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# EFFECTS OF CUTTING THE HERB AND THE USE OF NOTROBEIN AND PHOSPHOREIN ASSOCIATED WITH MINERAL FERTILIZERS ON GROWTH, FRUIT AND OIL YIELDS, AND CHEMICAL COMPOSITION OF THE ESSENTIAL OIL OF CORIANDER PLANTS *(Coriandrum sativum* L.)

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## ABSTRACT

This experiment was carried out on coriander plants (*Coriandrum sativum* L.) to study the effects of cutting the herb and the use of Notrobein and Phosphorein biofertilizers plus mineral fertilizers on growth, quality, fruit and oil yields, and the essential oil composition of coriander plants. The results showed that cutting the herb at 60 day after planting date reduced growth and fruit and essential oil yield of the fruits. Otherwise, it did not affect fruit quality and essential oil percentage of the fruits. The results also showed that inoculation with Notrobein substituted the effect of 25% of the mineral N fertilizer used to improve growth of the plant, yield of fruits and essential oil yield of fruits. The best growth was achieved using Phosphorein inoculation whether it was used with mineral NPK or with Notrobein plus 75% N plus PK. These two treatments gave the tallest plants, highest number of shoots and inflorescenceper plant, and the highest yield of both fruits and essential oil. The high yield was attributed to the increase in fruits weight and yield. These two treatments, on the other hand, decreased the oil percentage of the fruit. Separation of the essential oil using GLC revealed eight identified components forming more than 96% of oil. Linalool was the major constituent forming more than 76% of the oil; and the other constituents were α-Pinene, Camphene, β-Pinene, Limonene, Menthone, Geraniol, and Euginol. Treatments with biofertilizers changed the percentage of some essential oil components. Phosphorein plus Notrobein treatment gave the highest records for Linalool (81.3%) and Camphene (1.4%), and the lowest α-Pinene (1.7%), β-Pinene (2.9%), and Limonene (1.1%). Concentrations of Menthone (4%), Geraniol (3%), and Euginol (3.2%) were slightly or unaffected by this treatment compared with the control.

## INTRODUCTION

Recent years have witnessed a great interest in the use of biofertlizers in agriculture. Nitrogenous biofertilizers containing nitrogen fixing bacteria increased growth and yield of palmarosa (Maheshwari *et al.* 1995; Santhi and Vijaykumar 1998), rice (Hemalatha *et al.* 2000), radish (Panawar *et al.*, 2000), snap bean (Singer *et al.*, 2000), mulberry (Sudhakar *et al.* 2000), oil palm (Amir *et al.*, 2001), and sorghum (Nanda *et al.*, 2001).

Phosphorus biofertlizers contain phosphorus dissolving bacteria capable of releasing the fixed form of phosphorus in the soil to soluble form ready to soluble form ready for plant nutrition (Abdalla *et al.*, 2001). Inoculation with phosphorus biofertilizers increased growth and yield of potato (El-Gamal 1996), onion (El-Kalla *et al.*, 1997), globe artichoke (Abd El-Fattah 1998), soybeans, sesame, and sunflower (El-Lateef *et al.*, 1998), and sugar cane (*Ismail et al.*, 2000).

Other researchers reported better results for growth and yield when used mixed inoculation of both phosphorus and nitrogenous biofertlizers on maize (Allah 1998), marigold (Chandrikapure *et al.*, 1999), and sweet pepper (Abdalla *et al.*, 2001) than when each biofertilizer was used individually.

The importance of using biofertlizers is to reduce the amount and cost of chemical fertilizers and to eliminate environmental pollution as well (Abd El-Fattah 1998 and Allah 1998). Both phosphorus and nitrogenous biofertlizers are now produced under several commercial names. Phosphorein is a phosphorus biofertilizer (contains phosphate dissolvers or vesicular arbuscular mycorrhizas and silicane bacteria) and Notrobein is a nitrogenous biofertilizer (contains nitrogen fixing bacteria). The two biofertilizers are produced by the Ministry of Agriculture of Egypt. The aim of this work was to study the effects of biofertilizers individually or as mixed inoculation associated with mineral fertilizers as well as cutting the herb on growth, yield, and quality of fruits and volatile oil of coriander.

