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Effect of nitrogen fertilizers on root criteria, pigments and carbohydrates of *Vignasinensis* L. and *Helianthus annuus* L. plants.

Rasha M.E. Gamel[1], Mohammed A. Abbas[1], Samia A. Haroun[1]and Safia M. Ahmaida[2]

[1]*Botany Department, Faculty of Science, Mansoura University, Egypt*

[2]*Botany Department, Faculty of Science, Omar Al-Mokhtar University, Libya*

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Abstract

The objective of this study was to investigate the effects of different nitrogen fertilizers (potassium nitrate and / or urea) on root growth, leaf area ratio, pigments content and carbohydrate content of leguminous plant *Vigna sinensis* and non-leguminous plant *Helianthus annuus*, throughout two vegetative stages. Root criteria,in general non-significantly affected by the used source of nitrogen during the two vegetative stages of cowpea and sunflower plans growth. Concerning the leaf area ratio, except for the observed non-significant increase in response to treatment with 100% potassium nitrate + 100% urea at second stage, the other treatments was non-significantly decreased this ratio during the two vegetative stages of the two plants. Total chlorophyll and total pigments were increased by the used treatments at first stage of cowpea growth while these parameters were decreased during the second stage and vice versa in case of sunflower plant. Sucrose content of the two plants, was significantly increased by all used treatments at first vegetative stage. On the other hand, the different treatments led to a general increase in the determined carbohydrates (total soluble sugars- sucrose- polysaccharides – total carbohydrates) as compared to control values during second stage of the two plants. The result of this investigation demonstrated that, nitrogen fertilizers has an overall positive influence on growth, photosynthetic pigments and sugars especially in case of using (50% potassium nitrate + 50% urea) and the magnitude of response was more pronounced in case of cowpea plant.

1. Introduction

Cowpea (*Vigna* spp) is one of the important leguminous crops in the semi-arid tropics covering Asia, Africa, Southern Europe, Central and South America (Singh *et al.,* 1997). Cowpea has excellent nutritional qualities containing 24–26 percent protein and well balanced essential amino acids composition with high amounts of leucine, lysine and methionine (Bressani, 1985).High protein and carbohydrate contents make it not only important to the human diet, but also suitable as high protein feed and fodder to livestock. With its greater tolerance to heat, drought, and low soil fertility, *Vigna unguiculata* is a particularly valuable component of low-input farming systems of resource-poor farmers. Also, it is able to increase soil fertility through nitrogen fixation (Martins *et al*., 2003; Muchero *et al.,* 2009; Pule-Meulenberg *et al.,* 2010).

Sosulski and Dabrowski (1984) determined the phenolic acid composition of 10 legume species and found that cowpeas contain the highest concentration of antioxidant compounds. Plant flavonoids, anthocyanins, polyphenols and tannins are a diverse group of phytochemicals that occur in legume seeds and have gained attention due to their antioxidant capacity that benefits human health by preventing oxidative stress (Anderson *et al.,* 1984; Hughes *et al.,* 1997).

Helianthus annuus (sunflower), one of the most important crops worldwide, not only with food and energy value, but also with phytoremediation potential. Sunflower is a documented metal accumulator (Cindy *et al*., 2006; Niu *et al.*, 2007; Fassler *et al*., 2010; Rojas-Tapias *et al*., 2012) and its growth in contaminated land for simultaneous remediation and further energy production has been studied (Madejon *et al.*, 2003). Sunflower has recently been used for oil production. Since 1969, sunflower has been introduced from Canada, South Africa, and the USA by the Tainan District Agricultural Improvement Station (TDAIS) of Taiwan for its oil production programme (Fang, 1973). Sunflower is the third most important world source of edible vegetable oil, and its seeds are a key source of minerals, vitamins and antioxidants for animal and human nutrition (Senkoylu and Dale, 2006). More recent, it is the fourth most widely grown oilseed crop in the world. It is of major economic importance as it produces healthy oil and has low input requirements (nitrogen, water and fungicides (Rieseberg and Willis, 2007). Since 3000 B.C.

**Correspondence author:*
Tel.:
E-mail address:

throughout the world it is used as ornamental plant, alimentary, feedstock, medicinal, decorations, dyes, fodder and body painting. Edible oil is one of the basic food requirements and important component of diet for the human beings. (Naseem *et al*., 2015).

