Effect of Soil Moisture Deficit, Biological and Mineral Nitrogenous Fertilization on Growth and Yield of Soybean

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ABSTRACT

The current work was conducted in 2007 and 2008 seasons at the Experimental Farm of the Faculty of Agriculture "Saba Basha", Alexandria University, at Abees Alexandria Egypt, to study the effect of soil moisture stress, biological and mineral nitrogenous fertilization on growth, yield and yield components of soybean. The experimental design was a split split-plot with three replicates. The main plots were assigned to four irrigation regimes 70%, 60 %, 50 % and 40 % of soil field capacity (SFC) , three levels of nitrogen fertilization (zero, 15, 30 kg N/fed.) were randomly distributed in the sub-plots. Whereas, the sub-sub plots were represented by four biofertilization treatments (control, Rhizobacterien, Bradyrhizobium japonicum and dual inoculation).

The obtained data showed that plant height, no. of branches, pods, seeds, seed yield / plant, 100- seed weight, leaf area index, seed and biological yield (ton / fed), oil and protein yield (kg/fed), oil percentage, number and weight of nodules and N P K content in leaves depressed by increasing soil moisture depletion, whereas seed protein content exhibits an opposite trend. The mean values for seed yield (ton/fed) in the two growing seasons were 1.288, 1.172, 0.751 and 0.574 ton / fed. at 70 %, 60 %, 50 % and 40 % of soil field capacity, respectively. The data showed that application of nitrogen fertilizer was affected on most growth and yield attributes, particularly, in conjunction with Rhizobium japonicum. Concerning utilization of biofertilizers, the mean values for seed yield in both seasons were 0.911, 0.815, 1.02 and 1.04 ton / fed by uninoculation, Rhizobacterien, Rhizobial and dual inoculation, successively.

The concentration of NPK in soybean leaves decreased with increasing soil moisture depletion. In addition, its concentration increased with Rhizobial inoculation in comparison with the other biofertilizers.

INTRODUCTION

Soybean {Glycine max (L) Merr.} is an important leguminous crop all over the world, it accounts for approximately 50 % of the total production of oil seed crops in the world. The seeds of soybean contain about 40 % protein and 20 % oil. Moreover, seed is also valuable in the manufacture of many human foods and livestock feeds. Therefore, efforts are being focused on increasing the productivity of soybean crop by growing high yielding cultivars under the most favourable agricultural conditions.

Water supply is one of the most environmental factors that control growth and development in plants.

Increasing demand for fresh water sources makes it necessary to save as much water as possible. In general, depending on the level of reductions, deficit irrigation results in reduced yields (Dogan et al., 2006; Karam et al., 2005). It is reported that depending on hybrid characteristics, soybean use about 450–700 mm of water (Doorenbus and Kassam, 1979). The most critical period for water stress in soybean was claimed by some researchers to be the flowering stage and those stages following flowering.

Ergun et al. (2007) indicated that any water stress imposed on soybean in three different generative stages (R3, R5, and R6) resulted in substantial yield reduction compared with full irrigation; yield reduction was greatest at the R6 stage.

Several investigators reported that exposing soybean plants to moisture deficit reduced plant height, number of pods/plant, seed yield/plant, 100- seed weight, seed yield, oil % and protein yields, i.e Al-Assily and Mohamed(2002), EL – Sabbagh et al., (2006), Omar et al., (2007), Salwa (2008) and Moursi et al., (2009).

Nitrogen is an essential plant nutrient and, in agriculture, fertilization with nitrogen products is widely and increasingly practiced to increase the production yield of food (Reinhold- Hurek and Hurek, 2003). Nitrogen nutrition in soybean is met by a combination of the uptake and assimilation of inorganic soil N and symbiotic N2 fixation. The proportion of soybean crop's N derived from inorganic - soil N or from N2 fixation may change depending upon whether or not the crop is exposed to drought or other environmental constraints.

