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EFFECT OF NITROGEN FERTILIZATION ON VEGETATIVE GROWTH AND SOME ACTIVE CONTENTS OF CASTOR PLANT

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Abstract

This experiment was carried at the Horticultural Research Centre, College of Agriculture, University of Karbala between February 25, 2015 and December 15, 2015 to study the effect of nitrogen fertilization (Urea, 46% N) on the castor plant using the way of soil fertilization at three levels: 0gN/l (control), 2gN/l, and 5gN/l. the seeds were planted in the soil directly on 25/2/2015 and the fertilizer was applied at two levels, the first on 5/10/2015 and the second on 5/11/2015. The results showed that the application of nitrogen fertilizer significantly affected the growth parameters (plant height, number of leaves, leaf area, fresh weight, and dry weight). However, no significant changes in other parameters such as stem diameter, number of main branches, and the number of secondary branches.

***Keywords*:** Vegetative, Castor Plant, Nitrogen Fertilization.

Introduction

Castor bean (*Ricinus communis* L) belongs to the Euphoriaceae family. The native habitat of Caster-Bean is the warm tropical regions of Africa, Asia and Rarely in the temperate parts of the world, and its cultivation has spread in most parts of the world, however, Brazil is considered one of the largest producing country, followed by Mexico, America, India, Sudan, Egypt and China (Weiss, 2000, Vwioko and Fashemi, 2005). In Iraq, the cultivation of castro bean spread in the south and north area as well as to the western region (Hutchinson, 1959).

Castor bean plants are perennial erect shrubs with dense branches, their stems are slick colored with pale purple or green colors, their leaves are palmate in shape with deep lobes, light purple color, and their flowers are yellowish-green borne in terminal, or rarely lateral, panicle inflorescences. The female flowers, borne at the tips of the flower stalk and the male flowers lie under of them. The fruits are capsules containing three large dwellings in each of them a single seed with hard seed coats of brown color with white or yellow spots.

There are several cultivars of Castor bean different from each other morphologically and chemically, the most important of them are:

1. The purple varieties, the most important one is known by Cambodgensis.
2. The bronze varieties, the most important one is known by *Borbonies sesarboreus*
3. The red varieties, the most important one is known by Gibsoni.

Castor bean grows in most lands, especially of light soils such as sandy with good drainage and aeration. The plants are reproduced through seeds that could be planted in warm and temperate regions during February and March, while in the cold regions could be after snow falling and temperature starting to rise during April and May. Castor shrubs can be planted in the areas of sand dunes to prevent creep and move by wind, as well as they are used to reduce or avoid the erosion of the sloped soil as a result of rainfall and frequent floods. The one hectare needs 44 -52 kg of fully mature seeds intact free of fungal and insect infections or mechanical damages. Seed storage period should not exceed three to four years and be identical to the variety. Castor is one of the important medical plants containing effective compounds toxic effects such as Ricin having an antigenic effect, in addition to phenols, terpenes, and alkaloids (Duke and Wain, 1981). The castor plant has many benefits since the seed residue after squeezing and oil extraction, which is called the cake or Pomace may that be used as fertilizer or organic plant material useful in the fertilization of recently reclaimed agricultural lands, particularly sandy ones to raise their fertility and retain their water and nutrients for long periods. The medicinal oil extracted from the seeds in the cold method is used in the food industry as an anti-drought and hardening material, especially in the production of hard sweets to make them somewhat soft; furthermore, it is also used in medicine as a wrapper or as an outer membrane for preserving and coating the tablets, capsules and medical pills containing vitamins and other substances with unacceptable taste and odor. Moreover, the oil is medically used as a laxative agent for curing chronic constipation when taken in its liquid form and for cancer treatment and recently its medical oil is added to the components of soap shampoo used as a wash for women's head hair to increase its luster and aid to prevent hair loss (Bies *et al*., 2004). Castor is a medicinal plant that needs organic and mineral fertilization, especially nitrogen (N) and potassium (K). Nitrogen comprises between 0.1 and 1.5% of the dry weight of plant and 1% of soil. The importance of N comes from its necessary as one of the essential elements of plant growth and has many vital functions. It enters within the structure of the proteins and enzymes found in the plant and in the synthesis of free amino acids, as well as it participates in the synthesis of phorphyrins contributing to chlorophyll and cytokines synthesis which is necessary for in photosynthesis and respiration (Mohamed, 1985). Nitrogen also helps to form large, chlorophyll-rich leaves. While, nitrogen deficiency can be observed easily when the leaves are small with pale green- yellowish color and the branches are weak and short (Al-Rawi, 1982). Urea fertilizer is characterized that its contents high percentage of N (45%) and its ease water solubility and hydrolysis. It losses the N in the form of ammonia in calcareous soils and high salinity levels (Jarallah, 1998). This research was conducted due to the lack of research on fertilization on castor plant, especially N fertilization and its effect on volatile oils in plants.

