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PLANTING DATE, CINNAMIC ACID AND N FERTILIZER AFFECT GROWTH AND METABOLITES OF *Pimpinella anisum*

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ABSTRACT

Two field experiments were conducted, to determine the effect of planting anise plant on late date (٢٥th Dec.) in addition to the control date (٢٥th Oct.) on growth parameters, photosynthetic pigments, carbohydrates and nitrogen content of *Pimpinella anisum* L. treated with cinnamic acid (CA) and/ or urea. In general the obtained data showed that, treating anise plant with different concentrations of CA (١mM, ٥mM and ١٠mM) decreased all the growth parameters, photosynthetic pigments, carbohydrate and nitrogen contents during the two dates of cultivation. On the other hand the two used levels of urea fertilizer (٥٠٪ and ١٠٠٪) especially ١٠٠٪, increased all the growth parameters, photosynthetic pigments, carbohydrate and nitrogen contents during the two dates of cultivation. In general, the results obtained by CA and urea; either alone or together in case of control date of cultivation were much better than those obtained on the late date of cultivation.

Keywords: Planting date, cinnamic acid, urea, *Pimpinella anisum* L, growth.

INTRODUCTION

Anise, *Pimpinella anisum* L., a herbaceous annual native to the Mediterranean region and Egypt, is cultivated in Europe, the Middle East, Mexico, North Africa, India and Russia chiefly for its fruits, called aniseed, the flavour of which resembles that of licorice. Anise was well known to the ancient Egyptians and Romans. Anise is used for the treatment of a carminative, antiseptic, antispasmodic, expectorant, stimulant, and stomachic. In addition, it has been used to promote lactation in nursing mothers and as a medicine against bronchitis and indigestion Muller-Schwarze, Dietland (٢٠٠٦).

Cinnamic acid (٣-Pheynl-٢-propenoic acid) is a phenolic compound found naturally in many spices (cinnamon and cloves), cranberries, and prunes, and provides a natural protection against pathogenic organisms. At low concentration (٣٠ mg/L) cinnamic acid has been reported to have a flowery or cinnamon type flavor (Chambel *et al.,* ١٩٩٩; Anslow and Stradford, ٢٠٠٠; Eblen *et al.,* ٢٠٠٤). Cinnamic acid was shown to inhibit the uptake of phosphate and potassium ions by barley roots (Glass, ١٩٧٤). Some studies point to cinnamic acid as being an uncoupler of oxidative phosphorylation (Van Sumere *et al.,* ١٩٧٢), while others have shown that cinnamic acid is probably a weak uncoupler of oxidative phosphorylation but the effect could not totally account for the strong inhibitory effect observed (Tillberg, ١٩٧٠). Glass and Dunlop (١٩٧٤) demonstrated that cinnamic acid caused a rapid, strong depolarization of the membranes of barley roots, and they suggested that this depolarization would account for inhibition of uptake of inorganic ions. Cinnamic acid was found to inhibit seed germination and seedling growth of tomato (Yao, ٢٠٠٧). Singh *et al,* (٢٠١٣) reported that at ٠,٥, ١,٠ and ١,٥ mM concentrations CA has shown inhibitory effects on shoot and root length, fresh and dry weight of cabbage seedlings. Also CA significantly decreased the photosynthetic pigments and protein content.

Urea is a low cost nitrogen fertilizer form. This is because of its high nitrogen composition and consequent low transport and storage costs. It converts to ammonium bicarbonate within about ٤٨ hours after field application. Nitrogen in this form will tend to volatilize to the air as ammonia gas. This lost fertilizer investment risk can be minimized or eliminated by assuring that the urea gets into the soil and does not merely remain on the surface of the soil or crop foliage (James, ٢٠١٠). Urea was reported to increase the length, fresh mass and dry mass of the shoots and roots of wheat plant (Gharakand *et al.;* ٢٠١٢). Similar results were obtained on studying the effect of urea application as a common fertilizer on some vegetables; *Brassica compestris*, *Trigonella foenum graecum* and *Anethum graveolens*, as urea was found to increase the percentage of seed germination, root length, shoot length (root /shoot ratio) and seedling height (Ramteke and Shirgave, ٢٠١٢). Younis *et al,* ٢٠٠٨ studied the effect of treating lettuce plants with increasing concentrations of urea fertilizer and found that urea led to significant increases in nitrate-, ammonia-, amide-, urea-, protein- and total-N contents, led to positive changes in the protein content of the treated lettuce plants.

Global climate change is resulting in increases in the daily, seasonal, and annual mean temperatures experienced by plants. Moreover, climate change will increase the intensity, frequency, and duration of abnormally low and high temperatures (Christensen *et al.;* ٢٠٠٧). Temperature limits plant growth and is also a major determining factor in the distribution of plants across different environments (Mittler ٢٠٠٦). Since photosynthesis has long been recognized as one of the most temperature-sensitive processes in plants, understanding the physiological processes that underlie the temperature response of photosynthesis and its acclimation is important to both agriculture and the environment (Yamori *et al.;* ٢٠١٣). Haroun *et al.* (٢٠١٢) conducted a field experiment to determine the effect of two planting dates; early (٢٥th Oct.) and late (١٥th Dec.) in addition to the control planted at ٢٠th Nov. on phonology, growth, yield (yield components and yield quality) of four bread wheat (*Triticum aestivum* L.). In general, the obtained data showed that, the requirement of days and Growing degree days (GDD) to attain different phonological stages (seedling, booting, heading, anthesis and maturity) decreased with delay in sowing date. Also, planting on the control date (٢٠th Nov) surpassed the other sowing dates in all yield studied parameters and flour quality. However, late sowing date (١٥th Dec.) caused an increase in most technological properties (protein, wet and dry mass) of the yielded grains.

Accordingly the objective of this study was to evaluate the effect of the foliar application of different concentrations of cinnamic acid (١mM, ٥mM and ١٠mM) and / or two different concentrations of urea fertilizer (٥٠٪ and ١٠٠٪) of the recommended dose during a different planting late date (٢٥ Dec) and control one (٢٥ Oct) on growth parameters, some metabolites of *Pimpinella anisum* L. plant.

MATERIALS AND METHODS

Plants used and growth conditions:

Pure strains of *Pimpinella anisum* L. (anise) were purchased from the Agricultural Research Center, Ministry of Agriculture, Giza, Egypt. Two pot experiments were conducted at the Faculty of Science, Mansoura University during two different seasons control date (October ٢٠١١) and late date (December ٢٠١٢). The experiments were carried in clay: sandy soil (٢:١) mixed with phosphate and nitrate fertilizers as common practice. The pots were kept in the greenhouse under a normal day/night conditions and irrigated as usual practice with equal amounts of tap water when required.

The experiments were carried out to study the effect of foliar application of different concentrations of cinnamic acid and urea fertilizer; either each alone or together on growth parameters, photosynthetic pigments, different carbohydrate fractions, total protein content and different nitrogen constituents. According to a preliminary experiment three different concentrations of cinnamic acid (١mM, ٥mM and ١٠mM) and two levels of urea fertilizer were chosen [٥٠٪ urea (٠,٧ g/pot) and ١٠٠٪ (١,٤ g/pot)] according to the recommended dose for anise crop which is ٢٠٠ Kg/fed; according to the announcement of Ministry of Agriculture of Egypt.

In the two experiments, ٤٥ and ١٢٥ days old samples were collected as a vegetative and flowering stages referring to stage I and II respectively.

Analytical methods:

Growth parameters:

Length of root, length of shoot, fresh mass, dry mass and leaf area were estimated.

Estimation of photosynthetic pigments:

The plant photosynthetic pigments (chlorophyll a, chlorophyll b, and carotenoids) were determined at different stages of plant growth using the spectrophotometric method as recommended by Arnon (١٩٤٩) for chlorophylls and Horvath *et al.,* (١٩٧٢) for carotenoids as adopted by Kissimon (١٩٩٩).

Estimation of carbohydrates:

The method of extraction of different carbohydrate fractions (glucose, sucrose and total soluble sugars), used in this investigation was essentially those adopted by Yemm and Willis (١٩٥٤) and Handel (١٩٦٨). The method used for estimation of polysaccharides in the present study was that of Thayumanavan and Sadasivam (١٩٨٤).

Estimation of nitrogenous constituents:

The method used in this investigation was essentially that adopted by Yemm and Willis (١٩٥٦). The dried tissue samples were ground to a fine powder, then a known weight of this powder was extracted in distilled water by grinding the samples for ٣٠ minutes, at room temperature, in a glass mortar. The mixture was then quantitively transferred to a boiling tube, brought quickly to water bath maintained at ٨٠oC for ١٥ minutes. The insoluble residue was removed by filtration and the filtrate was made up to volume and used for estimation of ammonia-, amino-, amide- and total soluble-nitrogen fractions. Whereas, total nitrogen was determined directly using the dried powder tissue.