Nitrogen fertilizer is a key nutrient in the production of non legume crops. It is a component in many biological compounds that plays a major role in photosynthetic activity and crop yield capacity (Cathcart and Swanton, 2003). Nitrogen (N) is one of the most essential nutrients needed by plants and other organisms, such as water; the plant needs it as factor in plant growth more than other factors (Rajaei, 2010). Nitrogen fertilizers are among the most important and effective implements in agriculture, stimulating a lot of vital processes in plants. The amount of nitrogen applied to plants must be carefully managed to ensure that N will be available throughout the growing season and the vegetative and reproductive development (Vidal *et al*., 1999). The need for N is provided by the application of nitrogen fertilizers, where it is absorbed and accumulated in the plant in two inorganic nitrogen forms, ammonia (NH_4^+) or nitrates (NO_3^-), and is influenced by a number of factors such as the crop species, the vegetation period and soil conditions (Bloom, 1997; Siddiqi *et al*., 2002; Neata *et al*., 2013). Ammonium salt proved to be a source of nitrate nitrogen equivalent, when supplied with the pH buffer concentration and an appropriate level of macro and micronutrients (Siddiqi *et al*., 2002). An immediate effect of the application of nitrogen, is an increase yields by 15-20% following their application (Kirda *et al*., 2004; Anton *et al*., 2008; Ertek *et al*., 2012).

Nitrates are mainly produced for use as fertilizers in agriculture because of their high solubility and biodegradability (Laue *et al*., 2006).On the other hand, urea has the greatest nitrogen amount among all nitrogen solid fertilizers (Salardini, 1987).

The application of nitrogen fertilizers correlated positively with biomass production. The leaf nitrogen contents were significantly correlated with the nitrogen applications. Under the influence of the nitrogen fertilization, net photosynthesis increased from 3.7 to 6.6 µmol m^{-2} s^{-1}. The results of this experiment demonstrated that, nitrogen fertilization has an overall positive correlation with leaf nitrogen content, photosynthesis, and growth of the bioenergy crop *Fallopiasachalinensis* var. Igniscum Candy (Koning *et al*., 2015).The aim of the present work is study the effects of two nitrogen fertilizers (potassium nitrate & urea) on root growth, leaf area ratio, pigments content and carbohydrates content of leguminous and non leguminous plants. (*Vigna sinensis* L. and *Helianthus annuus* L.), respectively.

2. Materials and Methods

2.1. Plants used

Pure strain of *Vigna sinensis* L. (cowpea) and *Helianthus annuus* L. (sunflower) were obtained from the Agricultural Research Center, Ministry of Agriculture, Giza, Egypt. All chemicals used in this investigation were of analytical grade. The used potassium nitrate and urea fertilizers were obtained from Ministry of Agriculture Giza, Egypt.

2.2. Time course of experiment

A homogenously-sized lot of *Vigna sinensis* (cowpea) and *Helianthus annuus* (sunflower) were selected and surface sterilized by soaking in 0.01% $HgCl_2$ solution for 3 minutes. After washing thoroughly with distilled water, the seeds of each plant were divided into 5 equal groups each contains 100 seeds andwere treated as follow:

Group (1): left to grow without fertilization to serve as a control.

Group (2): fertilized twice at 10 and 30 days from sowing, with potassium nitrate (in concentration of 100% of the recommended dose).

Group (3): fertilized twice at 10 and 30 days from sowing, with urea (100% of therecommended dose).

Group (4): fertilized twice at 10 and 30 days from sowing, with potassium nitrate and urea (in concentration of each 50% of the recommended dose).

Group (5): fertilized firstly at 10 days from sowing with potassium nitrate (in concentration of 100% of the recommended dose) and secondly at 30 days from sowing, with urea (in concentration of 100% of the recommended dose).

Seeds of the five groups were cultivated at the 5th of March 2016 in pots (30 cm in diameter) containing equal amounts of soil (sand: clay, 1:2 v/v). Ten seeds were sown in each pot and irrigated by adding equal amounts of water to each pot when required. All plants were exposed to normal day night condition. At the 15th of March 2016 thinning takes place where 5 uniformedseedlings only left to grow in each pot.

Two successive sampling, during vegetative stage takes place; at the 25 days from sowing, samples of first stage were harvested. After another twenty five days from sowing (50 days from sowing), sampling of the second stage were collected.

The collected samples at the two stages were used for assessment of root growth parameters, leaf area ratio, pigments content & carbohydrates content.

Data were analyzed by least significant difference (L.S.D) test at probability of 0.05 to identify significant effect of a treatment. ANOVA analysis was done with the IBM SPSS-20 statics software **(Snedecor and Cochran, 1982)**.

2.3. Analytical Methods

1.3.2. Determination of leaf area ratio

As recommended by Poorter and Remkes (1990) leaf area ratio (LAR) is the ratio between total area and total plant weight.

