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# Improving the growth traits and essential oil of basil plants by using mineral N and some biostimulant substances

Mohamed A. M., Ali A. F., Ibrahim M. F.*

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

## Abstract

The present work was carried out during the two successive seasons of 2020 and 2021 at the Experimental Farm, Faculty of Agriculture, Al-Azhar University, Assiut, Egypt to investigate the impact of applying mineral N and foliar spray with some biostimulant substances, as well as their interactions between plant growth traits and essential oil percentage of basil (*Ocimum basilicum*) plants. Eleven N mineral and/or biostimulant substance treatments, as follows: control, 100 % N as ammonium nitrate (33.5% N) at 300 kg/acre, 75% N (225 kg/acre), moringa leaf extract (MLE) at 5 g/l, MLE at 10 g/l, yeast extract (YE) at 5 g/l, YE at 10 g/l, 75% N + MLE at 5 g/l, 75% N + MLE at 10 g/l, 75% N + YE at 5 g/l and 75% N + YE at 10 g/l. The obtained results cleared that the application of N fertilization and biostimulant substances, either separately or together led to a significant increase in growth parameters (plant height, branch number/plant, herb fresh and dry weights/plant and leaves fresh and dry weight/plant) and, also essential oil % in the three cuts, except for 5 g/l MLE and 5 g/l YE mostly, in these aspects among all cuts particularly the first and second cuts, in relative to the check treatment. Additionally higher values of the studied traits were detected due to combined treatments then those given by single ones, mostly. Obviously, the use of the combined treatment (75% N + 10 g/l YE) and the combined one (75% N + 10 g/l MLE) gave the highest values of the examined characteristics, mostly, among all cuts.

*Keywords:* basil, mineral N, moringa leaf extract, yeast extract.

*Corresponding author: Ibrahim M. F.,
*E-mail address:* mostafaahmed.4919@azhar.edu.eg

## 1. Introduction

Basil or sweet basil (*Ocimum basilicum* L.) is an annual herb, belongs to Lamiaceae (Labiateae) family and it is native to the tropical regions of Africa, Asia and central and south America (Gill and Randhawa, 1997). Basil is one of the most important medicinal and aromatic plants grown in Egypt. Sweet basil as a medicinal plant owing to their therapeutical action for examples: Coughs, constipation, diarrhea wart, headaches worms and kidney malfunction, carminative, expectorant, stomachicum, antispasmodic, antimalarial febrifuge and stimulant (Simon *et al.*, 1999). The fresh and dry leaves of basil have been utilized in spice and food industries dental and oral products, as well as perfumery (Vierira and Simon, 2000). Essential oil was extracted from the leaves and flowering tops which is used in flavor foods, dental and oral products, as well as, in fragrances. (Akgul, 1989; Passual-Villalobos and Ballesta-Acosta, 2003). Additionally, it has an antioxidant, antimicrobial and anticancer activities because it contains some organic compounds such as, phenols flavonoids and vitamins (Sgherri *et al.*, 2010; Taie *et al.*, 2010). Nitrogen has important roles in the growth and development, whereas it has the mineral nutrient element which most often limits the production of crop (Below, 2002). Moreover, nitrogen not only improves the yield but also enhances the quality of food (Ullah *et al.*, 2010). The efficiency of nitrogen fertilization on augmenting the plant growth was proved by Prakasa Rao *et al.* (2007) on french basil and Larimi *et al.* (2014) on *Ocimum basilicum*, Giorgi *et al.* (2009) on *Achillea epllina*, El-Hafid *et al*. (2002) on *Borago officinalis*, Al-Thabet (2006) and Awais *et al.* (2017) on sunflower, Atia *et al*. (2010) on basil, Beata (2011) on *Calendula officinalis*, Reza *et al*. (2011) on *Catharanthus roseus* and Reza *et al.* (2011) on thyme plants. Concerning the positive role of nitrogen fertilization on enhancing essential oil, Prakasa Rao *et al.* (2007) on French basil (*Ocimum basilicum*) and Omer *et al*. (2008) on *Ocimum americanum*) plants. Moringa a leaf extract is a biostimulant due to it has rich in phytohormones like, zeatin, IAA and GA (Fuglie, 1999). Likewise, it contains various phenols, proteins important minerals and carotene. Also, it has rich in zeatin + several flavonoid pigments consequently *Moringa oleifera* acts a good natural antioxidant system (Meehl *et al*., 2007). The stimulating influence of moringa leaf extract on plant growth traits was studied by Prabhu *et al.* (2010) and Nasir *et al.* (2016) on *Ocimum basilicum*, Abbas *et al*. (2016) on sage (*Salvia officinalis*), Ndubuaku *et al.* (2015) on cassava plants, Abdel Latif *et al.* (2017) on fenugreek plants, Ali *et al.* (2018) on *pelorganium graveolens*, Jain *et al.* (2020) on stevia plants and Fuglie (1999) on tea. As for essential oil, Abbas *et al*. (2016) on sage (*Salvia officinalis*) and Ali *et al*. (2018) on *pelargonium graveolens* plants. Yeast (*Saccharumysces cerevisiae*) is considered one of biostimulant which had been used as biofertilizer canable improving the growth, productivities and chemical constituents of horticulture crops. Yeast contains vitamin $B_1$ (thiamine) and $B_6$

