J. Plant Production, Mansoura Univ., Vol. 4 (7): 1109 - 1118, 2013

EFFECT OF IRRIGATION INTERVALS AND FERTILIZATION SYSTEMS ON SOYBEAN SEED YIELD AND ITS QUALITY

Mahmoud, Gamalat O. ; M. A. Almatboly and S. A. Safina
Agronomy Dep., Fac. Agric., Cairo Univ.

ABSTRACT

An field experiment was conducted during 2011 and 2012 growing seasons at Agric. Exp. Res. Stat., Fac. Agric., Cairo Univ., Giza, Egypt in clay loamy soil to study the effect of three irrigation intervals (12, 18 and 24 days) as well as soil and foliar fertilization treatments. The fertilizer treatment are 1- The recommended fertilizer dose:31 kg P+ 48 Kg K and 20 Kg N//fed as soil application(100% S), 2- Addition of 22.5 P+36 Kg K and15 Kg N/fed as soil application + 2 kg P+ 2 kg K and 2 kg N/fed as foliar application in two equal doses at flowering and pods filling stages (75% S+F_2) on productivity of soybean and 3- Addition of 15.5 Kg P+ 24 Kg K and 10 Kg N/fed as soil application + 4kg P+ 4kg K and 4kg N/fed as foliar application in two equal doses at flowering and pods filling stages (50%S+F_1). The obtained results showed that the highest values of plant height, number of branches, number of pods and seed yield/plant, 100 seeds weight, oil content and seed yield per feddan were obtained with irrigation every12 days compared with irrigation every 18 or 24 days. Concerning fertilization treatments effect, the highest values of plant height, number of branches, number of pods, seed yield/plant, oil content as well as seed yield/fed were obtained with fertilization (75% of the recommended dose as soil application + 2 kg/feddan of P, K, and N as foliar application in two equal doses at flowering and pods filling stages as compared with the other two levels (100% S, 50% S +F_1). It could be recommended to irrigate soybean every 12 days with application of 22.5 P+36 Kg K and15 Kg N/fed as soil application + 2 kg P+ 2 kg K and 2 kg N/fed as foliar application in two equal doses at flowering and pods filling stages (75% S+F_2).
Keywords: Soybean, irrigation intervals, fertilization, NPK, systems, clay loam soils.

INTRODUCTION

Soybean (*Glycin max* L. Merr) is one of the most important legume crops in the world as well as in Egypt. It can provide oils and vegetable protein suitable for feeding humans as well as animals. Increasing the productivity of this crop under Egyptian condition is a subject of continuous investigation in the last years. It is grown in an area of 15 233 000 ha and its production is 43 342 000 tons with an average seed yield of 2.84 tons ha^{-1} (FAO, 2010). In Egypt, soybean growth period ranges usually between 100 and 120 days and requires 325-436 mm of water depending on the location (Ainer *et al.*, 1999).

In order to optimize soybean yield, it is necessary to improve the plant nutrition through more efficient fertilization and irrigation techniques. Irrigation is one of the important factors affecting soybean growth, yield and its related components. Exposing soybean plants to soil moisture stress at any phase of its life cycle might lead to detrimental effect on growth, yield and its components. The most important stages for soybean plants to have adequate water are during pod development and seed fill (Kranz *et al.*, 1998). These are the stages in which water stress can lead to a significant

decrease in yield. Several environmental factors can influence protein and oil concentrations of soybean grain (Westagate *et al.*, 1999). Ansart *et al.*, 2000 found that six irrigations applied at different growth stages gave the maximum seed yield, which was associated with better growth and yield components. Oya *et al.*, 2004 reported that drought stress is one of the main constraints for soybean production in Brazil and water stress at any stage of soybean development can reduce yield, but the negative effects of water stress are particularly important during flowering, seed set and seed filing. Ibrahim and Kandil Hala, 2007 in clay loam soil in Egypt found that irrigation intervals significantly affected the growth and yield parameter. The highest values of plant height, plant dry weight, no. of seeds/plant and yields/fed. were obtained by irrigation every 14 days as compared with irrigation every 7 and 21 days. Also irrigation interval of 14 days gave the highest seed protein %, in comparison with those obtained by the other two irrigation intervals. Ouda *et al.*, 2007 stated that saving about 10% of the applied irrigation reduced seed yield and biological yield of soybean by an average of 5.20 and 5.33 over two growing seasons. Pod filling is the most sensitive stage to drought stress and under water limitation conditions and it could be increase grain yield at this stage by giving one irrigation. Irrigation soybeans as frequently are necessary until pods have completely filled (Jaimes, 2011). Chafi *et al.*, 2012 in studying the effect of irrigation intervals (6, 12 and 18 days) on soybean obtained the highest yield (5125.6 kg ha) with irrigation every 12 days.