The full data of different treatments were statistically analyzed and comparison among means at P ≤ ۰,۰٥ was carried out by using CoHort/ CoStat statistical software version display ANOVA (۷۹۸ lighthouse Ave. PMB ۳۲۰, Monterey, CA, ۹۳۹٤۰, USA) (McCrae and Costa, ۲۰۰٤).

RESULTS AND DISCUSSION

Changes in growth parameters:

During the control date of cultivation and at vegetative stage, the shoot length of anise plants decreased in case of ۱mM, ٥mM and ۱۰mM cinnamic acid, but it increased with ٥۰٪ and ۱۰۰٪ urea fertilizer. Also the interaction between cinnamic acid (٥mM and ۱۰mM) and urea (٥۰٪ and ۱۰۰٪) caused decrease in shoot length of anise plants. The pattern of changes in root length, in response to the different treatments was more or less similar to that of shoot length (Table ۱). Anise leaf area and fresh and dry masses in general, decreased with the three concentrations of CA. Whereas ٥۰٪ and ۱۰۰٪ urea fertilizer increased the leaf area, fresh and dry masses. Moreover urea interaction with the different concentrations of CA caused decrease in the leaf area of anise plants.

Table ۱: The effect of two planting dates , different concentrations of cinnamic acid (CA) and urea, either alone or in combination, on growth parameters; length of root (cm plant$^{-۱}$), length of shoot (cm plant$^{-۱}$), fresh mass (g plant$^{-۱}$), dry mass (g plant$^{-۱}$) and leaf area (cm^{۲} plant$^{-۱}$) of *Pimpinella anisum* plants during vegetative stage.

Date	Treatment	Shoot Length	Root Length	Leaf area	Fresh mass	Dry mass
Control	Control	۱۰,٦٥۰	۳,٦۰۰	۲,۲۳٤	٤,۲۷۳	۰,٦٦۸
	۱mM CA	۱۰,۰۰۰	۳,۳٥۰	۲,۲۱۲	۳,۹۲۱*	۰,٤٦٥*
	٥mM CA	۹,٥۰۰*	۲,۹۰۰*	۱,۹٦٥*	۳,٤۱۲*	۰,٤۳۷*
	۱۰mM CA	۸,٤۰۰*	۲,۷٥۰*	۱,۹۲۷*	۳,۰۳۲*	۰,٤۱٥*
	Urea ٥۰٪	۱۰,۷۰۰	۳,۷٥۰	۲,٤۲۰	٤,۳۳٥	۰,٦۷۰
	Urea ٥۰٪ + ۱mM CA	۱۰,۱٥۰	۳,٤٥۰	۲,۲۷۸	۳,۹۲۷*	۰,٥٤۸*
	Urea ٥۰٪ + ٥mM CA	۹,٤٥۰*	۳,٥٥۰	۲,۱۸۳	۳,٥٤۸*	۰,٤۸۷*
	Urea ٥۰٪ + ۱۰mM CA	۸,۸٥۰*	۲,۹٥۰*	۲,۰٥٤	۳,۱۲۹*	۰,۳۹۳*
	Urea ۱۰۰٪	۱۱,۱۰۰	٤,۲٥۰*	۲,٥٦۱*	٤,٤۲٦	۰,٦۸۲
	Urea ۱۰۰٪ + ۱mM CA	۱۰,۳۰۰	٤,۱۰۰*	۲,۱٦۳	٤,۳٥٤	۰,٦٤٥
	Urea ۱۰۰٪ + ٥mM CA	۹,٦٥۰*	۳,٥٥۰	۲,۱٤۲	٤,۱٦۲	۰,٥۹٦
	Urea ۱۰۰٪ + ۱۰mM CA	۹,٥۱۰*	۳,٤۰۰	۲,۱۲۸	۳,٦۸٥*	۰,٤۷۷*
	L.S.D	۰,۸۱٦	۰,٤۱۷	۰,۲٤٦	۰,۳۱۸	۰,۱۰۳
Late	Control	۹,٥٥۰	۳,۲٥۰	۲,٤٦۳	۳,۸۱۲	۰,٦٤۷
	۱mM CA	۹,۱٥۰	۲,۹٥۰*	۲,۲۸٤*	۳,٥٤۲	۰,٥۳۷*
	٥mM CA	۸,۸٥۰*	۲,۸۰۰*	۲,۰۸۳*	۳,۰۷٦*	۰,٤۷۰*
	۱۰mM CA	۸,۱٥۰*	۲,۲٥۰*	۱,۹۷۰*	۳,۰٦۱*	۰,٤٥۲*
	Urea ٥۰٪	۱۰,۱٥۰	۳,٥٥۰*	۲,٥٦۳	٤,۰۱۲	۰,۷۱۹*
	Urea ٥۰٪ + ۱mM CA	۹,۷٥۰	۳,۱٥۰	۲,٤۲۸	۳,۹٦٤	۰,٦٦۰
	Urea ٥۰٪ + ٥mM CA	۹,۱٥۰	۳,۰۰۰*	۲,۲٦۳*	۳,٦٥۳	۰,٦۱۲
	Urea ٥۰٪ + ۱۰mM CA	۸,۹۰۰	۲,۹۰۰*	۲,۱۰۷*	۳,۲۱۸*	۰,٥۸۳*
	Urea ۱۰۰٪	۱۰,۷٥۰*	۳,۷٥۰*	۲,۷۱۸*	٤,۳۲۰*	۰,۷۳٤*
	Urea ۱۰۰٪ + ۱mM CA	۱۰,۰۰۰	۳,٥۰۰*	۲,٥٤۱	٤,۱۹٥*	۰,٦۸۱
	Urea ۱۰۰٪ + ٥mM CA	۹,٤٥۰	۳,۱٥۰	۲,٤۳٥	۳,۸۸۲	۰,٦۰۹
	Urea ۱۰۰٪ + ۱۰mM CA	۹,۲۰۰	۲,۸٥۰*	۲,۳۲۲	۳,۲٦۷*	۰,٥۹٥
	L.S.D	۰,۰٦۳	۰,۲۱۷	۰,۱٤۹	۰,۲۸۸	۰,۰٦۳

At flowering stage the results in table ٢ show that, all the different concentrations of cinnamic acid decreased the shoot length of anise plants. Meanwhile ٥٠٪ urea fertilizer increased shoot length while its combination with different concentrations of CA decreased the shoot length of anise plants. The shoot length of plants supplied with ١٠٠٪ urea increased, whereas its combination with different concentrations of CA decreased the shoot length. Root length of anise plants decreased on treating with the three concentrations of CA. Also ٥٠ % urea fertilizer either alone or combined with the three CA concentrations decreased root length and increased with ١٠٠٪ urea fertilizer, whereas its combination with the different concentrations of CA decreased root length, as compared to control values.

Table ٢: The effect of two planting dates, different concentrations of cinnamic acid (CA) and urea, either alone or in combination, on growth parameters; length of root (cm plant$^{-١}$), length of shoot (cm plant$^{-١}$), fresh mass (g plant$^{-١}$), dry mass (g plant$^{-١}$) and leaf area (cm^{٢} plant $^{-١}$) of *Pimpinella anisum* plants during flowering stage.

