levels (A)											
	Control	8 m ³	16 m ³	24 m ³	Mean (B)	Control	8 m ³	16 m ³	24 m ³	Mean (B)		
First season					Second season							
First cut					First cut							
Control	44.7	52.3	59.7	65.3	55.5	46.7	54.0	61.7	66.7	57.3		
Ascorbic 50	48.0	56.0	61.7	67.0	58.2	50.0	57.7	64.7	69.3	60.4		
Ascorbic 100	49.7	58.0	63.0	68.0	59.7	52.7	60.0	65.0	72.0	62.4		
Active Yeast 5	53.7	60.0	65.0	71.7	62.6	55.0	61.0	67.3	72.7	64.0		
Active Yeast 10	56.0	62.3	65.7	74.0	64.5	56.7	62.3	69.0	76.0	66.0		
As 50 + Yeast 5	58.0	62.7	67.7	76.5	66.2	60.0	63.0	71.3	78.3	68.2		
As 100 + Yeast 10	60.0	64.7	70.3	83.7	69.7	61.7	65.7	72.7	87.0	71.8		
Mean (A)	52.9	59.4	64.7	72.3		54.7	60.5	67.4	74.6			
L.S.D. at 5%	A : 2.3			B : 4.0		AB : 7.9		A : 3.6		B : 2.5		AB : 5.0
Second cut					Second cut							
Control	40.3	49.0	54.0	56.7	50.0	42.3	50.3	56.3	59.7	52.2		
Ascorbic 50	44.7	52.7	56.3	57.7	52.8	45.0	52.0	57.7	61.7	54.1		
Ascorbic 100	48.0	54.7	57.7	59.3	54.9	48.7	55.7	59.7	63.7	56.9		
Active Yeast 5	51.7	58.3	59.7	60.0	57.4	53.7	58.3	61.3	64.3	59.4		
Active Yeast 10	55.3	59.7	62.0	62.0	59.8	56.0	60.7	63.0	65.3	61.3		
As 50 + Yeast 5	56.7	60.7	62.7	72.0	63.0	57.7	62.3	65.3	68.3	63.4		
As 100 + Yeast 10	58.7	63.7	65.0	77.3	66.2	60.0	64.0	66.3	82.0	68.1		
Mean (A)	50.8	57.0	59.6	63.6		51.9	57.6	61.4	66.4			
L.S.D. at 5%	A : 1.8			B : 3.0		AB : 5.9		A : 2.0		B : 3.1		AB : 6.1
Third cut					Third cut							
Control	40.0	43.5	48.0	49.7	45.3	41.7	44.5	47.8	52.7	46.7		
Ascorbic 50	40.2	45.5	50.0	52.0	46.9	42.2	44.8	48.5	54.5	47.5		
Ascorbic 100	44.0	46.2	51.7	53.7	48.9	45.0	45.5	51.0	56.3	49.5		
Active Yeast 5	46.8	48.8	53.0	55.0	50.9	48.0	49.5	54.2	57.3	52.3		
Active Yeast 10	45.5	51.2	55.2	56.3	52.0	49.3	51.2	57.0	59.3	54.2		
As 50 + Yeast 5	47.8	52.8	58.0	61.7	55.1	49.3	53.8	57.5	69.3	57.5		
As 100 + Yeast 10	50.2	54.8	59.0	73.0	59.3	50.5	54.5	59.5	74.0	59.6		
Mean (A)	44.9	49.0	53.5	57.3		46.6	49.1	53.6	60.5			
L.S.D. at 5%	A : 2.8			B : 3.0		AB : 6.0		A : 3.2		B : 3.0		AB : 5.9

The role of yeast extract in increasing plant height was also pointed out by Ali (2001) on *Calendula officinalis*, Abdou et al., (2012) on *Salvia officinalis*, El-Sherbeny et al. (2007) on rue plants, El-Leithy et al., (2011) on geranium. In regard to the interaction between the two studied factors, it was statistically significant effect on plant height, in all cuts, during the two consecutive seasons. Obviously, all combined treatments, among all cuts, in both seasons, resulted a significant augment in plant height, except for 0 compost with 50 ppm Asc, mostly, comparing to untreated plants. In most cases, the values of plant height were high in the first cut, followed by the

second cut and shortest plants were noticed in the third cut, during both seasons. Furthermore, the longest plants were detected due to treating peppermint plants with the high level of compost (24 m³/fed) plus foliar spray with the combined treatment (100 ppm ASC + 10 g /l YE), among the three cuts, in comparison with those given by other combination treatments, during both seasons, as clearly indicated in Table (4).

3.2 Number of branches /plant

Shown data in Table (5) revealed that the use of compost at all levels, in all cuts, during both seasons, significantly

increased branch number /plant of peppermint, as compared to untreated plants. By increasing the levels of compost, such parameter was gradual significantly augmented, among all cuts, in the two seasons. Therefore, the highest values of branch number /plant, among all cuts, were resulted due to utilizing compost at the high level (24 m³/acre) reached 49.2 and 63.1 %, in the first cut, 40.1 and 45.4 % in the second cut and 35.0 and 35.4 % in the third one over the check treatment, during the two seasons, respectively. Many investigators came to similar results obtained in the present study which indicated that organic fertilization augmented branch number such as, Khalil and El-Sherbeny (2003) on three *Mentha species*, El- Gendy et al. (2001) on basil, Kandeel et al. (2002) on *Ocimum basilicum*, Marzok (2011) on *Ocimum gratissimum*, Hassan et al. (2015), on rosemary, Shehata (2013) on guar, Hemdan (2008) on anise, Abdou et al. (2014) on marjoram, Helmy and Zarad (2003) on *Borago officinalis*. Obviously, foliar spray with ascorbic acid and yeast extract each at all concentrations, among all cuts, in both seasons, either single or together caused a significant augment in branch number /plant, except for Asc at 50 ppm in three cuts, for both seasons, in relative to no sprayed ones. Moreover, supplying peppermint plants with the combined treatment (100 ppm Asc +10 g/l YE) proved to be more effective in increasing branch number /plant in all cuts than those given by other treatments and