During the last few years, water has become a limited resource in Egypt. Consequently, the search for technologies/ measures to save/ conserve water in irrigated agriculture has intensified. Therefore, decreasing plant water consumption by using more efficient irrigation methods, plant breeding technology, longer irrigation intervals, higher moisture depletion, skipping irrigation during the early vegetative growth or during maturation stage and timing the length of irrigation interval with the stage of plant growth are required. This will save irrigation through reducing number of irrigation but still attain similar economic yield.

Foliar fertilization of soybeans (*Glycine max* (L.) Merr.) with N, P and K during the seed-filling period promises to increase soybean yields. Such foliar applications could be used to avoid the depletion of these nutrients in the leaves and the resulted in photosynthetic rate reduction during this period due to poor nutrient uptake from the soil and translocation of these elements from the leaves to the developing seeds.

Field experiments were conducted by Garcia and Hanway, (1976) to test this hypothesis by spraying soybeans plants with of N, P, K, and/or S in different proportions and at different times and rates. Very significant yield increases were obtained from two to four sprayings on different soybean cultivars at different experimental sites between developmental stages R5 and R7. The optimum rate of total nutrient application was about 80 + 8 + 2 4 + 4 kg/ha of N + P + K + S, respectively. Yield increases were due to the increase in number of harvestable seeds, not seed size. The results indicate

that foliar fertilization during the seed-filling period can become a very practical method for increasing soybean yields.

Boote *et al.*, (1978) found that foliar applications of N, P, K, and S increased the N, P, and K concentration of total canopy leaves of soybean. Even though FF did not significantly affect yields nor did it extend gross leaf photosynthesis duration or delay maturity. Treated soybeans yielded 3617 kg/ha compared to 3825 kg/ha for control soybeans. Parker and Boswell, 1980 conducted field experiments in Iowa and found that weight of pods, whole plants, or seeds, and seed quality were not affected by spray NPKS. Increase N level was detected only in seeds, and P level increased only in leaves, while K level was not changed. Under the conditions of this study, foliar N, P, K, and S fertilization of soybeans does not appear practicable for increasing yields. Sesay and Shibles, 1980 showed that NPK foliar fertilization at reproductive stages increased protein concentrations and reduced oil concentration of grains. Syverud *et al.,* 1980 showed that most foliar fertilization did not influence soybean yield, leaf nutrient concentration, or photo synthesis, and sometimes decreased yield. Vasilas *et al.*, 1980 found an increase in soybean yield with foliar fertilizations when other limiting factors particularly soil moisture was minimized and when measures were taken to prevent leaf burn. Ashour and Tholoth, 1983 showed that application of N during anthesis either to the soil or to the foliage increased fruit set, weight of pod, oil and protein percentage in soybean seeds. Poole *et al.,* 1983 showed that foliar applications of NPKS fertilizer to soybeans during the pod fill stages of growth have been inconsistent and in some cases severe yield depressions have occurred. In 16 cultivar-location-year trials, soybean seed yields significantly increased by the foliar fertilizer treatments over the control only once. Seed weights were generally decreased with many of foliar fertilizers. Seed N percentage and protein were increased and seed oil percentage decreased with four applications of the base NPKS formulation. Westley *et al.*, 1998 showed that foliar N fertilization increased oil concentration slightly and increased protein concentration. Haq and Mallarino, (2000) found that foliar fertilization did not affect plant maturity or weight of grains. KuePPer, 2003 and Mallarino, (2005) stated that foliar application could be used to avoid the depletion of these nutrients in soybean leaves and also the resulting reduction in photosynthetic rate during this period, due to poor nutrient uptake from the soil and translocation of this element from the leaves to the developing seeds. Guohua and Qing, (2010) found that there was no significant effect on the fat content when sprayed with nitrogen or phosphorus.