Date	Treatment	Shoot Length	Root Length	Leaf area	Fresh mass	Dry mass
Control	Control	٣٤,١٥٠	٥,٤٥٠	٤,٢٧١	٦,٢٤٧	١,٥٤٠
	١mM CA	٣٢,١٥٠*	٤,٩٠٠*	٤,١٨٠	٦,١١٦	١,٣٥٦*
	٥mM CA	٣١,٧٥٠*	٤,٤٥٠*	٤,٢١٥	٦,١٧١	١,٣٧٣
	١٠mM CA	٢٩,٩٠٠*	٤.٥٥٠*	٣,٩٤٦*	٤,٦٦٠*	٠,٨٨٥*
	Urea ٥٠٪	٣٤,٣٥٠	٥,١٠٠	٤,٣٠٧	٦,٤٢٤	١,٥٩٢
	Urea ٥٠٪ + ١mM CA	٣٤,٠٥٠	٤,٩٥٠	٤,٠٩٠	٦,٣٢٨	١,٤٨٦
	Urea ٥٠٪ + ٥mM CA	٣٣,٤٠٠*	٤,٩٠٠*	٤,٢٦٣	٦,١٣٤	١,٥٢٠
	Urea ٥٠٪ + ١٠mM CA	٣٣,٢٥٠	٤,٨٠٠*	٤,٠٣٤	٦,٠١٨	١,١٩٥*
	Urea ١٠٠٪	٣٥,٣٠٠*	٥,٦٥٠	٤,٣٢٦	٦,٧٦١	٢,٠١٣*
	Urea ١٠٠٪ + ١mM CA	٣٣,٩٥٠	٥,٢٥٠	٤,٢٨٢	٦,٤٨٠	١,٨٢٤*
	Urea ١٠٠٪ + ٥mM CA	٣٢,٩٠٠*	٥,٣٥٠	٤,٢٢٣	٦,٣٥٥	١,٣٧٠
	Urea ١٠٠٪ + ١٠mM CA	٣٢,٦٥٠*	٤,٧٠٠*	٣,٢٦٠*	٥,٩٨٤	١,٢٩٥*
	L.S.D	١,١٤٩	٠,٥٤٩	٠,٢٨١	٠,٥١٨	٠,١٨٦
Late	Control	٢٧,٥٠٠	٤,٩٠٠	٤,٠٩٥	٥,٣٤٢	١,٩٨٤
	١mM CA	٢٥,٥٥٠*	٤,٥٠٠*	٣,٨٤٦*	٥,٠٢٤*	١,٥٦٣*
	٥mM CA	٢٥,١٥٠*	٤,٢٥٠*	٣,٥٤٢*	٥,٠١٣*	١,٣٠٨*
	١٠mM CA	٢٣,٠٠٠*	٣,٧٥٠*	٣,٤٣٦*	٤,٤٥٨*	١,٠١٢*
	Urea ٥٠٪	٢٧,٩٠٠	٥,١٠٠	٤,٢١٤	٥,٧٢١*	٢,١١٢*
	Urea ٥٠٪ + ١mM CA	٢٧,٢٥٠	٤,٥٥٠*	٤,١٢٦	٥,٥٢٤	٢,٠١٤
	Urea ٥٠٪ + ٥mM CA	٢٦,٥٠٠	٤,٦٥٠	٤,٠٥٢	٥,٢٨٣	١,٨٥٠*
	Urea ٥٠٪ + ١٠mM CA	٢٥,٥٠٠*	٤,٥٠٠*	٣,٨٦٤*	٤,٩٧٢*	١,٥٤٤*
	Urea ١٠٠٪	٢٨,٤٠٠	٥,١٥٠	٤,٣٣٩*	٦,٢٤٨*	٢,٢٢٦*
	Urea ١٠٠٪ + ١mM CA	٢٧,٩٠٠	٥,١٠٠	٤,٢٦٣*	٦,٠٤٣*	٢,١٩٦*
	Urea ١٠٠٪ + ٥mM CA	٢٦,٤٥٠	٤,٨٠٠	٤,٠١٥	٥,٤٢٢	٢,٠٤٧
	Urea ١٠٠٪ + ١٠mM CA	٢٥,٥٠٠*	٤,٦٠٠	٣,٩٥٣	٥,١١٦	١,٩٤٢
	L.S.D	١,٠٥٧	٠,٣٢٨	٠,١٥٧	٠,٣١٢	٠,١١٦

Leaf area of anise plant decreased on treating with ١mM, ٥mM and ١٠mM CA but increased with ٥٠٪ urea, whereas its interaction with different concentrations of CA decreased leaf area. On the other hand, ١٠٠٪ urea either alone or in combination with ١mM CA caused increase in leaf area while its combination with CA decreased leaf area at ٥mM and ١٠mM CA. Fresh mass, decreased in case of ١mM, ٥mM and ١٠mM CA concentration. Meanwhile ٥٠٪ urea fertilizer either alone or in combination with ١mM CA caused increase in fresh mass, while its combination with ٥mM and ١٠mM CA led to decrease in fresh mass. Also ١٠٠٪ urea fertilizer either alone or combined with ١mM and ٥mM CA increased fresh mass while ١٠mM CA decreased it. The dry mass of plants treated with different concentrations of CA decreased with the three concentrations of CA. The ٥٠٪ urea-fed plants showed increase in dry mass, whereas ٥٠٪ urea combined with all CA concentrations decreased this parameter. Treatment with ١٠٠٪ urea alone or in combination with ١mM CA increased dry mass, while its combination with ٥mM and ١٠mM CA decreased this parameter.

Perusal of the data, at both vegetative and flowering stage during the late date of cultivation, shows nearly the same pattern of change occurred in the control date. It's worthy to mention that results obtained by CA and urea; independent or together in case of control date of cultivation were much better than those obtained on the late date of cultivation.

In this connection, under CA stress, the reduction in plant growth (root length, shoot length) and biomass was observed in *Lactuca sativa* (Hussain *et al.,* ٢٠١٠). Similar results were observed by Ye *et al.,* ٢٠٠٤ on *Cucumis sativus* L. The CA (٠,٥-٠,٢٥ mM) has been shown to cause oxidative stress in cucumber roots (Ding *et al.,* ٢٠٠٧). Altered root morphology in *Pisum sativum* (Vaughan and Ord, ١٩٩١). Trans- cinnamic acid inhibited the root elongation of *Lactuca sativa* (Fujita and Kabo, ٢٠٠٣). Likewise, Ding *et al.* (٢٠٠٧) reported that CA significantly inhibited the growth of cucumber.

In other study, urea was reported to increase the length, fresh mass and dry mass of the shoots and roots of wheat plant (Gharakand *et al.;* ٢٠١٢). Similar results were obtained on studying the effect of urea application as a common fertilizer on some vegetables; *Brassica compestris*, *Trigonella foenum graecum* and *Anethum graveolens*, as urea was found to increase the percentage of seed germination, root length, shoot length, root /shoot ratio and seedling height (Ramteke and Shirgave, ٢٠١٢). In support of the present observations, Puttanna *et al.,* (٢٠٠١) demonstrated that foliar application of urea fertilizer significantly enhanced the growth and yield of citronella plants and increased most of the growth parameters (plant height, leaf area, fresh and dry masses.

The improvement of vegetative characteristics of anise plant (height, fresh mass and dry mass) with increase in nitrogen fertilizer rate could be attributed to increased uptake of nitrogen and its associated role in chlorophyll synthesis and hence the process of photosynthesis and carbon dioxide assimilation (Jasso-chaverria *et al.,* ٢٠٠٥) leading to enhance growth. In addition, nitrogen stimulates vegetative growth resulting in large stems and leaves. The significant response of leaf area by urea fertilizer may be an indication that nitrogen was taken up by the plant and subsequently utilized in cell multiplication, amino acid synthesis and energy formation that acts as structural compound of the chloroplast which carries out photosynthesis as nitrogen fertilizer has been reported to be a constituent of chlorophyll (Lawlor, ٢٠٠٢). In support, nitrogen insufficiencies have been reported to reduce the individual leaf area, leaf area index, and total leaf area resulting to reduced surface light interception for photosynthesis (Cechin and Fumis, ٢٠٠٤).

Changes in photosynthetic pigments:

As compared to control values, the different concentrations of CA at vegetative stage caused decrease in chlorophyll a, chlorophyll b, total chlorophylls (chl a+ chl b), carotenoids and consequently total pigments in case of ١mM, ٥mM and ١٠mM CA. In ٥٠٪ urea-fed plants there was an increase in chlorophyll a, chlorophyll b, total chlorophylls (chl a+ chl b), carotenoids and total pigments. The combination of ٥٠٪ urea fertilizer and ١mM CA caused decrease in chlorophyll a, total chlorophylls (chl a+ chl b) and total pigments, but increased chl b and carotenoids. Meanwhile the interaction between ٥mM CA and ٥٠٪ urea caused decrease in chlorophyll a, chlorophyll b, total chlorophylls (chl a+ chl b), carotenoids and total pigments. Also ١٠mM CA mixed with ٥٠٪ urea caused decrease in chlorophyll a, chlorophyll b, total chlorophylls, carotenoids and total pigments content during the control date of cultivation (Table ٣).

Table ٣: The effect of two planting dates, different concentrations of cinnamic acid (CA) and urea, either alone or in combination, on photosynthetic pigments (mg g $^{-١}$ dry weight) of *Pimpinella anisum* plants during the vegetative stage.

