Phoenix dactylifera cv. Medjol Plantlets as Affected by Yeast Extract and NPK fertilizers

Rasmia Sayed Sayed Darwesh*

Central Laboratory for Research and Development of Date palm (ARC), Giza, Egypt

ABSTRACT

The primary aim of this study was to elucidate the effect of combination of yeast “Saccharomyces cerevisiae” and NPK fertilizers (14:6:43), nitrogen as 33% NH₄NO₃, phosphorus as P₂O₅, triple supper phosphate and potassium as K₂O potassium sulphate, on the plantlets of Phoenix dactylifera cv. Medjol (derived by in vitro) after end of acclimatisation stage in the greenhouse. These plantlets were subjected by two treatments of yeast (20 and 40 cm/l), and three treatments of NPK fertilizers (2.5, 3.0 and 3.5 g/l) in addition to control treatment, and two periods (8 months for each) were used. Different growth parameters were studied in this experiment, i.e. plant height, leaves number, root length, root number, fresh and dry weights of leaves, in appending to minerals content N, P and K and indole content in leaves. At the end of this investigation data were concluded indicating that the gradually significant growing of different growth parameters with tow treatments of yeast 20 and 40 cm/l. Three applications of NPK fertilizers (2.5, 3.0 and 3.5 g/l) were successfully enhancing all growth parameters of the plantlets, on the other hand there is no significant differences between the treatments 3.0 and 3.5 g/l NPK for tow seasons respectively, the treatment of 40 cm/l yeast with 3.0 and 3.5 g/l complete fertilizers resulted in the highest significant interaction of all tested growth parameters for tow seasons respectively. Nitrogen, phosphorus and potassium content were significant increased with all levels of yeast and NPK fertilizers; also indole content was raised with all treatments for two seasons respectively. This work recommended that the beneficial application of yeast extract which led to decrease doses of NPK fertilizers, the treatments of yeast was shown as enhancing growth and development of the date palm plantlets at few months after the end of acclimisation stage in the greenhouse.

INTRODUCTION

Interest in applying microorganisms beneficial to plants (in the context of sustainable agriculture) and efforts to avoid environmentally deleterious growth of chemicals explain the increasing number of studies on the management of soil plant microorganism systems (Bowen and Rovira, 1999). Bio-fertilizers are beneficial microorganisms, which can increase the availability of nutrients by their biological activity and improve the soil fertility, microorganisms involved in the formulation of bio-fertilizers can mobilise N and P involved in the process of producing crops and foods naturally and avoids the use of chemical fertilizers influencing the growth of crops (Pandya and Saraf, 2010), yeast as a source of phytohormones i.e. cytokinins, vitamins, enzymes, amino acids and minerals, in addition to stimulatory effect on the cell division and enlargement, synthesis of protein and nucleic acids, chlorophyll formation and protective role under different stresses (Shehata et al., 2012). Yeast (Saccharomyces cerevisiae) is considered a new promising plant growth promoting, and in the last few decade it became a positive alternative to chemical fertilizers safely used for human, animal and environment and are common components of soil rhizosphere (Omran, 2000; Slavikova and Vdakertiva, 2000; Mady, 2009), yeast extract (5%) increased shoot initiation, shoot and root length and fresh and dry weight (Sampedro et al., 2004 on Glycine max L., Mohan and Parabia (2007) on Lactadicia reticulate (Retzi) and Shalaby and El-Nady (2008) on Beta vulgaris “Sugar beet”). About 5 mg/l yeast improved the plant growth also developed callus growth [Maksoud (2007) on Osmun basilicum and Abd El-Aal (2008) on Hyscus muscum]. Using a grown bacterium rhizogenes improves rooting on fruit trees such as apple, almond, plum and pyrus (Carmine and Simona, 1998). Significant increasing dry matter and total phosphorus content by using phosphate solubilising strain of R. Leguminosarum bv. Pheasoli in the field trials (Chabot et al., 1996). Dry matter and all vegetative growth characters of potato increased with foliar spraying of yeast extract (Hussain and Khalaf, 2007), spraying of active dry yeast (8 g/L) improved plant height, stem diameter, leaf numbers/plant, fresh and dry weights of aerial parts, chlorophyll content and N, P, K, Fe, Zn and Mn in the leaves of Brussaha actinophylla (241) (Abdel-Fattah et al., 2009), dry matter and plant height, shoots numbers increased with increasing active dry yeast and different concentrations of potassium and zinc (Ahmad et al., (2011) on potato and Abou El-Nasr and Ibrahim (2011) on Daucus carota), plant height and fresh weight of leaves of onion plant “Giza 20 and Super X”