control, in both seasons. Numerically, such parameter was augmented by the above mentioned superior treatment by 69.2 and by 63.1 %, in the first cut, by 61.2 and by 48.6 % in the second cut and by 44.9 and by 50.5 %, in the third one over untreated plants, during the two experimental seasons, respectively, as clearly declared in Table (5). The enhancement of branch number due to applying ascorbic acid was also explored by Abdou et al. (2012) on *Mentha piperita*, Khalil et al. (2010) and Abd El-Salam (2014) on sweet basil, Youssef and Talaat (2003) on rosemary and Abo kutta (2016) on fennel. The increments of branch number as a result of using yeast extract was also insured by Salman (2006), El-Keasy et al. (2011), Abd El-Salam (2014) and Nassar et al. (2015) on basil plant Ali (2001) on *Calendula officinalis*, El-Sherbeny et al. (2007) on rue plants and El-Leithy et al. (2011) on geranium. In relation to the combined, the listed data in Table (5) emphasized that branch number /plant of peppermint had significantly affected, in the three cuts, during both seasons, as a result of the interaction treatments between the two examined factors. It could be concluded that utilizing most combined treatments led to a significant augment in branch number /plant, among all cuts, as compared to control plants, during both seasons. Additionally, higher values of branch number /plant were obtained in the third cut, followed by the second cut and then the first one, during the two seasons. Clearly, the most effective

treatment on augmenting branch number /plant was given by treating the plants with compost at the high level (24 m³/acre) plus the combined treatment (100 ppm Asc + 10 g/l YE), in comparison with those revealed by other combination treatments, during the two consecutive seasons.

Table (5): The impact of utilizing compost and some biostimulant treatments, as well as, their interactions on number of branches /plant of peppermint (*Mentha piperita* L.) plants during 2019 and 2020 seasons.

Biostimulant treatments (B)	Compost levels (A)									
	Control	8 m ³	16 m ³	24 m ³	Mean (B)	Control	8 m ³	16 m ³	24 m ³	Mean (B)
First season					Second season					
First cut					First cut					
Control	8.7	9.7	13.0	15.3	11.7	9.7	11.0	15.0	18.0	13.4
Ascorbic 50	9.3	12.3	14.7	16.0	13.1	10.7	13.3	15.7	18.3	14.5
Ascorbic 100	11.0	13.3	15.7	17.0	14.3	13.0	14.3	17.3	19.3	16.0
Active Yeast 5	12.7	14.7	16.3	18.0	15.4	13.3	15.7	18.3	20.0	16.8
Active Yeast 10	13.0	16.3	17.3	18.7	16.3	13.7	16.7	20.0	21.7	18.0
As 50 + Yeast 5	14.0	17.3	18.7	21.3	17.8	14.7	18.0	20.7	22.3	18.9
As 100 + Yeast 10	15.7	18.7	19.7	25.0	19.8	16.0	19.3	21.7	28.7	21.4
Mean(A)	12.6	14.6	16.5	18.8		13.0	15.5	18.4	21.2	
L.S.D. at 5%	A : 1.8		B : 2.0		AB: 4.0	A : 1.7		B : 1.8		AB : 3.6
Second cut					Second cut					
Control	12.0	13.3	16.0	17.3	14.7	12.6	16.7	21.0	22.0	18.1
Ascorbic 50	13.0	14.7	18.0	19.0	16.2	15.3	18.4	22.0	24.4	20.0
Ascorbic 100	15.0	16.7	19.7	20.7	18.0	16.6	20.7	22.3	25.7	21.3
Active Yeast 5	16.0	18.3	20.0	21.3	18.9	18.3	21.7	24.0	24.4	22.1
Active Yeast 10	17.3	20.0	21.3	22.7	20.3	20.3	22.7	25.6	28.0	24.2
As 50 + Yeast 5	18.0	21.3	22.0	23.7	21.3	21.6	23.4	24.6	29.4	24.8
As 100 + Yeast 10	18.7	22.7	23.3	30.0	23.7	23.3	26.0	26.0	32.4	26.9
Mean(A)	15.7	18.1	20.0	22.1		18.3	21.4	23.6	26.6	
L.S.D. at 5%	A : 1.5		B : 1.8		AB : 3.5	A : 1.9		B : 2.0		AB : 3.9
Third cut					Third cut					
Control	16.6	17.7	22.0	23.0	19.8	16.0	19.4	21.5	23.2	20.0
Ascorbic 50	18.3	20.0	22.9	24.7	21.5	18.3	21.0	22.6	25.1	21.8
Ascorbic 100	19.3	22.0	24.0	25.0	22.6	20.3	22.7	24.3	26.8	23.5
Active Yeast 5	20.0	23.4	24.3	26.4	23.5	21.3	24.0	26.3	28.1	24.9
Active Yeast 10	21.0	24.7	26.0	27.4	24.8	22.6	25.7	27.3	29.1	26.2
As 50 + Yeast 5	23.0	25.4	26.6	28.4	25.8	24.3	27.4	27.6	30.1	27.4
As 100 + Yeast 10	24.0	26.4	27.3	37.0	28.7	25.3	28.0	28.6	38.3	30.1
Mean(A)	20.3	22.8	24.7	27.4		21.2	24.0	25.5	28.7	
L.S.D. at 5%	A : 1.8		B : 2.1		AB : 4.1	A : 1.4		B : 1.9		AB : 3.7

3.3 Herb fresh weight (g) /plant

The listed data in Table (6) cleared that supplying peppermint plants with compost at all levels, at all cuts, in both seasons, led to a significant increase in herb fresh weight /plant, except for the low level of such manure (8 m³/acre) in the second and third cuts, for the second season, as compared to the check treatment. By increasing the levels of

compost, herb fresh weight /plant was gradual significantly augmented, in all cuts, during the two experimental seasons. Thus, the heaviest herb fresh weight /plant among all cuts was given by adding the high level of compost (24 m³/acre) as ranged 32.8 and 35.8 %, in the first cut, 38.4 and 37.2 % in the second cut and 33.6 and 35.5 %, in the third one over control plants, in the first and second seasons, respectively.