Date	Treatment	Chl a	Chl b	Chl a + b	Cars	Total pigments
Control	Control	٥,٨٨٠	٣,٤٩٠	٩,٣٧٠	٣,١٦٠	١٢,٥٣٠
	١mM CA	٥,٦٥٠	٣,١٢٠	٨,٧٧٠	٢,٨٨٠	١١,٦٥٠
	٥mM CA	٥,٦٧٠	٣,٠٧٠	٨,٧٤٠	٢,٧٢٠	١١,٤٦٠
	١٠mM CA	٤,١٥٠*	٢,٨٦٠*	٧,٠١٠*	٢,١٨٠*	٩,١٩٠*
	Urea ٥٠٪	٥,٩٦٠	٣,٥٨٠	٩,٥٤٠	٣,٣٥٠	١٢,٨٩٠
	Urea ٥٠٪ + ١mM CA	٥,٧٨٠	٣,٥١٠	٩,٢٩٠	٣,٢٢٠	١٢,٤٨٠
	Urea ٥٠٪ + ٥mM CA	٥,٧٢٠	٣,٤٤٠	٩,١٦٠	٣,٠٧٠	١٢,٢٣٠
	Urea ٥٠٪ + ١٠mM CA	٤,٨٣٠*	٣,١٦٠	٧,٩٩٠*	٢,٩٢٠	١٠,٩١٠
	Urea ١٠٠٪	٥,٩٢٠	٤,٢١٠*	١٠,١٣٠	٣,٦٧٠	١٣,٨٠٠
	Urea ١٠٠٪ + ١mM CA	٥,٧٣٠	٤,١٣٠*	٩,٨٦٠	٣,٤٢٠	١٣,٢٨٠
	Urea ١٠٠٪ + ٥mM CA	٥,٦٤٠	٣,٨٨٠	٩,٥٢٠	٣,١٥٠	١٢,٦٧٠
	Urea ١٠٠٪ + ١٠mM CA	٥,٠٧٠	٣,١٥٠	٨,٢٢٠	٢,٩٤٠	١١,١٦٠
	L.S.D	٠,٨٨٤	٠,٦٠٥	١,٣٣٥	٠,٥٩٠	١,٧٢٦
Late	Control	٤,٩٣٠	٢,٣١٠	٧,٢٤٠	٢,٢٣٠	٩,٤٧٠
	١mM CA	٤,٤٦٠	٢,١٥٠	٦,٦١٠	٢,٢٤٠	٨,٨٥٠
	٥mM CA	٣,٩٠٠*	٢,١٣٠*	٦,٠٣٠*	٢,١٥٠	٨,١٨٠
	١٠mM CA	٣,٣٨٠*	٢,٠٧٠*	٥,٤٥٠*	١,٨٨٠*	٧,٣٣٠*
	Urea ٥٠٪	٤,٩٦٠	٢,٤٢٠	٧,٣٨٠	٢,٢٦٠	٩,٦٤٠
	Urea ٥٠٪ + ١mM CA	٤,٥٩٠	٢,١٧٠	٦,٧٦٠	٢,٣١٠	٩,٠٧٠
	Urea ٥٠٪ + ٥mM CA	٤.٠٧٠*	٢,٠٠٠*	٦,٠٧٠*	٢,٠٢٠	٨,٠٩٠
	Urea ٥٠٪ + ١٠mM CA	٣,٣٨٠*	١,٩٥٠*	٥,٣٣٠*	١,٨٩٠*	٧,٢٢٠*
	Urea ١٠٠٪	٥,٠٩٠	٢,٤٦٠	٧,٥٥٠	٢,٢٥٠	٩,٨٠٠
	Urea ١٠٠٪ + ١mM CA	٤,٧١٠	٢,٢٨٠	٦,٩٩٠	٢,١٧٠	٩,١٦٠
	Urea ١٠٠٪ + ٥mM CA	٣,٨٢٠*	٢,٠٣٠*	٥,٨٥٠*	٢,٠١٠	٧,٨٦٠*
	Urea ١٠٠٪ + ١٠mM CA	٣,٥٥٠*	١,٩٥٠*	٥,٥٠٠*	١,٩٦٠	٧,٤٦٠*
	L.S.D	٠,٥٤٢	٠,١٦٨	٠,٧٠٣	٠,٣٠٢	١,٧٩٢

Plants supplied with ١٠٠٪ urea fertilizer at the control date of cultivation showed increase in chlorophyll a, chlorophyll b, total chlorophylls, carotenoids and total pigments. The interaction of ١٠٠٪ urea with ١mM CA caused decrease in chlorophyll a and increase in chlorophyll b, total chlorophylls, carotenoids and total pigments. The application of ٥mM CA with ١٠٠٪ urea decreased chlorophyll a and carotenoids, but increased chlorophyll b, total chlorophylls and total pigments content. Meanwhile, combination of ١٠٠٪ urea and ١٠mM CA decreased chlorophyll a, chlorophyll b, total chlorophylls, carotenoids and total pigments.

At flowering stage during the control date of cultivation, showed decrease in chlorophyll a, chlorophyll b, total chlorophylls (chl a+ chl b), carotenoids and total pigments in case of ١mM, ٥mM and ١٠mM CA. The application of ٥٠٪ urea fertilizer caused increase in chlorophyll a, chlorophyll b, total chlorophylls, carotenoinds and total pigments. ٥٠٪ urea + ١mM CA caused decrease in chlorophyll a, chlorophyll b, total chlorophylls (chl a+ chl b), and total pigments and increase in carotenoids. Whereas, interaction of ٥mM CA as well as with ١٠mM CA and ٥٠٪ urea decreased chlorophyll a, chlorophyll b, carotenoids, total chlorophylls and total pigments. ١٠٠٪ urea fertilizer caused increase in chlorophyll a, chlorophyll b, total chlorophylls (chl a+ chl b), carotenoids and total pigments. Combination of ١٠٠٪ urea with ١mM, ٥mM or ١٠mM CA resulted in decrease in chlorophyll a, chlorophyll b, total chlorophylls (chl a+ chl b), carotenoids and total pigments (Table ٤).

Table ٤: The effect of two planting dates, different concentrations of cinnamic acid (CA) and urea, either alone or in combination, on photosynthetic pigments (mg g $^{-١}$ dry weight) of *Pimpinella anisum* plants during the flowering stage.

Date	Treatment	Chl a	Chl b	Chl a + b	Cars	Total pigments
Control	Control	٤,٩٣٠	٢,٣١٠	٧,٢٤٠	٢,٢٣٠	٩,٤٧٠
	١mM CA	٤,٤٦٠	٢,١٥٠	٦,٦١٠	٢,٢٤٠	٨,٨٥٠
	٥mM CA	٣,٩٠٠*	٢,١٣٠*	٦,٠٣٠*	٢,١٥٠	٨,١٨٠
	١٠mM CA	٣,٣٨٠*	٢,٠٧٠*	٥,٤٥٠*	١,٨٨٠*	٧,٣٣٠*
	Urea ٥٠٪	٤,٩٦٠	٢,٤٢٠	٧,٣٨٠	٢,٢٦٠	٩,٦٤٠
	Urea ٥٠٪ + ١mM CA	٤,٥٩٠	٢,١٧٠	٦,٧٦٠	٢,٣١٠	٩,٠٧٠
	Urea ٥٠٪ + ٥mM CA	٤,٠٧٠*	٢,٠٠٠*	٦,٠٧٠*	٢,٠٢٠	٨,٠٩٠
	Urea ٥٠٪ + ١٠mM CA	٣,٣٨٠*	١,٩٥٠*	٥,٣٣٠*	١,٨٩٠*	٧,٢٢٠*
	Urea ١٠٠٪	٥,٠٩٠	٢,٤٦٠	٧,٥٥٠	٢,٢٥٠	٩,٨٠٠
	Urea ١٠٠٪ + ١mM CA	٤,٧١٠	٢,٢٨٠	٦,٩٩٠	٢,١٧٠	٩,١٦٠
	Urea ١٠٠٪ + ٥mM CA	٣,٨٢٠*	٢,٠٣٠*	٥,٨٥٠*	٢,٠١٠	٧,٨٦٠*
	Urea ١٠٠٪ + ١٠mM CA	٣,٥٥٠*	١,٩٥٠*	٥,٥٠٠*	١,٩٦٠	٧,٤٦٠*
	L.S.D	٠,٥٤٢	٠,١٦٨	٠,٧٠٣	٠,٣٠٢	١,٧٩٢
Late	Control	٢,٦٥٠	١,٩٣٠	٤,٥٨٠	١,٩٥٠	٦,٥٣٠
	١mM CA	٢,٤٩٠	١,٨٥٠	٤,٣٤٠	١,٨٦٠	٦,٢٠٠
	٥mM CA	٢,٤٣٠	١,٨٢٠	٤,٢٥٠*	١,٧٦٠*	٦,٠١٠
	١٠mM CA	١,٥١٠*	١,٧١٠*	٣,٢٢٠*	١,٧٥٠*	٤,٩٧٠*
	Urea ٥٠٪	٢,٧٦٠	١,٩٨٠	٤,٧٤٠	١,٩٩٠	٦,٧٣٠
	Urea ٥٠٪ + ١mM CA	٢,٥١٠	١,٨٩٠	٤,٤٠٠	١,٨٧٠	٦,٢٧٠
	Urea ٥٠٪ + ٥mM CA	٢,٤٥٠	١,٨٣٠	٤,٢٨٠*	١,٨٠٠	٦,٠٨٠
	Urea ٥٠٪ + ١٠mM CA	١,٩٣٠*	١,٧٦٠	٣,٦٩٠*	١,٦٤٠*	٥,٣٣٠*
	Urea ١٠٠٪	٢,٦٨٠	٢,٠٧٠	٤,٧٥٠	٢,٠٥٠	٦,٨٠٠
	Urea ١٠٠٪ + ١mM CA	٢,٥٢٠	١,٩١٠	٤,٤٣٠	١,٩١٠	٦,٣٤٠
	Urea ١٠٠٪ + ٥mM CA	٢,٤٤٠	١,٨٣٠	٤,٢٧٠*	١,٨٢٠	٦,٠٩٠
	Urea ١٠٠٪ + ١٠mM CA	٢,٠٧٠*	١,٧٥٠	٣,٨٢٠*	١,٨٠٠	٥,٦٢٠*
	L.S.D	٠,٥١٩	٠,٢٠٧	٠,٢٩٧	٠,١٥٨	٠,٦٣٩