KEYWORDS yeast, fertilizers, NPK, growth, indole, date palm

*Address reprint requests to Dr. Rasmia Sayed Sayed Darwesh, Central Laboratory for Research and Development of Date palm (ARC), Giza, Egypt.
E-mail: darweshssrasmia@gmail.com
increased with 3 gm/L foliar spraying of yeast (Fawzy et al., 2012). Recently, 15% yeast extract increased plants height, stem and root fresh and dry weights, chlorophyll and N of *Azadirachta indica* (Taha et al., 2016). The main purpose of this study was to evaluate the effect of employment of combination of yeast extract with helpful contents and complete fertilizers NPK on the enhancement growth and development of plantlets of *Phoenix dactylifera* L. after acclimatisation stage in the greenhouse.

**MATERIALS AND METHODS**

This investigation was done in the greenhouse of Central Laboratory for Research and Development of Date Palm (ARC). The plantlets of *Phoenix dactylifera* L. cv. Medjol which were derived by *in vitro* (after acclimatisation stage) used in this work, and described as (2–3 leaves, 1–2 roots, 8–10 cm shoot length and 8–12 cm for root length (Fig. 1). The plantlets were cultured in peat moss and sand 2:1 in the plastic bags at 40 cm for length and 20 cm for width, and they were subjected with yeast extract (1 × 10⁶ cells/ml) at two treatments 20 and 40 cm/l, and NPK fertilizers (14:6:43), nitrogen as 33% NH₄NO₃, phosphorus as P₂O₅, triple super and potassium as K₂O potassium sulphate, NPK fertilizers were used at three treatments (2.5, 3.0 and 3.5 g/l) in the water irrigation two times for a week in addition to control treatment (recommended fertilizers), three replicates were used, nine plantlets for each replicate, and two periods (8 months for each). The following growth parameters were recorded:

1. shoot and root length; 2. number of leaves and roots; 3. fresh and dry weights; 4. minerals N, P and K and indole contents.

**Indoles content:**

As described by Larsen et al. (1962), concentration was calculated as mg. indole acetic acid /100 g fresh weight.

**N, P and K content:**

Nitrogen was determined according to Koch and McMeckin (1924), phosphorus as P₂O₅, triple super and potassium as K₂O potassium sulphate, NPK fertilizers were used at three treatments (2.5, 3.0 and 3.5 g/l) in the water irrigation two times for a week in addition to control treatment (recommended fertilizers), three replicates were used, nine plantlets for each replicate, and two periods (8 months for each). The following growth parameters were recorded:

- Indoles content:
- N, P and K content:
- Statistical analysis:
- Yeast content:
- Root growth expressed as average length was significantly increased (Table 2) by addition of 20 and 40 cm/L.

**RESULTS AND DISCUSSION**

**Plant Height and Leaves Number/Plantlet**

In order to determine the role of different concentrations of yeast combined with NPK fertilizers at different concentrations on growth parameters of date palm plantlets, Table 1 and Fig. 1b, c show that increasing the yeast concentrations 20 and 40 cm/l and complete fertilizers NPK at 2.5, 3.0 and 3.5 g/l were significant for the height of plantlets at first and second seasons, respectively. The treatment 40 cm/l for yeast extract gave high significant value of plant height 37.7 and 45.9 cm for two periods respectively, comparable to control treatment 16.2 and 19.4 cm for two periods respectively, gradual increase in plant height were occurred by increasing NPK concentrations 2.5, 3.0 and 3.5 g/l NPK fertilizers 25.2, 35.7 and 37.2 and 27.8, 44.3 and 45.5 cm respectively for two periods. The treatments 3.0 and 3.5 g/l NPK were recorded non significant differences on the plant height. The treatment 40 cm/l yeast and 3.5 g/l NPK proved significantly high interaction on the values of plant height at two seasons.

