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EFFECT OF WATER STRESS ON PROTEIN AND AMINO ACIDS PERCENTAGE IN SEEDS OF SOME LEGUME CROPS.

El – Ghobashy A. K. and H. Y. M. Youssef

Agronomy department, Faculty of Agriculture, Al – Azhar University, Cairo, Egypt

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ABSTRACT **Four legume crops (Lupin, chickpea, Faba bean and Lintel) were used to study the effect of irrigation water levels on protein, essential amino acids, and non–essential amino acids percentage in seeds of these crops. This investigation was carried out to study the effect of water stress i.e. irrigation at 40 %, 60 % and 80% depletion from available soil moisture. The highest values at essential amino acids percentage (Thrionine, Lucine, isolucine, Valine, Phenylalanine, Histidine and Lycine) in Lupin and Lintel increased at 40% depletion, while it was increased in chickpea and faba bean at 60 % and 80 % depletion respectively.**

Results presented indicated that soil moisture levels on non – essential amino acids (N.E.A.A) percentage. Aspartic, Serine, Glutamic acid, Proline, Glycine, Alanine and Tyrocine in lupin and faba bean increased with increasing depletion of available soil water from 40 % to 80 % depletion. At the highest water stress (80 % depletion) lupin and faba bean gave the highest protein percentage, while chickpea and lintel gave the highest protein at 40 % depletion. The obtained results showed that increasing water depletion (from 40 % to 80 %) increased protein percentage.

INTRODUCTION

Leguminous seeds are one of the most important proteins, which varied between 18 – 45 % for human foods and animal feeds (Youssef, 1978 ; Sathe et al, 1982 ; Abd El – Aal et al, 1986).

In Egypt leguminous seeds are the major nutritional sources of plant proteins. These leguminous plants include faba beans, lentils, lupin and chickpea.

In Europe and North America leguminous seeds are more extensively used as protein supplements for poultry and livestock than for direct human consumption. Recently, soybean and cotton seeds, protein concentrates and isolates have been utilized as replacements in many processed foods and as a binder and extender in ground meat products. These products are given a considerable attention as an economical high – protein foods which are very suitable for overcoming malnutrition of infants in many developing countries. Because legumes are important and constitute the second large food after cereals, leguminous seeds form the first basic ingredient of the daily diet for most food products in many parts of the world. Leguminous seeds contain high amount of amino acids i.e. Lycine, Arginine, Phenylalanins, Aspartic and Glutamic.

Aly (1982) applied 1, 2 and 3 irrigations as well as planting irrigation. He found that 3 irrigations as well as planting irrigation gave maximum protein yield of lintel.

Abd – Allah (1987) reported that increasing number of irrigations to 3 times crude protein percentage was not affected. However protein was greatest when plants were irrigated 3 times.

Salama (1988) found the following values for amino acids in lupin, broad bean, chickpea, lentil and soybean gm / 100 gm protein: Aspartic (10.97, 12.28, 13.15, 13.69 and 12.224, Thrionine (3.39, 3.79, 4.05, 3.77 and 4.01, Serine (5.14, 5.32, 5.39, 5.45 and 5.28, Glutamic (28.16, 20. 19, 18. 81, 21. 13 and 21.00),

Proline (3.60, 3.81, 4.53, 4.00 and 5.15), Glycine (3.42, 3.93, 3.77, 3.83and 3.89), Alanine (3.14, 3.92, 4.16, 4.06 and 3.95), Cysteine (1.96, 0.88, 1.14, 1.13 and 1.01), valine (3.09, 4.42, 3.90, 4.34 and 4.18), Methionine (0.48, 1.07, 1.37, 0.69 and 1.88), Isolucine (3.47, 3.88, 3.72, 3.76 and 4.20), Lucine (6.64, 7.48, 7.48, 7.54 and 7.78), Tyrosine (4.36, 4.10, 3.08, 3.33 and 3.95), Phenylalanine (3.47, 5.06, 5.06, 5.78, 5.79 and 5.50), Histidine (2.15, 2.73, 2.69,1.88 and 2.64), Lycine (4.39, 7.45, 7.21 and 6.37), Arginine (12.35, 9.81, 9.79, 9.78 and 7.59) and Tryptofhan (0.59, 0.51, 0.70, 0.75 and 1.03), respectively.

El – Sharnoby (1990) studied the amino acids content of chickpea (Cicer arietnum). He reported that the amino acids values for Aspartic acid were: 11.21 gm / 16 mg N, Thronine was 3.73, Serine 5.07, Glutamic 15.55, Proline 3.54, Glycine 4.18, Alanine 4.75 and Valine 5.30.