2.3.2. Estimation of photosynthetic pigments

The plant photosynthetic pigments (chlorophyll a, chlorophyll b and carotenoids) were determined at the two vegetative stages of plant growth using the spectrophotometric method as recommended by Arnon (1949) for chlorophylls and Horvazth *et al*. (1972) for carotenoids as adopted by Kissimon (1999).

2.3.3. Estimation of carbohydrates

The methods adopted in this investigation for extraction of the different carbohydrate fractions tested were essentially those of Yemm and Willis (1954) and Handel (1968). Sucrose content was determined using modification of the procedures of Handel (1968). Total soluble sugars (TSS) content was determined using modification of the procedures of Yemm and Willis (1954). The method used for estimation of polysaccharides was that of Sadasivam and Manickam (1996). Total carbohydrates were calculated as the summation of the amount of total soluble sugars and polysaccharides of the same sample.

3. Results and Discussion

3.1. Changes in growth parameters

According the results in table 1, root depth recorded a non-significant decrease by 100% urea&50% potassium nitrate + 50% urea treatments at first vegetative stage and 100% potassium nitrate + 100% urea at second stage and then increased by the other used treatments during the two vegetative stages of *Vigna sinensis* growth table (1). Concerning root fresh weight and root water content except for 50% potassium nitrate + 50% urea at first and second stages was increased these parameters non-significantly and significantly respectively and 100% potassium nitrate + 100% urea at second stage which increased these parameters non-significantly all treatments decreased these parameters non-significantly. On the other hand, root dry weight increased non-significantly with the used treatments except for 100% urea and 50% potassium nitrate + 50% urea treatments recorded a non-significant decrease at the first vegetative stage. According the result in table 1 leaf area ratio, shown a non-significant increase in response to treatment with 100% potassium nitrate + 100% urea at second vegetative stage as well as treatment with 100% potassium nitrate, 50% potassium nitrate + 50% urea and 100% potassium nitrate + 100% urea at first stage and100% urea at second stage decreased this ratio significantly, the other treatments led to a non-significant decrease in leaf area ratio during the two vegetative stages.

The obtained results in table (2) show that, during the two vegetative stages, a general non-significant response was detected in root depth of *Helianthus annuus* in response to all treatments. Regarding root fresh weight and root water content except for 100% potassium nitrate + 100% urea treatment which recorded a non-significant decrease at stage II all treatments increased them significantly. On the other hand, root dry weight increased significantly during first stage with the used treatments while decreased non-significantly at stage II by 50% potassium nitrate + 50% urea and 100% potassium nitrate + 100% urea treatments and increased non-significantly by the other treatments. According to leaf area ratio, except for the observed non-significant increase in response to treatment with 100% potassium nitrate + 100% urea at second stage, whereas the other treatments caused a general non-significant decrease in this parameter during the two vegetative stages (Table 2).

In this concern, the fresh weight of spinach plants grown in nutrient solution with a 1.5-fold decrease in the nitrate component was 10% less thanwhen the nitrate concentration was 1.3-fold or higher than normal (Zhang *et al*., 1990). Plant weight of spinach (*Spinacia oleracea* L.) and komatsuna (*Brassica campestris* L.) decreased in response to smaller application of nitrogen in the used soil (Takebe *et al*., 1995).

The results obtained with maize due to application of nitrogenous fertilizers showed that, root length did not vary statistically (Shirazi *et al*., 2011). On the other hand, leaf area index (LAI) values increased with N level up to 80 kg N ha^{-1}, but further increase in N level did not generate any significant increase in LAI in soybean (Caliskan *et al.,* 2008).

The seedling growth of two drought-resistant wheat varieties was studied under solution culture in a plant growth chamber. The results showed that,the root growth was negatively correlated with the increase of nitrogen supply. The distribution of root length in different layers was similar for the two varieties. The root length was the longest at the layer of 5-15 cm, the shortest below 15 cm, and in between at the layer of 0-5 cm. The water use efficiency (WUE) decreased with increasing ratio of root to shoot (R/S), while leaf photosynthetic rate tended to increase initially and then decrease. The increase in R/S was unfavorable to increase WUE, and the appropriate R/S for leaf photosynthetic rate was about 0.5 (Shangguan *et al*., 2004).