Data in tables ٣ and ٤ shows that at both vegetative and flowering stages during the late date of cultivation, the pattern of change didn't differ so much from the control date. But as mentioned before, results obtained by CA and urea; independent or together in case of control date of cultivation were much better than those obtained on the late date of cultivation.

In this respect, chlorophylls are the core component of pigment protein complexes embedded in the photosynthetic membranes and play a major role in the photosynthesis. Any changes in chlorophyll content are expected to bring about change in photosynthesis (Reigosa *et al.,* ٢٠٠٦). The influence of N on plant growth and development is often connected with the process of photosynthesis, because the quantity of N, in the highest degree, determines the formation and the functional state of assimilation apparatus of plants including the content of photosynthetic pigments, the synthesis of the enzymes taking part in the carbon reduction and the formation of the membrane system of chloroplasts (Stanev, ١٩٨٤; Ivanova and Vassilev, ٢٠٠٣).

Also the positive effects of N fertilization may be due to the important physiological role of N in molecule structure as porphyrin. The porphyrin structure is found in such metabolically important compounds as the chlorophyll pigments and the cytochromes, which are essential in photosynthesis and respiration. Coenzymes are essential to the function of many enzymes. Accordingly, nitrogen plays an important role in synthesis of the plant constituents through the action of different enzymes activities and protein synthesis (Jones *et al,.* ١٩٩١) that reflected in the increase in growth parameters of plants such as anise, coriander and sweet fennel plants. Also, these results are in accordance with those obtained by Khalid (١٩٩٦, ٢٠٠١) on some Apiaceae and *Nigella sativa* L. plants; Ashraf *et al.* (٢٠٠٦) on cumin; Akbarinia *et al.* (٢٠٠٧) on coriander; Hellal *et al.* (٢٠١١) on dill (*Anethum graveolens* L.), all of them reported that N fertilizer treatments were superior to the control treatment and significantly improved the vegetative growth characters of family Apiaceae.

Changes in carbohydrate contents:

Regarding the control date of cultivation at vegetative stage, glucose content, sucrose, total soluble sugars, polysaccharides and total carbohydrates of anise plant were decreased by treating with ١mM, ٥mM and ١٠mM CA. But increased by ٥٠٪ or ١٠٠٪ urea or their combination with different CA concentrations. Also different concentrations of CA led to decrease in these parameters. Meanwhile applying ٥٠٪ urea to anise plants either alone or in combination with ١mM CA increased glucose, sucrose, total soluble sugars, polysaccharides and total carbohydrates (Table ٥).

On the other hand, ٥mM CA+ ٥٠٪ urea decreased glucose and sucrose and increased total soluble sugars, polysaccharides and total carbohydrates, whereas ١٠mM CA with ٥٠٪ urea decreased glucose, sucrose, total soluble sugars, polysaccharides and total carbohydrates. Fertilization by ١٠٠٪ urea caused increase in all the determined carbohydrates content. Also ١٠٠٪ urea and ١mM CA increased glucose, sucrose, total soluble sugars, polysaccharides and total carbohydrates, whereas ١٠٠٪ urea+ ٥mM CA increased all the determined carbohydrates content except for sucrose content which decreased. Regarding the interaction of ١٠٠٪ urea and ١٠mM CA a decrease in all the determined carbohydrates was detected.

Table ٥: The effect of two plantimg dates, different concentrations of cinnamic acid (CA) and urea, either alone or in combination, on carbohydrates content (mg g $^{-١}$ dry weight) of *Pimpinella anisum* plants during the vegetative stage.

Date	Treatment	Glucose	Sucrose	TSS	Polysaccharides	Total carbohydrates
Control	Control	٢١,٦٧٠	٣٢,٢٢٠	٧٦,٨٠٠	٤٠,١٢٠	١١٦,٩٢٠
	١mM CA	٢١,٢٨٠	٢٩,٨٧٠*	٧٦,٣٤٠	٤٠,٣٣٠	١١٦,٦٧٠
	٥mM CA	٢٠,٨٧٠	٢٩,٠٤٠*	٦٨,٠٠٠*	٣٨,٦٧٠	١٠٦,٦٧٠*
	١٠mM CA	١٩.١٥٠*	٢٨,١٨٠*	٦٢,٢٧٠*	٣٥,٨٩٠*	٩٨,١٦٠*
	Urea ٥٠٪	٢٣,٢٨٠	٣٨,١٢٠*	٨٢,٤٠٠*	٤٢,٨٩٠*	١٢٥,٢٩٠*
	Urea ٥٠٪ + ١mM CA	٢٣,٠٣٠	٣٥,٨٣٠*	٨٢,٢٤٠*	٤٢,٧٠٠*	١٢٤,٩٤٠*
	Urea ٥٠٪ + ٥mM CA	٢٢,١٥٠	٣٥,٩٠٠*	٨٠,١٠٠*	٤٢,٠٢٠*	١٢٢,١٢٠*
	Urea ٥٠٪ + ١٠mM CA	٢٢,٠٠٠	٣٤,٤٢٠*	٧٨,٣٠٠	٤١,٠٠٠*	١١٩,٣٠٠*
	Urea ١٠٠٪	٢٥,٦٧٠*	٤٠,٦٧٠*	٩٤,٢٠٠*	٤٨,٠٠٠*	١٤٢,٢٠٠*
	Urea ١٠٠٪ + ١mM CA	٢٥,٥٢٠*	٤٠,٤٧٠*	٩٤,١٥٠*	٤٧,٦٢٠*	١٤١,٧٧٠*
	Urea ١٠٠٪ + ٥mM CA	٢٥,١٥٠*	٣٨,٢٧٠*	٩٣,٨١٠*	٤٧,١٣٠*	١٤٠,٩٤٠*
	Urea ١٠٠٪ + ١٠mM CA	٢٤,٢٩٠*	٣٨,٠٨٠*	٩٢,١٥٠*	٤٦,٣٣٠*	١٣٨,٤٨٠*
	L.S.D	٢,٥٠٣	١,٩٣٣	٢,٧٣٧	٢,٠٥٢	٣,٦٩٦
Late	Control	٢٥,٥٤٠	٢٢,٥٨٠	٦٣,٢٢٠	٤٩,٨٢٠	١١٣,٠٤٠
	١mM CA	٢٣,٤١٠*	٢٢,١٢٠	٦٢,٥٤٠	٤٨,٦٥٠	١١١,١٩٠
	٥mM CA	٢٢,٦٩٠*	٢٠,٤٧٠*	٦٢,٢٤٠	٤٨,٢٦٠*	١١٠,٥٠٠*
	١٠mM CA	٢٠,٧٥٠*	٢٠,١٦٠*	٦٠,١٧٠*	٤٨,١٧٠*	١٠٨,٣٤٠*
	Urea ٥٠٪	٢٦,٣٤٠	٢٣,٥٦٠	٦٥,٢٩٠	٥٠,٥٧٠	١١٥,٧٦٠*
	Urea ٥٠٪ + ١mM CA	٢٥,٨٢٠	٢٣,٧٢٠	٦٥,١١٠	٥٠,٤٢٠	١١٥,٥٣٠*
	Urea ٥٠٪ + ٥mM CA	٢٤,٧٣٠	٢٢,٤٦٠	٦٥,٠٧٠	٥٠,١٨٠	١١٥,٢٥٠
	Urea ٥٠٪ + ١٠mM CA	٢٣,٤٦٠*	٢١,٥٥٠	٦٤,٢١٠	٤٨,٣٦٠*	١١٢,٥٧٠
	Urea ١٠٠٪	٢٧,٤٩٠*	٢٣,٨٩٠*	٦٩,٣٤٠*	٥٢,٤٧٠*	١٢١,٨١٠*
	Urea ١٠٠٪ + ١mM CA	٢٦,١٧٠	٢٣,٥٤٠	٦٧,٤٢٠*	٥٢,١٢٠*	١١٩,٥٤٠*
	Urea ١٠٠٪ + ٥mM CA	٢٥,٥٥٠	٢٢,١٤٠	٦٥,٢٢٠	٥١,٣٤٠*	١١٦,٥٦٠*
	Urea ١٠٠٪ + ١٠mM CA	٢٥,٤٢٠	٢١,٣١٠	٦٣,١٤٠	٤٩,٣١٠	١١٢,٤٥٠
	L.S.D	١,٧٨٣	١,٢٤٥	٣,٠١٨	١,٤٠٢	٢,٣٦١