Table (6): The impact of utilizing compost and some biostimulant treatments, as well as, their interactions on herb fresh weight (g) /plant of peppermint (*Mentha piperita* L.) plants during 2019 and 2020 seasons.

Biostimulant treatments (B)	Compost levels (A)									
	Control	8 m ³	16 m ³	24 m ³	Mean (B)	Control	8 m ³	16 m ³	24 m ³	Mean (B)
First season					Second season					
First cut					First cut					
Control	379.6	425.1	479.1	526.2	452.5	391.3	440.2	498.0	555.7	471.3
Ascorbic 50	393.0	443.5	494.5	544.1	468.8	403.3	455.2	513.5	570.3	485.6
Ascorbic 100	409.4	453.1	506.1	557.6	481.5	416.0	469.6	525.9	574.0	496.4
Active Yeast 5	412.2	472.1	523.9	566.5	493.7	425.0	498.2	543.5	591.1	514.4
Active Yeast 10	437.8	492.0	540.1	577.7	511.9	436.7	512.6	556.2	602.0	526.9
As 50 + Yeast 5	442.8	507.4	562.3	587.9	525.1	454.8	527.1	585.1	612.8	545.0
As 100 + Yeast 10	463.4	528.9	573.8	603.2	542.3	470.2	556.2	599.2	622.5	562.0
Mean(A)	426.4	474.6	525.7	566.2		434.3	494.2	545.9	589.8	
L.S.D. for 5%	A : 26.2		B : 13.7		AB : 27.3	A : 25.2		B : 12.5		AB : 25.1
Second cut					Second cut					
Control	479.7	534.0	598.7	695.1	576.9	494.1	551.2	618.5	712.2	594.0
Ascorbic 50	511.7	576.8	631.1	710.7	607.6	523.6	613.0	670.7	758.4	641.4
Ascorbic 100	543.7	599.1	670.3	745.5	639.7	559.3	617.7	692.3	783.7	663.3
Active Yeast 5	560.9	612.0	673.7	772.2	654.7	580.4	626.4	696.3	807.3	677.6
Active Yeast 10	579.3	638.0	689.2	804.9	677.8	597.4	654.7	722.3	835.6	702.5
As 50 + Yeast 5	591.1	665.4	751.4	813.2	705.3	622.9	675.7	783.7	859.7	735.5
As 100 + Yeast 10	627.3	681.3	777.8	847.3	733.4	638.8	683.7	805.3	881.5	752.3
Mean(A)	556.2	615.2	684.6	769.8		587.1	631.8	712.7	805.5	
L.S.D. for 5%	A : 48.1		B : 13.8		AB : 27.6	A : 56.2		B : 15.8		AB : 31.5
Third cut					Third cut					
Control	532.0	590.4	665.4	752.0	635.0	551.7	615.3	700.5	767.9	658.8
Ascorbic 50	569.8	622.8	703.5	786.4	670.6	582.0	636.3	752.8	814.7	696.4
Ascorbic 100	593.6	650.3	739.8	805.8	697.4	606.7	667.0	762.6	834.5	717.7
Active Yeast 5	613.0	665.8	744.8	833.5	714.3	627.1	677.3	787.9	863.6	739.0
Active Yeast 10	627.2	698.4	769.2	859.7	738.6	642.7	714.3	807.9	890.2	763.8
As 50 + Yeast 5	643.1	716.6	812.1	873.0	761.2	661.0	716.0	851.9	914.8	785.9
As 100 + Yeast 10	677.6	746.3	834.1	895.3	788.4	693.1	765.2	871.5	939.7	817.4
Mean(A)	620.7	670.1	752.7	829.4		635.4	684.5	790.7	860.8	
L.S.D. for 5%	A : 33.7		B : 15.3		AB : 30.6	A : 64.2		B : 13.1		AB : 26.3

It is evident from the given results in Table (6) that herb fresh weight /plant of peppermint among all cuts, in both seasons, was significantly augmented due to foliar spray with the two examined biostimulants at all concentrations, either alone or mixed, in relative to no sprayed ones. Apparently, the application of the combined treatment namely 100 ppm Asc + 10 g/l YE produced the heaviest herb fresh weight /plant among all cuts which increased it by 19.8 and by 19.2 %, in the first cut, by 27.1 and by 26.6 %, in the second cut and by 24.2 and by 24.1 % in the third one over no sprayed plants, during the two seasons, respectively. As for the interaction, it could be noticed that it was statistically significant effect

on herb fresh weight /plant of peppermint among all cuts, during the two growing seasons. Clearly, applying all combined treatments, in the three cuts, for both seasons, resulted a significant augment in herb fresh weight /plant, except for the treatment of 0 compost + 50 ppm Asc in the first cut for the two seasons and, also the second cut for the second season, as compared to untreated plants. Among all cuts, the third cut gave the highest values of herb fresh weight /plant followed by those given in the second cut and then the first cut gave the lowest values of such trait, mostly, in the two seasons. In this concern, the use of the high level of compost (24 m³/acre) with the combined treatment (100 ppm Asc + 10 g/l YE)

followed by with the combined one (50 ppm Asc + 5 g / YE), in some cases, among all cuts, proved to be more effective in increasing such aspect, in comparison with those revealed by other combination treatments, during the two consecutive seasons, as clearly shown in Table (6).

