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EFFECT OF SHADE, DROUGHT AND NUTRIENTS ON PEAS (*Pisum sativum* L.) AND ITS PHOTOSYNTHETIC ACTIVITY.

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ABSTRACT

Two field experiments were carried out in 2000 and 2001 seasons at the Experimental Farm (Cockle Park farm) of the Faculty of Agriculture, Newcastle University, to investigate the effect of shade, drought, nutrients and shade + drought + nutrients on vegetative growth, yield of pea (c.v. Eiffel) and its quality, as well as photosynthetic activity.

The results showed that nutrients treatment (formula-4) increased vegetative growth (plant length, number of reproductive nodes, both fresh and dry weight of stems, stipules, tendril, and pod of pea plant) and yield and its components (pod fresh weight, number of pods and number of seeds per plant. On the other hand, the lowest values of most studies characters were obtained by the drought treatment.

Regarding the effect of studied treatments on photosynthetic activity, it may be concluded that nutrients treatment caused an increase on photosynthetic activity characters of pea bottom leaves (delta e, delta c, E, g_s and A) at most of ages of leaves (71, 82, 93 and 100 days from planting), while the control treatment increased e ref, c ref, U and Ci. On the other hand, delta c, E, g_s and A were at maximum values on top pea leaves with nutrients treatment in both ages of 93 and 100 days from planting.

***Conclusively,** it could be concluded that the nutrients treatment(formula-4), being the most effective on vegetative growth, green pod yield and its quality as well as photosynthetic activity of peas plants.*

Key words: Peas, shade, drought, nutrients, photosynthetic activity.

INTRODUCTION

Pea (*Pisum sativum* L.) is one of the most important vegetable crops grown in the UK, which occupies a great figure in the local consumption.

Pea yield could be increased horizontally by increasing the cultivated area and /or vertically by increasing yield of unit area. Some physiological studies such as, shade, drought and macro-micronutrients formula are among the important factors affecting the yield of unit area.

Many investigators showed that NPK and / or Fe, Bo, Mo (Macro and microelements) increased legume plants growth parameters, green pod yield and its components as well as pod and seed quality (Ashour and Thalooth, 1974; Amer, 1992; El-Afifi *et al*., 1995; Abou El-Salehein and Ghali, 1997 and Muhammad, 1998).

Moreover, Some investigators indicated that drought caused a decrease in all aforementioned characters (Alvino *et al*., 1986 and Adam *et al*.,2002).

In addition, in the same trend, Brink(1999) concluded that development, growth and dry matter production of bambara groundnut were lower in the shaded treatment than in the unshaded ones.

Therefore,this work has been designed to study the effect of shade, drought and nutrients on vegetative growth, green pod yield as well as pod and seed quality of pea and also photosynthetic activity.

MATERIALS AND METHODS

The experiment was done during 2000 and 2001 seasons at the Cockle Park Farm, Newcastle University, England, UK.

Pea seeds of Eiffel CV(medium in tall) were sown on 9th of June 2000 and 2001, at pots in green house(diameter of pot,25 cm).

This experiment was performed to study the effects of shade, drought and nutrients on pea plants which included 5 treatments as follows:

1. Shade (it watered every week with 100 ml water).
2. Shade + Drought + Nutrient (it watered every week with 100 ml formula-4).
3. Nutrients (it watered every week with 200 ml formula-4).
4. Drought (it watered with every week 100 ml water).
5. Control (with 200 ml water, every week).

Every treatment included 6 pots and 3 plants per pot and the treatment of control included 9 pots.

The radiation interception out of green house was 132.6 Lux, inside of green house was 81.8 Lux and inside of shade was 58.2 Lux. Seeds were sown in pots and when it grown we thin at 3 plants.

These treatments were arranged in complete block randomised with three replicates. he formula-4 consists of some elements as follows:

Nitrogen (N) 15% (Nitric Nitrogen 8.0%, Amonomical Nitrogen 2.8% and Vreic Nitrogen 4.2%).

Phosphorus pentoxide (P_2 O_5) 15% (6.5% P) soluble in neutral ammonium citrate and water.

Potassium Oxide (K_2O) 30% (24.9% K) soluble in water

Trace elements:

Boron (B) 0.02%

Copper (Cu) 0.01%

Iron (Fe) 0.20%

Manganese (Mn) 0.02%

Molybdenum (Mo) 0.002)%

Zinc(Zn) 0.05%

Also containing Magnesium (Mg)

Wt: 800 g.