In a study with two varieties of winter wheat (*Xinong No. 1043*and*Xiaoyan No. 6*) total root length was significantly reduced at higher nitrogen concentrations. For *Xinong No. 1043*, total root length decreased when nitrogen concentration was over 11.25 mmol·L^{-1}. For *Xiaoyan No. 6*, root length decreased when nitrogen concentration was over 7.5 mmol·L^{-1}. For both varieties, total root length was the highest at the 5-15 cm depth layer, shortest below 15 cm, and intermediate at 0-5 cm. For *Xinong No. 1043*, the average root diameter at 0-5 cm and below 20 cm was greater than that at 5-15 cm, especially at 10-15 cm in which the root diameter was the smallest. For *Xiaoyan No. 6,* the smallest root diameter was found between 5-15 cm. Based on the root length and diameter, the main uptake part of the root system in wheat seedlings was at the 5-15 cm depth since the root length was the highest and diameter was the smallest for this layer. For both varieties, the root surface area decreased as nitrogen concentration increased (Shangguan *et al*., 2004).

Mackay and Barber (1985) carry out a study to investigate the effect of applied N on mean N influx and root growth of two genotypes of corn (*zea mays*) that differed in their response to nitrogen rates and they concluded that, corn (*Zea mays* L.) genotypes vary in their response to applied N fertilizer. Nitrogen uptake by the plant is controlled by N influx at the root surface and the size and morphology of the root system.

Root growth and nutrient uptake of a tea clone (*Camellia sinensis* L.) were studied in a sand culture experiment using ammonium sulphate, ammonium nitrate and urea each at 35, 70 and 105 ppm N. Results showed that increasing N levels regardless of forms increased the proportion of white roots and decreased brown root weight (Chamuah, 1988).

Caliskan *et al*. (2008) indicated that either leaf area and biomass growth or photosynthetic rate can be increased with combined usage of N and Fe fertilization under Mediterranean conditions in soybean. Increasing photosynthetic rate with N and Fe fertilization can be attributed to increasing amount of chlorophyll pigments, since N is one of the main components of chlorophyll and Fe acts in chlorophyll synthesis (Hardy *et al*., 1971; Harper and Hageman, 1972).

Table 1. Effect of different nitrogen fertilizers on growth parameters of *Vigna sinensis* L. during two vegetative stages.

Treatments		Parameters				
		Root depth (cm)	Root fresh weight (g)	Root dry weight (g)	Root water content	Leaf area ratio
Stage I	Control	3.513	0.103	0.029	**0.074**	13.671
	100% Potassium Nitrate	3.725	0.090	0.031	0.058	11.006*
	100% Urea	3.35	0.053	0.023	0.030	12.813
	50% Potassium Nitrate + 50% Urea	2.963	0.135	0.025	0.110	10.365*
	100% Potassium Nitrate + 100% Urea	3.688	0.075	0.031	0.044	12.207*
Stage II	Control	7.3	0.464	0.112	0.343	34.149
	100% Potassium Nitrate	7.5	0.462	0.135	0.327	26.350
	100% Urea	7.85	0.459	0.116	0.343	22.240*
	50% Potassium Nitrate + 50% Urea	8.025	0.650*	0.166*	0.484*	26.177
	100% Potassium Nitrate + 100% Urea	6.375	0.529	0.135	0.396	36.293

(*)= significant increase or decrease at 0.05 LSD

Table 2. Effect of different nitrogen fertilizers on growth parameters of *Helianthus annuus* L. during two vegetative stages.

Treatments		Parameters				
		Root depth (cm)	Root fresh weight (g)	Root dry weight (g)	Root water content	Leaf area ratio
Stage I	Control	1.525	0.110	0.013	0.097	6.653
	100% Potassium Nitrate	1.938	0.191*	0.025*	0.166*	6.531
	100% Urea	1.5	0.165*	0.024*	0.141*	5.687*
	50% Potassium Nitrate + 50% Urea	1.813	0.176*	0.025*	0.151*	5.625
	100% Potassium Nitrate + 100% Urea	1.633	0.181*	0.024*	0.157*	6.258
Stage II	Control	6.313	0.824	0.231	0.592	174.724
	100% Potassium Nitrate	7.688	1.603*	0.448	1.155*	161.944
	100% Urea	6.788	1.390*	0.357	1.033*	141.358*
	50% Potassium Nitrate + 50% Urea	7.225	1.049	0.198	0.851	63.087*
	100% Potassium Nitrate + 100% Urea	6.125	0.722	0.151	0.571	204.491

(*)= significant increase or decrease at 0.05 LSD

3.2. Changes in photosynthetic pigments.

Chlorophyll content is of particular significance to precision in agriculture as an indicator of photosynthetic activity. Nitrogen concentration in green vegetation is related to chlorophyll content, and therefore indirectly to one of the basic plant physiological processes which in photosynthesis (Sabo *et al.,* 2002; Bojovic and Stojanovic, 2005; Tranaviciene *et al*., 2008).