The objective of this study was how to obtain maximum seed yield of soybean with saving in water and fertilizer requirements.

MATERIALS AND METHODS

Field experiments were carried out during 2011 and 2012 summer seasons at Agric. Exp. Res. Station, Fac. Agric., Cairo Univ., Giza, to study

the effect of three irrigation intervals (12, 18 or 24 days) and some combination of foliar and soil fertilization of NPK on productivity and seed quality of soybean. The soil texture of the experimental site was clay loam and its chemical analysis is shown in Table 1.

Each plot consisted of 5 ridges each of them 5 meter long and 60 cm apart. Seeds of soybean variety Giza 111 were inculcated as recommended with the proper *Rhizobium* and directly seeded in hills spaced 20 cm apart on one side of the ridge in June 20th in both seasons.

Table 1. Mechanical and chemical analysis of soil at experimental site in 2011 and 2012 seasons

Season	Mechanical analysis			Chemical analysis			
	Clay %	Silt %	Sand %	Organic Matter %	N (PPM)	P (PPM)	PH
2011	38.1	23.5	38.4	1.9	48	16.1	7.8
2012	37.2	24.6	38.2	1.7	47	14	7.9

The experimental design was split plot in randomized complete block design with four replications. The main plots were allocated to the three irrigation intervals (12, 18 and 24 days) and fertilizer treatments were assigned to sub plots.The tested fertilization treatments were:

1. Recommended NPK fertilizers doses: addition of 31 kg P + 48 kg K and 20 Kg N/fed as soil application at sowing (100%S).
2. Addition of 75% of recommended NPK fertilizers doses (22.5 kg P+36 kg K and15 kg N/fed) as soil application + (2 kg P+ 2 kg K and 2 kg N/fed) as foliar application in two equal doses at flowering and pods filling stages (75% S+ F_2). Total addition of P, K and N are 24.5, 38 and 17 kg//fed, respectively.
3. Addition of 50% of recommended NPK fertilizers doses (15.5 kg P + 24 kg K and 10 Kg N/fed) as soil application + (4 kg P+4 kg K and 4kg N/fed) as foliar application in two equal doses at flowering and pods filling stages (50% S+ F_1). Total addition of P, K and N are 19.5, 28 and14 kg//fed, respectively.

At harvest, ten plants were randomly taken from the central three ridges to determine plant height, number of branches, number of pods and seed yield/plant. Seed index and seed yield/feddan were determined from the all plot area (three central ridges). Seed oil and protein contents were determined as described in A. O. A. C., 2000.

The obtained data of each season were statistically analyzed according to Gomez and Gomez, 1984. Data for the two years was tested for homogeneity using Bartlett's, 1937 test of homogeneity and it was found to be homogeneous so the data were combined for analysis according to Steel *et al.*, 1997. Means of the measured traits were compared using L.S.D. at 0.05% level of probability.

RESULTS AND DESCUSSION

Effect of irrigation intervals

Irrigation regimes are one of the most important methods to save irrigation water without much damage to plants. Results presented in Table 2

show that growth traits (plant height and number of branches/plant), seed yield attributes (number of pods/plant, seed index, seed yield/plant and fed.) ad seed content of oil and protein in both seasons were significantly affected by irrigation intervals. It was evident (from the combined analysis) that irrigation every 12 days surpassed 18 and 24 days intervals in plant height (107.1 cm), number of branches/plant (3.3), number of pods/plant (89.9) and seed yield/plant (34.0 g).

The highest seed index (26.1 g) and oil content (26.5 %) was obtained when plants irrigated every 18 days compared to irrigation every 12 or 24 days. Protein content was not significantly different between irrigation every 12 and 24 days treatments. This could be attributed to the fact that as leaf water potentials decreased, leaf enlargement was inhibited earlier and more severely than photosynthesis or respiration. Increasing available soil moisture during vegetative and reproductive growth of soybean plants increase yield and its components (Gardner *et al.*, 1985).