Manufactured in the UK by chempak products Geddings Road, Hoddesdon Herts EN11OLR.

Soil characteristics of the experimental pots were shown in Table 1:

Table 1 . Soil characteristics of the experimental pots

Soil characteristics	**Values**
Texture class	Clay loam
O.M. %	1.34
pH	7.92
EC (dSm^{-} at 25^{o}C)	3.20
Available N (ppm)	45.60
Available P (ppm)	7.80
Available K (ppm)	291.00
Available Zn (ppm)	0.81

At 84 days from planting, the plants from every treatment in all replicates from 3 pots. The following data were recorded:

I-Plant growth measurements:

1- Plant length (cm).

2- Stem diameter (cm).
3- Number of vegetative nodes.
4- Number of reproductive nodes.
5- Fresh and dry weight of stems (g).
6- Fresh and dry weight of stipules (g).
7- Fresh and dry weight of tendrils (g).

At harvest time, the plants were taken from the other 3 pots of every treatment and following data were recorded:

II- Yield and its components:

1- Number of pods per plant.
2- Fresh and dry weight of pods (g).
3- Dry weight of seeds (g).

III- Physical pod characters:

1- Number of seeds per pod and per plant.
2- Pod length (cm).
3- Pod width (cm).
4- Pod thickness (cm).

Photosynthetic activity measurements:

Data were taken by Lci apparatus. The Lci (with its leaf chamber) is specifically designed for portability and field use, and provides internal battery suitable for up to 10 hours of continuous operation. Its purpose is to measured the environment of a leaf contained in the Jaws of the chamber, and to calculate the photosynthetic activity of the leaf.

The instrument comprises a main console with signal conditioning, air supply, microprocessor control, PC (personal computer) card data storage, a-5-button keypad, and a leaf chamber connected by an umbilical cord. The main console supplies air with a relatively stable CO_2 concentration to the chamber at a measured rate. The CO_2 and H_2O concentrations are measured, and the air is directed over both surfaces of the leaf. The discharged air leaving the chamber is analysed, and its CO_2 content (generally decreased) and H_2O content(increased) determined.

From the differences in gas concentration and the airflow rate, the assimilation and transpiration rate are calculated approximately every 20 seconds. A small fan in the chamber insures through mixing of the air around the leaf. Measurement of CO_2 is by an infrared gas analyser (IRGA). H2O measurement is by two Laser-trimmed humidity sensors. The system also measures leaf temperature, chamber air temperature, PAR (Photosynthetically Active Radiation), and atmospheric presser. The PAR level at the leaf and the radiant energy balance of the leaf are calculated. The measurements are carried out in an "Open System" configuration in which fresh gas (air) is passed through the PLC (Plant Leaf Chamber) on a continuous basis. Measurements are carried out on the state of the incoming gas (the 'reference' levels) and after passing the leaf specimen (the 'analysis' level); the gas is then vented away. This arrangement tolerates some outward gas leakage and adsorption by the materials used in the gas path. Data were taken at 4 times during growing of plants in pots as follows:

1. At 30 August (71 days from sowing).
2. At 11 September (82 days from sowing).
3. At 22 September (93 days from sowing).
4. At 29 September (100 days from sowing).

At these times the following data were recorded.

e ref: water vapour pressure into leaf chamber, m Bar.

delta e: difference in water vapour pressure, m Bar.

C ref: Co_2 flowing into leaf chamber, µ mol mol^{-1}.

Delta c: difference in CO_2 concentration through chamber, dilution corrected, µ mol mol^{-1}.

Q leaf: P.A.R. incident on leaf surface, µ mol mol^{-1} m^2. (Q leaf = Q * Trw)

Where: Q: photon flux density insident on leaf chamber window, µ mol m^{-2} s^{-1}

Trw: leaf chamber window transmission factor to P.A.R. (given).

S: span factor, determined during calibration (span adjustment).

U: molar air flow in mol s^{-1}.

Ci: sub-stomatal cavity CO_2 concentration, µ mol mol^{-1}.

E: Transpiration rate, mol m^{-2} s^{-1}.

g_s: stomatal conductance of water vapour, mol m^{-2} s^{-1}.

A: Photosynthetic rate (Rate of CO_2 exchange in the leaf chamber), µ mol m^{-2} s^{-1}.