(Pyridoxine), enzymes and co-enzymes, amino acids like, methionine tryptophan, cysteine glycine, lysine, lucien, isoleucine phenylalanine, histidine, arginine, threonine and tyrosine. Also, it contains dry matter, phytohormones namely, IAA and cytokinins and, also N, protein, fat, ash, nucleic acid, as well as lecithin and glutathione (Abou-Zaid, 1984). The capability of yeast extract on enhancing plant growth and essential oil were explored by many authors such as, Salman (2006), El-Naggar *et al.* (2015), Nassar *et al.* (2015) and Abdou *et al.* (2017) on basil (*Ocimum basilicum*), Khaled *et al.* (2014) on *Anethum graveolens* plant. Therefore, the target of this work was on attempt to examined the influence of nitrogen and some biostimulent substances (moringa leaf extract and yeast extract), as well as, their interactions on plant growth aspects and essential oil of basil plants to find out the most suitable treatment for improving these parameters.

## 2. Materials and methods

### *2.1 Experimental site and treatments*

A field trial was conducted at the Experimental farm fac. of Agric. Al-Azhar Univ., Assiut, Egypt. During the two successive seasons of 2020 and 2021 to elucidate the influence of nitrogen fertilization and some bio stimulant substances (moringa leaf extract and yeast extract), as well as, their interactions on the plant growth traits and volatile oil of basil (*Osmium basilicam* L.) plants. The seeds of basil were sown on March 15$^{th}$ in the nursery for both seasons. Forty five days later (April 29$^{th}$ ) the seedlings were transplanted in the experimental unit (1.8 × 2.0) m in hills 25 cm apart, included 3 rows 60 cm apart, there for, the experimental plot contains 24 plants. Physical and chemical characteristics of the experimental soil were determined according to Klute (1986) and Yancey *et al.* (1982) and are shown in Table (1).

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

| Characters | | 2020 | 2021 |
|---|---|---|---|
| Physical properties | Sand (%) | 20.0 | 18.3 |
| | Silt (%) | 56.3 | 59.1 |
| | Clay (%) | 23.4 | 22.1 |
| Texture | | Silty loam | Silty loam |
| pH Susp. (1:2.5) | | 7.5 | 7.3 |
| E.C ($dSm^{-1}$) soil past | | 2.2 | 2.0 |
| O.M (%) | | 0.50 | 0.60 |
| Total $CaCO_3$ % | | 2.53 | 2.43 |
| Cations (cmol $kg^{-1}$ soil) | | | |
| $Ca^{++}$ | | 3.4 | 3.6 |
| $Mg^{++}$ | | 1.9 | 2.3 |
| $Na^{+}$ | | 22.72 | 18.07 |
| $K^{+}$ | | 3.5 | 3.35 |
| Anions (cmol $kg^{-1}$ soil) | | | |
| $HCO_3^{-}$ | | 2.8 | 3.3 |
| $Cl^{-}$ | | 2.1 | 1.9 |
| $SO_4^{-}$ | | 6.5 | 6.2 |

Randomized complete block design was set up in the three replicates with eleven treatments as follows: control (untreated plants), 100% N, 75% N, moringa leaf extract (MLE) at 5 g/l, MLE at 10 g/l, yeast extract (YE) at 5 g/l, YE at 10 g/l, 75% N + MLE at 5 g/l, 75% N + MLE at 10 g/l, 75% N + YE at 5 g/l and 75% N + YE at 10 g/l.

### *2.2 Preparation of biosteamulants*

Moringa leaf extract (MLE) was prepared from dry leaves of *Moringa oliefera* L., dried under shade which were soaked in water at concentrations of 5 and 10 g $L^{-1}$ in 250 ml tap water for each concentration and kept 24 hours at temperature room, then filtered through the filter paper type 12 Whatman to obtain the extract in pure form. Yeast extract (YE) (*Sacchaomyces cerevisiae*) was prepared by dissolving in warm water (35$^{o}$ C) followed by adding sugar at a ratio 1:1 to active growth and reproduction of yeast and left stand for 2 hours before spraying. Mineral nitrogen fertilizer was applied as ammonium nitrogen (33.5 % N) at 100 and 75 % N were represented by 300 and 255 kg/acre, respectively. These amounts were divided to three equal batches, the first dose was done after three weeks from the transplanting date (May 20$^{th}$) the second dose was added after the first cut (July 4$^{th}$) while the third one was applied after the second cut (August 18$^{th}$) for each season. In addition, calcium superphosphate (15.5% $P_2O_5$) at 200 kg/acre was added to the soil before transplanting the seedlings. While potassium sulphate (48% $K_2O$) at 100 Kg/acre was divided to the two equal batches, the first dose was done with the first dose of N and the second one was added with the seconds dose of N. The seedlings were foliar sprayed with the two studied biostimulants, either alone or together, three times as follows: May 27$^{th}$, July 11$^{th}$ and August 25$^{th}$, for the first, second and third sprays, respectively. The plants were sprayed till run off. All other agricultural practices were performed as usual. The chemical analysis of *moringa oleifera leaf* extract according to Ali *et al*. (2018) is proved in Table (2). Also, the chemical analysis of yeast (*saccharomyces cerevisiae*) extract according to Khedr and Farid (2000) is listed in Table (3). The plants were harvested three times for each season, the first cut was on July 4$^{th}$, the second cut was on August 18$^{th}$ and the third cut was on October 2$^{nd}$ by cutting the plants at 10 cm above the soil surface. For each cut, the following data were recorded as follow: plant height (cm) number of branches/plant, herb fresh weight (9)/plant, herb dry wight (9)/plant leaves fresh weight (9)/plant leaves dry weight (9) /plant and essential oil percentage of the air-dried leaves was estimated according to the method of British Pharmacopoeia (1963). The obtained data were tabulated and statistically analyzed according to Steel and Torrie (1986).