Meanwhile irrigated interval at 24 days produced the lowest values (99.3 cm for plant height, 2.3 for number of branches/plant, 24.8 g for seed index, 29.5 g for seed yield/plant, 1.123 ton for seed yield/fed. and 0.289 ton for oil yield/fed.). Seed yield is the combined function of different components and it is a complex character depending upon a large number of environmental, morphological and physiological characters. It can be seen the seed yield of soybean was significantly affected by irrigation intervals (Table 2). The highest seed yield/fed (1.401 ton) was obtained with irrigation every 12 days, which was 24.75 % higher than that irrigated every 24 days (1.123 ton/fed.). Reduction in crop yield as a result of water stress has also been reported for soybean by several researchers (Behtari and Abadiyan, 2009; Jaimes, 2011; Kobraee *et al.*, 2011 and Masoumi *et al.*, 2011).

It could be recommended from the previous data that soybean planted in clay loam soils in Egypt must be irrigated every 12 days. This result confirm data of Ibrahim and Hala Kandil, 2007 who concluded that soybean must be irrigated every 14 days under similar conditions in Egypt and also with Chafi, *et al.* (2012) who obtained the highest yield (5125.6 kg ha) of soybean with irrigation every 12 days.

2. Effect of fertilization

Regarding the influence of fertilization treatments (Table 3), the results revealed significant differences between fertilizer treatments in its effect on all studied traits of soybean exceop, seed index. The highest soybean plant height (108.8 cm), number of branches/plant (3.4), number of pods/plant (92.4), seed yield/plant (35.3 g), seed yield/fed (1.360 ton), oil content (27.1 %), oil yield/fed (0.369 ton) and protein content (40.40 %) were obtained with addition of 75% of the recommended NPK fertilizers doses (22.5 kg P+36 kg K and15 kg N/fed) as soil application + (2 kg P+ 2 kg K and 2kg N/fed) as foliar application in two equal doses at flowering and pod filling stages (75% S+ F_2). It is obvious that the recommended NPK fertilizers doses yielded lower values of growth, seed yield and seed quality traits in spite of the increase in phosphorus, potassium and nitrogen doses.

Table 2. Effect of irrigation intervals on growth traits, seed yield attributes and seed quality traits of soybean in 2011 and 2012 Seasons and its combined data.

Irrigation intervals (days)	Growth traits		Seed yield attributes				Seed quality traits		
	Plant height (cm)	Branches / plant (no)	Pods/ plant (no)	Seed index (g)	Seed yield/ plant (g)	Seed yield/ fed (ton)	Oil (%)	Oil yield/ fed (ton)	Protein (%)
2011season									
12	107.6	3.0	87.2	25.3	36.4	1.532	25.0	0.382	41.81
18	100.9	2.8	84.8	25.7	35.3	1.280	26.2	0.336	39.80
24	99.3	2.1	82.1	25.3	28.9	1.056	25.8	0.272	39.90
LSD $_{0.05}$	2.7	0.5	2.6	ns	2.5	0.059	1.0	0.013	0.013
2012 season									
12	106.6	3.5	92.7	24.0	31.5	1.270	25.0	0.319	38.50
18	100.3	2.1	78.8	26.6	29.2	1.382	26.8	0.373	38.00
24	99.2	2.5	83.2	24.3	30.0	1.191	25.7	0.306	40.00
LSD $_{0.05}$	5.2	0.7	3.2	2.0	1.0	0.093	1.3	0.012	0.014
Combined season									
12	107.1	3.3	89.9	24.7	34.0	1.401	25.0	0.351	40.16
18	100.6	2.4	81.8	26.1	32.3	1.331	26.5	0.354	38.90
24	99.3	2.3	82.7	24.8	29.5	1.123	25.7	0.289	39.95
LSD $_{0.05}$	2.4	0.4	1.7	1.1	1.3	0.042	0.8	0.018	0.016

NS = non-significant

Table 3. Effect of fertilizer treatments on growth traits, seed yield attributes and seed quality traits of soybean in 2011 and 2012 seasons and its combined data