Statistical analysis*:*

The obtained data were statistically analysed according to Snedecor and Cochran (1980) and using LSD test at 5% level of significance to verify the differences between treatments.

RESULTS AND DISCUSSION

Vegetative growth characters:

Data in Tables (2 and 3) indicated that the effect of shade, drought and nutrients on pea plants resulted in greater vegetative growth of most of studies characters. It is clearly evident from such data that the addition of nutrients (formula-4) to pea plants resulted in the highest values of plant length, number of reproductive nodes, both fresh and dry weight of stem, stipules and tendril. On the other hand, the lowest values of most studies characters were obtained by the drought treatment.

The stimulation effect of formula-4 (nutrients treatment) might be due to the macro and microelements content of this structure and its role in pea plants. As the role of NPK elements in plant, Edmond *et al*., (1981) concluded that nitrogen needed in the formation of protoplasm , new cells and for encouragement of cell elongation. Phosphorus plays indispensable role in the enzyme system necessary for the energy transform in photosynthesis and respiration. In addition, it is also a constituent of cell nucleus and essential for cell division and for the development of meristem tissues. Moreover, they added that potassium in the prevalent caution in plant and may be involved in maintenance of ionic balance in cells and it bounds ionically to the enzyme pyruvate kinase. So that, potassium elements is very important in the overall metabolism in plant.

Regarding the role of micro elements in plant, Miller, 1968 indicated the promoting effect of Fe may be due to that Fe acts a part of enzyme activation of protoplasm.

In addition, Zinc is a microelement which have been shown to be important in metabolic process and symbiotic nitrogen fixation in legumes (El-Hawary, 1999).

The lowest values of shade treatment may be due to the low photosynthesis, which causes lowest of metabolic processes and carbohydrates building (Brink, 1999).

In addition, the lowest values of drought treatment may be due to the direction of plants for searching the water and consumption the constituents materials ,cosquently,it gave a low growth characters(Adam *et al*,2002).

The obtained results regarding nutrients coincided with those mentioned by Ashour and Thalooth (1974); Amer (1992); El-Afifi *et al* (1995); Abou El-Salehein and Ghali (1997) and Muhammad (1998).

On the other hand, the obtained results respecting to drought treatment are going in agreement with those obtained by Alvino *et al*. (1986) and Adam *et al*.(2002). In addition, similar results were obtained by Brink (1999) on shading treatment. He concluded that development, growth and dry matter partitioning in bambara groundnut (*Vigna subterranean*) were 41% lower in the shaded treatment than in the unshaded ones.

***Green pod yield and its components*:**

Data shown in Table 4 reveal that most of studied characteristics of yield and its components were significantly affected by the studied treatments. The nutrients treatment, being the most effective on increasing the pod yield and its components expressed as, pod fresh weight, pod dry weight, seed dry weight, number of pods and number of seeds per plant, while the drought treatment showed the lowest values in this respect.

The superiority in green pod weight by application of formula-4 which contains N, P, K ,Fe and Mo might be attributed to the amount of metabolites synthesised by the plant, which reflected on vegetative growth (Tables 2 and 3) and consequently, on yield components.

The increase in green pod yield and its quality due to nutrients treatment may be also due to the enhancing effect of this treatment on the metabolism and translocation of carbohydrates to pod and consequently to seeds (Bidwell, 1979). Moreover, this formula contains Mo, which increased pod yield (Hafner *et al*., 1992). These results are in good line with those reported by Amer (1992); El-Afifi *et al*.(1995); Abou El-Salehein and Ghali (1997) and Muhammad (1998). On the other hand, Alvino *et al*., 1986 reported that drought caused a decrease in green pod yield and its components.

Photosynthetic activity:

a) On bottom leaves:

Data in Table (5) illustrate that the addition of nutrients to pea plants resulted in greater photosynthetic activity expressed as delta e, delta c, U, E, g_s and A, but these increased did not reach the 5% level of significance in the age of 71 days from sowing. In the second age (82 days from sowing), data in Table (7) reveal that, nutrients caused an increase in delta e, delta c, Q leaf, E, g_s and A. On the other hand, control treatment gave the highest values on e ref, C ref, U and Ci. In addition, another results were found in the third age, 93 days from sowing (Table 9),where drought treatment increased delta C, C ref, U, E and gs, but at the

latter age,100 days from sowing (Table 11), nutrients treatment caused the increases in delta e, C ref, delta C, E, g_s and A.