## MATERIALS AND METHODS

This work was carried out at the experimental farm of the Agricultural Research Station at El-Gimiza, ElGarbia during the two successive seasons 1998/1999 and 1999/2000 in order to study the effects of bio and mineral fertilizers and cutting the herb on growth and yield of coriander plants. Seeds (fruits) of coriander (*Coriandrum sativum* L.) were obtained from the Medicinal and Aromatic Plants Section, El-Dokki. The experiment was set as a split plot design with three replicates. Cutting the herb was considered the main plot, while fertilizers treatments were the sub-plots. The main treatments were one cut of the herbs and no cut of the herbs. The sub-treatments were as follows:

1- **Control** (no fertilizer added).
2- **NPK** [400 Kg/feddan of ammonium sulfate (20.5 % N) plus 300 Kg/feddan of calcium superphosphate (15.5 % P2O5) plus 50 Kg/feddan potassium sulfate (48% K2O5)].
3- **Notrobein treatment** [Notrobein inoculation plus 75% N plus PK (260 Kg/feddan ammonium sulfate plus 300 Kg/feddan of calcium superphosphate plus 50 Kg/feddan potassium sulfate)].
4- **Phosphorein treatment** [Phosphorein inoculation plus NPK (fertilizer of treatment 2)].
5- **Phosphorein plus Notrobein treatment** [Phosphorein inoculation plus fertilizers of treatment 3 (Notrobein inoculation plus 75% N plus PK)].

For treatments included biofertilizers, seeds were inoculated with Phosphorein and/or Notrobein before planting as recommended. Calcium superphosphate was added before planting and potassium sulphate was added one month after planting, while ammonium sulfate was divided into two equal portions; the first was added one month after planting, and the second was added one month later. Each experimental plot consisted of 5 rows and each row was 60 cm in width and 3.5 m in length. On the 3rd of November in both seasons, seeds were sown at 25 cm apart. Thinning was done 30 days after sowing. Sixty days after sowing, herbs were cut to 15 cm from the soil level.

At the end of the experiment (on 15th of May), plants of three rows from each treatment were harvested and the growth and yield characters were recorded. Number of inflorescence/plant, number of shoots/plant, Plant height (cm), weight of 1000 fruits, and fruit yield per plant and per feddan. Fruits were air dried in shade for 10 days until their weight remained constant (after 3 successive weights). The dried fruits were weighed and their essential oil was extracted by water distillation using clevenger apparatus according to the method described by the British Pharmacopoeia (1963). Percentage of oil was recorded as cm of essential oil per 100 g dry fruits. All data were subjected to analysis of variance using LSD values to determine the magnitude of significance between means of the treatments at $P \leq 0.05$.

**GLC study**

Gas Liquid Chromatography. This study was done in the second season in order to compare the composition of the essential oil samples resulted from plants of the tested biofertilizer treatments with the control sample. The essential oil obtained by steam distillation was dried using natrium anhydrous sulphate, solved in pure petrolium ether, and prepared for separation by Gas Liquid Chromatography (GLC). GLC analysis was done using DS Chrom. 6200 (Donam Instrument Company) with flame ionization detector (FID). Separation was carried out according to temperature program 70-190 °C at three ramps; 70-80 °C (at 1 °C/min), 80-120 °C (at 5 °C/min), and 120-190 °C (at 10 °C/min). The detector temperature was 300 °C and the injector one was 250 °C. Nitrogen (carrier gas) flow rate was 1 ml/min, the other carrier gas (hydrogen) flow rate was 30 ml/min, and the air flow rate was 300 ml/min. Reference substances were injected under similar conditions. The peaks obtained at same retention times from the chromatograms were compared to qualitatively identify the constituents of the essential oil. Quantitative determinations were obtained based on peak area measurements (Bunzen *et al.*, 1969). The percentage of each constituent was measured as the ratio between its peak area to the total area multiplied by 100.