Fertilization treatments	Growth traits		Seed yield attributes				Seed quality traits		
	Plant height (cm)	Branches/ plant (no)	Pods/ plant (no)	Seed index (g0	Seed yield/ plant (g)	Seed yield/ fed(ton)	Oil (%)	Oil yield/ fed(ton)	Protein (%)
2011season									
100 %S	97.2	2.2	69.8	25.8	31.3	1.276	25.1	0.318	40.93
75% S+F_2	108.4	3.5	96.2	25.3	37.8	1.303	26.3	0.342	40.56
50% S+F_1	102.2	2.2	88.1	25.2	31.6	1.289	25.6	0.330	39.85
LSD $_{0.05}$	4.6	0.4	2.4	ns	2.2	0.080	ns	ns	0.01
2012 season									
100 %S	95.4	2.7	81.3	25.1	29.0	1.159	24.4	0.283	40.10
75% S+F_2	109.2	3.3	88.6	24.9	32.8	1.418	27.8	0.395	40.23
50% S+F_1	101.5	2.0	84.7	24.9	29.0	1.267	25.2	0.320	39.90
LSD $_{0.05}$	3.9	0.6	2.2	ns	2.3	0.079	0.9	0.032	0.011
Combined season									
100 %S	96.3	2.5	75.6	25.4	30.1	1.217	24.8	0.301	40.52
75% S+F_2	108.8	3.4	92.4	25.1	35.3	1.360	27.1	0.369	40.40
50% S+F_1	101.8	2.1	86.4	25.1	30.3	1.278	25.4	0.325	39.88
LSD $_{0.05}$	2.8	0.3	1.5	ns	1.5	0.053	0.8	0.022	0.018

ns = non-significant

S = 31.0 kg P + 48.0 Kg K +20 Kg N/fed as soil application

F_1 = 4.0 kg P, 4 kg K and 4 kg N/fed as foliar application

F_2= 2 kg P, 2 kg K and 2 kg N/fed as foliar application

Also, results show that application a little part of nutrients as foliar application in two equal doses at flowering and pod filling stages of soybean seemed to be superior in all soybean traits except, seed index in comparison with soil application. On the other hand, the lowest values were obtained with the Recommended NPK fertilizers doses (100% S).

The results are in the same line with those of Kuepper, 2003 and Mallarino, 2005 whom stated that foliar application could be used to avoid the depletion of these nutrients in the leaves and also the resulting reduction in photosynthetic rate during this period, due to poor nutrient uptake from the

soil and translocation of this element from the leaves to the developing seeds.

3. Interaction effects

The interactions between the irrigation intervals and fertilizers treatments revealed significant differences for plant height, branches/plant, pods/plant, seed yield/plant and fed., oil yield/fed and protein % ($P \leq 0.01$). These interactions indicated that soybean responded differently at different irrigation intervals and fertilizers treatments (Table 4). Moreover, the interaction of irrigation intervals × fertilizers treatments effect was not significant for seed index and oil percentages (Table 4).

Table 4. Effect of irrigation intervals x fertilizer treatments interaction on traits of soybean in 2011 and 2012 seasons and its combined data