At first vegetative stage of cowpea plant growth, except for the observed general non-significant decrease in chlorophyll a in response to treatment with100% potassium nitrate & 100% potassium nitrate + 100% urea as well as in carotenoids in response to treatment with 100% potassium nitrate, 50% potassium nitrate + 50% urea & 100% potassium nitrate + 100% urea and chlorophyll a / chlorophyll b ratio with all treatments, the other treatments induced a general non-significant increase in the estimated photosynthetic pigments (Table 3).

During second vegetative stage of *vigna sinensis* L. growth, a general non-significant increase was detected in chlorophyll a / chlorophyll b ratio in response to the all used treatments and in chlorophyll a, chlorophyll a + chlorophyll b & total pigments in response to treatment with 50% potassium nitrate+50% urea, on the other hand, the other treatments with urea and/or potassium nitrate caused a general non-significant decrease in the determined photosynthetic pigments (Table3).

At first vegetative stage of sunflower a non-significant increase was detected in chlorophyll a in response to treatment with 100% potassium nitrate + 100% urea and in chlorophyll a/chlorophyll b in response to the all used treatments, compared to control values. On the other hand, the other treatments showed a general non- significant decrease in all determined photosynthetic pigments (chlorophyll a, chlorophyll b, chlorophyll a + chlorophyll b, chlorophyll a / chlorophyll b, carotenoidsand total pigment) (Table4).

During second vegetative stage of sunflower growth, a non-significant decrease was detected in chlorophyll b in response to treatment with 100% urea as well as in carotenoids in response to treatment with 100% potassium nitrate and in chlorophyll a / chlorophyll b in response to 100% potassium nitrate & 50% potassium nitrate + 50% urea treatments. Whereas the other estimated photosynthetic pigments generally increased non-significantly by these treatments with the exception oftreatment with 100% potassium nitrate + 100% urea which caused a general significant increase in the all determined photosynthetic pigment as compared to control values (Table4).

Many researchers proved that there is a very close link between N and chlorophyll content (Tucker, 2004; Amaliotis *et al*., 2004). The chlorophyll synthesis is depending on mineral nutrition (Daughtry *et al*., 2000) where N is responsible for the leaf growth and one of the constituent elements of chlorophyll molecule that contains 4N in tetrapyrolle ring. Nitrogen also acts as prominent element in green leaves and related to chlorophyll content (Haboudane *et al*., 2002) and protein molecules which affects the chloroplast formation (Daughtry *et al*., 2000).

Nursu'aidah *et al*. (2014) stated that, long bean grown with fertilizer obtained the highest chlorophyll content due to the highest chlorophyll a content. This mean that, mung bean grown without fertilizer possessed the least total chlorophyll content due to lowest chlorophyll a content. This is because chlorophyll a content able to capture a limited wave length only. Mung bean grown without fertilizer needs to produce more chlorophyll b which leads to the highest chlorophyll a/b ratio in order to increase its photosynthetic ability because chlorophyll b can capture a wider range of light (Kumar, 2009). The highest photosynthetic activity was found in long bean grown with fertilizer due to the highest total chlorophyll and chlorophyll a content. Hesketh *et al*. (1981) demonstrated a positive correlation between leaf photosynthesis rate and chlorophyll content.

Bojovic and Markovic (2007) measured the lowest leaf chlorophyll content in plants grown in unfertilized soil. These elements, especially N, involved indirectly in photosynthesis process (Haboudane *et al*., 2002) and photosynthetic capacity due to the activated RUBISCO content (Jia and Gray, 2004), increases the leaf area of plants (Evans and Seemann, 1989) and helps in increment uptake of nitrate and K ions which contribute to increase in chlorophyll content.

Evidence shows that plants with a higher nitrogen supply develop greener leaves unlike plants growing in nitrogen-deficient conditions which exhibit pale-green colouration of leaves or in extreme cases, uniform chlorosis(Perry and Hickman, 1998).

Previous studies have shown that the chlorophyll contents of potatoleaves correlate strongly with the nitrogen contents of leaves (Gianquinto *et al*., 2004) and based on this relationship, hand-held devices measuring the chlorophyll in living plants can reflect the nitrogen status and physiological activity of plants (Bullock and Anderson, 1998; Netto *et al*., 2005).

In this respect, Chlorophylls are very sensitive to changes in nitrogen contents. According to the results of Tranaviciene *et al*. (2007) total contents of photosynthetic pigments increased with plant age and were higher at higher fertilization rates. Chlorophyll a, b and carotenoid biosynthesis showed similar responses to N fertilization. However, the chlorophyll a/b ratio decreased in the later developmental stages. Nitrogen showed the most pronounced effect on photosynthetic pigment synthesis in the flowering stage. The photosynthetic capacity of leaves is related to the nitrogen content primarily because of proteins of the Calvin cycle, and thylacoids represent the majority of leaf nitrogen (Gibson, 2005).