## RESULTS AND DISCUSSION

**A. Effects of Treatments on Plant Growth**

**a. Statistical significance of the treatments**

In both seasons of the experiment, the main plot (cutting the herb) alone and the sub-plot (fertilizers treatments) alone had significant effects on the number of inflorescence per plant, number of shoots per plant, and plant height of coriander plants (Table 1). On the other hand, the interaction between cutting the herb and fertilizers treatments did not have any significant effect on the three growth parameters.

**Table 1: Statistical analysis of the effects of cutting the herb (A) and fertilizers treatments (B) on growth and flowering characteristics of coriander plants in 1998/99 and 1999/2000 seasons.**

| Comparison | No. of inflorescence/plant | | No. of shoots/plant | | Plant height (cm) | |
|---|---|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| A | * | * | * | * | * | * |
| B | * | * | * | * | * | * |
| AXB | ns | ns | ns | ns | ns | ns |

*, ns significant or non significant at $P$ ? 0.05, respectively.

**b. Effects of cutting the herb**

In both seasons, cutting coriander herbs sixty days after planting resulted in significantly shorter plants and number of shoots and inflorescence per plant lesser than those plants which were not cut (Table 2). The cutting treatment was done on January 3rd when climate was cold and humid. It seems that plants cut at that time of the year could not produce enough buds and break out also could not develop properly. As a consequence, the number of shoots and inflorescence produced by these plants was lesser than the untreated plants which were left to develop normally. Also flower induction and fruit set seem to be environmentally controlled and took place for all plants regardless of size of the plant and age of shoots. Thus, the development of shoots resulted from buds broke out in winter (from treated plants) was ceased as plants flowered and resulted in short plants.

**Table 2: Effects of cutting the herb on growth and flowering characteristics of coriander plants in 1998/99 and 1999/2000 seasons.**

| Treatments | No. of inflorescence/plant | | No. of shoots/plant | | Plant height (cm) | |
|---|---|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| No cutting | 185.7 a | 170.8 a | 8.2 a | 8.2 a | 144.7 a | 146.3 a |
| Cutting the herb | 113.6 b | 122.8 b | 5.4 b | 5 7 b | 98.4 b | 96 7 b |
| L.S.D. | 14.7 | 15 | 0.9 | 0.2 | 8.4 | 3.3 |

Means followed by the same letter (s) within columns are not significantly different by L.S.D. at P=0.05.

**c. Effects of bio fertilizer treatments**

As for the effect of Notrobein, Phosphorein or both associated with mineral fertilizers, the obtained results of Table (3) clearly show that addition of NPK to coriander plants resulted in significantly better growth than the control plants. Plants received NPK fertilization had significantly more shoots and inflorescences and were significantly taller than the control plants. Results also showed that there were no significant differences between plants received NPK and those inoculated with Notrobein plus received 75% N T PK treatment in all previously mentioned growth parameters in both seasons of the study. This indicates that Notrobein inoculation substituted 25% of the total mineral N fertilizer applied. The efficacy of N biofertilizers is variable depending on type or types of bacteria, method and rate of application, along with the crop (Maheshwari *et al.* (1995); Santhi and Vijakumar (1998); Panwar *et al.* (2000); Singer *et al.* (2000)). Our results herein are in line with Amir *et al.* (2001) who showed that *Azosprillum* inoculation contributed up to 40% of the total nitrogen requirement oil palm plantlets, and Maheshwari *et al.* (1995), reported that *Azotobacter chroococcum* applied as a drench at 10 Kg/ha to palmasrosa was equal to 80 kg mineral N/ha. Our results are similar to those of Allah (1998) on maize and Chandrikapure *et al.* (1999) on Tagetes who indicated that N biofertilizer substituted 25% of the total N fertilizer thereby, using only 75% of the chemical N fertilizer.