		Growth traits			Seed yield attributes			Quality traits		
Irrig. intervals (days)	Fertilization treatments	Plant height cm	Branches/ plant No	Pods/ plant	Seed index g	Seed/yield/ Plant g	Seed yield/ fed. ton	Oil %	Oil yield /fed ton	Protein %
					2011 season					
12	100 %S	102.7	3.3	71.3	25.7	35.7	1.573	23.7	0.372	41.89
	75% S+F_2	111.5	3.8	98.6	24.7	40.1	1.435	25.7	0.368	41.81
	50% S+F_1	108.5	2.1	91.8	25.7	33.5	1.587	25.7	0.407	40.78
18	100 %S	93.7	2.4	76.3	26.7	37.9	1.107	26.0	0.288	40.93
	75% S+F_2	110.0	3.3	95.3	24.3	36.0	1.427	26.7	0.380	40.86
	50% S+F_1	98.9	2.6	82.7	26.0	32.1	1.307	26.0	0.340	40.00
24	100 %S	95.1	0.9	61.9	25.0	20.2	1.147	25.7	0.295	39.97
	75% S+F_2	103.8	3.5	94.5	27.0	37.3	1.047	26.7	0.279	39.01
	50% S+F_1	99.1	1.9	89.9	24.0	29.3	0.973	25.0	0.243	38.93
	LSD 0.05	4.0	0.7	4.1	ns	3.8	0.125	ns	0.056	0.027
					2012season					
12	100 %S	100.6	3.4	91.9	24.7	30.9	1.223	24.0	0.294	40.90
	75% S+F_2	111.0	4.4	92.3	23.3	36.4	1.427	27.0	0.385	40.70
	50% S+F_1	108.2	2.6	93.7	24.0	27.3	1.160	24.0	0.277	41.60
18	100 %S	92.3	2.0	70.9	26.0	25.9	1.200	24.3	0.292	40.70
	75% S+F_2	115.1	2.5	86.5	27.7	33.4	1.560	29.3	0.458	40.65
	50% S+F_1	93.5	1.7	78.9	26.0	28.3	1.387	26.7	0.370	40.55
24	100 %S	93.2	2.7	81.1	24.7	30.2	1.053	25.0	0.264	39.90
	75% S+F_2	101.5	2.9	86.9	23.7	28.5	1.267	27.0	0.342	38.99
	50% S+F_1	102.8	1.7	81.5	24.7	31.3	1.253	25.0	0.313	39.80
	LSD 0.05	6.7	0.4	3.8	ns	4.0	0.138	ns	0.061	0.017
					Combined season					
12	100 %S	101.7	3.3	81.6	25.2	33.3	1.398	23.8	0.333	41.40
	75% S+F_2	111.2	4.1	95.5	24.0	38.2	1.431	26.3	0.377	41.26
	50% S+F_1	108.4	2.3	92.7	24.8	30.4	1.373	24.8	0.342	41.19
	100 %S	93.0	2.2	73.6	26.3	31.9	1.153	25.2	0.290	40.82
18	75% S+F_2	112.6	2.9	90.9	26.0	34.7	1.493	28.0	0.419	40.76
	50% S+F_1	96.2	2.1	80.8	26.0	30.2	1.347	26.3	0.355	40.28
24	100 %S	94.2	1.8	71.5	24.8	25.2	1.100	25.3	0.280	39.94
	75% S+F_2	102.7	3.2	90.7	25.3	32.9	1.157	26.8	0.310	39.00
	50% S+F_1	100.9	1.8	85.7	24.3	30.3	1.113	25.0	0.278	39.37
	LSD $_{0.05}$	4.9	0.6	2.7	ns	2.6	0.092	ns	0.038	0.011

ns = non-significant
S = 31.0 kg P + 48.0 Kg K +20 Kg N/fed as soil application
F_1 = 4.0 kg P, 4 kg K and 4 kg N/fed as foliar application
F_2= 2 kg P, 2 kg K and 2 kg N/fed as foliar application

As shown in Table 4, plants irrigated at 12 days interval with addition of 75% of recommended treatment (22.5 kg P+36 kg K and15 kg N/fed) as soil application + (2 kg P+ 2 kg K and 2 kg N/fed) as foliar application in two equal doses at flowering and pod filling stages (75% S+ F_2) significantly gave the greatest values of plant height, branches, pods, seed yield/plant and seed yield/feddan. However, the lowest values were obtained from irrigation every 24 days with addition of 31 kg P + 48 kg K and 20 Kg N/fed as soil application at sowing (100%S).

REFERENCES

A.O.A.C. ,2000. Official Methods of Analysis of Association of Official Agricultural Chemists. Washington 25, D.C.: The Association of Official Analytical Chemists.

Ainer, N. G.; W. I. Miseha,; F. A. Abbas, and H. M. Eid, , 1999. A new concept of rationalization of irrigation. 3rd Conference on farm irrigation and agroclimatolgy. Cairo, Egypt.

Ansart, A. H.; A.A. Kakar; A.B. Tareen; A.R. Barecht, and G.M. Kakar, 2000. Planting pattern and irrigation level effects on growth, yield components and seed yield of soybean (*Glycine max* (L.) Merr.). Pak. J. Agric. Sci., 370 (2):61-64.

Ashour, N. I. and A. T. Tholloth, , 1983. Effects of soil and foliar application of N during pod development and yield of soybean (*Glycine max*. (L) Merill) plants. Field crops Research, 6: 261-266.