Biofertilizers are products containing living cells of different types of microorganisms, which have an ability to convert nutritionally important elements from unavailable to available form through biological processes (Hegde et al., 1999; Vessey, 2003). In recent years, biofertilizers have emerged as an important component of the integrated nutrient supply system and hold a great promise to improve crop yields through environmentally better nutrient supplies. However, the application of microbial fertilizers in practice, somehow, has not achieved constant effects. The mechanisms and interactions among these microbes still are not well understood, especially in real applications.

Inoculation of soybean is a significant agency for the manipulation of rhizobia for improving crop productivity and soil fertility. It can lead to the establishment of a large rhizobial population in the plant rhizosphere and to improved nodulation and N2-fixation, even under adverse soil N conditions. Sometimes, yields are not increased by inoculation, but N concentration in seed or plant parts may be increased over that of non-inoculated plants .In cases where both types of responses are not observed, the result might simply be a saving of soil N for succeeding crops. (Wani et al.1995).

MATERIALS AND METHODS

Two field experiments were conducted at the Experimental Farm of the Faculty of Agriculture "Saba Basha", Alexandria University, at Abees Alexandria Egypt, in 2007 and 2008 seasons to study the effect of soil moisture stress, biological and mineral nitrogenous fertilization on growth, yield and yield components of soybean (Glycine max L. Merril). Each sub-plot consisted of 5 rows, 3.5 m long on 0.6 m width (10.5 m2). Seeds of Giza 111(soybean cultivar) were planted on one side in hills at 20 cm apart, on 28 and 30April, in the first and second season, respectively. The preceding crop was Egyptian clover (Trifolium alexandrinum L.) during both of growing seasons. The experimental soil was clay loam in texture, poor in organic matter

(0.90%) with pH (8.0).Available phosphorus was (0.41mg/kg) and available nitrogen was (0.42 mg/kg) (average of the two seasons for upper 30 cm of the soil surface). Soil moisture content was gravimetrically determined in soil samples collected before each irrigation from 60 depth by using cylindrical sharp edge samples Vomocil (1957). The cylinder was pressed gently into the soil to the desired depth to obtain a known volume of the soil sample which placed, immediately, in moisture container, then, oven dried at 105°C for 24h.Soil field capacity was approximately (43.0% as average of two seasons). Irrigation water was applied when soil moisture content decreased to the desired available soil moisture in each treatment, which divided into separated plots to keeping them away from interaction effects. Inoculation with strains of Bradyrhizobium japonicum (Okadin) and Rhizobacterien was performed by coating the wetted soybean seeds using a sticking substance (Arabic gum) just before sowing and irrigated for securing the moist surrounding to bacterial inoculation. Nitrogen fertilizer was in form of NH_4NO_3 and was added to the experimental unit once after twenty days from sowing date. Phosphorous fertilizer in the form of calcium super phosphate (15.5% P_2O_5) was applied at the rate of 30 kg/fed during land preparation. Other practices for growing soybean were realized as recommended. Harvesting took place on 15 and

17 September for the first and second seasons, respectively. Protein content in seeds was determined according to the improved Kjeldahl method of A.O.A.C. (1980). Crude protein percentage was calculated by multiplying the total nitrogen percentage for each sample by a factor of 6.25. Oil Percentage was determined according to A.O.A.C. (1980). Total N was determined colorimetrically by the Nessler's methods (Chapman and pratt, 1978). Total P was determined using Vanadomolybdophosphori method (Jackson, 1973) by Spectrophotometer apparatus. Total Potassium was determined using the Flame spectrophotometer.

All the collected data were subjected to statistical analysis of variance according to Gomez and Gomez (1984). The treatment means were compared using L.S.D. to 0.05 level of significant.

The measured characters included

A) Growth attributes:

Plant height, no. of branches, leaf area index, number and weight of nodules.

B) Yield and yield components:

No. of seeds/plant, no. of pods/plant, seed yield (g/plant), 100- seed weight, seed yield (ton/fed), biological yield (ton/fed), harvest index, oil and protein yield (kg/fed).

C) Chemical composition:

Oil, protein percentage in seeds and N, P, K in the leaves.