3.4 Herb dry weight (g) /plant

Data in Table (7) emphasized that herb dry weight /plant of peppermint was significantly increased, in all cuts, during both seasons, due to the addition of compost at all levels, in relative to unfertilized ones. However, such character was gradual significantly augmented with increasing the levels of compost, among all cuts, in both seasons. Therefore, the heaviest herb dry weight /plant was detected, in all cuts resulting from utilizing compost at the high level (24 m³/acre) as ranged 44.3 and 43.4 %, in the first cut, 45.3 and 43.6 % , in the second cut and 35.8 and 36.6 % in the third one, over unfertilized plants, during both seasons, respectively. In accordance with these findings regarding the augment in herb weight due to of organic manures was also those of Sakr (2001) on *Mentha piperita*, Sukhmai et al. (2006) on *Mentha arvensis*, El-Gendy et al. (2001) on basil, Kandeel et al. (2002)

and Khalid et al. (2006) on *Ocimum basilicum*, Marzok (2011) on *Ocimum gratissimum*, Shehata (2013) on guar, Hemdan (2008) on anise, Abdou et al. (2014) on marjoram, Hassan et al. (2015), on rosemary and Helmy and Zarad (2003) on *Borago officinalis*. Obviously, foliar spray with the two tested biostimulants at all concentrations, either individual or in combination, among all cuts, led to a significant augment in herb dry weight /plant comparing to no sprayed ones, in both seasons. Apparently, spraying the plants with the combined treatment i.e. 100 ppm Asc + 10 g /l YE proved to be more effective in increasing herb dry weight /plant, among all cuts, than those of revealed by other treatments and control, in the two seasons. Numerically, this previous superior treatment augmented such trait by 21.5 and by 21.8 %, in the first cut, by 23.4 and by 23.6 % , in the second cut and by 17.4 and by 17.8 % in the third one over no sprayed plants, during the two experimental seasons, respectively, as clearly in Table (7). The promoting effect of ascorbic acid on herb weight was also demonstrated by Abdou et al. (2012) on *Mentha piperita*, Abd El-Naeem (2012) on mint plants, Abd El-Salam (2014) on basil plants, Youssef and Talaat (2003) on rosemary Ali et al. (2016) and Abo kutta (2016) on fennel.

Table (7): The impact of utilizing compost and some biostimulant treatments, as well as their interactions on herb dry weight (g) /plant of peppermint (*Mentha piperita* L.) plants during 2019 and 2020 seasons.

Biostimulant treatments (B)	Compost levels (A)										
	First season					Second season					
	Control	8 m ³	16 m ³	24 m ³	Mean (B)	Control	8 m ³	16 m ³	24 m ³	Mean (B)	
	First cut					First cut					
Control	70.6	80.8	90.5	103.8	86.4	74.9	85.7	94.8	108.6	91.0	
Ascorbic 50	74.5	85.0	93.3	107.0	90.0	77.8	86.8	99.8	112.4	94.2	
Ascorbic 100	77.2	86.7	95.5	109.6	92.2	79.7	91.0	99.9	113.2	95.9	
Active Yeast 5	75.7	91.0	96.9	111.5	93.8	81.0	94.8	103.2	116.4	98.8	
Active Yeast 10	78.3	93.5	102.4	114.9	97.3	84.2	97.4	105.4	119.2	101.6	
As 50 + Yeast 5	81.9	96.5	105.9	118.5	100.7	84.4	100.1	110.8	121.9	104.3	
As 100 + Yeast 10	83.4	100.4	108.4	127.8	105.0	88.0	105.4	113.5	136.3	110.8	
Mean (A)	78.5	90.5	99.0	113.3		82.5	94.5	103.9	118.3		
L.S.D. at 5%	A : 5.1				B : 2.1	AB : 4.2		A : 4.9		B : 2.3	AB : 4.6
	Second cut					Second cut					
Control	94.9	109.8	124.8	139.9	117.3	97.5	111.2	126.5	141.7	119.2	
Ascorbic 50	101.8	112.7	129.9	144.7	122.3	101.6	114.3	131.6	146.7	123.5	
Ascorbic 100	104.7	115.9	135.4	149.5	126.3	105.0	117.3	136.4	151.5	127.6	
Active Yeast 5	107.6	118.7	140.2	153.8	130.1	108.9	119.9	142.0	156.1	131.7	
Active Yeast 10	110.5	123.1	144.8	161.9	135.1	112.0	124.4	149.6	164.2	137.5	
As 50 + Yeast 5	115.1	126.9	151.0	168.9	140.5	116.6	128.4	152.1	173.2	142.6	
As 100 + Yeast 10	117.7	129.6	157.0	174.9	144.8	120.6	130.9	157.0	180.7	147.3	
Mean (A)	107.5	119.5	140.4	156.2		110.8	120.9	142.2	159.1		
L.S.D. at 5%	A : 4.5			B : 2.0		AB : 4.1		A : 5.5		B : 2.1	AB : 4.3
	Third cut					Third cut					
Control	129.5	144.5	164.6	182.1	155.2	134.3	150.7	167.5	185.0	159.4	
Ascorbic 50	134.8	147.9	170.3	188.4	160.3	138.4	151.5	172.9	191.5	163.6	
Ascorbic 100	139.4	153.2	173.7	191.9	164.6	143.4	155.7	177.1	197.3	168.4	
Active Yeast 5	146.0	156.1	178.6	195.5	169.0	144.6	158.2	181.4	198.9	170.8	
Active Yeast 10	145.5	162.1	183.4	200.4	172.9	148.4	165.9	189.2	205.1	177.2	
As 50 + Yeast 5	148.7	165.8	189.1	207.4	177.8	152.4	168.3	192.3	211.4	181.1	
As 100 + Yeast 10	154.2	171.0	192.0	211.5	182.2	157.7	174.5	197.6	221.5	187.8	
Mean (A)	144.8	157.2	178.8	196.7		147.5	160.7	182.6	201.5		
L.S.D. at 5%	A : 4.7		B : 1.6		AB : 3.3		A : 4.3		B : 2.4		AB : 4.8