Hamed et al (1990) reported that decreasing of soil moisture content from 75 % field capacity reduced protein content of faba bean.

Most legumes have a low biological value because of their deficiency in one or more of essential amino acids. This deficiency can be corrected either by adding the limiting or deficit amino acid or proper combining of different proteins (Flis et al, 1992).

El – maghraby and Abd El – Hay (1994) found that the protein percentage of faba bean, lupin and chickpea differed according to irrigation regimes. Irrigation at 80 % depletion of available soil moisture decreased crude protein percentage of faba bean, lupin and chickpea as compared to irrigation at 40 % depletion of available soil moisture.

Dwivedi et al (1996) found that total oil and total proteins were not affected by mid – season drought but end of season drought reduced oil and increased protein peanut.

El – Danasory (1999) found that the highest level of protein content was found in soybean (44.35 %), followed by lupin (31.42 %), lentil (24.50 %), broad bean (24.00%) and chick pea (23.85 %). Also he found

that as essential amino acids (EAA) increased the non EAA decreased and the ratio between these two parameters was the lowest value.

MATERIALS AND METHODS

The legume crops i.e. lupin, chickpea, faba bean and lentil are used in this investigation to study the effect of three irrigation levels (irrigation at depletion 40, 60 and 80 % from available soil water) on protein percentage and essential as well as non essential amino acids in seeds of previously used legume crops.

Normal agriculture practices were applied for legume crops studied as recommended by Ministry of Agriculture. Seeds samples of legume crops were taken and prepared to determine protein and amino acids.

Protein was determined using the improved Kyeldaht's methods of the A.O.A.C (1990) modified by distilling the amonia into boric acid solution and titrated standard acid.

Amino acids were determined by high performance liquid chromatographic (HPLC) with the columns 200 x 4.6 mm.

RESULTS AND DISCUSSION

The effect of irrigation levels (irrigation at depletion 40 %, 60 % and 80% from available soil water) on protein was studied. Essential amino acids and non-essential amino acids of the four legume crops (lupin, chickpea, faba bean and lintel) are shown in tables 1, 2, 3 and 4. Results indicated that protein percentage at water depletion 40 % were 29.12, 25.30 %, 24.50 % and 23.95 % in the seeds of lupin, faba bean, lintel and chickpea respectively. Meanwhile, the highest protein percentage at 60% water depletion was 30.80 % followed by 26.30 %, 24.75% and 22.05% for lupin, faba bean, lintel and chickpea respectively. The same values were obtained at 80 % water depletion. The highest protein percentage was 32.4 % (lupin), 28.26 % (faba bean), 25.80 % (lintel) and 21.50 % (chickpea). The obtained results indicated that lupin, faba bean

Table (1). Effect of water depletion on essential amino acids and non-essential amino acids percentage in seed of lupin crop .

Available water depletion / Amino Aicds	40 %	60 %	80 %
Thrionine	3.89	3.80	3.48
Lucine	7.50	7.51	6.92
Isolucine	4.28	4.17	3.83
Valine	4.57	4.02	4.00
Phenylalanine	5.80	5.61	5.29
Histidine	5.88	2.68	2.62
Lycine	7.49	6.79	6.33
Arginine	14.26	9.98	9.69
T.E.A.A	50.67	44.56	42.15
Aspartic acid	10.39	12.13	12.65
Serine	4.36	4.94	5.13
Glutamic acid	17.04	18.83	19.94
Proline	4.94	5.30	5.58
Glycine	3.55	3.96	4.05
Alanine	3.84	4.27	5.01
Tyrocine	5.23	5.61	5.86
T.N.E.A.A	49.35	55.04	28.22
% protein	29.12	30.80	32.40

Table (2). Effect of water depletion on essential amino acids and non-essential amino acids percentage in seed of chickpea crop .

Available water depletion / Amino Acids	40 %	60 %	80%
Thrionine	3.79	3.77	3.69
Lucine	7.77	7.50	7.56
Isolucine	4.27	4.26	4.29
Valine	3.97	3.93	3.94
Phenylalanine	3.80	3.75	3.74
Histidine	2.48	2.39	2.35
Lycine	4.50	4.65	4.48
Arginine	10.91	11.26	10.86
T.E.A.A	41.49	41.51	40.91
Aspartic acid	11.04	11.09	11.40
Serine	5.37	5.31	5.42
Glutamic acid	24.72	25.36	26.53
Proline	5.78	5.96	6.22
Glycine	3.77	3.81	4.13
Alanine	3.27	3.31	3.34
Tyrocine	3.81	3.84	3.86
T.N.E.A.A	57.76	58.68	60.90
% protein	23.95	22.05	21.50

Table (3). Effect of water depletion levels on essential amino acids and non-essential amino acids percentage in seed of faba bean crop .