Table (2): chemical analysis of moringa leaf extract (mg/g D.W).

| Components | Value (mg/g$^{-1}$ D.W) |
|---|---|
| Total phenols | 1.635 |
| Total chlorophyll | 4.378 |
| Ascorbic acid (mg g–1 FW) | 8.47 |
| Total carotenoids | 1.72 |
| Amino acids | 387.72 |
| Proline | 33.65 |
| Total | 352.28 |
| Nutrient profile | |
| Potassium | 13.78 |
| Phosphorus | 3.82 |
| Nitrogen | 12.36 |
| Calcium | 15.92 |
| Magnesium | 3.96 |
| Zinc | 0.051 |
| Iron | 0.379 |
| Manganese | 0.081 |
| Copper | 0.038 |
| Phytohormonal profile (µg/g$^{-1}$ FW) | |
| Gibberellins | 0.65 |
| Cytokinins | 0.63 |
| Indol acetic acid | 0.72 |
| Abscisic acid | 0.13 |
| Salicylic acid | 1.87 |

Table (3): chemical analysis of yeast extract (weight /100g D.W.).

| Minerals | | Amino acid mg/100g DW | | Vitamins mg/100g DW | | Carbohydrates mg/100g DW | |
|---|---|---|---|---|---|---|---|
| N | 33.24 g | Arginine | 1.99 | Vitamin $B_l$ | 2.23 | Carbohydrates | 23.2 |
| $P_2O_5$ | 7.22 g | Histidine | 2.63 | Vitamin $B_2$ | 1.33 | Glucose | 13.33 |
| $K_2O$ | 49.66 g | Isoleucine | 2.31 | Vitamin $B_6$ | 1.25 | | |
| Mg | 5.75 mg | Leucine | 3.09 | Vitamin $B_{12}$ | 0.15 | | |
| CaO | 3.02 mg | Methionine | 0.72 | Riboflavin | 4.96 | | |
| Nacl | 0.28 mg | Phenylalanine | 2.01 | Insitrol | 0.26 | | |
| Zn | 335.9 mg | Threonine | 2.09 | Biotin | 0.09 | | |
| Mn | 82.3 mg | Tryptophan | 0.45 | Nicotinic acid | 39.88 | | |
| B | 177.3 mg | Valine | 2.19 | Panthothenic acid | 19.56 | | |
| FeO | 0.93 mg | Glutamic acid | 2.00 | Paminobenzoic acid | 9.23 | | |
| Al | 650.2 mg | Serine | 1.59 | Folic acid | 4.36 | | |
| Co | 67.8 mg | Aspartic acid | 1.33 | Pyridoxine | 2.90 | | |
| Sn | 223.9 mg | Cystine | 0.23 | | | | |
| Sio2 | 1.55 mg | Proline | 1.53 | | | | |
| So2 | 0.49 mg | Tyrosine | 1.49 | | | | |
| Cl | 0.06 mg | | | | | | |

## 3. Results and discussion

### *3.1 Plant height*

The obtained data in Table (4) indicated that treating basil (*Ocimum basilicum*) plants with nitrogen as ammonium nitrate (N) and biostimulant substances namely, moringa leaf extract (MLE) and yeast extract (YE) either separately or in combination led to a significant increase in plant height among the three cuts, except for MLE 5 g/l and YE at 5 g/l in the three cuts, during both seasons, in relative to the check treatment. Obviously, higher values of plant height were noticed due to the use of the combined treatments, mostly among the

three cuts than those given by single ones, in the two seasons. Moreover, in most cases, higher values of such parameter were observed at the third cut, in comparison with those obtained by other cuts, during the two growing seasons. Apparently, the longest plants were detected when the application of the combined treatment (75% in the recommended dose of N + 10 g/l YE) and the combined one (75% N + 10 g/l MLE). Numerically, these previous superior treatments augmented such trait by 55.0, 55.0, 62.6 and by 64.6%, in the first cut, by 57.1,54.9, 79.0 and by 76.3%, in the second cut and by 67.1,62.8.,74.4 and by 77.4% in the third cut over untreated ones, in both seasons respectively. The increments of plant height due to applying nitrogen fertilization was also studied by Ivanova and Vassilev (2003) on chrysanthemum plants, Iftikhar *et al*. (2007) on zinnia (*Zinnia elegans* cv. Giant dahlia flowered) and Mesbah *et al*. (2010) on (*Satureja hortensis* L.) plants. The enhancement of plant height as a result of adding moringa leaf extract was also explored by Ndubuaku *et al*. (2015) on cassava plants, Nasir *et al*. (2016) on *Ocimum basilicum*, Abbas *et al*. (2016) on *salvia officinalis* and Ali *et al*. (2018) on *Pelargonium graveolens* L. The beneficial role of yeast extract in stimulating plant height was also insured by Khaled *et al.* (2014) on *Anethum graveolens* plant and Abdou *et al*. (2017) on basil (*Ocimum basilicum*).