RESULTS AND DISCUSSION

1- Growth attributes

Means values of the studied characters as affected by soil moisture deficit, N levels and biofertilizers in both seasons are presented in Table (1). The results indicated that increasing soil moisture deficit from 70 % to 40 % of soil field capacity (SFC) significantly decreased plant height, no. of branches/plant, L.A.I, number and weight of nodules/plant. This may be due to water deficit which causes losses in tissues water, and in turn reduces the turgor pressure in cell, thereby inhibiting both cell enlargement and cell division. Moreover, the photosynthesis and translocation of their product may become limited under water deficit conditions (Hsiao and Aceved, 1974). Conforming results were reported by Karam et al. (2005), El-Sabbagh et al. (2006), Omar et al. (2007) and Moursi et al. (2009).

Exposing soybean plants to soil moisture stress up to 40 % of soil field capacity obviously affected on number and weight of nodules.

Andy and Purcell (2001) indicated that large nodules maintained higher relative water content than small nodules across a range of soil water deficit. Moisture deficiency is major causes of nodulation failure, affecting all stages of the symbiosis and limiting rhizobial growth and survival in soil. This may contribute to undesirable changes in rhizobia, including plasmid deletions, genomic rearrangements and reduced diversity.

The data in Table (1) clarified that plant height, no. of branches, number and weight of nodules were not significantly affected by N levels in both seasons. While N levels influenced leaf area index significantly in both seasons, where 30 kg/N/fed produced the highest L.A.I. These results, partially, are in agreement with those achieved by Varco (1999), Hoeft et al.,(2000), , Scharf and Wiebold, (2003).

Data also revealed that biofertilizers significantly affected no. of branches, L.A.I, number and weight of nodules in both seasons, whereas plant height did not affect by biofertilizers. The acquired data indicate that Rhizobacterien gave comparative increment in L.A.I compared with control, Rhizobial and dual inoculation by approximately (13.0%, 9.4%,and 16.7%, orderly, as a mean of the two seasons. These findings are relatively in harmony with the results obtained by Abd El- Lateef et al.,(1998), Mkhaeel et al., (2000) and Samira and El- Melegy (2005). Inoculation soybean seeds with Rhizobacterien failed to create root nodules with soybean in both seasons. This may contribute to concept of specialization between bacterial strains and host plants. The roots of leguminous plants secrete a variety of organic compounds, such as amino acids, which can be utilized by soil microorganisms, such as free – living Rhizobium. Thus, these organisms can grow to high density in the area surrounding these roots. Nodulation takes place because of specific and complex interactions between bacteria strains and the plant. Ueli A. Hartwig (1998). The interaction between soil moisture deficit x nitrogen fertilizer was significant for plant height, no. of branches, number and weight of nodules in the first season, while it was significant for leaf area index in the two seasons. First order interaction between soil moisture deficit x biofertilizer was significant for leaf area index in the first season only and for number and weight of nodules in both seasons. The interaction between nitrogen fertilizer x biofertilizer for leaf area index was significant in both seasons and for number and weight of nodules in the first season. Second order interaction was significant for leaf area index and nodules weight in the first season only.

Table: (1) Effect of soil moisture deficit, Nitrogen fertilization and biofertilizers on some growth attributes of soybean in 2007 and 2008 seasons