**Table 3: Effects of biofertilizer treatments associated with mineral on growth and flowering characteristics of coriander plants in 1998/99 and 1999/2000 seasons.**

| Treatments | No. of inflorescence/plant | | No. of shoots/plant | | Plant height (cm) | |
|---|---|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| Control | 85 6 c | 90.37 c | 4 6 c | 4.6 c | 96.0 c | 90.6 c |
| NPK | 134.8 b | 133.23 b | 6.4 b | 6.7 b | 117.7 b | 121.8 b |
| Notrobein | 142.1 b | 133.12 b | 6.4 b | 6.4 b | 118 7 b | 119.7 b |
| Phosphorein | 193.9 a | 185.85 a | 8.2 a | 8.6 a | 138.0 a | 138.1 a |
| Phosphorein - Notrobein | 191.8 a | 191.52 a | 8.5 a | 8.2 a | 137.2 a | 137.2 a |
| L.S.D. | 11.2 | 8.98 | 0.4 | 0.6 | 8.5 | 3.6 |

**Means followed by the same letter (s) within columns are not significantly different by L.S.D. at P=0.05.**

The same table (3) also show that the tallest plants with the highest number of shoots and inflorescences were those received Phosphorein and Phosphorein plus Notrobein treatments. Also these two treatments did not significantly differ from each others in these growth parameters. These results indicate that the best growth was achieved when seeds were inoculated with Phsphorein. In this regard, Abdel Fattah (1998) found positive interactions between mineral phosphorus and Phsphorein inoculation. He reported that the best growth and yield of globe artichoke plants were obtained using 120 Kg P2O5/fed or using 90 Kg P2O5/fed (75% P2O5) in the presence of Phsphorein.

Establishment of a strong root system is related to the level of available phosphate in soil (Abou El Hassan *et al.* 1993). Phosphorein is a biofertilizer that contains phosphate dissolvers or vesicular arbuscular micorrhizae and silicane bacteria is capable of converting tricalcium phosphate to monocalcium phosphate ready for plant nutrition (Abdalla *et al.* 2001). Phsphorein increased mineral uptake and water use efficiency by soyabeans (El-Awag 1993), and increased growth, yield and quality of onion (Leilah and mostafa 1993), Potatoes (El-Gamal 1996), and sugar cane (Ismail *et al.*, 2000).

## B. Effects of Treatments on Fruit Quality

### a. Statistical significance of the treatments

Quality of fruits is expressed as weight of 1000 fruits/gram and percentage of the volatile oil within the coriander fruit. The main plot (cutting the herb) significantly affected weight of 1000 fruits in the second season only, while it had no significant effect on the volatile oil percentage in both seasons (Table 4). In both seasons, the sub-plot (fertilizers treatments) alone significantly affected the two parameters, while the interaction between the main and sub-plots had no significant effect on both parameters.

**Table 4: Statistical analysis of the effects of cutting the herb (A) and fertilizers treatments (B) on fruit quality and volatile oil percentage of coriander plants in 1998/99 and 1999/2000 seasons.**

| Comparison | Weight of 1000 fruits (g) | | Volatile oil % | |
|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season |
| A | ns | * | ns | ns |
| B | * | * | * | * |
| AXB | ns | ns | ns | ns |

*, ns significant or non significant at P ? 0.05, respectively.

### b. Effects of cutting the herb

In the second season only, weight of 1000 fruits when plants were not cut was better than those which were cut (Table 5). On the other hand, in both seasons, the volatile oil percentage in fruits was not affected whether plants were cut or not. These results indicate that fruit weight was slightly affected by plant growth, whereas fruit volatile oil percentage seems to be genetically controlled and is affected by the cultivar genotype.

**Table 5: Effects of cutting the herb on fruit quality and volatile oil percentage of coriander plants in 1998/99 and 1999/2000 seasons.**

| Treatments | Weight of 1000 fruits (g) | | Volatile oil % | |
|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season |
| No cutting | 13.1 a | 12.83 b | 0.43 a | 0.44 a |
| Cutting the herb | 13.2 a | 13.1 a | 0.44 a | 0.42 a |
| L.S.D. | 0.3 | 0.22 | 0.02 | 0.04 |

Means followed by the same letter (s) within columns are not significantly different by L.S.D. at P=0.05.