Available water depletion / Amino Acids	40 %	60 %	80 %
Thrionine	3.86	3.85	4.79
Lucine	7.96	7.84	7.93
Isolucine	4.28	4.17	4.42
Valine	4.48	4.76	4.96
Phenylalanine	4.54	4.47	4.44
Histidine	2.65	2.72	2.89
Lycine	6.33	6.25	6.32
Arginine	10.75	9.93	10.92
T.E.A.A	44.85	44.98	46.37
Aspartic acid	11.87	12.28	12.09
Serine	4.94	5.03	5.14
Glutamic acid	16.62	19.92	19.71
Proline	6.21	6.42	6.32
Glycine	4.19	4.21	4,07
Alanine	4.40	4.51	4.37
T.N.E.A.A	52.67	56.84	56.24
% protein	24.50	26.30	28.26

Table (4). Effect of water depletion levels on essential amino acids and non-essential amino acids percentage in seed of faba bean crop .

Available water depletion / Amino Acids	40 %	60 %	80 %
Thrionine	3.51	3.89	3.83
Lucine	7.95	6.63	7.22
Isolucine	4.55	3.25	3.73
Valine	4.87	4.38	4.29
Phenylalanine	3.69	3.84	4.08
Histidine	2.24	2.22	2.19
Lycine	5.68	5.19	5.03
Arginine	10.37	8.04	8.61
T.E.A.A	42.86	37.44	38.98
Aspartic acid	12.57	13.99	14.60
Serine	4.80	5.42	5.28
Glutamic acid	20.45	22.26	20.31
Proline	5.39	5.42	6.42
Glycine	7.81	8.61	8.71
Alanine	3.27	4.52	4.28
Tyrocine	2.73	2.03	1.98
T.N.E.A.A	57.02	62.25	61.58
% protein	25.30	24.75	25.88

and lintel protein percentage were increased with increasing water depletion. On the other hand, chickpea protein percentage was inversely affected by water depletion. That may refer to the sensitivity of chickpea to water depletion. These results are in agreement with those of El – Maghraby and Abd – el – Hay (1994) and Dwividi et al (1996).

The effect of water depletion on the essential amino acids and non – essential amino acids percentage in lupin (table 1) showed that Lysine percentage decreased with increasing water depletion from 40 % to 80 % (7.49 %, 6.79 % and 6.33 % respectively. While Isolucine percentage was (4.28 %, 4.17 % and 3.83 %) at 40 %, 60 % and 80% water depletion. Therionine percentage was 3.84 %, 3.80 % and 3.48 % at water depletion 40 %, 60 % and 80 % respectively. This refers to the opposite trend of Aspartic acid (10.39 %, 12.13 % and 12.65 %) at water depletion 40 %, 60 % and 80% respectively. In this context it should be mentioned that Lysine and Lucine are the amino acids senthasided from Aspartic acid (West et al, 1971). The values of Proline and Glutamic acid at water depletion 40 % were 4.94 % and 17.46 % and at 60 % were 5.30 % and 18.83 %, as well as at 80 % were 5.58 % and 19.94 % respectively. On the other hand, Histidine and Arginine values at water depletion 40 % were 2.88 % and 12.46 %, at 60 % water depletion the values were 9.98 % and 2.68 %, and at 80 % water depletion the values were 9.69 % and 2.62 % respectively. In this context it seemed that Arginine, Proline and Histidine amino acids are from Glutamic acid (West et al, 1971). The decrement in Histidine and Arginine percentage refers to the increment of Glutamic acid and Proline. Results indicated that the values of Serine, Glycine and Alanine increased with increasing depletion available water. This refers to the decreasing of the values of Valine and Lucine with the depletion of available water (40 %, 60 % and 80 %) respectively.The effect of water depletion in chickpea is shown in (table 2). The values of Aspartic acid (11.04%, 11.09 % and 11.40 %) increased with increasing water depletion at 40 %, 60% and 80 % respectively. In