Table (4): Effect of mineral nitrogen and foliar spray with moringa and yeast extracts, as well as their interaction on plant height (cm) of basil plants during 2020 and 2021 seasons.

| Treatments | First season | | | Second season | | |
|---|---|---|---|---|---|---|
| | First cut | Second cut | Third cut | First cut | Second cut | Third cut |
| Control | 43.8 | 45.2 | 46.5 | 39.3 | 41.0 | 40.3 |
| N 100% | 57.4 | 63.8 | 65.6 | 55.0 | 57.5 | 63.7 |
| N 75% | 53.1 | 55.6 | 59.3 | 52.0 | 53.5 | 55.8 |
| 5g /L (MLE) | 50.6 | 51.1 | 53.9 | 49.0 | 50.5 | 52.1 |
| 10g /L (MLE) | 54.7 | 56.7 | 61.0 | 51.8 | 52.4 | 58.5 |
| 5g /L (YE) | 50.0 | 51.4 | 53.9 | 48.5 | 49.7 | 51.8 |
| 10g /L (YE) | 54.8 | 57.9 | 61.7 | 52.5 | 55.8 | 57.5 |
| N 75% + 5g /L (MLE) | 59.7 | 67.9 | 70.4 | 61.4 | 63.2 | 68.8 |
| N 75% + 10g /L (MLE) | 66.8 | 70.0 | 75.7 | 64.7 | 72.3 | 71.5 |
| N 75% + 5g /L (YE) | 58.0 | 66.0 | 71.6 | 59.7 | 63.7 | 68.7 |
| N 75% +10g /L (YE) | 67.9 | 71.0 | 77.7 | 63.9 | 73.4 | 70.3 |
| LSD. 0.05% | 6.9 | 7.3 | 8.7 | 6.8 | 8.6 | 9.1 |

*3.2 Number of branches /plant*

The presented results in Table (5) postulated that branch number/ plant of basil was significantly augmented due to supplying the plants with nitrogen and biostrimulant substance treatments, either alone or together among the three cuts, except for 5g/l MLE and 5g/l YE, in the first and second cuts, as well as the same these treatments plus 75% N in the third cut, for the first season, as compared to

control plants. In this concern, the addition of nitrogen and biostimulant substance treatment led to a significant increase, in branch number, plant among all cuts, in the second season, except for 5 g/l MLE, 10 g/l MLE and 5 g/l YE in the first cut and, also the previous treatments plus 10 g/l YE, in the second cut as well as, 5 g/l MLE, 5 g/l YE and 10 g/l YE, in the third cut comparing to untreated plants. It could be noted that the combined treatment gave higher values of branch number / plant than those obtained by individual ones among all cuts, mostly in both seasons. Among all cuts, the third cut gave the highest branch number/plant, followed by the second and then the first cut, mostly, during to two seasons. Furthermore, supplying basil plants with the combined treatment (75% N + 10 g/l YE) and the combined one (75% N + 10 g/l MLE) achieved the highest values of branch number /plant as ranged 100.0, 99.3, 94.9 and 100% in the first cut, 121.3, 119.5, 125.9 and 118.7 %, in the third cut over control plants, in the first and second seasons, respectively. The efficiency of nitrogen fertilization on increasing branch number has to be discussed by EI-Mekawey *et al*. (2010) on coriander (*Coriandrum sativum* L.) plants, Sotiropoulou and Karamanos (2010) on Greek oregano (*Origanum vulgare* ssp. hirtum (Link) Ietswaart) plants and Ruveyde *et al*. (2011) on fenugreek plant.

Table (5): Effect of mineral nitrogen and foliar spray with moringa and yeast extracts, as well as their interaction on branch number of basil plants during 2020 and 2021 seasons.

| Treatments | First season | | | Second season | | |
|---|---|---|---|---|---|---|
| | First cut | Second cut | Third cut | First cut | Second cut | Third cut |
| Control | 13.8 | 15.2 | 16.4 | 11.7 | 14.3 | 13.9 |
| N 100% | 21.3 | 24.0 | 27.0 | 16.7 | 20.2 | 23.5 |
| N 75% | 19.1 | 19.9 | 20.6 | 16.5 | 18.8 | 19.9 |
| 5g /L (MLE) | 15.3 | 16.2 | 17.8 | 12.0 | 15.9 | 17.2 |
| 10g /L (MLE) | 18.8 | 22.7 | 24.3 | 14.9 | 17.2 | 19.1 |
| 5g /L (YE) | 15.8 | 16.9 | 18.6 | 13.0 | 16.0 | 17.2 |
| 10g /L (YE) | 19.7 | 22.8 | 25.0 | 15.9 | 17.0 | 18.1 |
| N 75% + 5g /L (MLE) | 22.7 | 26.5 | 32.5 | 18.1 | 21.7 | 26.9 |
| N 75% + 10g /L (MLE) | 27.5 | 29.9 | 36.0 | 23.4 | 26.8 | 30.4 |
| N 75% + 5g /L (YE) | 23.0 | 26.5 | 32.9 | 17.9 | 21.8 | 25.7 |
| N 75% +10g /L (YE) | 27.6 | 30.0 | 36.3 | 22.8 | 25.1 | 31.4 |
| LSD. 0.05% | 4.1 | 4.3 | 6.2 | 3.5 | 3.4 | 4.6 |

The positive influence of moringa leaf extract on number of leaves was also concluded by Abbas *et al*. (2016) on *salvia officinalis*, Ali, *et al*. (2018) on *Pelargonium graveolens* L. and Jain *et al*. (2020) on stevia plant. The capability of yeast extract on enhancing branch number was also demonstrated by Ahmed (2002) on *Leucaena leucoceplala*, Salman (2006) on *Ocimum basilicum* and Al-Qubaie (2002) on roselle (*Hibiscus sabdariffa*) plant.