Bartlett, M. S., 1937. Some Examples of Statistical Methods of Research in Agriculture and Applied Biology. J. Roy. Stat. Soc. Suppl. 4:137-185.

Behtari, B. and H. Abadiyan , 2009. Quality and quantity responses of soybean (Glycine max L.) seeds to water deficit. Conference on International Research on Food security, Natural Resource Management and Rural Development. University of Hamburg.

Boote, K. J.; R. N.Gallaher; W. K. Robertson; K. Hinson, and L.C. Hammond, 1978. Effect of foliar fertilization on photosynthesis, leaf nutrition and yield of soybeans. Agron. J., 70: 787-791.

Chafi, A. A.; E. Amiri, and D. A. Nodehi, (2012). Effects of irrigation and nitrogen fertilizer on soybean (Glycine max) agronomic traits. Int. J. Agric. Crop Sci., 4 (16):1188-1192.

Desclaux, D.; T.T. Huynh, and P. Roumet, 2000. Identification of soybean plant characteristic that indicate the timing of drought stress. Crop Sci., 40:716-722.

FAO, 2010. FAO Stat-Agriculture. Food and Agriculture Organization of the United Nations. Available online at httb://www.fao.org/site/408/DesktopDefault. Aspx?pageID=408.

Garcia, R.L., and J. J., Hanway, 1976. Foliar fertilization of soybean during the seed-filling period. Agron. J., 68: 653-657.

Gardner, F. P.; R.B. Pearce, and R.L. Mitchell, , 1985. Physiology of crop plants. Iowa State University Press-Ames. Global. Say Forum, Chicago. Il. 4-7 Aug. American Soybean-Assoc. Sl: Louis, Mo.

Gomez, K. A. and A. A. Gomez, 1983. Statistical procedures for Agricultural Research. John willey and sons. Inc New York, U.S.A As hour and Talooth 83.

Guohua, H.U. and K. A Qing, 2010. The effect of spraying NPK Fertilizer on the content of protein and fat in soybean. January 13, by China papers.

Haq, M. U. and A. P. Mallarino, , 2000. Foliar fertilization of soybean at early vegetative stages. Agron. J., 92: 17-24.

Ibrahim, S.A. and Hala Kandil, 2007. Growth, yield and chemical constituents of soybean (glycin max I.) plants as affect by plant spacing under different irrigation intervals. Res. J. Agric. Biolo. Sci., 3(6): 657-663.

Jaimes G. T., 2011. Soybean irrigation. Acts of Congress, May 8 and June 30.

Kale, F. S., 1985. Soybean, its value in dietetics, Cultivation and uses, International Books and Peridicals supply services, India, 479 PP.

Kobraee, S., K. Shamsi, and B. Rasekhi, , 2011. Soybean production under water deficit condition. Ann. Biol. Res., 2:423-434.

Kranz, W.L.; R.W. Elmore, and J. E. Specht, 1998. Irrigation soybean. University of Nebraska-Lincoln Extension Educational Programs.

KuePPer, G., 2003. Foliar Fertilization ATTRA publication, HCT 135, http://attra.ncat. Org-pub/PDF/foliar.pdf.

Mallarino, A.P., 2005. Foliar fertilization of soybean: Is it useful to supplement primary fertilization2 In: Integrated Crop Management, IC-494, 15: 125-126.

Masoumi, H.; F. Darvish,; J. Daneshian,; Noor G.H. mohammadi, and D. Habibi, , 2011. Effects of water deficit stress on seed yield and antioxidants content in soybean (*Glycine max*. L.) cultivars. Afr. J. Agric. Res., 6:1209-1218.

Ouda, S. A.; F. A. F. Khalil,; M. R. K. Ashery, and K. M. R. Yousef, , 2007. Effect of water stress on soybean yield and water relations. Res. J. Agric. Biolog. Sci., 3(6):827-834.

Oya, T.; Nepomuceno, L.; N. Neumaier,; J.R.B. Farias,; S. Tobita, and O. Ito, , 2004. Drought tolerance characteristics of Brazilian soybean cultivars: Evaluation and characterization of drought tolerance of various Brazilian soybean cultivars in the field. Plant Prod. Sci., 7(2): 129-137.