### c. Effects of fertilizers treatments

Quality of fruits, expressed as weight of 1000 fruits (Table 6), was significantly greater in case of the two treatments which included Phosphorein inoculation than the other two treatments and the control . On the other hand, quality of fruits expressed as the percentage of the volatile oil in the fruits followed an opposite direction. It was better in case of the control plants and when plants were not inoculated with Phosphorein. The least oil percentages were found in fruits produced by plants inoculated with Phosphorein. These results suggest that the volatile oil of coriander plants is genetically controlled and is distributed among different organs. Since plants inoculated with Phosphorein recorded the best growth and the highest number of shoots, and that oil in their fruits became lesser than other treatments.

**Table 6: Effects of biofertilizer treatments associated with mineral fertilizers on fruit quality and volatile oil percentage of coriander plants in 1998/99 and 1999/2000 seasons.**

| Treatments | Weight of 1000 fruits(g) | | Volatile oil % | |
|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season |
| Control | 13.0 b | 12.75 b | 0.44 ab | 0.45 a |
| NPK | 12.85 b | 12.7 b | 0.45 a | 0.44 ab |
| Notrobein | 12.85 b | 12.82 b | 0.44 ab | 0.43 bc |
| Phosphorein | 13.4 a | 13.35 a | 0.43 bc | 0.42 c |
| Phosphorein + Notrobein | 13.55 a | 13.22 a | 0.42c | 0.42 c |
| L.S.D. | 0.25 | 0.3 | 0.019 | 0.017 |

x Means followed by the same letter (s) within columns are not significantly different by L.S.D. at P=0.05.

## C. Effects of Treatments on Fruit and Volatile Oil Yields

### a. Statistical significance of the treatments

In both seasons of the experiment, the main plot (cutting the herb) alone and the sub-plot (fertilizers treatments) alone had significant effects on fruit yield per plant, fruit yield per feddan, and volatile oil yield per feddan (Table 7). On the other hand, the interaction between cutting the herb and fertilizers treatments did not have any significant effect on the three yield parameters.

**Table 7: Statistical analysis of the effects of cutting the herb (A) and fertilizers treatments (B) on fruit and oil yield of coriander plants in 1998/99 and 1999/2000 seasons.**

| Comparison | Fruit yield /plant (g) | | Fruit yield / feddan (Kg) | | Volatile oil Yield (Kg/feddan) | |
|---|---|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| A | * | * | * | * | * | * |
| B | * | * | * | * | * | * |
| AXB | ns | ns | ns | ns | ns | ns |

*, ns significant or non significant at P ? 0.05, respectively.

### b. Effects of cutting the herb

Results in Table (8) show that plants which were not cut yielded an average of 1072.77 and 997.55 kilogram of fruits per feddan in the first and second seasons respectively, while those which were cut yielded 719.23 and 753.2 kilograms per feddan in the same respective order. Also, plants which were not cut yielded an average of 4.61 and 4.38 kilograms of volatile oil per feddan in the first and second seasons respectively, while those which were cut yielded 3.12 and 3.16 kilograms per feddan in the same respective order. Thus, the untreated plants produced fruit and volatile oil yields higher than plants which were cut. Since average weight of 1000 fruits and volatile oil percentage were not affected by cutting the plants, one can conclude that the high fruit and volatile oil yields produced by the untreated plants were based on their high number of shoots and inflorescence giving more number of fruits/plant.

**Table 8: Effects of cutting the herb on fruit and oil yield of coriander plants in 1998/99 and 1999/2000 seasons.**

| Treatments | Fruit yield /plant (g) | | Fruit yield / feddan (Kg) | | Volatile oil Yield (Kg/feddan) | |
|---|---|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| No cutting | 38.31 a | 35.63 a | 1072.77 a | 997.55 a | 4.61 a | 4.38 a |
| Cutting the herb | 25.69 b | 26.9 b | 719.23 b | 753.2 b | 3.12 b | 3.16 b |
| L.S.D | 1.89 | 2.83 | 52.87 | 79.11 | 0.18 | 0.15 |

**Means followed by the same letter (s) within columns are not significantly different by *L.S.D. at P=0.05.***

### c. Effects of fertilizers treatments

*Table (9) shows* the final fruit and volatile oil yields of coriander plants of different treatments. In both seasons, the highest fruit yield per plant was produced using Phosphorein inoculation ( either Phosphorein or Phosphorein plus Notrobein treatments ), followed by those inoculated with Notrobein , while NPK treatment ranked fourth and the control came last. Phosphorein and Phosphorein plus *Notrobein treatments yielded more than* one ton of fruits per feddan and were not sifgnificantly different. These two *treatments were significantly* higher than Notrobein treatment which yielded 925.4 and 903.47 kilograms per feddan in the first and second seasons, respectively.