In table ٦ the results show that, at flowering stage at the control date of cultivation, the different concentrations of CA decreased glucose, sucrose, polysaccharides, total soluble sugars and total carbohydrates content. The application of ٥٠٪ urea fertilizer caused increase in glucose, sucrose, polysaccharides and total carbohydrates content but decreased total soluble sugars content. Whereas the interaction of ٥٠٪ urea with ١mM CA decreased sucrose, total soluble sugars and total carbohydrates content but increased glucose and polysaccharides contents. Also ٥٠٪ urea + ٥mM CA increased glucose, total soluble sugars, total carbohydrates and polysaccharides, and decreased sucrose content. While ٥٠٪ urea with ١٠mM CA decreased these metabolites.

Treatment with ١٠٠٪ urea fertilizer increased all determined carbohydrates fractions. Glucose, sucrose and polysaccharides content also increased in response to ١٠٠٪ urea combined with the three different concentrations of CA. Total soluble sugars and total carbohydrates also increased with ١mM and decreased with ٥mM and ١٠mM CA mixed with ١٠٠٪ urea.

Table ٦: The effect of two planting dates, different concentrations of cinnamic acid (CA) and urea, either alone or in combination, on carbohydrates content (mg g ⁻١ dry weight) of *Pimpinella anisum* plants during the flowering stage.

Date	Treatment	Glucose	Sucrose	TSS	Polysaccharides	Total carbohydrates
Control	Control	٣٢,٤٨٠	٤٤,٤٠٠	٩٨,٧٨٠	٤٥,٣٤٠	١٤٤,١٢٠
	١mM CA	٣١,٦٤٠	٤٤,٢١٠	٩٦,٢٤٠*	٤٦,٢١٠	١٤٢,٤٥٠
	٥mM CA	٣١,٠٧٠	٤١,٤٧٠	٩٥,٦٣٠*	٤٥,٠٠٠	١٤٠,٦٣٠
	١٠mM CA	٣٠,٦٣٠	٤٠.٦٧٠*	٩٥,٢٢٠*	٤٥,٨١٠	١٤١,٠٣٠
	Urea ٥٠٪	٣٣,٥٩٠	٤٥,٢٨٠	٩٨,٣٢٠	٤٧,٢٣٠	١٤٥,٥٥٠
	Urea ٥٠٪ + ١mM CA	٣٣,٤٢٠	٤٤,٢٣٠	٩٧,٧٣٠	٤٦,٢٢٠	١٤٣,٩٥٠
	Urea ٥٠٪ + ٥mM CA	٣٣,٠٠٠	٤٢,٣٣٠	٩٦,٢٠٠*	٤٥,٣٥٠	١٤١,٥٥٠
	Urea ٥٠٪ + ١٠mM CA	٣١,٢١٠	٤٣,٥٢٠	٩٥,٢٦٠*	٤٤,٦٢٠	١٣٩,٨٨٠*
	Urea ١٠٠٪	٤٠,٠٩٠*	٥٠,٢٣٠*	١١٠,٤٧٠*	٥٠,٧٢٠*	١٦١,١٩٠*
	Urea ١٠٠٪ + ١mM CA	٣٨,١٣٠*	٤٨,٠٠٠*	٩٩,٦٢٠	٤٨,٢١٠*	١٤٧,٨٣٠
	Urea ١٠٠٪ + ٥mM CA	٣٦,٧٣٠*	٤٥,٥٦٠	١٠٢,٥٤٠*	٤٧,٢٣٠	١٤٩,٧٧٠*
	Urea ١٠٠٪ + ١٠mM CA	٣٣,٤٢٠*	٤٤,٨٥٠	٩٨,٣٥٠	٤٥,٢١٠	١٤٣,٥٦٠
	L.S.D	٢,٥٦٣	٢,١٧٧	٢,٣٣٣	٢,٤٠٨	٤,٤٥٠
Late	Control	٤٦,١٨٠	٣٩,٢٦٠	٨٦,٣٢٠	٤٩,٨٢٠	١٣٦,١٤٠
	١mM CA	٤٤,٢٥٠	٣٨,٤٢٠	٨٦,٢٤٠	٤٧,٣٦٠*	١٣٣,٦٠٠
	٥mM CA	٤٣,٨٧٠*	٣٧,٥٤٠	٨٥,٦٧٠	٤٧,٢٥٠*	١٣٢,٩٢٠*
	١٠mM CA	٤٢,٧٣٠*	٣٧,١٦٠	٨٤,٢١٠*	٤٦,٢٢٠*	١٣٠,٤٣٠*
	Urea ٥٠٪	٥٠,٤٧٠*	٤٣,٥١٠*	٨٨,٤٧٠*	٥٠,٢٧٠	١٣٨,٧٤٠
	Urea ٥٠٪ + ١mM CA	٥٠,٢١٠*	٤٠,٧٢٠	٨٦,٩٤٠	٤٩,٩٧٠	١٣٦,٩١٠
	Urea ٥٠٪ + ٥mM CA	٤٨,٧٦٠*	٣٩,٥٢٠	٨٦,٢٤٠	٤٨,٦٧٠	١٣٤,٩١٠
	Urea ٥٠٪ + ١٠mM CA	٤٨,٢٢٠*	٣٨,١٤٠	٨٥,٢٣٠	٤٧,٠٩٠*	١٣٢,٣٢٠*
	Urea ١٠٠٪	٥٣,٧٤٠*	٤٢,٥٧٠*	٨٩,٧٦٠*	٥٢,٤٧٠*	١٤٢,٢٣٠*
	Urea ١٠٠٪ + ١mM CA	٥١,٠٨٠*	٤١.٧٨٠	٨٨,٣٤٠	٥٢,١٤٠*	١٤٠,٤٨٠*
	Urea ١٠٠٪ + ٥mM CA	٥٠,٤٢٠*	٣٩,٧٨٠	٨٧,٤١٠	٥٠,٨٩٠	١٣٨,٣٠٠
	Urea ١٠٠٪ + ١٠mM CA	٥٠,٠٤٠*	٣٨,٦٤٠	٨٦,٠٨٠	٥٠,١٢٠	١٣٦,٢٠٠
	L.S.D	١,٩٦٣	٢,٧٤٦	٢,٠٧٧	١,٣٤٩	٣,١٥٢

Also at the late date of cultivation during the flowering stage, results in table ٦ show that, comparing to control levels, ١mM, ٥mM and ١٠mM CA decreased all the determined carbohydrates fractions. On the other hand ٥٠٪ urea increased the determined carbohydrate contents. Meanwhile the interaction of ٥٠٪ urea with the three concentrations of CA increased glucose content significantly, whereas ٥٠٪ urea+ ١mM CA decreased sucrose, total soluble sugars, polysaccharides and total carbohydrates. Also ٥٠٪ urea+ ٥mM led to increase in sucrose and decrease in total soluble sugars, polysaccharides and total carbohydrates content, while the combination of ٥٠٪ urea and ١٠mM CA decreased sucrose, total soluble sugars polysaccharides and total carbohydrates. Regarding ١٠٠٪ urea either alone or combined with ١mM CA, an increase in all the determined carbohydrates content was detected. Interaction of ٥mM and ١٠mM CA with ١٠٠٪ urea led to increase in glucose, polysaccharides and total carbohydrates content and increased sucrose and total soluble sugars with ٥mM CA combined with ١٠٠٪ urea and decreased in response to ١٠mM CA + ١٠٠٪ urea.