Treatments A) Irrigation treatments	Plant height(cm)		No.of branches		L.A.I		Nodules number/plant		Nodules weight(g)/plant	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
70 %	77.4a	53.8 a	4.9 a	4.8 a	2.5 a	2.2 a	12.6 a	12.7 a	0.12 a	0.14 a
60 %	72.3b	52.5 a	4.1 b	4.9 a	1.8 b	1.9 b	11.7 a	12.5 a	0.11 b	0.14 a
50 %	62 5 c	40.4 b	3.5 c	3.7 b	1.3 c	1.3 c	8.2 b	8.7 b	0.08 c	0.09 b
40 %	59.0 c	37.1 b	2.5d	3,1 c	0.98 d	1.1 d	7.2 b	6.8 c	0.04 d	0.07c
B)N(kg/fed)										
0	64.0 b	46.1 a	3.7 a	4.3 a	1.2 c	1.4 c	10.6 a	10.3 a	0.09 a	0.11 a
15	68.1 a	47.5 a	3.8 a	4.3 a	1.5 b	1.6 b	9.3 a	9.3 a	0.08 a	0.11 a
30	71.4 a	44.0 a	4.2 a	3.9 a	2.1 a	1.9 a	9.8 a	9.8 a	0.08 a	0.11 a
C)Biofertilizers										
Control	67.9 a	43.0 a	3.4 c	3.9 b	1.5 b	1.6 b	0.0 c	0.0 c	0.0 c	0.0 c
Rhizo	68.8 a	44.0 a	3.6 b	3.8 b	1.8 a	1.7 a	0.0 c	0.0 c	0.0 c	0.0 c
R .J	69.7 a	48.8 a	4.1 a	4.3 a	1.5 b	1.7 a	20.8 a	21.0 a	0.19 a	0.23 a
Dual inoculation	61.8 a	47.7 a	4.0 a	4.6 a	1.5 b	1.5 c	18.9 b	19.7 b	0.16 b	0.22 b
Interactions										
A x B	*	n.s	n.s	*	**	**	**	n.s	**	n.s
A x C	n.s	n.s	n.s	n.s	**	n.s	**	**	**	**
B x C	n.s	n.s	n.s	n.s	**	**	**	n.s	**	n.s
A x B x C	n.s	n.s	n.s	n.s	**	n.s	n.s	n.s	**	n.s

Means followed by the same letter or letters are not significantly different at the level of5 Rhizo = Rhizobacterien R. J = Rhizobium japonicum
n.s = not significant

2-Yield and yield components:

Table (2) showed that no. of seeds, no. of pods, seed yield (g)/plant and 100- seed weight decreased as soil moisture deficit increased. soil moisture deficit at 70 % of SFC gave relative increase in comparison with 60 %, 50 % and 40 % SFC in No. pods / plant (4.86%, 14.85%, 76.24%), (5.45% , 78.1% and 136.7%) in seed yield(g)/plant and (7.85, 27.07, 51.09%) in 100- seed weight, respectively,as mean of two seasons. These findings are consistent with those attained by Karam et al. (2005), EL – Sabbagh et al.(2006) and Salwa (2008). The data also indicated that N levels not significantly impact on the aforementioned characters in both seasons. John Imsande (1998) Cited that the conflicting responses of soybean yield to fertilizer N could be caused, at least in part, by differences in soil pH, the relative abundance of nitrate and ammonium in the soil, and/or the relative efficiency with which the two forms of N are taken up and assimilated by the plant. Concerning the effect of biofertilizers, the data in Table (2) manifested that biofertilizers significantly affected no. of seeds, no. of pods/ plant in the second season, while it significantly affected 100- seed weight in the first season only.These findings are in agreement with the results obtained by. Freeborn et al. (2001), Gan yinbo et al. (2003) and Moursi et al. (2009). The data in Table (2) showed that first order interaction between soil moisture deficit x nitrogen fertilizer was significant for no. of pods/ plant in the second season only. I The interaction was Significant between soil moisture deficit x biofertilizer for no. of seeds, no. of pods, seed yield / plant and 100- seed weight in the second season only. Other order interactions were significant for no. of seeds, pods, seed yield / plant in the second season only.