**Table 9: Effects of biofertilizer treatments associated with mineral on fruit and oil yield of coriander plants in 1998/99 and 1999/2000 seasons..**

| Treatments | Fruit yield /plant (g) | | Fruit yield / feddan (Kg) | | Volatile oil Yield (Kg/feddan) | |
|---|---|---|---|---|---|---|
| | 1st season | 2nd season | 1st season | 2nd season | 1st season | 2nd season |
| Control | 20.22 d | 19.13 d | 566.07 d | 535.73 d | 2.51 d | 2.39 c |
| NPK | 29.3 c | 29.03 c | 820.4 c | 812.93 c | 3.69 c | 3.65 b |
| Notrobein | 33.05 b | 32.27 b | 925.4 b | 903.47 b | 4.0 b | 3.89 b |
| Phosphorein | 39.2 a | 37.77 a | 1097.6 a | 1057.47 a | 4.68 a | 4.47 a |
| Phosphorein + Notrobein | 38.23 a | 38.12 a | 1070.53a | 1067.27 a | 4.45 a | 4.47 a |
| L.S.D. | 1.61 | 2.46 | 45.31 | 68.73 | 0.31 | 0.33 |

**Means followed by the same letter (s) within columns are not significantly different by L.S.D. at P=0.05.**

The results of fruits volatile oil yield followed the same trend of the fruit yield. *In that respect*, El-Lateef *et al.* (1998) showed that using phosphate dissolving bacteria together with 100 kg P fertilizer increased seed yield of 3 oil crops (soyabeans, sesame and sunflowers) and produced similar or greater seed yield than obtained with 200 kg mineral P alone without affecting the quality of seed. Plants given 75% of the recommended N fertilizer with combinations of biofertilizer (*nitrogen fixing and phosphorus* solublizing bacteria) gave best plant growth and grain yield of Maize with the *highest monetary return* (Allah 1998) Also Chandrikapure *et al.* (1999) showed that mixed inoculation of biofertilizer (Azotobacter + phosphorus solublizing bacteria (PSB)) along with 75% N gave the best results for plant growth and flower yield of marigold (Tagetes erecta L.). These results indicate that the highest fruit and volatile oil yield produced by Phosphorein inoculation was a *result of the vigorous growth resulted from* Phosphorein and Phosphorein plus Notrobein treatments.

Separation of oil samples by GLC revealed eight identified constituents; α-Pinene, Camphene, β-Pinene, Limonene, Linalool, Menthone, Geraniol, and Euginol (Table 10). These oil components constituted 97.6%. 96.5%, 98.6%, and 98.6% of the oil samples from the control, Notrobein, Phosphorein and Phosphorein plus Notrobein treatments, respectively. Linalool was the major constituent of the essential oil of coriander. The highest percentage of Linalool was in oil sample from plants under Phosphorein plus Notrobein treatment (81.3%), the lowest was in case of the control sample (76.6%), while percentages were 79% and 79.6% in case of oil samples from Notrobein and Phosphorein treatments, respectively. The highest Camphene percentage (1.4%) was in case of Phosphorein plus Notrobein treatment. The highest percentages of α-Pinene (3.4%), β-Pinene (4.1%), and Limonene (2.8%) were found in the oil sample of the control, while they were the lowest (1.7, 2.9, and 1.1%) in case of Phosphorein plus Notrobein treatment. Oil sample of Notrobein treatment had the lowest Menthone (3.8%), Geraniol (2.3%), and Euginol (2.8%). The percentages of these previously mentioned three constituents were slightly or unaffected by the other two biofertilizer treatments (which included Phosphorein) compared with the control sample.