With regard to leaves number/plantlet in Table 1 there were pronounced differences between 20 and 40 cm/l yeast extract 4.7 and 5.1 and 5.4 and 6.0 leaves/plantlet (Table 1) respectively for two periods, same line with the three concentrations of NPK fertilizers on the significant increasing of leaves number/plantlet for two periods respectively, no significant differences occurred with two levels 3.0 and 3.5 g/l NPK and seasons, The highest production of leaves number/plantlet was obtained by 40 cm/l yeast combined with 3.0 and 3.5 g/l complete fertilizers for two periods respectively. These data corresponded to Hashem et al. (2008) on Grape vines, Hassan et al. (2010), on Olive, and Lakshmi et al. (2010), on *Hoya wightii*, Ghoname et al. (2010), on sweet pepper (*Capsicum annuum* L.), shoot length and leaves number significantly increased with yeast extract at 50 to 150 mg/l or 1, 2 and 3 g/l and complete fertilizers at 1, 2 and 3 g/l or 100 g/l mineral nitrogen, Carmina et al. (2000) on *Lycopersicon esculentum* Mill, Zayed (2000) on *Spathiphyllum* and El-Mahalawy et al. (2004) on *Zea mays*, found that shoot length and leaves number were highest when treated with yeast extract at 100 mg/l. Doris and Ling (2007) on *Aureothrichus formosanus* Hayata and Svanesans and Jeong (2009) on *Plumbago zeylanica* L., stated that soil treatment with *Agrobacterium rhizogenes* and Rhizoctonia significantly increased shoot length and leaves number, plant height, leaves numbers, fresh and dry weights of leaves and roots of turnip plants cv. “Balady” were increased with 2% foliar spraying of dry yeast (Shafeek et al., 2015).

**Root Length (cm) and Root Number/Plantlet**

Root growth expressed as average length was significantly increased (Table 2) by addition of 20 and 40 cm/l.
Effect of yeast extract and NPK fertilizers on the growth and development of date palm plantlets.

**Table 1**: Effect of different concentrations of yeast (cm/l) and complete fertilizers NPK (g/l) on plant height (cm) and leaves number / plantlet of *Phoenix dactylifera* L. cv. Medjol.

<table>
<thead>
<tr>
<th>Yeast A</th>
<th>NPK B</th>
<th>Plant height cm.</th>
<th>Leaves number/plantlet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>First season</td>
<td>Second season</td>
</tr>
<tr>
<td>Con</td>
<td>20</td>
<td>40 Mean</td>
<td>Con 20 40 Mean</td>
</tr>
<tr>
<td>9.7</td>
<td>16.2</td>
<td>18.4 14.8</td>
<td>20 19.6 23.6 19.1</td>
</tr>
<tr>
<td>2.5</td>
<td>14.5</td>
<td>27.8 33.2</td>
<td>25.2 16.2 31.1 36.1</td>
</tr>
<tr>
<td>3.0</td>
<td>19.4</td>
<td>38.2 49.4</td>
<td>35.7 22.8 48.7 61.5</td>
</tr>
<tr>
<td>3.5</td>
<td>22.8</td>
<td>39.2 49.6</td>
<td>37.2 24.2 49.8 62.5</td>
</tr>
<tr>
<td>Mean</td>
<td>16.2</td>
<td>30.1 37.7</td>
<td>19.4 37.3 45.9</td>
</tr>
</tbody>
</table>

**Table 2**: Effect of different concentrations of yeast (cm/l) and complete fertilizers NPK (g/l) on root length (cm) and roots number / plantlet of *Phoenix dactylifera* L. cv. Medjol.

<table>
<thead>
<tr>
<th>Yeast A</th>
<th>NPK B</th>
<th>Root length (cm)</th>
<th>Roots number/plantlet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>First season</td>
<td>Second season</td>
</tr>
<tr>
<td>Con</td>
<td>20</td>
<td>40 Mean</td>
<td>Con 20 40 Mean</td>
</tr>
<tr>
<td>14.7</td>
<td>16.9</td>
<td>19.4 17.0</td>
<td>17.4 20.0 22.9 20.1</td>
</tr>
<tr>
<td>2.5</td>
<td>19.8</td>
<td>28.6 30.2</td>
<td>26.2 23.4 32.1 34.2</td>
</tr>
<tr>
<td>3.0</td>
<td>25.8</td>
<td>34.6 36.2</td>
<td>32.2 29.1 36.8 39.2</td>
</tr>
<tr>
<td>3.5</td>
<td>26.2</td>
<td>34.8 36.5</td>
<td>32.5 29.6 38.4 40.2</td>
</tr>
<tr>
<td>Mean</td>
<td>21.7</td>
<td>28.7 30.6</td>
<td>24.8 31.6 34.1</td>
</tr>
</tbody>
</table>