Table: (2) Effect of soil moisture deficit, Nitrogen fertilization and biofertilizers on some yield characters of soybean in 2007 and 2008 seasons

Treatments	No. of seeds/plant		No. of pods/plant		seed yield(g/plant)		100 – seed weight	
A) Irrigation treatments	2007	2008	2007	2008	2007	2008	2007	2008
70 %	60.7 a	68.3 a	35.3 a	44.8 a	8.8 a	9.8 a	14.9 a	14.2 a
60 %	53.2 a	68.4 a	30.9 a	45.4 a	7.4 ab	10.2 a	12.3 b	14.7 a
50 %	25.4 b	39.1 b	38.5 a	31.2 b	5.6 b	4.8 b	10.6 c	12.2 b
40 %	13.2 b	38.7 b	19.9 a	25.6 b	4.3 b	3.6 b	9.9 c	9.4 c
B)N (kg/fed)								
0	33.2 a	53.5 a	27.5 a	36.3 a	5.9 a	7.3 a	11.7 a	12.7 a
15	41.7 a	54.0 a	37.3 a	35.0 a	6.9 a	7.1 a	12.0 a	12.5 a
30	39.5 a	53.2 a	28.8 a	38.9 a	6.6 a	6.7 a	12.1 a	12.7 a
C)Biofertilizers								
Control	35.6 a	56.8 a	28.7 a	35.7 b	6.4 a	7.3 a	11.3 b	11.8 a
Rhizo	32.9 a	42.8 b	36.9 a	29.9c	5.8 a	5.5 a	11.3 b	12.3 a
R .J	38.9 a	54.8 a	29.5 a	41.4 a	7.0 a	7.3 a	12.7 a	13.1 a
Dual inoculation	45.1 a	59.9 a	29.7 a	39.9 a	6.8 a	8.3 a	12.4 a	13.1 a
Interactions								
A x B	n.s	n.s	n.s	**	n.s	n.s	n.s	n.s
A x C	n.s	**	n.s	**	n.s	**	n.s	*
B x C	n.s	**	n.s	**	n.s	**	n.s	n.s
A x B x C	n.s	**	n.s	**	n.s	**	n.s	n.s

Means followed by the same letter or letters are not significantly different at the level of 5 %
Rhizo = Rhizobacterien , R. j = Rhizobium japonicum n.s = not significant

The data in Table (3) indicated that soil moisture deficit significantly affected seed yield, biological yield ton/ fed, harvest index, oil and protein yield (kg/ fed) in both seasons. The previously mentioned characters decreased with increasing soil moisture depletion. The mean values for seed yield (ton/fed) in two growing seasons were 1.288, 1.172, 0.751 and 0.574 ton / fed at 70 %, 60 %, 50 % and 40 % of soil field capacity, respectively. These results are confirmed by Omar et al., (2007), Salwa (2008) ,Moursi et al., (2009) and Rotundo and Westgate. (2010). The data demonstrated that nitrogen fertilizer levels have significant effect on biological yield/fed , harvest index, oil yield / fed in the first season only. These results are in the same line with Freeborn et al. (2001), Gan yinbo et al., (2003), and Dorivar et al., (2009). Regarding the effect of biofertilizers, Seed, biological yield (ton/fed), oil and protein yield (kg/fed) significantly affected by biofertilizers in the second season only, while biofertilizers have significant effect on harvest index in both seasons. Seed yield (ton / fed) with dual inoculation treatment was higher than other biofertilizers treatments. The relative increases in seed yield(ton/fed) by application of dual inoculation in comparison with Rhizobial, Rhizobacterien and control treatments were 10.7%, 46.1%, 21.1%, respectively. These conclusions are in agreement with those obtained by Mehasen, et al. (2002), Mohamed (2003) and Lorena et al.(2010). In addition, data in Table (3) indicated that first order interaction between soil moisture deficit x nitrogen fertilizer was significant for biological yield and harvest index in the first season, the interaction between soil moisture deficit x biofertilizer was significant for all aforementioned characters. First order interaction between nitrogen fertilizer x biofertilizer was significant for seed yield (ton / fed), harvest index, oil and protein yield (kg / fed). Concerning second order interaction, it was significant for seed yield, biological yield (ton /fed) in the second season and harvest index in both seasons.