Materials and Methods

The research was carried out at the University of Karbala, College of Agriculture field, Al-Husseinya sub district, Karbala, Iraq to study the effect of N fertilization (Urea) ($CO(NH_2)_2$, 46%N) on castor plant. Three levels of N fertilization, 0 $N.l^{-1}$ (control), 2 $gmN.l^{-1}$, and 5gm $N.l^{-1}$), were sprayed in two doses (the first one on 5/10/2015 and the second on 5/11/2015). Urea was dissolved in water at two concentrations (2gm.i^{-1} and 5gm.i^{-1}) before spraying the castor plants. Land preparation had been done before planting and divided into 5 m furrows separated by 75 cm, next the seed were planted in holes in depth of 2cm separated from each other by 50cm, then on 25/2/2015 three seeds were put in each hole, after that it irrigated manually by a garden jug.

Randomized Complete Block Design (RCBD) consisted of one factor with three fertilization levels and three replications were used and each experimental unit was represented by three plans. The fruits were collected on 15/12/2015. The soft GenStat-Release was used for statistical analysis and the means were compared according to the least significant difference (LSD) at the level of 0.05.

Studied traits:

1. Plant height (cm): was measured, by a measuring tape, from the ground level to the highest point in the plant.
2. Stem diameter (cm): measured, by Vernier, at 5 cm below the upper branch point.
3. Number of the main branches (branch.$plant^{-1}$): calculated at the field directly.
4. Number of the secondary branched (branch. $plant^{-1}$): calculated at the field directly.
5. Number of leaves (leaves.$plant^{-1}$): calculated at the field directly.
6. Leaf area (cm^2): measured by comparing the weight of small square pieces cut from leaves, which areas already known (1 cm^{-2}), with the known weight plant leaves.
7. Leaf fresh weight (g): measured by weighing three leaves by sensitive balance.
8. Leaf dry weight (g): measured by putting three leaves inside perforated paper bags in an oven at 70°c for 72 hours, till the weight fixed, then weighed by a sensitive balance.
9. Volatile oils of castor leaves: extracted and measured at the ministry of sciences and technology, Baghdad. Modern HPLC (IC-10A) manufactured by the Shimadzu koyota company was used. This device was connected with UV-Vis-detector to determine the retention time and the sample package area for both the standard solution and the sample solution and according to the specific separation conditions for each type of compound.
10. Phenolic compounds: the plant samples of 1.0 g were ground, put in a glass test tube, five ml of methanol-water (80: 20 V), and then the tube was put in the Ultra-sonication device (type Branson Sonifier, USA) at the temperature 25C°. After that, it centrifuged for 15 minutes at 7500 rpm, then the color was bleached by Charcoal, later on, the solvent was evaporated under low pressure by Buchi-Rota vapar Retype. The dried sample was resolved by methanol and filtered through filter paper (2.5 mm), then 20 µl were taken and injected into the column according to the separation conditions included the main compound in the FLC under the typical conditions:

- Column type C-18 with the molecular volume of 3µm of 50*20 mm.
- The moveable phase: included the solvent A, acetic acid 0.1%, solved in distilled water and the solvent B, acetonitrile, (20: 80 V/V).
- Flow velocity: 1.2 $ml.min^{-1}$ and the detection by the UV radiation at a wavelength of 280 nm (Zhang and Land, 2013).

$$\text{Compound concentration in the sample} = \frac{\text{Compound packet space x standard concentration}}{\text{Standard space}}$$

Results and Discussion

Vegetative Traits

- Table 1 show that the differences in some traits were significant and in others were not.
- The number of leaves differed significantly as a result of fertilization treatments. The treatment of 5g $N.l^{-1}$ was superior in producing the highest number of leaves (14.42 leaves.plant-1) compared to the other treatment of 2g N/l and the control where the number of leaves were 12.33 and 10.58 leaves.plant-1 respectively. This increment in the number of leaves is attributed to the role of nitrogen fertilizer, which considered one of the most important nutrient elements helping in seedling growth where the growth vigor depends on increasing the number of leaves (Al-Douri and Al-Rawi, 2000).
- The highest plant height recorded in 52$gN.l^{-1}$ treatment was (117. 50 cm) then 113.80 cm in 2$gN.l^{-1}$ treatment and the plant height was recorded lowest in control treatment (100.60 cm). This increment may be attributed the role of N in increasing chlorophyll in the leaves of plant which leading to improve photosynthesis process and then increasing shoot system finally the height of plant (Popov, 1978)
- Significant differences were revealed among the treatments in the trait of leaf fresh weight. The treatment of fertilization with 5$gN.l^{-1}$ was superior in producing the heaviest fresh weight of the leaves (4.08 $g.leaf^{-1}$) compared to the control treatment that produced 2.9$g.leaf^{-1}$, which did not differ significantly from the treatment of 2g/l that produced 3.54 $g.leaf^{-1}$. This difference was due to the plant activity of photosynthesis that increased the vegetative plant growth including fresh leaf weight.
- Significant differences were appeared among the treatments in the trait of leaf dry weight. The two treatments of 2 and 5$gN.l^{-1}$ were superior in this trait giving 0.710 and 0.780 $g.leaf^{-1}$ compared to the control (0$gN.l^{-1}$) which produced 0.577 $g.leaf^{-1}$. This difference has been attributed to the role of N in leading to an abundant growth resulted in an increment in the dry weight of the shoot system (Al-Rayes, and Mohammed, 1987).

- The leaf area trait showed significant differences among fertilization treatments. The treatment of 5gN.l^{-1} was superior to other treatments in producing the highest value (4.11cm^2) compared to the treatments of 2gN.l^{-1} and 0gN.l^{-1} which produced 3.56 and 2.75 cm2 respectively. This increment is attributed to the role of N which helping to form wide leaves rich in chlorophyll, in contrary to the N deficiency which leads to leaves with a small area and pale yellowish-green color (Al-Rawi, 1982).
- The differences in the traits of stem diameter, number of main branches, and the number of secondary branches were not significant at all levels of N concentrations compared to the control. This result might be due to the absence of vascular meristems activity that produces cells added to the plant diameter growth; consequently, no more thickness of stem happens (Devlin, 1975). This led to a lack of enough cells added to the main or s econdary branch growth or increasing the stem thickness (Abdul Qader et al, 1982). Insignificant differences in the number of main and secondary branches could be attributed to the insufficient levels of N fertilization that contribute to the synthesis of proteins, co-enzymes, amino acids, and organic alkaline considered a part of the nucleic acids, RNA and DNA, as well as it participates in the synthesis of Phrophyrins which is essential in forming the compounds of chlorophyll and cytochrome which are necessary to the process of photosynthesis and increasing vegetative growth thus increasing the number of branches (Mohamed, 1985).