For yeast, the level 20 cm/l yeast extract had less significant product for root length 28.7 and 31.6 cm for two periods respectively. Highly outcome of root lengths were resulted in the treatment 3.0 and 3.5 g/l NPK fertilizers 32.2 and 35.0 cm and 32.5 and 46.1 cm which had no significant results between them respectively for two periods.
seasons. Much greater efficiency in root length was being observed with 40 cm/l yeast extract combined with 3.0 and 3.5 g/l NPK fertilizers.

For root numbers/plantlet, the different levels of yeast 20 and 40 cm/l and three levels of NPK fertilizers 2.5, 3.0 and 3.5 g/l might be responsible for significantly high increasing of roots number/plantlet for two periods. The highest increasing of roots number/plantlet was observed in 40 cm/l yeast extract 7.3 and 8.3 respectively for two periods, also the highest concentration of NPK fertilizers 3.0 and 3.5 g/l proved the highest significant number of roots/plantlet 7.8 and 8.3 and 9.4 roots/plantlet, respectively for two periods. No significant differences between two treatments of NPK fertilizers 3.0 and 3.5 g/l, high interaction was found with 40 cm/l yeast and 3.0 and 3.5 g/l NPK fertilizer. In this respect Yazawa et al. (1992) on Actinidia delicosa (Kiwi fruit), Gutierrez et al. (1998) on Prunus avium, Abou Rayya et al. (2010) on bitter almond, Centeno and Campo (2010) on Olea europaea L., Van Minh (2010) on Mangosteen (Garcinia mangostena) cleared that hairy roots and root length were increased with yeast extract also with Agrobacterium rhizogenes, Aya et al. (2006) on Glehnia littoralis stated that root length were positively increased with yeast extract which acts bi functionally on the roots as nutrient and an elicitor, 50.0 and 100.0 ml pot-1 increased root length and diameter and fresh and dry weights of sugar beet (Agamy et al., 2013).

### Fresh and Dry Weights of Leaves

Table 3 shows the positive effect of yeast and NPK as can be seen, significant increasing of fresh and dry weights were attributed by 40 cm/l yeast and 3.0 and 3.5 g/l NPK fertilizer. In this respect Yazawa et al. (1992) on Actinidia delicosa (Kiwi fruit), Gutierrez et al. (1998) on Prunus avium, Abou Rayya et al. (2010) on bitter almond, Centeno and Campo (2010) on Olea europaea L., Van Minh (2010) on Mangosteen (Garcinia mangostena) cleared that hairy roots and root length were increased with yeast extract also with Agrobacterium rhizogenes, Aya et al. (2006) on Glehnia littoralis stated that root length were positively increased with yeast extract which acts bi functionally on the roots as nutrient and an elicitor, 50.0 and 100.0 ml pot-1 increased root length and diameter and fresh and dry weights of sugar beet (Agamy et al., 2013).

### Table 3: Effect of different concentrations of yeast (cm/l) and complete fertilizers NPK (g/l) on fresh and dry weight of Phoenix dactylifera L. cv. Medjool.