Generally, the nutrients treatment, being the most effective on photosynthetic activity. Moreover, nutrients increased and built strong vegetative growth (Tables 2 and 3) with active photosynthetic apparatus (Tables 5, 7 and 11) and consequently, the highest yield with the best quality (Table 4).

Photosynthesis rate or (A) sum of all data in LCi apparatus, which resulted in strong photosynthetic activity by the treatments of this experiment.

b) On top leaves:

Data presented in Table (6) illustrate that delta c, Q leaf, U, g_s and A were significantly increased with nutrients treatment, while e ref, delta e and E were significantly increased with control treatment at 71 days from planting. On the other hand, at 82 days from sowing, (Table, 8), obtained data show that nutrient treatment significantly increased Q leaf only and there were an increase in U and A with nutrient treatment, but this increase not reach the 5% leaf of significance. In addition, on this age, the control treatment, being the most effective treatment on most of photosynthetic activity, i.e. e ref, delta e, c ref, E and g_s.

Results in Tables (10 and 12) show that delta e, delta c, E, g_s and A were at maximum values when pea plants were added with nutrients treatment in both ages from sowing (93 and 100 days).

The increase in photosynthetic activity data might be due to the favourable effect of nutrients treatment (formula-4) on growth characters (Tables 2 and 3) and its effect on yield and its components (Table 4) from all Tables of photosynthetic activity in both botton and top leaves, it may be concluded that nutrients treatment increased most of photosynthetic activity data of pea plants at all ages from sowing.

Conclusively, it could be concluded that the nutrients treatment(formula-4), being the most effective on vegetative growth, green pod yield and its quality as well as photosynthetic activity of peas plants.

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تأثير التظليل ،الجفاف،والعناصر الغذائية علي البسلة وكفاءة عملية التمثيل الضوئي

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أجريت تجربتان حقليتان في موسمي ٢٠٠٠ ،٢٠٠١ بمزرعة التجارب (كوكل بارك) التابعة لكلية الزراعة ، جامعة نيوكاسل لدراسة تأثير التظليل ،الجفاف ، والعناصر الغذائية ، التظليل +الجفاف +العناصر الغذائية علي النمو الخضري ، محصول البسلة (صنف آيفل) وجودته وكفاءة التمثيل الضوئي .

أوضحت النتائج أن :المعاملة بالعناصر الغذائية (فوميولا – ٤) قد أدت إلى زيادة النمو الخضري (طول النبات،عدد العقد المنتجة للقرون، كلا الوزنين الطازج و الجاف لكل من السيقان ، الأوراق ، المحاليق ، القرون، المحصول ومكوناته (الوزن الطازج للقرون ، عدد القرون على النبات وعدد البذور لكل نبات) . من ناحية أخرى ، قد تم الحصول على أقل القيم للصفات المدروسة من معاملة الجفاف .

بالنظر إلى تأثير المعاملات المدروسة على كفاءة عملية التمثيل الضوئي ، يمكن أن نوصى بأن المعاملة بالعناصر الغذائية قد سببت زيادة في صفات كفاءة التمثيل الضوئي للأوراق القاعدية (الاختلاف في ضغط بخار الماء ، الاختلاف فى تركيز ثاني أكسيد الكربون بالغرفة الهوائية ، معدل النتح ، معدل مرور بخار الماء بفتحه الثغر و معدل التمثيل الضوئي) وذلك لأغلب الأعمار (٧١ ،٨٢، ٩٣، ١٠٠، يوم من الزراعة) ، بينما معاملة المقارنة قد رفعت (ضغط بخار الماء في غرفة الورقة ،تدفق ثاني أكسيد الكربون بغرفة الورقة ،تدفق الهواء ،تركيز ثاني أكسيد الكربون تحت الغرفة).

من ناحية أخري ،أدت المعاملة بالعناصر الغذائية إلى زيادة كفاءة عملية التمثيل الضوئي لأعلي القيم بالأوراق القمية (الاختلاف في تركيز ثاني أكسيد الكربون بالغرفة الهوائية ، معدل النتح ، معدل مرور بخار الماء بفتحة الثغر، ومعدل التمثيل الضوئي) وذلك عند عمري ٩٣ ، ١٠٠ من الزراعة.