The capability of yeast extract on increasing herb weight was also concluded by Salman (2006) and Abd El-Salam (2014) on *Ocimum basilicum*, Massoud (2006) and Mosaad (2012) on sage plants. Ali (2001) on *Calendula officinalis*, Abd El-Latif (2006) on *Salvia officinalis*, El-Sherbeny et al. (2007) on rue plants, El-Leithy et al. (2011) on geranium. The combined affect between the two examined factors on herb dry weight /plant of peppermint, among the three cuts, had significant, in both seasons (Table 7). It could be observed that applying all combined treatments, among all cuts, for both seasons, resulted

a significant increase in herb dry weight /plant, except for 0 compost plus Asc at 50 ppm in most cases, as compared to untreated plants. Clearly, the third cut gave the highest herb dry weight /plant, followed by these obtained in the second cut and then by those given in the first one, mostly for both seasons. Furthermore, receiving peppermint plants the high level of compos (24 m³/acre) with the combined treatment namely 100 ppm Asc + 10 g /YE proved to be more effective in augmenting such parameter, among all cuts, than those obtained by other combination treatments, during the two growing seasons.

3.5 Leaves fresh weight (g) /plant

From the obtained data in Table (8), it could be noticed that the use of compost at all levels, among all cuts, in both seasons, resulted a significant increase in leaves fresh weight /plant of peppermint, except for the low level of compost (8 m³/acre) in the second and third cuts, for the second season, in relative to the check treatment. In this regard, such

aspect was gradual significantly increased, among all cuts, mostly, with augmenting the levels of compost, in the two consecutive seasons. Thus, the application of compost at the high level (24 m³/acre) produced the heaviest leaves fresh weight/plant among all cuts reached 52.5 and 52.1 %, in the first cut, 48.6 and 46.8 %, in the second cut and 42.5 and 38.2 % in the third one over unfertilized plants, for the two seasons, respectively.

Table (8): The impact of utilizing compost and some biostimulant treatments, as well as their interactions on leaves fresh weight (g) /plant of peppermint (*Mentha piperita* L.) plants during 2019 and 2020 seasons.

Biostimulant treatments (B)	Compost levels (A)											
	Control	8 m ³	16m ³	24 m ³	Mean (B)	Control	8 m ³	16m ³	24 m ³	Mean (B)		
First season					Second season							
First cut					First cut							
Control	157.2	178.3	215.3	245.9	199.2	164.8	186.3	227.6	260.9	209.9		
Ascorbic 50	166.5	187.9	223.3	248.1	206.4	170.4	207.8	233.7	262.2	218.5		
Ascorbic 100	176.1	195.4	230.3	264.7	216.6	179.9	223.1	243.6	273.6	230.1		
Active Yeast 5	175.3	209.6	241.7	275.9	225.6	187.9	232.7	249.7	282.1	238.1		
Active Yeast 10	183.0	220.9	252.0	282.1	234.5	192.1	240.2	258.4	289.4	245.0		
As 50 + Yeast 5	190.4	232.5	262.6	287.3	243.2	199.8	247.6	277.7	302.8	257.0		
As 100 + Yeast 10	198.5	248.3	270.0	296.8	253.4	208.9	256.6	286.2	312.8	266.1		
Mean(A)	178.1	210.4	242.2	271.6		186.3	227.8	253.8	283.4			
L.S.D. at 5%	A : 23.9		B : 7.9		AB : 15.8		A : 36.8		B : 11.2		AB : 22.3	
Second cut					Second cut							
Control	233.6	261.4	305.5	326.0	281.6	241.9	276.1	316.5	358.5	298.2		
Ascorbic 50	248.0	276.3	324.0	365.7	303.5	258.1	293.1	346.0	362.6	314.9		
Ascorbic 100	261.3	288.9	331.0	388.0	317.3	269.3	307.9	357.2	396.7	332.8		
Active Yeast 5	271.4	303.5	342.8	403.4	330.3	288.6	311.4	378.9	413.9	348.2		
Active Yeast 10	282.4	318.3	367.5	428.4	349.2	293.0	331.1	392.6	437.8	363.6		
As 50 + Yeast 5	289.5	325.1	376.1	431.8	355.6	306.2	342.5	409.3	443.7	375.4		
As 100 + Yeast 10	299.5	338.5	391.1	459.5	372.2	314.7	353.1	417.6	481.7	391.8		
Mean(A)	269.4	301.7	348.3	400.4		281.7	316.4	374.0	413.6			
L.S.D. at 5%	A : 32.3		B : 13.4		AB : 26.7		A : 26.1		B : 23.5		AB : 47.0	
Third cut					Third cut							
Control	265.2	297.7	326.7	366.0	313.9	279.7	313.0	341.8	383.1	329.4		
Ascorbic 50	280.0	325.4	342.8	393.5	335.4	294.1	330.9	368.7	411.4	351.3		
Ascorbic 100	287.5	320.4	357.5	410.2	343.9	313.3	345.0	378.0	421.3	364.4		
Active Yeast 5	302.4	343.4	375.1	424.9	361.4	325.0	360.1	402.8	445.2	383.3		
Active Yeast 10	317.8	354.1	391.0	445.8	377.2	347.0	379.9	419.8	466.5	403.3		
As 50 + Yeast 5	327.9	357.5	406.2	467.7	389.8	350.0	396.0	439.9	498.1	421.0		
As 100 + Yeast 10	340.2	386.5	420.8	513.9	415.3	367.0	410.1	447.5	519.7	436.1		
Mean(A)	303.0	340.7	374.3	431.7		325.2	362.1	399.8	449.3			
L.S.D. at 5%	A : 28.1		B : 12.1		AB : 24.2		A : 38.2		B : 16.2		AB : 32.3	