### *3.3 Herb fresh weight (g) /plant*

Data in Table (6) proved that receiving basil plants nitrogen and biostimulant substance treatments, either single or mixed resulted a significant augment in herb fresh weight/plant among all cuts, except for moringa leaf extract at 5 g/l in the second and third cuts for the first season and, also the same treatment in the first and the second cuts for the second season, as well as, yeast extract at 5 g/l in the second cut for the first season, in relative to the check treatment, during the two experimental seasons. Obviously, higher values of such aspect were given by utilizing the combined treatment than those resulted by separately treatment in all cuts, mostly, during the two consecutive seasons. Moreover the values of such trait were higher in the third cut, followed by the second and then the first cut, mostly, in both seasons. The application of the combined treatment *i.e*. 75% N + 10 g/l YE and the combined one (75% N + 10 g/l MLE) registered the heaviest herb fresh weight/plant reached 41.6, 39.8, 31.3 and 36.0%, in the first cut, 43.5, 44.3, 29.1 and 32.1 %, in the second cut and 58.0, 57.1, 55.5 and 50.1%, in the third cut over the check treatment, during the two growing seasons respectively.

### *3.4 Herb dry weight /plant*

The given data in Table (7) illustrated that herb dry weight /plant of basil was significantly augmented due to the use of nitrogen and biostimulant substance treatments, either separately or together among the three cuts, in both seasons, expect for the treatments of 5 g/l MLE and 5 g/l YE in the three cuts, for the first season and, also in the first and third cuts for the second season, as well as, the treatment of 5 g/l MLE for the second season in the second cut, comparing to untreated plants. Obviously, higher values of such aspect resulting from applying the combined treatment than those given by single ones, mostly among all cuts, during the two experimental seasons.

Table (6): Effect of mineral nitrogen and foliar spray with moringa and yeast extracts, as well as their interaction on herb fresh weight (g)/plant of basil plants during 2020 and 2021 seasons.

| Treatments | First season | | | Second season | | |
|---|---|---|---|---|---|---|
| | First cut | Second cut | Third cut | First cut | Second cut | Third cut |
| Control | 156.6 | 167.8 | 173.7 | 151.3 | 165.9 | 160.3 |
| N 100% | 194.0 | 206.2 | 224.4 | 175.2 | 194.8 | 209.3 |
| N 75% | 181.7 | 197.7 | 215.6 | 173.5 | 180.2 | 186.3 |
| 5g /L (MLE) | 162.1 | 169.1 | 177.6 | 154.3 | 162.6 | 174.1 |
| 10g /L (MLE) | 175.3 | 193.9 | 211.9 | 168.7 | 174.3 | 184.7 |
| 5g /L (YE) | 162.9 | 170.7 | 184.3 | 156.5 | 172.2 | 174.7 |
| 10g /L (YE) | 179.1 | 195.9 | 213.4 | 162.9 | 172.7 | 179.4 |
| N 75% + 5g /L (MLE) | 194.4 | 215.8 | 247.7 | 178.2 | 191.7 | 219.9 |
| N 75% + 10g /L (MLE) | 218.9 | 242.2 | 272.9 | 205.7 | 219.2 | 240.6 |
| N 75% + 5g /L (YE) | 198.3 | 215.2 | 246.0 | 181.7 | 192.9 | 214.4 |
| N 75% +10g /L (YE) | 221.7 | 240.8 | 274.5 | 198.7 | 214.1 | 249.3 |
| LSD. 0.05% | 4.2 | 4.7 | 6.7 | 3.4 | 3.5 | 5.6 |

Table (7): Effect of mineral nitrogen and foliar spray with moringa and yeast extracts, as well as their interaction on herb dry weight (g)/plant of basil plants during 2020 and 2021 seasons.

| Treatments | First season | | | Second season | | |
|---|---|---|---|---|---|---|
| | First cut | Second cut | Third cut | First cut | Second cut | Third cut |
| Control | 43.7 | 47.0 | 48.5 | 42.3 | 43.9 | 44.7 |
| N 100% | 54.2 | 57.8 | 62.7 | 48.9 | 54.4 | 58.3 |
| N 75% | 50.8 | 55.1 | 59.9 | 48.5 | 50.3 | 51.9 |
| 5g /L (MLE) | 45.3 | 47.4 | 49.6 | 43.1 | 45.4 | 48.5 |
| 10g /L (MLE) | 49.0 | 54.9 | 59.2 | 47.1 | 48.7 | 51.4 |
| 5g /L (YE) | 46.4 | 48.5 | 51.5 | 44.2 | 48.1 | 49.1 |
| 10g /L (YE) | 50.0 | 54.9 | 59.7 | 45.5 | 48.2 | 50.0 |
| N 75% + 5g /L (MLE) | 54.3 | 60.4 | 69.2 | 49.8 | 53.5 | 61.3 |
| N 75% + 10g /L (MLE) | 61.1 | 68.3 | 76.2 | 57.5 | 61.2 | 67.0 |
| N 75% + 5g /L (YE) | 55.4 | 60.3 | 68.7 | 50.8 | 53.9 | 59.7 |
| N 75% +10g /L (YE) | 62.2 | 67.5 | 77.6 | 55.5 | 59.8 | 69.4 |
| LSD. 0.05% | 3.7 | 4.4 | 5.9 | 2.9 | 3.3 | 4.9 |