Table 3. Effect of different nitrogen fertilizers on photosynthetic pigments content (g / 100g dry weight) of *Vignasinensis* L. during two vegetative stages.

Treatments		Parameters					
		Chl. a	**Chl. b**	**Carotenoids**	**Chl.a / Chl. b**	**Chl.a + Chl.b**	**Total pigments**
Stage I	Control	٠,٠٥٠	٠,٠٣٩	٠,٠٢٢	١,٢٨٢	٠,٠٨٩	٠,١١١
	100% Potassium Nitrate	٠,٠٤٦	٠,٠٨٢	٠,٠١٤	0.560*	٠,١٢٨	٠,١٤٢
	100% Urea	0.139*	٠,١١٣	٠,٠٣٩	١,٢٣٠	0.252*	0.291*
	50% Potassium Nitrate + 50% Urea	٠,٠٨٩	٠,١٠٣	٠,٠٠٧	٠,٨٦٤	٠,١٩٢	٠,١٩٩
	100% Potassium Nitrate + 100% Urea	٠,٠٣٧	٠,١١١	٠,٠١٩	0.333*	٠,١٤٨	٠,١٦٧
Stage II	Control	٠,١٧٤	٠,١٩٢	٠,٠٦٦	٠,٩٠٦	٠,٣٦٦	٠,٤٣٢
	100% Potassium Nitrate	0.086*	0.082*	٠,٠٤٠	١,٠٤٨	0.168*	0.208*
	100% Urea	٠,١٦٥	٠,١٢٣	٠,٠٥٥	1.341*	٠,٢٨٨	٠,٣٤٣
	50% Potassium Nitrate + 50% Urea	٠,١٧٧	٠,١٩٢	٠,٠٦٤	٠,٩٢١	٠,٣٦٩	٠,٤٣٣
	100% Potassium Nitrate + 100% Urea	٠,١٣٧	0.106*	٠,٠٥٤	1.292*	٠,٢٤٣	٠,٢٩٧

(*)= significant increase or decrease at 0.05 LSD.

Table 4. Effect of different nitrogen fertilizers on photosynthetic pigments content (g / 100g dry weight) of *Helianthus annuus* L. during two vegetative stages.

	Treatments	Parameters					
		Chl. a	**Chl. b**	**Carotenoids**	**Chl.a/Chl. b**	**Chl.a+ Chl.b**	**Total pigments**
Stage I	Control	٠,١٠٣	٠,١٣٥	٠,٠٣٨	٠,٧٦٢	٠,٢٣٨	٠,٢٧٦
	100% Potassium Nitrate	٠,٠٢٨	٠,٠٣٢	0.014	٠,٨٧٥	٠,٠٦	0.074*
	100% Urea	٠,٠٨٧	٠,١٠٦	٠,٠٢٨	٠,٨٢٠	٠,١٩٣	٠,٢٢١
	50% Potassium Nitrate + 50% Urea	٠,٠٨٦	٠,٠٦٨	٠,٠٢٢	١,٢٦٤	٠,١٥٤	٠,١٧٦
	100% Potassium Nitrate + 100% Urea	٠,١٠٥	٠,١٠٧	٠,٠٣١	٠,٩٨١٦	٠,٢١٢	٠,٢٤٣
Stage II	Control	٠,٠٨٢	٠,٠٨٨	٠,٠٣٧	٠,٩٣١	٠,١٧	٠,٢٠٧
	100% Potassium Nitrate	٠,٠٨٧	٠,١٠١	٠,٠٣٥	٠,٨٦١	٠,١٨٨	٠,٢٢٣
	100% Urea	٠,١١٢	٠,٠٧٦	٠,٠٤٠	1.473*	٠,١٨٨	٠,٢٢٨
	50% Potassium Nitrate + 50% Urea	٠,١٠٣	0.134	٠,٠٤٥	٠,٧٦٨	0.237	٠,٢٨٢
	100% Potassium Nitrate + 100% Urea	0.150*	٠,١٦٠*	0.053*	0.937	0.31*	0.363*

(*)= significant increase or decrease at 0.05 LSD.

3.3. Changes in carbohydrates content

The obtained result in Table (5) show that, at the first vegetative stage of cowpea plant growth, except for the observed general significant decrease in total soluble sugar in response to treatment with 100% potassium nitrate, 100% urea & 100% potassium nitrate + 100% urea, and in polysaccharides & total carbohydrates in response to treatment with 100% potassium nitrate, 50% potassium nitrate + 50% urea & 100% potassium nitrate + 100% urea, the other treatments induced a general significant increase in all estimated carbohydrate fractions as compared to control values.