**Table 10: Percentages of identified constituents of the coriander essential oil samples of different biofertilizer associated with mineral fertilizers treatments in the 1999/2000 season.**

| Constituents | Treatments | | | |
|---|---|---|---|---|
| | Control | Notrobein | Phosphorein | Phosphorein + Notrobein |
| α-Pinene | 3.4 | 2.7 | 2.8 | 1.7 |
| Camphene | 0 9 | 1.0 | 0.7 | 1.4 |
| β-Pinene | 4.1 | 4 1 | 3.5 | 2 9 |
| Limonene | 2.8 | 1 8 | 1.9 | 1.1 |
| Linalool | 76.6 | 79.0 | 79.6 | 81 3 |
| Menthone | 4.0 | 3.8 | 4.0 | 4.0 |
| Geraniol | 2 9 | 2.3 | 2.9 | 3.0 |
| Euginol | 3.1 | 2.8 | 3.2 | 3.2 |
| Total identified | 97 8 | 96.5 | 98.6 | 98.6 |

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## تأثير قص العشب و إضافة الأسمدة الحيوية النتروبين و الفسفورين إلى السماد الكيماوى على النمو و محصول الثمار و الزيت و التركيب الكيميائى للزيت العطرى للكسبرة

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تم إجراء هذه التجربة فى محطة البحوث الزراعية بالجميزة – الغربية – مصر خلال الموسمين المتتاليين ١٩٩٨/١٩٩٩ و ١٩٩٩/٢٠٠٠ على نبات الكسبرة وكان الهدف من هذا البحث هو دراسة تأثير قرط العشب و إستخدام الأسمدة الحيوية النتروبين و الفسفورين على النمو والجودة و محصول الثمار و الزيت و تركيب الزيت العطرى للكسبرة ، ولقد أظهرت النتائج أن قرط العشب بعد الزراعة بستين يوما قد أدى إلى تقليل النمو و محصول كل من الثمار و الزيت العطرى للثمار إلا أنه لم يؤثر على جودة الثمار أو النسبة المئوية للزيت العطرى فى الثمار. و أظهرت النتائج أيضا أن التلقيح بالنتروبين قد حل محل تأثير ٢٥% من السماد النتروجينى المعدنى المستخدم وذلك فى تحسين النمو و زيادة محصول كل من الثمار و الزيت العطرى ، و قد تم الحصول على أفضل نمو باستخدام التلقيح بالفسفورين سواء تمت إضافته إلى السماد المعدنى (نتروجين فوسفات بوتاسيوم) أو إلى النتروبين + (٧٥% نتروجين + فوسفات بوتاسيوم) ، و لقد أدت هاتان المعاملتان إلى الحصول على أطول النباتات و أكبر عدد من الأفرع و النورات و أكبر محصول للثمار و الزيت العطرى. و يعزى المحصول الكبير إلى زيادة عدد النورات و وزن الثمار حيث أن هاتان المعاملتان قد أدتا إلى تقليل نسبة الزيت بالثمار. و لقد أظهر الفصل الكروماتوجرافى للزيت ٨ مركبات تم التعرف عليها تشكل أكثر من ٩٦% من تركيب الزيت. و كان اللينالول هو المركب الرئيسى مكونا أكثر من ٧٦% من تركيب الزيت ، و كانت المركبات الأخرى هى ألفا-باينين و كامفين و بيتا-باينين و ليمونين و منثون و جيرانيول و يوجينول ، ولقد أدت المعاملة بالأسمدة الحيوية إلى تغيير نسبة بعض مكونات الزيت. و إحتوت معاملة الفسفورين + النتروبين على أعلى نسبة لينالول (٨١,٣%) و كامفين (١,٤) و أقل نسبة من ألفا-باينين (١,٧%) و بيتا-باينين (٢,٩%) و ليمونين (١.١ %) بينما لم تتغير تركيزات المنثون (٤%) و جيرانيول (٣%) و يوجينول (٣.٢%) أو تغيرت بنسبة طفيفة بالمقارنة بالكونترول.