<table>
<thead>
<tr>
<th>Yeast A (g/l)</th>
<th>NPK B (g/l)</th>
<th>Fresh weight (g)</th>
<th>Dry weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>First season</td>
<td>Second season</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Con 20 40 Mean</td>
<td>Con 20 40 Mean</td>
</tr>
<tr>
<td>Con</td>
<td>2.3</td>
<td>3.9 4.2 3.5</td>
<td>2.6 4.2 4.6</td>
</tr>
<tr>
<td>2.5</td>
<td>2.8</td>
<td>4.1 4.9 3.9</td>
<td>3.1 4.6 5.4</td>
</tr>
<tr>
<td>3.0</td>
<td>3.4</td>
<td>5.4 5.7 4.8</td>
<td>3.7 6.3 6.7</td>
</tr>
<tr>
<td>3.5</td>
<td>3.8</td>
<td>5.5 5.7 5.0</td>
<td>4.1 6.6 6.7</td>
</tr>
<tr>
<td>Mean</td>
<td>3.1</td>
<td>4.7 5.1</td>
<td>3.4 5.4 5.8</td>
</tr>
<tr>
<td>l.s.d</td>
<td>A=0.2</td>
<td>B=0.2 AB=0.3</td>
<td>A=0.1 B=0.2 AB=0.3</td>
</tr>
</tbody>
</table>

A = yeast; B = NPK; AB = yeast x NPK.

The previous results revealed the highest positive effect of yeast which is considered as a natural source of protein, cytokinins that stimulates cell division and enlargement as well as the synthesis of protein, nucleic acid and chlorophyll, all of these promoting substances of yeast were produced highly improvement of different growth parameters which exhibited on high values of plant height, root length, number of leaves and roots and fresh and dry weights of leaves, also these highly results were allowed to possibility used small quantity of fertilizers with two concentrations of yeast to improve the date palm plantlets in the greenhouse.

N, P and K g/100g d.w. and total indoles mg/g f.w.

Data in Tables 4 and 5 and Figs. 2–5 clearly showed the linearly increasing of N, P and K contents as the increasing of yeast concentrations from 20 to 40 cm/l and three concentrations of NPK fertilizers 2.5, 3.0 and 3.5 g/l, on the other hand the lowest contents of N, P and K. were resulted in with control treatment, in the presence of 40 cm/l yeast and 3.5 g/l complete fertilizers NPK the greatest interaction on the contents of N, P and K were detected.
Table 4: Effect of different concentrations of yeast (cm/l) and complete fertilizers NPK (g/l) on nitrogen and phosphorus (g/100 g) of *Phoenix dactylifera* L. cv. Medjol.

| Yeast | Nitrogen | | | Phosphorus | | |
|-------|----------|-------|-------|----------|-------|-------|-------|
|       | First season | Second season | First season | Second season | First season | Second season | First season | Second season |
| NPK   | Con | 20 | 40 | Mean | Con | 20 | 40 | Mean | Con | 20 | 40 | Mean | Con | 20 | 40 | Mean |
| 2.5   | 2.1 | 3.6 | 5.1 | 3.6 | 2.0 | 4.1 | 6.4 | 4.2 | 1.1 | 1.4 | 1.5 | 1.3 | 1.2 | 1.4 | 1.6 | 1.4 |
| 3.0   | 2.4 | 6.3 | 7.5 | 5.4 | 2.7 | 7.8 | 9.6 | 6.7 | 1.3 | 1.5 | 1.6 | 1.5 | 1.4 | 1.6 | 1.9 | 1.6 |
| 3.5   | 2.7 | 8.9 | 9.5 | 7.0 | 2.9 | 9.3 | 10.0 | 7.4 | 1.4 | 1.8 | 2.2 | 1.8 | 1.5 | 2.0 | 2.4 | 2.0 |
| Mean  | 2.1 | 5.3 | 6.2 | 2.2 | 6.0 | 7.2 | 0.96 | 1.4 | 1.7 | 1.1 | 1.6 | 1.9 |  |  |  |
| l.s.d | A=0.3 | B=0.4 | AB=0.6 | A=0.3 | B=0.4 | AB=0.6 | A=0.1 | B=0.1 | AB=0.1 | A=0.1 | B=0.1 | AB=0.1 |

A = yeast; B = NPK; AB = yeast x NPK.