Table: (3) Effect of soil moisture deficit, Nitrogen fertilization and biofertilizers on some yield characters, in 2007 and 2008 seasons

Treatments	seed yield(ton/fed)		Biological yield(ton/fed)		Harvest index %		Oil yield (kg/ fed)		Protein yield (kg/ fed)	
A) Irrigation treatments	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
70 %	1.28 a	1.29 a	4.165a	3.233a	30.6b	39.6a	290.74 a	308.94a	471.68 a	469.17a
60 %	1.01 b	1.33 a	3.308b	3.274a	31.9a	40.3a	229.19a	[illegible]28.36a	376.77ab	509.83a
50 %	0.781c	0.722b	2.558c	2.291b	31.1ab	30.6b	171.02b	[illegible]47.05b	272.63 b	259.20b
40 %	0.612c	0.536c	1.912d	1.870c	31.5 a	28.0b	127.32b	[illegible]05.63b	222.17b	192.89b
B)N (kg/fed)										
0	0.841a	0.989a	2.552b	2.771a	32.8 a	32.9a	185.96b	223.99a	337.13a	360.26a
15	1.01 a	0.982a	3.062a	2.680a	33.9 a	35.9a	222.46a	223.80a	340.67a	361.35a
30	0.913a	0.944a	3.323a	2.551a	27.1b	35.1a	205.29ab	219.70a	329.63a	351.70a
C)Biofertilizers										
Control	0.882a	0.941b	2.881a	2.573b	30.5 b	34.9a	185.84a	221.57a	324.56 a	361.39a
Rhizo	0.851a	0.780c	3.001a	2.311b	29.8 b	32.3b	182.39a	168.95b	277.99a	268.85b
R. j	1.01 a	1.03ab	3.330a	2.791ab	31.0 b	36.2a	230.52a	[illegible]25.92a	414.88a	382.31a
Dual inoculation	0.942a	1.14a	2.731a	3.002 a	33.8 a	35.0a	219.52a	263.53a	325.82a	418.53a
Interactions										
A x B	n.s	n.s	**	n.s	**	n.s	n.s	n.s	n.s	n.s
A x C	**	**	**	**	*	n.s	**	**	n.s	**
B x C	n.s	**	n.s	n.s	n.s	**	n.s	**	n.s	**
A x B x C	n.s	**	n.s	**	*	**	n.s	n.s	n.s	n.s

Means followed by the same letter or letters are not significantly different at the level of 5 %. Rhizo = Rhizobac erien R. j = Rhizobium japonicum n.s = not significant

3- Oil, protein percentage in seeds and N, P and K in leaves.

The concluded data in Table (4) indicated that oil percentage and content of N, P and K in soybean leaves depressed by increasing soil moisture deficit in both seasons except protein percentage, which showed reverse trend. The mean values for oil, protein percentage and N, P, K in both seasons as affected by soil moisture deficit at 70%, 60%, 50 %, and 40% were (21.5%, 21.4%, 20.4%, 19.9%), (31.3%, 32.8%, 34.5%, 35.2%) , (3.04, 3.06, 2.57, 2.37), (0.23, 0.28, 0.18, 0.14) and (1.80, 1.70, 1.60, 1.51), respectively. These results are in agreement with those achieved by Noureldin et al., (2002), EL – Sabbagh et al., (2006) , and Rotundo and Westgate. (2010).

Levels of Nitrogen fertilizer have significant influence only on K leaves content in the two seasons. It could noticed that 30 kg /N/fed gave the highest values in protein % and N , P , K in leaves compared with zero and 15 kg/N/fed, while application nitrogen fertilizer 15 kg/N/fed and 30kg / N/ fed realized the same value (20.9%) for oil percentage as an average in both seasons. Similar results were obtained by Saleh et al., (2004), Mehasen and Saeed (2005) and El – Murshedy et al., (2008).