Among all cuts, the third cut recorded the highest herb dry weight, followed by the second and then the first cut, mostly in the two seasons. Clearly the heaviest herb dry weight/plant was detected by supplying basil plants with the combined treatment (75% N + 10 g/l YE and the combined one *i.e*. 75% N+10 g/l MLE. Numerically, the above-mentioned superior treatment increased such trait by 42.3, 39.8, 31.2 and by 35.9%, in the first cut, 43.6, 45.3, 36.2 and by 39.4% in the second cut and by 60.0, 57.1, 55.3 and by and by 49.9%, in the third cut, over the check treatment, during both seasons, respectively. The efficiency of nitrogen fertilization on augmenting herb weight has to be studied by El-Hafid *et al*. (2002) on borage (*Borago officinalis* L.), Al-Thabet (2006) on sunflower (*Helianthus annus* L.), Asghar *et al*. (2006) on asparagus (*Asparagus officinalis*) plants and Abdul Al-Kiyyam *et al*. (2008) on marjoram plants. The stimulating effect of moringa leaf extract on herb weight was also reported by Prabhu *et al*. (2010), on basil (*Ocimum basilicum*) Abbas *et al*. (2016) on *Salvia* officinalis and Abdel Latef *et al*. (2017) on fenugreek (*Trigonellafoenum-graecum*) plants. The promotionin herb weight due to yest extract was also obtained by Ali (2001) on *Calenduala officinalis*, Ahmed *et al.* (2001) on *Ambrosia maritime*, Abd El-Latif (2006) on *Salvia officinalis* and El-Sherbeny *et al.* (2007) on Rue (*Ruta graveolens*).

### *3.5 Leaves fresh weight /plant*

Data in Table (8) emphasized that applying basil plants with nitrogen and biostimulant substance treatments, either single or together among the three cuts, in both seasons, led to a significant increase in leaves fresh weight/plant, except for 5 g/l MLE and 5 g/l YE, in all cuts, during both seasons and, also the treatment of YE at 10 g/l, in the first cut for the second season, as compared to the check treatment. The combined treatment achieved higher values of such parameter than those detected by individual ones, during the two consecutive seasons.

Furthermore, the third cut produced the highest leaves fresh weight, followed by those given by the second and then by the first cut, in the two seasons, mostly. Clearly, the highest values of leaves fresh weight/plant were obtained due to the use of the combined treatment (75% N+10 g/l YE) and the combined one (75% N+10 g/l MLE) as ranged 41.7, 39.9, 31.3 and 36.0%, in the first cut, 43.5, 44.3, 31.5 and 34.7%, in the second cut and 58.1, 57.3, 55.7 and 50.2% in the third cut over untreated plants during the two experimental seasons, respectively.

Table (8): Effect of mineral nitrogen and foliar spray with moringa and yeast extracts, as well as their interaction on leaves fresh weight (g)/plant of basil plants during 2020 and 2021 seasons.

| Treatments | First season | | | Second season | | |
|---|---|---|---|---|---|---|
| | First cut | Second cut | Third cut | First cut | Second cut | Third cut |
| Control | 54.9 | 59.1 | 60.9 | 53.1 | 57.1 | 56.4 |
| N 100% | 68.1 | 72.6 | 78.7 | 61.5 | 68.4 | 73.7 |
| N 75% | 63.8 | 69.2 | 75.3 | 60.9 | 64.2 | 67.5 |
| 5g /L (MLE) | 56.9 | 59.5 | 62.3 | 54.1 | 57.1 | 61.3 |
| 10g /L (MLE) | 61.5 | 68.1 | 73.3 | 59.2 | 63.3 | 65.6 |
| 5g /L (YE) | 57.2 | 61.1 | 64.7 | 54.9 | 60.4 | 61.5 |
| 10g /L (YE) | 62.8 | 70.1 | 74.9 | 57.2 | 62.2 | 63.2 |
| N 75% + 5g /L (MLE) | 68.2 | 76.0 | 86.9 | 62.5 | 67.3 | 77.4 |
| N 75% + 10g /L (MLE) | 76.8 | 85.3 | 95.8 | 72.2 | 76.9 | 84.7 |
| N 75% + 5g /L (YE) | 69.6 | 75.8 | 86.3 | 63.8 | 67.7 | 75.5 |
| N 75% +10g /L (YE) | 77.8 | 84.8 | 96.3 | 69.7 | 75.1 | 87.8 |
| LSD. 0.05% | 4.7 | 5.4 | 7.3 | 4.9 | 4.0 | 6.3 |