There has been increase in research on the role of the demand for photo-assimilates in regulating photosynthesis through changes in carbohydrate partitioning and accumulation under stress condition (Paul and Driscoll, ١٩٩٧; Nielsen *et al.,* ١٩٩٨; Paul and Foyer, ٢٠٠١). N plays an important role in synthesis of the plant constituents through the action of different enzymes activity and protein synthesis (Jones *et al.,* ١٩٩١) that reflected on an increase in growth parameters and chemical constituents of anise, coriander and sweet fennel plants. The obtained results are in accordance with those obtained by previous literature. N is a necessary component of several vitamins. N improves the quality and quantity of dry matter in leafy plants and protein in grain crops (Silva and Uchida, ٢٠٠٠). Increase the N fertilizer caused a significant increase in the seed yield of *Mentha arvensis* L and *Anethum graveolens* L. (Munsi, ١٩٩٢; Randhawa *et al.,* ١٩٩٦ respectively). N fertilization increased the vegetative growth, essential oil, fixed oil, total carbohydrates, soluble sugars and NPK content of *Nigella sativa* L. plants (Khalid, ٢٠٠١). Zheljazkov and Margina (١٩٩٦) established that vegetative growth and essential oil (yield and constituents) of *Mentha piperita* and *Mentha arvensis* were increased as N fertilizer increase. Arabaci and Bayram (٢٠٠٤) found that N fertilizer increased the amount of green herb yield, drug herb yield, drug leaves, essential oil (% & yield) of basil (*Ocimum basilicum* L.).

Changes in nitrogenous fractions:

Results presented in table ٧ show that, at the vegetative stage, the different concentrations of CA decreased ammonia-N content with the three CA concentrations. Amino- N content increased with ١mM CA and decreased with the two other concentrations. Whereas amide-, total soluble- N, total- N and protein- N they decreased with the different concentrations of CA during the control date of cultivation. Ammonia- and amino- N increased with ٥٠٪ urea either alone or when mixed with the three concentrations of CA. However, ١٠٠٪ urea either alone or combined with different CA concentrations increased both ammonia- and amino-N. Amide- N increased with ٥٠٪ urea either alone or in combination with ١mM CA, and this parameter decreased with ٥mM and ١٠mM CA mixed with ٥٠٪ urea. Meanwhile, ١٠٠٪ urea either alone or in addition to ١mM and ٥mM CA increased amide- N content, while ١٠٠٪ urea+١٠mM CA caused in amide- N content.

Table ٧: The effect of two planting dates, different concentrations of cinnamic acid (CA) and urea, either alone or in combination, on nitrogenous constituents (mg g -١ dry weight) of *Pimpinella anisum* plants during the vegetative stage.

Date	Treatment	Ammonia N	Amino N.	Amide N.	Total soluble N.	Total nitrogen	Protein nitrogen
Control	Control	٤,٣٣٠	٣,٦٢٠	٠,٨٨٠	١١,٣٧٠	٣٣,٤٦٠	٢٢,٠٩٠
	١mM CA	٤,٢٥٠	٣,٧٤٠	٠,٨٢٠	١٠,٩٦٠	٣٢,١٩٠*	٢١,٨٥٠
	٥mM CA	٤,٠٧٠	٣,٤٥٠	٠,٧٩٠	١٠,٢٣٠*	٣١,٨٦٠*	٢١,٦٣٠
	١٠mM CA	٣,٩٢٠*	٣,١٨٠	٠,٧٤٠	١٠,٠٧٠*	٣١,٤٢٠*	٢١,٣٥٠
	Urea ٥٠٪	٤,٦٣٠*	٣,٩٤٠*	٠,٩٢٠	١٢,٤٨٠	٣٥,٦٢٠*	٢٣,١٤٠
	Urea ٥٠٪ + ١mM CA	٤,٦١٠*	٣,٨٢٠*	٠,٨٩٠	١٢,١٢٠	٣٥,١٥٠	٢٣,٠٣٠
	Urea ٥٠٪ + ٥mM CA	٤,٥٠٠	٣,٥١٠	٠,٨٥٠	١١,٨٤٠	٣٤,٨٥٠	٢٣,٠١٠
	Urea ٥٠٪ + ١٠mM CA	٤,٥٧٠	٣,١٢٠	٠,٧٩٠	١١,٥٣٠	٣٤,٢٦٠	٢٢,٧٣٠
	Urea ١٠٠٪	٥,١٤٠*	٤,٢٦٠*	٠,٩٨٠	١٢,٩٣٠*	٣٨,٧٢٠*	٢٥,٧٩٠*
	Urea ١٠٠٪ + ١mM CA	٥,٠٦٠*	٤,١٧٠*	٠,٩٦٠	١٢,٤٤٠	٣٦,٤٥٠*	٢٤,٠١٠*
	Urea ١٠٠٪ + ٥mM CA	٤,٨١٠*	٤,١٣٠*	٠,٩٧٠	١١,٩٦٠	٣٦,٢٩٠*	٢٤,٣٣٠*
	Urea ١٠٠٪ + ١٠mM CA	٤,٧٢٠*	٣,٩١٠*	٠,٨٧٠	١١,٦٥٠	٣٥,١٢٠	٢٣,٤٧٠
	L.S.D	٠,٢٧٥	٠,٢٠٥	٠,٣١١	١,٤٩٤	١,٠٧٩	١,٢٣٦
Late	Control	٤,٦٥٠	٤,٠٥٠	٠,٧٩٠	١٣,٤٨٠	٣٥,٧١٠	٢٢,٢٣٠
	١mM CA	٤,٢٣٠*	٣,٩٢٠	٠,٧٥٠	١١,٨٧٠	٣٥,١٦٠	٢٣,٢٩٠*
	٥mM CA	٤,١٢٠*	٣,٧٣٠*	٠,٦٩٠*	١١,٥٣٠	٣٣,٧٦٠*	٢٢,٢٣٠
	١٠mM CA	٣,٠٨٠*	٣,٥٤٠*	٠,٦٦٠*	١١,٣٧٠*	٣٣,١٢٠*	٢١,٧٥٠
	Urea ٥٠٪	٤,٧٩٠	٤,٢٧٠*	٠,٩٦٠*	١٤,٤٢٠	٣٦,٦٦٠	٢٢,٢٤٠
	Urea ٥٠٪ + ١mM CA	٤,٦٣٠	٤,١٣٠	٠,٩٤٠*	١٣,٦٩٠	٣٥,٩٥٠	٢٢,٢٦٠
	Urea ٥٠٪ + ٥mM CA	٤,٤٩٠	٤,٠٧٠	٠,٩١٠*	١٢,٨٤٠	٣٥,٨٥٠	٢٣,٠١٠
	Urea ٥٠٪ + ١٠mM CA	٤,٣٦٠*	٣,٨٧٠	٠,٨٧٠*	١٢,٢٩٠	٣٥,٧٦٠	٢٣,٤٧٠*
	Urea ١٠٠٪	٥,٣٧٠*	٤,٥٧٠*	١,١٤٠*	١٥,٧٣٠*	٣٨,٩٧٠*	٢٣,٢٤٠*
	Urea ١٠٠٪ + ١mM CA	٥,٢١٠*	٤,٣٣٠*	١,٠٨٠*	١٣,٦٤٠	٣٧,٤٥٠*	٢٣,٨١٠*
	Urea ١٠٠٪ + ٥mM CA	٤,٩٤٠*	٤,٢١٠	٠,٩١٠*	١٢,٧٠٠	٣٦,٤٥٠	٢٣,٧٥٠*
	Urea ١٠٠٪ + ١٠mM CA	٤,٨٠٠	٣,٩٤٠	٠,٨٣٠	١١,٠٨٠*	٣٥,٨٢٠	٢٤,٧٤٠*
	L.S.D	٠,١٨٧	٠,١٩٣	٠,٠٧٤	١,٩٨٥	١,٥٦٧	٠,٩٨٤

Total soluble- and protein- N increased as a result of treating anise plants with ٥٠٪ urea either alone or in combination with three different CA concentrations. On the other hand total- N increased in plants supplied with ٥٠٪ urea alone or combined with the different concentrations of CA. Fertilization of anise plant with ١٠٠٪ urea alone or combined with the different CA concentrations increased total soluble-, total- and protein- N.