Regarding the effect of biofertilizers, the data obviously exhibited that Rhizobium japonicum gave the highest values for oil, protein percentages and leaves content of N, P and K. The data in Table (4) exhibited that Rhizobial inoculation acquired relative increases in oil, protein percentages and N, P, K over control, Rhizobacterien and dual inoculation by about (7.0%, 3.4%, 1.4%) , (5.20%, 4.9%, 2.1%, (14.7%, 15.2%, 12.2%), (9.1%, 33.3%, 20.0%) and (10.0%, 10.0%, 6.7%), respectively. These findings are in agreement with those achieved Mehasen, et al. (2002), Mohamed (2003) and Samira and El – Melegy (2005). The interaction between soil moisture deficit x nitrogen fertilizer was significant only for K content in leaves in the second season. First order interaction between soil moisture deficit x biofertilizer was significant for oil percentage in two seasons and N, K content in leaves in the second season only. First order interaction between nitrogen fertilizer x biofertilizer was significant for K content in the leaves in two seasons. Second order interaction between soil moisture deficit x nitrogen fertilizer x nitrogen fertilizer was significant for K content in the leaves in the first season only.

Table: (4) Effect of soil moisture deficit, Nitrogen fertilization and biofertilizers on oil, protein percentages in seeds and N, P, K content in leaves of soybean in 2007 and 2008 seasons

Treatments	Oil %		Protein %		N		P		K	
A) Irrigation treatments	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
70 %	22.0 a	21.0 a	30.6 d	32.0 c	3.06 a	3.02 a	0.22 ab	0.24 b	1.75 a	1.80 a
60 %	21.3 ab	21.4 a	32.6 c	33.0 b	3.02 a	3.10 a	0.27 a	0.28 a	1.67 b	1.74 b
50 %	20.4 b	20.3 b	33.3 b	35.8 a	2.54 b	2.60 b	0.17 b	0.18 c	1.56 c	1.60 c
40 %	19.9 b	19.8 b	34.7 a	35.7 a	2.32 c	2.42 c	0.15 b	0.13d	1.49 d	1.53 d
B)N (kg/fed)										
0	20.8 a	20.4 a	32.4 a	33.8 a	2.63 a	2.80 a	0.18 a	0.21 a	1.58 b	1.59 c
15	20.9 a	20.8 a	32.9 a	34.3 a	2.77 a	2.77 a	0.19 a	0.20 a	1.58 b	1.66 b
30	21.0 a	20.8 a	33.0 a	34.3 a	2.80 a	2.79 a	0.24 a	0.21 a	1.69 a	1.75 a
C)Biofertilizers										
Control	20.0 a	19.9 a	32.2 c	33.3 b	2.82 b	2.69 b	0.24 a	0.19 c	1.56 b	1.58 c
Rhizo	20.9 a	20.5 a	32.1 c	33.6 b	2.61 b	2.67 b	0.16 a	0.20 b	1.59 b	1.60 c
R. j	21.6 a	21.2 a	33.9 a	35.0 a	3.02 a	3.06 a	0.24 a	0.24 a	1.68 a	1.83 a
Dual inoculation	21.3 a	20.9 a	33.0 b	34.6 a	2.69 b	2.72 b	0.18 a	0.20 b	1.65 a	1.65 b
Interactions										
A x B	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	**
A x C	**	*	n.s	n.s	n.s	**	n.s	n.s	n.s	**
B x C	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	**	**
A x B x C	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	*	n.s

Means followed by the same letter or letters are not significantly different at the level of 5 %

R. j = Rhizobium japonicum

n.s = not significant

Rhizo = Rhizobacterien

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الملخص العربي

تأثير نقص رطوبة التربة والتسميد النتروجيني الحيوي والمعدني على نمو ومحصول فول الصويا

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أجريت هذه الدراسه الحقليه خلال موسمين زراعيين 2007 ، 2008 بمزرعة كلية الزراعه (سابباشــا) بمنطقة ابيس – الاسكندريه، لدراسة تأثير نقص رطوبة التربة والتسميد النتروجيني الحيوي والمعدني على نمو ومحصول فول الصويا. التصميم الأحصائي المستخدم في الدراسة هو القطع المنشقة مرتين بــثلاث مكررات ، حيث خصصت القطع الرئيسية لأربع أنظمه من الري وهي 70%، 60%، 50%، 40% من السعة الحقلية والمعاملات تحت الرئيسية كانت عبارة عن ثلاث مستويات من النتروجين المعــدني (0 ، 15 ، 30 ،، كجم/ فدان) وزعت بشكل عشوائي، في حين المعاملات تحت الرئيسية الأخرى كانت عبارة عن أربع انواع من التسميد الحيوي (بدون تلقيح، الرايزوبكتيرين، الرايزوبيوم، ومخلوط اللقاحين معــا) وزعت ايضا بشكل عشوائي.ويمكن تلخيص أهم النتائج في الآتي :