With respect to the impact of biostimulant treatments, the presented results in table (8) claimed that spraying peppermint plants with the two studied biostimulants at all concentrations, either alone or mixed led to a significant

augment in leaves fresh weight /plant in all cuts, during both seasons, except for the treatment of Asc at 50 ppm in the first cut for both seasons and, also in the second cut for the second season, in relative to no sprayed plant. Obviously,

foliar spray with the combined treatment (100 ppm Asc + 10 g /l YE), among all cuts, proved to be more effective in increasing leaves fresh weight /plant than those given by other treatments and control, in both seasons. This previous superior treatment augmented leaves fresh weight /plant among all cuts, by 27.2 and by 26.8 %, in the first cut, by 32.3 and by 31.4 %, in the second cut and by 32.3 and by 32.4 % in the third one over no sprayed plants, during the two seasons, respectively. Concerning the interaction, it was statistically significant effect on leaves fresh weight /plant of peppermint, among all cuts, in both seasons. Additionally, all combined treatments, in most cuts, caused a significant increase in leaves fresh /plant, except for 0 compost with 5 g/l or with 10 g /l YE, as compared to untreated ones, in the two seasons. Obviously, higher values of such parameter were detected in the third cut, followed by the second cut and then the first one, for both seasons. Clearly, the heaviest leaves fresh weight /plant was given, among all cuts, due to treating the plants with compost at the high level (24 m³/acre) with the combined treatment (100 ppm Asc + 10 g /l YE), in comparison with those detected by other combination treatments, during the consecutive season, as clearly indicated in Table (8).

3.6 Leaves dry weight (g) /plant

The revealed data in Table (9) illustrated that fertilizing peppermint plants with

compost at all levels led to a significant increase in leaves dry weight /plant among all cuts, in both seasons, except for the low level of compost (8 m³/acre) in the first cut, for the second season and, also in the second cut, for both seasons, comparing to the check treatment. However, such trait was gradual significantly augmented, among all cuts, in the two seasons, with increasing the levels of compost, except for between the low and moderate levels in the first cut, for both seasons and, also between the same levels, in the third cut, for the second season. Therefore, the use of compost at the high level (24m³/acre) proved to be more effective in augmenting leaves dry weight /plant in all cuts than those given by other treatments and control, during the two growing seasons. Numerically, this above mentioned superior treatment increased such aspect among all cuts by 46.4 and by 46.6 %, in the first cut, by 46.4 and 46.0 by, in the second cut and by 48.8 and by 43.8 %, in the third one over unfertilized plants, respectively. The effectiveness of organic manures an augmenting leaf weight was also explained by El-Leithy *et al.* (2006) on *Salvia officinalis*. In respect to biostimulant treatments, the data proved that foliar spray with the two studied biostimulants, either separately or together resulted a significant augment in leaves dry weight /plant of peppermint, among the three cuts, in both seasons, except for 50 ppm Asc, in the first cut, for the second season and, also in the

third cut for the first season, as compared to no sprayed ones, during the two experimental seasons. Apparently, treating the plants with the combined treatment (100 ppm Asc + 10 g /l YE) gave the heaviest leaves dry weight

/plant, among all cuts, as ranged 22.2 and 20.9 %, in the first cut, 22.3 and 22.3 % in the second cut and 23.8 and 24.6 %, in the third one over no sprayed plants during the two seasons, respectively, as clearly revealed in Table (9).

Table (9): The impact of utilizing compost and some biostimulant treatments, as well as their interactions on leaves dry weight (g) /plant of peppermint (*Mentha piperita* L.) plants during 2019 and 2020 seasons.

Biostimulant treatments (B)	Compost levels (A)											
	Control	8 m ³	16 m ³	24 m ³	Mean (B)	Control	8 m ³	16 m ³	24 m ³	Mean (B)		
First season					Second season							
First cut					First cut							
Control	44.1	52.0	58.5	66.7	55.3	46.1	55.3	62.3	69.3	58.3		
Ascorbic 50	46.7	56.2	59.9	69.4	58.0	48.3	55.2	62.1	71.0	59.1		
Ascorbic 100	49.6	56.8	62.1	70.9	59.8	49.9	56.7	63.9	73.2	60.9		
Active Yeast 5	49.9	58.9	63.2	72.0	61.0	51.1	59.8	65.3	73.3	62.4		
Active Yeast 10	50.2	61.0	64.6	75.3	62.8	53.1	62.3	66.7	79.8	65.4		
As 50 + Yeast 5	52.1	61.5	67.2	78.2	64.8	54.4	62.8	69.8	80.5	66.9		
As 100 + Yeast 10	53.6	64.6	68.3	83.8	67.6	55.6	66.9	71.4	88.1	70.5		
Mean(A)	50.4	58.7	63.4	73.8		52.1	59.8	65.9	76.4			
L.S.D. at 5%	A : 8.0		B : 2.7		AB : 5.3		A : 8.1		B : 1.4		AB : 2.7	
Second cut					Second cut							
Control	60.9	68.7	78.0	88.9	74.1	62.1	70.9	81.1	91.2	76.3		
Ascorbic 50	63.8	71.0	82.2	92.1	77.3	65.1	73.7	83.9	94.7	79.4		
Ascorbic 100	65.4	72.3	84.7	95.1	79.4	66.1	75.8	87.5	97.6	81.7		
Active Yeast 5	67.3	74.8	87.6	98.1	82.0	68.6	77.9	91.5	100.0	84.5		
Active Yeast 10	68.7	76.4	90.4	101.7	84.3	70.2	79.7	94.1	105.6	87.4		
As 50 + Yeast 5	71.0	80.9	93.9	105.3	87.8	72.6	82.2	96.2	109.3	90.1		
As 100 + Yeast 10	73.4	84.2	97.2	107.7	90.6	74.3	86.2	100.4	112.3	93.3		
Mean(A)	67.2	75.5	87.7	98.4		69.5	78.1	90.7	101.5			
L.S.D. at 5%	A : 8.6		B : 1.5		AB : 3.1		A : 8.5		B : 1.1		AB : 2.3	
Third cut					Third cut							
Control	65.6	72.2	84.3	97.0	79.8	67.4	78.2	88.6	101.9	84.0		
Ascorbic 50	68.4	75.7	86.7	99.5	82.6	73.7	83.6	91.8	103.1	88.1		
Ascorbic 100	73.1	80.1	89.8	102.8	86.5	75.5	84.6	93.1	107.5	90.1		
Active Yeast 5	70.9	82.5	91.5	104.4	87.3	76.1	87.8	96.6	113.3	93.5		
Active Yeast 10	73.7	86.5	95.5	110.0	91.4	77.5	90.6	97.9	115.9	95.5		
As 50 + Yeast 5	75.0	88.3	97.7	116.3	94.3	83.6	95.0	103.7	121.0	100.8		
As 100 + Yeast 10	77.8	93.5	101.1	121.0	98.3	85.8	100.3	105.1	127.6	104.7		
Mean(A)	72.1	82.7	92.4	107.3		78.7	88.6	96.7	112.9			
L.S.D. at 5%	A : 9.0		B : 3.1		AB : 6.2		A : 9.7		B : 3.2		AB : 6.3	