*3.6 Leaves dry weight /plant*

The illustrated data in Table (9) cleared that the addition of nitrogen and biostimulant substance treatments, either alone or in combination among all cuts during the two consecutive seasons led to a significant increase in leaves dry weight/plant, except for moringa leaf extract (MLE) at 5 g/l in the first cut, for the first season, as well as, the treatments of MLE and YE each at 5 g/l in the third and first cuts for both seasons, as compared to control plants. Apparently, the application of combined treatments registered higher values of leaves dry weight/plant than those detected by single ones, mostly among the three cuts, in both seasons. moreover the values of such parameter at the third cut, in most cases, was higher than those noticed by the second and first cuts, during the two growing seasons. Furthermore, receiving basil plants. The combined treatment namely 75% N + 10 g/l YE and the combined one (75% N + 10 g/l MLE) produced the highest leaves dry weight/plant as ranged 62.6, 60.1, 48.3 and 53.8%, in the first cut, 71.5, 72.8, 74.3 and 59.2%, in the second cut and 74.3, 68.9, 74.5 and 69.3%, in the third cut, over the check treatment, in the first and second seasons, respectively. The superiority of nitrogen fertilization in increasing leaf weight was also declared by Selim and Magd El-Din (2007) on Datura (*Datura innoxia* Mill.), Abdul Al-Kiyyam *et al*. (2008) on marjoram plants,

Anita and Anna (2010) on basil, Król (2011) on marigold (*Calendula officinalis* L.) plants and Reza *et al*. (2011) on thyme (*Thymus vulgaris* L.). The role of moringa leaf extract in enhancing leaf weight was also explored by Prabhu *et al*. (2010) and Nasir *et al*. (2016) on basil (*Ocimum basilicum* L.) and Fuglie (1999) on tea. The augment in leaf weight as a result of using yeast extract was also proved by Al-Qubaie (2002) on roselle (*Hibiscus sabdariffa*), Abd El-Latif (2006) on *Salvia officinalis*, El-Sherbeny *et al.* (2007) on spraying rue plants (*Ruta graveolens*) and Hanafy *et al.* (2012**)** on *Schefflera arboricola*.

Table (9): Effect of mineral nitrogen and foliar spray with moringa and yeast extracts, as well as their interaction on leaves dry weight (g)/plant of basil plants during 2020 and 2021 seasons.

| Treatments | First season | | | Second season | | |
|---|---|---|---|---|---|---|
| | First cut | Second cut | Third cut | First cut | Second cut | Third cut |
| Control | 14.8 | 15.1 | 16.7 | 14.5 | 15.7 | 15.3 |
| N 100% | 21.2 | 22.4 | 23.2 | 19.1 | 22.2 | 22.7 |
| N 75% | 19.8 | 20.4 | 22.1 | 18.9 | 19.1 | 20.2 |
| 5g /L (MLE) | 17.7 | 18.6 | 18.3 | 16.9 | 18.8 | 18.9 |
| 10g /L (MLE) | 19.2 | 20.0 | 21.6 | 18.4 | 18.7 | 19.5 |
| 5g /L (YE) | 18.3 | 19.1 | 19.0 | 17.1 | 19.8 | 19.1 |
| 10g /L (YE) | 19.5 | 21.3 | 22.0 | 17.8 | 20.3 | 19.4 |
| N 75% + 5g /L (MLE) | 21.1 | 23.4 | 25.6 | 19.4 | 21.8 | 23.8 |
| N 75% + 10g /L (MLE) | 23.7 | 26.1 | 28.2 | 22.3 | 25.0 | 25.9 |
| N 75% + 5g /L (YE) | 21.5 | 23.3 | 25.4 | 19.8 | 22.0 | 23.3 |
| N 75% +10g /L (YE) | 24.1 | 25.9 | 29.1 | 21.5 | 24.1 | 26.7 |
| LSD. 0.05% | 3.2 | 2.1 | 2.4 | 3.1 | 2.8 | 2.2 |

The superiority of nitrogen fertilization in increasing leaf weight was also declared by Selim and Magd El-Din (2007) on Datura (*Datura innoxia* Mill.), Abdul Al-Kiyyam *et al*. (2008) on marjoram plants, Anita and Anna (2010) on basil, Król (2011) on marigold (*Calendula officinalis* L.) plants and Reza *et al*. (2011) on thyme (*Thymus vulgaris* L.). The role of moringa leaf extract in enhancing leaf weight was also explored by Prabhu *et al*. (2010) and Nasir *et al*. (2016) on basil (*Ocimum basilicum* L.) and Fuglie (1999) on tea. The augment in leaf weight as a result of using yeast extract was also proved by Al-Qubaie (2002) on roselle (*Hibiscus sabdariffa*), Abd El-Latif (2006) on *Salvia officinalis*, El-Sherbeny *et al.* (2007) on spraying rue plants (*Ruta graveolens*) and Hanafy *et al.* (2012**)** on *Schefflera arboricola*.