- أوضحت النتائج المتحصل عليها أن كل الصفات المدروسة قد انخفضت مع زيادة اســتنفاذ رطوبــة التربة فيما عدا محتوى البذور من البروتين الذي زاد بزيادة تعرض النباتات للأجهاد الرطوبي.
- متوسط القيم لمحصول البذور طن / فدان خلال الموسمين كانت 1.288 ، 1.172 ، 0.751 ، 0.574 طن / فدان بالري عند 70% ، 60% ، 50% ، 40% من السعة الحقلية، على التوالي.
- أوضحت النتائج أن مستويات التسميد النتروجيني المعدني لم يكن لها أي تأثير معنوي على الــصفات التي تم دراستها ماعدا دليل المساحة الورقية خلال الموسمين، والمحصول البيولوجي ودليل الحــصاد ومحصول الزيت / فدان في الموسم الاول فقط.

- بالنسبة للتسميد النتروجيني المعدني ، فقد وجد أن مستوى السماد النتروجيني بمعدل 15 و 30كجم لم تظهر بينهما فروقات معنوية في معظم الصفات المدروسة.

- فيما يتعلق بالتسميد الحيوي ، متوسط القيم في كلا الموسمين لمحصول البذور / فدان كانت 0.911 ، 0.815 ، 1.02 ، 1.04 طن / فدان للمعاملات بدون تلقيح ، الرايزوبكتيرين ، الرايزوبيوم ، ومخلوط النوعين على التوالي.

- محتوى الأوراق من النتروجين ، الفوسفور و البوتاسيوم أنخفضت مع زيادة استنفاذ رطوبة التربــة . كما زادت نسبتها مع التلقيح بالرايزوبيوم مقارنة بمعاملات التسميد الحيوي الأخرى.

توصي هذة الدراسة الى ضرورة تجنب تعرض نباتات فول الصويا للجفاف وذلك للحساسية العالية لنقص المياة وخاصة في المراحل الزهريه وتكوين البذور.

مراعاة أن يكون الري كل 12 الى 15 يوم خلال المراحل الاولى من الانبات مع تقصير فترات الــري خلال المرحلة الزهرية ومرحلة تكوين القرون و البذور.

تلقيح البذور بلقاح الرايزوبيوم أهمية كبيرة لنباتات فول الصويا ، لذلك يجب تلقيح البذور بهــذا اللقــاح البكتيري بالطريقة المناسبة وضرورة التأكد من مصدر وصلاحية اللقاح البكتيري المستخدم، كما ترى هذة الدراسة الى أمكانية أستخدام لقاحات بكتيرية أخرى فضلاً عن لقاح الرايزوبكتيرين كلقاح مزدوج مع لقاح الرايزوبيوم للحصول على انتاجية عالية من نباتات فول الصويا. فيمــا يتعلــق بالتــسميد النتروجينــي المعدني، فهذة الدراسة ترى أن توقيت ومعدل الاضافة لهما أهمية كبيرة لنباتات فــول الــصويا ، لــذلك توصي هذه الدراسة الى أن تقسيم جرعات السماد النتروجيني المضاف لنباتات فول الصويا على فتــرتين يمكن أن يكون لها فائدة كبيرة كأن تضاف مثلاً في بداية النمو الخضري ، والثانية فــي مرحلــة تكــوين الازهار ،و ضرورة تخفيض المعدلات المضافة الى نصف الكمية المقررة مــع اســتخدام الرايزوبيــوم الخاص بفول الصويا بالكمية والطريقة المثلى الموصى بها.