The stimulating influence of ascorbic acid on leaf weight was also studied by Khalil *et al.* (2010) and Abd El-Salam (2014) on sweet basil. The increments of leaf weight due to applying Yeast extract was also detected by Ali (2001) on *Calendula officinalis*, Abd El-Latif (2006) on *Salvia officinalis*, El-Sherbeny *et al.* (2007) on rue plants. Accordingly, the combined between the two examined factors of leaves dry weight /plant of

peppermint had statistically significant effect, among all cuts, during the two consecutive seasons (Table 9). It is obvious that supplying the plants all combined treatments, in both seasons, led to a significant increase in such parameter, among the three cuts, except for the treatment of 0 compost plus Asc at 50 ppm, in the most cases, as compared to untreated plants, in the two seasons. Among all cuts, the third cut

gave high values of leaves dry weight /plant, followed by those obtained in the second cut and the first cut recorded the lowest values of such trait, in the two seasons. Moreover, the application of compost at the high level (24 m³/acre) in combination with the combined treatment *i.e.* 100 ppm Asc + 10 g/l YE proved to be more effective in increasing leaves dry weight /plant, among all cuts, than those given by other combination treatments, during the two experimental seasons.

3.7 Essential oil %

The registered data in Table (10) exhibited that supplying peppermint plants with at compost of all levels, in both seasons, resulted a significant increase in essential oil %, among the three cuts, except for the low level (8 m³/acre) in the first cut for the second season and, also in the second cut for the first season, as compared to unfertilized plants. Clearly, essential oil % was gradual significantly augmented with increasing the levels of compost among all cuts, mostly, in the two seasons. Thus, the application of compost at the high level (24 m³/acre) registered the highest essential oil % among all cuts reached 38.9 and 19.7 % in the first cut, 31.7 and 23.4 % in the second cut and 43.4 and 21.5 % in the third one over the check treatment, during the two experimental seasons, respectively. Our results regarding organic fertilization are in augment with the findings of Hassan et

al. (2015) on rosemary Hemdan (2008) on anise. In respect to biostimulant treatments, the presented results in Table (10) cleared that foliar spray with the two examined materials at all concentrations, either alone or together, in both seasons, led to a significant augment in essential oil %, among all cuts, except for 50 ppm Asc in the second cut for the two seasons, comparing to no sprayed ones. Apparently, treating the plants with the combined treatment *i.e.* 100 ppm Asc + 10 g /l YE proved to be more effective in increasing essential oil % in the three cuts, than those revealed by other treatments and control, during the two growing seasons. Numerically, this previous superior treatment augmented such aspect among all cuts by 28.6 and by 24.8 % in the first cut, by 25.0 and by 21.7 %, in the second cut and by 26.2 and by 22.1 %, in the third cut over control plants, during the two consecutive seasons, respectively. The promotion of essential oil as a result of using ascorbic acid was also reported by Abdou *et al.* (2012) on *Mentha piperita*, Youssef and Talaat (2003) on rosemary, Abd El-Salam (2014) on basil plants, Ali *et al.* (2016) and Abo kutta (2016) on fennel and Helmy (2016) on cumin plants. The role of yeast extract in augmenting essential oil was also explained by Salman (2006), Abdou *et al.* (2014), Nassar *et al.* (2015) and Omar *et al.* (2016) on *Ocimum sp.* as for the combined effect, it was statistically significant on essential oil %, among all cuts, in the two seasons (Table, 10).

Table (10): The impact of utilizing compost and some biostimulant treatments, as well as their interactions on essential oil % of peppermint (*Mentha piperita* L.) plants during 2019 and 2020 seasons.