The volatile oils in the castor leaves

Table 2 and figure 1 shows significant differences in the leaf content of volatile oils influenced by the nitrogen fertilization. The treatment of 2gN.l^{-1} produced the highest amount of Ferulic acid (629.35 mg.g-1) and Syringic acid (436.7 mg.g-1) while the lowest average of coumaric acid (45.30mg.g-1) was produced by the control treatment. This may be attributed to the differences in the concentrations of volatile oils coincided with the different concentrations of N fertilization may be due to the nitrogen participation in the synthesis of amino acids, nucleotides, enzymes, and hormones contributing to the vital construction of many secondary compounds (Aniszewski, 2007).

Table 1: Effect of N fertilization on some vegetative traits of the castor plant.

Dry weight (g)	Fresh weight (g)	Leaf area (cm^2)	Number of leaves	Number of secondary branches. plant	Number of main branches. Plant	stem diameter (cm)	Plant height (cm)	Traits concentration
a 0.577	a 2.95	a 2.75	a 10.58	a 2.63	a 1.57	a 13.40	a 100.60	0g/l (control)
b 0.710	ab 3.54	ab 3.56	a 12.33	a 3.13	a 2.10	a 15.50	b 113.80	2g/l
b 0.780	b 4.08	b 4.11	b 14.42	a 3.44	a 2.40	a 16.30	b 117.50	5g/l
0.689	3.52	3.47	12.44	3.07	2.2	15.10	110.60	mean
0.1288	0.720	0.830	1.958	n. s	n. s	n. s	8.42	LSD 0.05

Table 2: Effect of N fertilization on the castor leaf content of volatile oils

volatile oils concentrations	Syringic acid	O-Coumaric acid	Ferulic acid	P-Coumaric acid	Cinnamic acid
0g/l (control)	229.8	45.30	451.96	97.28	118.73
2g/l	436.7	56.18	629.35	49.27	150.63
5g/l	336.5	220.32	443.65	143.1	55.25
mean	334.33	107.26	508.32	96.55	108.20
LSD 0.05	**11.66**	**6.42**	**4.23**	**0.98**	**2.71**

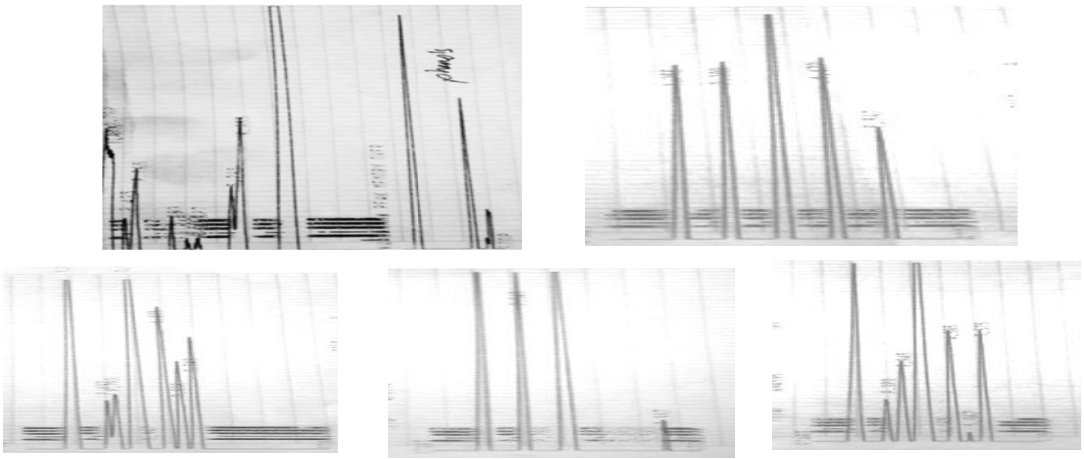

Fig. 1 : Analysis of phenols in castor oil seed extract

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