contrary, Thrionine values were (3.79 %, 3.77 % and 3.69 % at water depletion 40 %, 60 % and 80 % respectively. The highest value of Isolucine was (4.29 %) at 80 % water depletion and the lowest value was 4.26 % at 60 % compared with 40 % water depletion (4.27 %). Alanine values (3.27 %, 3.31 % and 3.34 %) and Glycine values (3.77 %, 3.81 % and 4.13 %) increased due to the increase of water depletion at 40 %, 60 % and 80 % respectively. Valine value (3.97%) and Lucine value (7.50 %) decreased at 60 % water depletion, and increased at 80 % water depletion; 3.94 % and 7.56 % respectively. Glutamic acid, Arginine and Proline values increased as water depletion increased, this was due to Histidine decrement.

Tyrocine values 3.81 %, 3.84 % and 3. 86 % were increased at 40 %, 60 % and 80 % water depletion respectively. This was a result of Phenylalanine decrease (3.88%, 3. 75 % and 3. 74 % respectively.

Results for faba bean in (table 3) revealed that Aspartic acid value (12.28 %) increased at 60 % due to the decrement of Isolucine value (4.17 %) and Thrionine value (3. 89 %). But Aspartic acid decreased (12.09 %) at 80 %, Isolucine and Thrionine increased 4.42 % and 4.49 % respectively. At the same rate, Alanine, Glycine, Valine and Serine increased at 60 % water depletion, while Lucine decreased at the same water depletion. Meanwhile, Alanine and Glycine decreased at 80 %, while Serine, valine and Lucine gave the highest values at the same rate. Tyrocine values increased (4.44 %, 4. 47 % and 4.54 %) at 40 %, 60 % and 80 % respectively. On the other hand, Phyenlalanine values decreased to 4.94 %, 4.47 % and 4.42 % at the same rates. Glutamic acid, Proline and Histidine values increased at water depletion 60 %, this refers to Arganine decrement at the same rate. Proline and Glutamic acid values decreased at 80 % whereas Arganine and Histidine values increased at the same water depletion rate.

Results for Lintel in (table 4) showed that, Phenylalanine values increased at 60 % and 80 % water depletion, while Tyrosine decreased at the same rate. On the other hand, Serine,

Glycine and Alanine values increased at 60 % water depletion. So, Lucine and Valine values decreased. Glycine and Lucine values decreased at 80 % water depletion, while Alanine and Valine values decreased at the same water depletion rate. Aspartic increased at 60 % and 80 % water depletion, while Lycine, Isolucine and Serine decreased. Proline and Valine contents in Lintel increased at 60 % and 80 % water depletion accompanied by decreasing Histidine and Glutamic acid values at both rates. The highest values for the total essential amino acid in Lintel protein are (42.86 %) at 40 % followed by (38.98 %) at 80 % and (37.44 %) at 60 %.

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تأثير الإجهاد المائي علي النسبة المئوية للبروتين والأحماض الأمينية في بذور بعض المحاصيل البقولية

أحمد السيد خطاب الغباشي هاني يوسف محمد يوسف
قسم المحاصيل – كلية الزراعة – جامعة الأزهر – القاهرة

أجريت هذه التجربة لدراسة تأثير ثلاث مستويات من الري (الري عند استنفاذ ٤٠ % ، ٦٠ %، ٨٠ % من الماء المتاح) علي النسبة المئوية للبروتين والأحماض الأمينية في بـذور بعض المحاصيل البقولية وهي: الترمس – الحمص – الفول البلدي والعدس.

وتتلخص أهم النتائج المتحصل عليها فيما يلي:

-الري عند استنفاذ ٨٠ % من الماء المتاح أعطي علي نسبة مئوية للبروتين فى الترمس ، وعلي العكس من ذلك أعطي أقل نسبة مئوية للبروتين فى الحمص.

-زيادة الأحماض الأمينية الأساسية في الترمس والعدس عند استنفاذ ٤٠ % من المـاء المتـاح، بينما أعطي الحمص والفول البلدي أعلي نسبة مئوية للأحماض الأمينية الأساسية عند اسـتنفاذ ٤٠ % ، ٦٠ %.

-أعطى الفول البلدى عند استنفاذ ٦٠% من الماء المتاح زيادة فى الاحمـاض الأمينيـة غيـر الأساسية.

وعموما تشير النتائج أن زيادة الإجهاد المائي يؤدي إلي زيادة النسبة المئوية للبـروتين وبعض الأحماض الأمينية الأساسية وغير الأساسية.