### *3.7 Essential oil percentage*

The listed data in Table (10) revealed that essential oil percentage of basil leases was significantly increased as a result of applying nitrogen and biostimulant substance treatments, either single or mixed, among all cuts, during the two experimental seasons, except for 5 g/l MLE and 5 g/l YE in all cuts, as well as, 10 g/l MLE in the first and second cuts, for the first season, besides, the treatments of MLE and YE each at 5

g/l and 10 g/l in the first and third cuts, in the second seasons comparing to the chick treatments. It appears that the mean effect has not significant in the second cut for the second seasons. Obviously, the second cut resulted in the highest essential oil% followed by those reveled by the third and then by the first cut, mostly, in both seasons. Moreover, higher values of essential oil percentage were observed resulting from the addition of the combined treatments, mostly, in the three cuts, than those given by individual treatments, during the two growing seasons. Furthermore, supplying basil plants the combined treatment (75% N + 10 g/l YE) and the combined one (75% N + 10 g/l MLE) proved to be more effective in increasing essential oil percentage, among the three cuts, than those revealed by other treatments and control, in the two seasons. Numerically, the previous superior treatments augmented such parameter by 98.94, 96.81, 91.11and by 88.89%, in the first cut, by 212.24, 204.08, 188.66, and by 177.32%, in the second cut and by 209.47, 203.16, 94.79 and by 92.71%, in the third cut over untreated plants, during the two successive seasons, respectively.

Table (10): Effect of mineral nitrogen and foliar spray with moringa and yeast extracts, as well as their interaction on essential oil percentage of basil plants during 2020 and 2021 seasons.

| Treatments | First season | | | Second season | | |
|---|---|---|---|---|---|---|
| | First cut | Second cut | Third cut | First cut | Second cut | Third cut |
| Control | 0.94 | 0.98 | 0.95 | 0.90 | 0.97 | 0.96 |
| N 100% | 1.65 | 2.48 | 2.45 | 1.51 | 1.74 | 1.67 |
| N 75% | 1.46 | 2.16 | 2.12 | 1.39 | 1.46 | 1.55 |
| 5g /L (MLE) | 1.28 | 1.41 | 1.69 | 1.15 | 1.29 | 1.20 |
| 10g /L (MLE) | 1.32 | 1.92 | 2.09 | 1.31 | 1.35 | 1.46 |
| 5g /L (YE) | 1.27 | 1.43 | 1.74 | 1.18 | 1.28 | 1.31 |
| 10g /L (YE) | 1.43 | 2.15 | 2.06 | 1.32 | 1.43 | 1.42 |
| N 75% + 5g /L (MLE) | 1.75 | 2.93 | 2.81 | 1.61 | 2.39 | 1.77 |
| N 75% + 10g /L (MLE) | 1.85 | 2.98 | 2.88 | 1.70 | 2.69 | 1.85 |
| N 75% + 5g /L (YE) | 1.76 | 2.95 | 2.84 | 1.61 | 2.35 | 1.78 |
| N 75% +10g /L (YE) | 1.87 | 3.06 | 2.94 | 1.72 | 2.80 | 1.87 |
| LSD. 0.05% | 0.48 | 1.16 | 1.11 | 0.44 | N.S | 0.51 |

In agreement with these result regarding nitrogen fertilization were those of Omer *et al.* (2008) on *Ocimum americanum*, Sharafzadeh *et al.* (2011) and Biesiada and Kus (2010) on sweet basil (*Ocimum basilicum*). Some authors indicated that moringa leaf extract resulted an augment in essential oil percentage such as, Abbas *et al*. (2016) on sage (*Salvia officinalis*), Ali *et al*. (2018) on *Pelargonium graveolens* L and Sarhan *et al.* (2022) on Lemon Bee balm plant (*Monarda ciriodora* L.). The capability of yeast extract on increasing essential oil% was also exhibited by Nassar *et al.* (2015) and Abdou *et al.* (2017) on basil (*Ocimum basilicum*). From the obtained results, it could be discussed as follows: the increment in the growth and essential oil% of basil plants may be due to the positive physiologyical and biological roles of nitrogen fertilization, moringa leaf extract

and yeast extract which were explained by many studies such as, nitrogen is an important roles in the synthesis of proteins and nucleic acids, as well as, in the formation of proto plasm. Besides, such element can able promotes the merstimic activity which in turn results in more new organs (Kopytin *et al*., 1984; Russel, 1973). Nitrogen is a major component for many organic substances namely, proteins, enzymes, vitamins, nucleic acids, hormones and chlomphyll which they are beneficial roles in the plant life (Lieber and Blevins 1989). In regard to morings leaf extract (MLE), (Fnglie, 1999) mentioned that MLE plays an important role as biostimulant substance due to is rich in phytohormones namely, zeatin, GA and IAA. It contains macro and micronutrients vitamins, amino acids, plant growth regulators, allele chemical and antioxid ants (Pakar *et al*., 2013). It acts as one of the valuable plant biostimulant because it contains phenols, phytohormones, antioxidants, essential nutrients and ascorbates (Rady and Mohamed, 2015). Concerning yeast extract, it is a source of many natural plant growth hormones i.e cytokines, a lot of vitamin B and nutritional elements (P, K, S, Ca, Mg and Na), lipids, proteins, carbohydrates and nucleic acids (Reed and Nagodawithana, 1991). The application of yeast extract not only augmented endogenous phytohormones (Cytokinins and auxins) but also reduced abscisic acid (Mady, 2009). Moreover, yeast in a significant influence on making available nutrient elements for the plants (Khalil and Ismael, 2010). From the obtained resalts, it could be recommended to supply basil (*Ocimum basilicum*) plants with 75% mineral N as ammonium nitrate (33.5% N) at 225 kg/acre + yeast extract at 10 g/l or with moringa leaf extract at 10 g/l to enhance the growth traits and essential oil under this research conditions.

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