During flowering stage results illustrated in table ٨ show that, all the determined nitrogenous constituents decreased with the three concentrations of CA. Fertilization with ٥٠٪ urea either alone or combined with the CA used concentrations increased all the determined nitrogenous constituents. The highest concentration of urea (١٠٠٪) when used either alone or in combination with CA different concentrations caused significant increase in all the determined nitrogenous fractions.

Table ٨: The effect of two planting dates, different concentrations of cinnamic acid (CA) and urea, either alone or in combination, on nitrogenous constituents (mg g -١ dry weight) of *Pimpinella anisum* plants during the flowering stage.

Date	Treatment	Ammonia N	Amino N.	Amide N.	Total soluble N.	Total nitrogen	Protein nitrogen
Control	Control	٥,٤٣٠	٤,٣٢٠	١,٤٧٠	١٣,٤٠٠	٤٦,٣١٠	٣٢,٩١٠
	١mM CA	٥,٣٧٠	٤,١٨٠	١,٣٥٠*	١٢,٨٧٠	٤٦,١٦٠	٣٢,٢٩٠
	٥mM CA	٤,٨٢٠*	٣,٨٥٠*	١,٣٣٠*	١٢,٥٢٠	٤٤,٨٢٠*	٣٢,٣٠٠
	١٠mM CA	٤,٥١٠*	٣,٤٧٠*	١,١٩٠*	١١,٨٢٠*	٤٣,٩٨٠*	٣٢,١٦٠
	Urea ٥٠٪	٥,٩٨٠	٤,٦٩٠	١,٨٣٠*	١٤,٥٦٠*	٥٠,٨٢٠*	٣٦,٢٦٠*
	Urea ٥٠٪ + ١mM CA	٥,٩٣٠	٤,٤٦٠	١,٦٢٠*	١٤,١٣٠	٤٩.٧٣٠*	٣٥,٦٠٠*
	Urea ٥٠٪ + ٥mM CA	٥,٤٧٠	٤,٥١٠	١,٦٣٠*	١٣,٨٦٠	٤٨,٢١٠*	٣٤,٣٥٠*
	Urea ٥٠٪ + ١٠mM CA	٥,١٢٠	٤,٤٤٠	١,٥٦٠	١٣,٤٢٠	٤٨,١١٠*	٣٤,٦٩٠*
	Urea ١٠٠٪	٦,٦٨٠*	٥,٢٣٠*	١,٩٧٠*	١٥,٤٤٠*	٥٢,٩٦٠*	٣٧,٥٢٠*
	Urea ١٠٠٪ + ١mM CA	٦,٥٣٠*	٤,٨٧٠*	١,٨٤٠*	١٤,٨٣٠*	٥٢,٧٩٠*	٣٧.٩٦٠*
	Urea ١٠٠٪ + ٥mM CA	٦,٠٧٠*	٤,٧٣٠	١,٨٢٠*	١٤,٥٤٠	٥١,٨٤٠*	٣٧,٣٠٠*
	Urea ١٠٠٪ + ١٠mM CA	٥,٩٢٠	٤,٤٢٠	١,٧٩٠*	١٣,٩٢٠	٥٠,٩١٠*	٣٦,٩٩٠*
	L.S.D	٠,٦٢١	٠,٤٢٢	٠,١٠٧	١,٢١٧	١,٠٨٧	١,٣٠٨
Late	Control	٦,٢٤٠	٥,٥٢٠	١,٣٣٠	١٥,٦٨٠	٤٦,٨٩٠	٣١,٢١٠
	١mM CA	٦,٠٥٠	٥,١١٠*	١,٢٨٠	١٤,٨٤٠	٤٥,٢٧٠	٣٠,٤٣٠
	٥mM CA	٥,٨٧٠*	٤,٨٨٠*	١,١٦٠*	١٤,٥٠٠	٤٥,٣١٠	٣٠,٨١٠
	١٠mM CA	٥,٢٩٠*	٤,٣٩٠*	١,٠٩٠*	١٣,٧٧٠*	٤٤,٤٧٠	٣٠,٧٠٠
	Urea ٥٠٪	٦,٩٤٠*	٥,٧٩٠	١,٥٦٠*	١٧,٧٢٠*	٤٩,٥٤٠*	٣١,٨٢٠
	Urea ٥٠٪ + ١mM CA	٦,٩٣٠*	٥,٧٦٠	١,٥٢٠*	١٦,٤٣٠	٤٧,٦٨٠	٣١,٢٥٠
	Urea ٥٠٪ + ٥mM CA	٦,٤٦٠*	٥,٥٨٠	١,٤٧٠*	١٦,٦٦٠	٤٧,٣٢٠	٣٠,٦٦٠
	Urea ٥٠٪ + ١٠mM CA	٦,١٢٠	٥,٥٤٠	١,٣٦٠	١٥,٤٨٠	٤٦,٩٤٠	٣١,٤٦٠
	Urea ١٠٠٪	٧,٣٥٠*	٦,٢٧٠*	١,٨٩٠*	١٧,٩٣٠*	٥١,٢٨٠*	٣٣,٣٥٠*
	Urea ١٠٠٪ + ١mM CA	٦,٨٦٠*	٦,٠٧٠*	١,٧٧٠*	١٧,٥٩٠*	٥١,١٩٠*	٣٣,٦٠٠*
	Urea ١٠٠٪ + ٥mM CA	٦,٣٩٠	٥,٩٣٠*	١,٧٤٠*	١٦,٨٢٠	٥٠,٧٩٠*	٣٣,٩٧٠*
	Urea ١٠٠٪ + ١٠mM CA	٦,١٢٠	٥,٦١٠	١,٦١٠*	١٥,٨٥٠	٥٠,٠٠٠*	٣٤,١٥*
	L.S.D	٠,٢٠٧	٠,٣٨١	٠,٠٩٣	١,٦١٨	٢,٤٦٢	١,٠٥٦

Similar pattern of change in general was obtained at the two stages of growth during the late date of cultivation. Again, results obtained by CA and urea; independent or together in case of control date of cultivation were much better than those obtained on the late date of cultivation.

Based on the mentioned results CA as an allelochemical was found to decrease the nitrogenous fractions and according to the allelopathy definition, it is so evident that allelochemicals could affect all phases of nitrogen cycle that involve plant or microorganisms. When plants take up nitrate, they must use energy to convert it to ammonium form before it can be used. Thus, growth reduction due to missing of energy could be an argument for nitrogen reduction in seedlings which treated by allelochemicals, also loosing of nitrogen content in some seedling, could be occurred by limiting or reducing some key factors in nitrogen metabolism such as nitrate reductase and glutamine synthetase (Reigosa *et al.,* ٢٠٠٦).

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تأثير تاريخ الزراعة، حمض السيناميك و السماد النيتروجينى على نمو وأيض نبات الينسون

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تمت زراعة الينسون في تجربتين منفصلتين، أحدهما في الموعد المعتاد لزراعته والأخرى في موعد متأخر. و أدت معاملة نبات الينسون بالتركيزات المختلفة من حمض السيناميك خلال مرحلتي النمو إلى نقص في كل دالات النمو المختلفة للنبات (طول الجذر- طول الساق – مساحة الورقة – الوزن الطازج و الوزن الجاف) بالمقارنة بالعينات الضابطة، كذلك لوحظ نقصان معنوي في المكونات النسبية لأصباغ البناء الضوئي (كلوروفيل أ ، كلوروفيل ب ، كلوروفيل أ+ب ، الكاروتينات، و المحتوى الصبغى) أيضا حدث اختزال في محتوى الكربوهيدرات (الجلوكوز، السكروز، السكريات العديدة والمحتوى الكلى للكربوهيدرات) كما أدى إلى نقص في محتوى المركبات النيتروجينيه (الامونيا، الامينو، الاميد، المحتى النيتروجينى الذائب والبروتين والمحتوى النيتروجينى الكلى) عند مقارنتها بالعينات الضابطة وذلك خلال موعدي الزراعة المختلفين. بينما أدت معاملات تركيزي اليوريا المستخدمين (٥٠% - ١٠٠%) إلى زيادة كل دالات النمو، المكونات النسبية لأصباغ البناء الضوئي، محتوى الكربوهيدرات و المحتوى النيتروجينى وذلك عند استخدام اليوريا منفردة أو مع التركيزات المختلفة من حمض السيناميك، مع الأخذ في الاعتبار أن اليوريا منفردة كانت أفضل. ومما تجدر الإشارة إليه أن جميع النتائج كانت أفضل في حالة زراعة الينسون في موعده عن زراعته في الموعد المتأخر.