At second vegetative stage of *vigna sinensis* L. plant, the different treatments led to a general increase in the determined carbohydrate fractions either significantly in total soluble sugar, sucrose &total carbohydrate or non-significantly in polysaccharides as compared to control values (Table 5).

The obtained results in Table (6) show that, at first vegetative stage of *Helianthus annuus* growth, sucrose content significantly increased by the all used treatments, except 100% potassium nitrate treatment which caused a non-significant increase in sucrose. Meanwhile, total soluble sugar was significantly increased in response to 100% potassium nitrate and 100% potassium nitrate + 100% urea treatments and non-significantly increased in response to 100% urea and 50% potassium nitrate + 50% urea treatments. polysaccharides and total carbohydrates increased either significantly in response to 100% urea and 100% potassium nitrate + 100% urea treatment or non-significantly in response to 100% potassium nitrate and 50% potassium nitrate + 50% urea treatments as compared to control values.

During second vegetative stage of sunflower plant growth, the all used treatment caused a general increase in the determined carbohydrate fractions either significantly in total soluble sugar & total carbohydrate or non-significant in sucrose & polysaccharides as compared to control values (Table 6).

The observed impact in stimulation of the determined carbohydrate fractions in this study may be due to the effect of these treatments on the photosynthetic capacity and growth parameters especially leaf area ratio. In this concern, Mcintyre (2001) stated that nitrogen metabolism affects wheat photosynthesis and controls plant development, possibly through carbohydrate metabolism which is involved in other important plant signaling and regulatory pathways. Fertilization with nitrogen enables to manage physiological indices during wheat vegetation. Nitrogen metabolism affects wheat photosynthesis and controls plant development, possibly through carbohydrate metabolism which is involved in other important plant signaling and regulatory pathways.Combineddata over years and sites resulted that fresh roots and sugar yields were maximized at high N rates (Ayoub *et al*., 2003).

Almodares *et al*. (2008) stated that, total sugar, sucrose content and juice extract were highest with the application of 180 kg urea ha^{-1}.While total sugar at 90 kg urea ha^{-1} was higher than control. The sucrose content and juice extract were not significant between 90 kg urea ha^{-1} and the control.The effect of nitrogen fertilizer on total sugar, sucrose content and juice extract was significant. Tallat (2002) reported that, sucrose in the cane juice obtained from control plots was 14.6 percent against the significantly higher sucrose content of 16.5 percent found in plots treated with 200 kg K_2O ha^{-1}.

High nitrogen application to the soil caused a decrease in glucose and fructose in the leaves of cabbage (Yano *et al.,* 1981). Conversely, the content of sucrose, glucose, and fructose in cabbage plants all increased in response to decreased nitrogen levels in culture solution (Hara, 1989), and in spinach and komatsuna leaves, sugar content also increased with decreased nitrogen application (Takebe *et al*., 1995).

On the other hand, nitrogen fertilizer had a substantial influence on water soluble carbohydrate (WSC) percentage in the fractions of Korean lawngrass. WSC percentage underwent a change according to the levels of nitrogen applied, decreasing from a high at 0kgN plot to a low at 700kgN plot (Jones *et al*., 1965).

In conclusion, the results of this investigation demonstrated that, nitrogen fertilizers has an overall positive correlation with growth, photosynthetic pigments and sugars especially in case of using (50% Potassium Nitrate + 50% Urea)and the magnitude of response was more pronounced in case ofcowpea plant as a leguminous plant.

Table 5. Effect of different nitrogen fertilizers on carbohydrates content (g / 100g dry weight) of *Vigna sinensis* L. during two vegetative stages.

Treatments		Parameters			
		Sucrose	**Total soluble sugar**	**Polysaccharides**	**Total carbohydrates**
Stage I	Control	٧,٧٠٠	١٥,٦٠٨	٤٦,٦٣٢	٦٩,٩٤
	100% Potassium Nitrate	٨,١٩٣	١٤,٣٧٦	24.560*	47.122*
	100% Urea	9.019*	١٤,٣١٦	70.849*	94.185*
	50% Potassium Nitrate + 50% Urea	٨,٩١٢	١٥,٧٤٤	26.533*	٥١,١٨٩
	100% Potassium Nitrate + 100% Urea	٨,٧٩٤	١٢,٦٤٩	٣٠,٣٩٤	٥١,٨٣٧
Stage II	Control	١٠,٦٢٨	١٣,٠٨٤	٣٣,٠٣٣	٥٦,٧٤٥
	100% Potassium Nitrate	15.250*	29.300*	٤٢,٨٣٥	87.385*
	100% Urea	14.382*	١٦,٢٤٨	٥٢,٥٥٢	٨٣,١٨٢
	50% Potassium Nitrate + 50% Urea	16.023*	24.828*	٥٣,٦٦٧	94.518*
	100% Potassium Nitrate + 100% Urea	15.218*	19.272*	٥٧,٢٠٧	91.697*

(*)= significant increase or decrease at 0.05 LSD.