Biostimulant treatments (B)	Compost levels (A)											
	First season					Second season						
	Control	8 m ³	16 m ³	24 m ³	Mean (B)	Control	8 m ³	16 m ³	24 m ³	Mean (B)		
	First cut					First cut						
Control	0.95	1.11	1.28	1.43	1.19	1.08	1.16	1.23	1.37	1.21		
Ascorbic 50	1.01	1.14	1.31	1.51	1.24	1.14	1.23	1.29	1.42	1.27		
Ascorbic 100	1.08	1.25	1.41	1.53	1.32	1.22	1.29	1.32	1.43	1.32		
Active Yeast 5	1.09	1.37	1.46	1.51	1.36	1.27	1.31	1.37	1.44	1.35		
Active Yeast 10	1.19	1.44	1.54	1.58	1.44	1.33	1.36	1.41	1.48	1.40		
As 50 + Yeast 5	1.26	1.27	1.56	1.67	1.44	1.34	1.40	1.45	1.69	1.47		
As 100 + Yeast 10	1.33	1.39	1.63	1.79	1.53	1.36	1.42	1.48	1.77	1.51		
Mean(A)	1.13	1.28	1.46	1.57		1.27	1.31	1.37	1.52			
L.S.D. at 5%	A : 0.06			B : 0.05		AB : 0.10		A : 0.05		B : 0.05		AB : 0.11
	Second cut					Second cut						
Control	1.04	1.18	1.26	1.49	1.24	1.14	1.27	1.29	1.46	1.29		
Ascorbic 50	1.10	1.22	1.34	1.56	1.31	1.17	1.32	1.33	1.49	1.33		
Ascorbic 100	1.22	1.25	1.40	1.59	1.37	1.24	1.40	1.37	1.53	1.38		
Active Yeast 5	1.27	1.28	1.56	1.59	1.43	1.31	1.41	1.44	1.54	1.43		
Active Yeast 10	1.28	1.31	1.56	1.63	1.45	1.37	1.42	1.49	1.57	1.46		
As 50 + Yeast 5	1.31	1.33	1.59	1.68	1.48	1.38	1.50	1.54	1.66	1.52		
As 100 + Yeast 10	1.36	1.38	1.63	1.82	1.55	1.39	1.54	1.56	1.79	1.57		
Mean(A)	1.23	1.28	1.48	1.62		1.28	1.41	1.43	1.58			
L.S.D. at 5%	A : 0.06			B : 0.08		AB : 0.16		A : 0.06		B : 0.05		AB : 0.10
	Third cut					Third cut						
Control	1.07	1.13	1.33	1.50	1.26	1.11	1.32	1.38	1.43	1.31		
Ascorbic 50	1.14	1.25	1.41	1.57	1.34	1.14	1.35	1.41	1.50	1.35		
Ascorbic 100	1.22	1.27	1.45	1.61	1.39	1.25	1.42	1.45	1.52	1.41		
Active Yeast 5	1.14	1.39	1.54	1.60	1.42	1.34	1.46	1.48	1.53	1.45		
Active Yeast 10	1.23	1.43	1.61	1.65	1.48	1.41	1.48	1.54	1.58	1.50		
As 50 + Yeast 5	1.33	1.44	1.63	1.75	1.54	1.42	1.52	1.58	1.68	1.55		
As 100 + Yeast 10	1.38	1.48	1.66	1.83	1.59	1.43	1.53	1.60	1.83	1.60		
Mean(A)	1.22	1.34	1.52	1.64		1.30	1.44	1.49	1.58			
L.S.D. at 5%	A : 0.05			B : 0.05		AB : 0.09		A : 0.05		B : 0.04		AB : 0.09

Obviously, the use of all combined treatments resulted a significant increase in essential oil %, among all cuts, except for 0 compost with 50 ppm Asc, comparing to untreated plants, in the two seasons. In most cases, the third cut produced the highest essential oil %, followed by those detected in the second cut and then by those obtained in the first cut, for the two seasons. Moreover, the most effective treatment, among all cuts, in augmenting such trait was detected when supplying the plants with compost at the high level (24m³/acre) plus the combined treatment namely, 100 ppm Asc + 10 g / YE, in comparison with those obtained by other combination treatments, during both seasons. From

the obtained results, it could be discussed as follows: The increments of plant growth traits and essential oil % of peppermint plants as a result of applying compost as organic fertilizer might be due to the positive, physiological and biological roles of organic manures which were explained by many investigators such that Bohn *et al.* (1985) mentioned organic manure is considered as a main source of some elements like, N, P and S, as well as, contains high amounts of both B and Mo. However, the same authors indicated that organic matter plays an important role as a source of energy for Azotobacter growth. Organic manure led to minimizing the loss of nutrients via leaching (Saber,

1997). Additionally, organic manure contains some growth promoting hormones namely GA₃ and IAA and, also macronutrients, essential micronutrients, as well as, beneficial microorganisms (Natarajan, 2007 and Sreenivasa *et al.*, 2010). Furthermore, organic manure plays an essential role in increasing the microbial activities in the root zone by utilizing organic manure by the soil (Taiwo *et al.*, 2002). The stimulation of plant growth aspects and essential oil % in peppermint plants due to the use of ascorbic acid reflects the beneficial roles of ascorbic acid which were described by many studies such as, Blokhina *et al.* (2003) suggested that ascorbic acid acts as antioxidant defense, photoprotection and regulates the growth and photosynthesis. Ascorbic acid has to be beneficial role in plant like, promoting respiration, photosynthesis and cell division, It plays in management of enzymes activate and, also stimulating lipase and catalase, besides to augments vegetative growth and oil percentage (Oertli, 1987, Dewick, 2000, Reda *et al.*, 2005 and Eid *et al.*, 2010). The augment in these studied parameters resulting from supplying yeast extract may be attributed to the important roles of yeast extract which were explored by many researchers such as, Abou-Zaid (1984) showed that yeast contains protein, dry matter, vitamins B, phytohormones namely, (IAA and cytokinins) and amino acids (tryptophan, methionine, cysteine, glycine, lycine, leucine, isoleucine, histidine, tyrosine, phenylalanine,

threonine and arginine). The author added that yeast contains N, ash, crude protein, fat and nucleic acid. Also, it contains enzymes, co-enzymes, glutathione and lecithin, in addition, it containing vitamin B1 (thiamine) and B6 (pyridoxine). From the obtained results, it could be recommended to supply the soil of peppermint plants with compost at 24 m³/acre and foliar spray with 100 ppm ascorbic acid + 10 g /l yeast extract to enhance the plant growth aspects and essential oil under the conditions of this investigation.

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