Table 5: Effect of different concentrations of yeast (cm/l) and complete fertilizers NPK (g/l) on potassium (g/100 g) and indole (mg/g) of *Phoenix dactylifera* L. cv. Medjol.

| Yeast | Potassium | | | Indoles | | |
|-------|----------|-------|-------|--------|-------|-------|-------|
|       | First season | Second season | First season | Second season | First season | Second season | First season | Second season |
| NPK   | Con | 20 | 40 | Mean | Con | 20 | 40 | Mean | Con | 20 | 40 | Mean | Con | 20 | 40 | Mean |
| 2.5   | 0.02 | 2.03 | 2.4 | 1.5 | 0.02 | 2.2 | 2.5 | 1.6 | 1.2 | 6.6 | 6.8 | 4.9 | 1.2 | 6.7 | 7.4 | 5.1 |
| 3.0   | 1.6 | 2.9 | 3.1 | 2.5 | 1.8 | 3.03 | 3.2 | 2.7 | 5.9 | 13.9 | 15.7 | 11.8 | 6.4 | 15.8 | 17.0 | 13.1 |
| 3.5   | 1.7 | 3.1 | 3.4 | 2.7 | 2.3 | 3.5 | 4.0 | 3.3 | 6.2 | 15.6 | 17.4 | 13.1 | 6.4 | 15.9 | 17.9 | 13.4 |
| Mean  | 1.2 | 2.6 | 2.9 | 1.4 | 2.9 | 3.2 | 4.7 | 11.2 | 13.4 | 5.0 | 12.1 | 14.0 |  |  |  |
| l.s.d | A=0.1 | B=0.1 | AB=0.1 | A=0.1 | B=0.1 | AB=0.2 | A=0.1 | B=0.1 | AB=0.1 | A=0.1 | B=0.1 | AB=0.1 |

A = yeast; B = NPK; AB = yeast x NPK.

Fig. 2 Effect of different concentrations of yeast (cm/l) and complete fertilizers NPK (g/l) on nitrogen and phosphorus (g/100 g) at (a) first and (b) second season.

Fig. 3 Effect of different concentrations of yeast (cm/l) and complete fertilizers NPK (g/l) on nitrogen and phosphorus (g/100 g) of *Phoenix dactylifera* L. cv. Medjol at first and second season.
Regarding total indole contents which is considered a limit factor for growth in the plants, same trend was found in total indole content with two levels of yeast 20 and 40 cm/l and three levels of NPK fertilizers 2.5, 3.0 and 3.5 g/l for two periods respectively. The treatment 40 cm/l yeast with 3.5 g/l NPK fertilizers had the highest interaction on the indole contents mg/l. These findings supported by Hussain et al. (2002) showed that yeast (Saccharomyces spp) improved crop growth and yield by increasing photosynthesis producing bioactive substances such as hormones and enzymes, controlling soil diseases and accelerating decomposition of lignine materials in the soil, Wu et al. (2005) stated that use of soil microorganisms which can either fix atmospheric nitrogen, solubilise phosphate by synthesis of growth promoting substances or enhancing the decomposition of plant residues to release vital nutrients and increase humatic content of soils, will environmentally begin approach for nutrient management and ecosystem function. Boby et al. (2007) on Cowpea, Osman on olive, Abd El-Motty et al. on Keitte mango, Arafat et al. (2010) on peanut found that the contents of N, P and K were significantly increased with soil applications of yeast extract and bio fertilizers also with complete fertilizers and foliar fertilization, bio-fertilization are biological preparations containing primarily patent strains of microorganisms in sufficient numbers, these microorganisms have definite beneficial roles in the fertility of soil rhizosphere and the growth of the plants, Han and Lee (2005) on Solanum torvum L. (eggplant), Han et al. (2006) on pepper and cucumber, Aftab and Asghari (2008) on Triticum aestivum, proved that N, P and K increased with Bacillus megaterium and phosphite solubilising bacterium and Rock P and K. Nassar et al. (2005) on Zea mays stated that IAA increased with yeast extract, Biswas et al. (2000) on Oryza sativa and Chandra et al. (2007) on Brassica campestris showed that IAA increased when the soil inoculated with Rhizobium strains. Yeast fixed the nitrogen and phosphorus, and contains the cryptophan which considered the precursor of IAA, these specifications of yeast increased the contents of nitrogen, phosphorus and IAA which had the closely effect of the plant elongation, Bacillus licheniformis (1010 cells/ml), Yeast (5 g/L), Algal extract (0.1%) and Humic acid (20 g/L) increased shoot contents auxins and gibberellins in addition of growth estimations (Salwa, 2013), shoots and roots contents of N, P, K of Caraway (Carum carvi L.) increased under treatment with dry yeast (Ramadan and Ragab, 2015).

REFERENCES