Table 6. Effect of different nitrogen fertilizers on carbohydrates content (g / 100g dry weight) of *Helianthus annuus* L. during two vegetative stages.

Treatments		Parameters			
		Sucrose	**Total soluble sugar**	**polysaccharides**	**Total carbohydrates**
Stage I	Control	٤,١٥٤	١٥,٢٣٧	٢٠,٠٠٧	٣٩,٣٩٨
	100% Potassium Nitrate	٤,٤٢٧	19.305*	24.415	48.147
	100% Urea	٥,٢٣٧*	16.731	٣٩,٥٢٥*	61.493*
	50% Potassium Nitrate + 50% Urea	6.122*	17.277	22.984	46.383
	100% Potassium Nitrate + 100% Urea	6.128*	20.527*	٣٢,٨٥٦*	59.511*
Stage II	Control	٥,٩٩٠	٥,٧٥٩	٣٠,٧٤٦	٤٢,٤٩٦
	100% Potassium Nitrate	6.810	9.330*	36.397	52.539
	100% Urea	٦,٨٥٨	١٣,٤٧١*	41.711	62.04*
	50% Potassium Nitrate + 50% Urea	٧,٣٤٧	17.632*	٥٢,٠٣٥*	٧٧,٠١٤*
	100% Potassium Nitrate + 100% Urea	9.099*	18.548*	31.763	59.411

(*)= significant increase or decrease at 0.05 LSD.

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الملخص العربي

تأثير الاسمدة النيتروجينية على سمات الجذر و الأصباغ و السكريات لنباتي اللوبيا و دوار الشمس

رشا محمد عيد جميل[1] محمـــد عـــلي عبـاس[1]
سامية عـــلي هارون[1] صفية مصطفى احميده[2]

[1] قسم النبات- كليه العلوم- جامعة المنصورة- مصر
[2] قسم النبات- كليه العلوم- جامعة عمر المختار- ليبيا

يهدف هذا البحث الي دراسة تأثير الأسمدة النيتروجينية المختلفة (نترات البوتاسيوم و / أو اليوريا) على نمو الجذور ونسبة مساحة الورقة ومحتوى الأصباغ ومحتوى الكربوهيدرات للنباتات البقولية وغير البقولية (اللوبيا و دوار الشمس) على التوالي خلال مرحلتي النمو الخضري. و قد أوضحت النتائج أن سمات الجذر قد استجابت بصوره غير معنوية للمعاملات المختلفة المستخدمة خلال مرحلتي النمو الخضري لنباتي اللوبيا ودوار الشمس. وفقا لنسبة مساحة الورقة، باستثناء الزيادة الغير معنويه عند المعاملة ب ١٠٠٪ نترات البوتاسيوم + ١٠٠٪ من اليوريا أثناء المرحلة الثانية، تسببت المعاملات الأخرى في انخفاض غير معنوي عام لهذه النسبة خلال مرحلتي النمو الخضري لكلا النباتين. وزاد المحتوي الكلي للكلوروفيل والأصباغ باستخدام مختلف المعاملات في المرحلة الأولى من نمو اللوبيا في حين انخفضت هذه الأصباغ خلال المرحلة الثانية لنمو اللوبيا والعكس بالعكس في حالة نبات عباد الشمس. بصفه عامه ازداد محتوى السكروز من قبل جميع المعاملات المستخدمة في المرحلة الخضرية الأولى لكلا النباتين. و كذلك أدت المعاملات المختلفة بالأسمدة النيتروجينية إلى زيادة عامة في المحتوي الكربوهيدراتي (السكريات الذائبة الكلية و السكروز و عديدات التسكر و المحتوي الكلي للكربوهيدرات) بالمقارنة مع قيم العينة الضابطة خلال المرحلة الخضرية الثانية لكلا النباتين.

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JOESE 5

Effect of nitrogen fertilizers on root criteria, pigments and carbohydrates of *Vignasinensis* L. and *Helianthus annuus* L. plants.

Rasha M.E. Gamel[1], Mohammed A. Abbas[1], Samia A. Haroun[1] and Safia M. Ahmaida[2]

[1]*Botany Department, Faculty of Science, Mansoura University, Egypt*

[2]*Botany Department, Faculty of Science, Omar Al-Mokhtar University, Libya*

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