Parker, M.B. and F.C. Boswell, 1980. Foliar injury, nutrient intake and yield of soybean as influenced by foliar fertilization. Agron. J., 72: 110-113.

Poole, W.D.; G.W. Randall, and G.E. Ham, 1983. Foliar fertilization of soybean. 1. Effect of fertilizer sources, rates and frequency of application. Agron. J., 75(2): 195-200.

Sesay, A., and R. Shibles, , 1980. Mineral depletion and leaf senescence in soybean as influenced by foliar nutrient application during seed filling. Ann.Bot., 45: 47-55.

Steel, R.G.D., J.H. Torrie, and D.A. Dickey, 1997. Principles and procedures of statistics: A biometrical approach. McGraw Hill Book International Co., New York.

Syverud, T.D.; L.M. Walsh,; E. S. Oplinger, and K.A. Kelling, 1980. Foliar fertilization of soybean (*Glycine max*. L) Commun. Soil. Sci. Plant Anal., 11: 637-651.

Vasilas B.L.; J. O. Legg, and D. C. Wolf, 1980. Foliar fertilization of soybeans: Absorption and translocation of 15N-Labeled Urea. Agron. J., 72: 271-275.

Westgate, M.E.; E. Piper,; , W.D. Batchelorand Hurburgh Jr., C.R., 1999. Effect of cultural and environmental conditions during soybean growth on nutritive value of soy products. P. 75-89 in proc.

Westley, T.L.; R. M. Lamond,; V.L. Martin, and R. S. Duncan, 1998. Effects of late-season nitrogen fertilizer on irrigated soybean yield and composition. J. Prod. Agric., 11: 331-336.

تأثير فترات الرى ونظم التسميد على محصول فول الصويا وجودته

جمالات عثمان محمود ، أماني محمد عبد الله المتبولي و سيد أحمد سفينة

قسم المحاصيل – كلية الزراعة – جامعة القاهرة

أجريت هذه الدراسة بهدف دراسة تأثير فترات الري ونظم إضافة الأسمدة الفوسفاتية والبوتاسية والأزوتية على نمو ومحصول فول الصويا. وفترات الري التي تم دراستها هي الري كل ١٢ أو ١٨ أو ٢٤ يوم والثلاث نظم التسميد المستخدمة هي

- ١٠٠% من السماد (٣١ كج فوسفور + ٤٨ كج بوتاسيوم + ٢٠ كج نيتروجين/ فدان) يضاف إضافة أرضية.
- و٧٥% من السماد (٢٢.٥ فوسفور +٣٦ كج بوتاسيوم + ١٥ كج نيتروجين) إضافة أرضية + ٦.٥ % فوسفور + ٤ %بوتاسيوم +١٠% نتروجين إضافة بالرش على جرعتين متساويتين فى مرحلتى التزهير وإمتلاء القرون.
- ٥٠ % من السماد (١٥.٥ فوسفور + ٢٤ كج بوتاسيوم + ١٠ كج نيتروجين إضافة أرضية + ١٣% فوسفور + ٨% بوتاسيوم + ٢٠% نيتروجين إضافة بالرش على جرعتين متساويتين فى مرحلتى التزهير وإمتلاء القرون.

وقد تبين من النتائج ما يلي:

١- أدى الري كل ١٢ يوم إلى زيادة حقيقية في ارتفاع النبات وعدد الأفرع ومحصول الزيت كما أدى إلى الحصول على اكبر محصول بذور للفدان كنتيجة لزيادة مكونات المحصول المختلفة.

٢- أدى التسميد بإضافة ٧٥% من الجرعة الموصى بها من الفوسفور والبوتاسيوم والنيتروجين كإضافة أرضية + ٦.٥ % فوسفور + ٤ %بوتاسيوم +١٠% نتروجين فى صورة تسميد بالرش على جرعتين متساويتين فى مرحلتى التزهير وإمتلاء القرون إلى زيادة معنوية في ارتفاع النبات، وعدد الأفرع للنبات وإنتاج أعلى محصول بذور للفدان ومكوناته.

الخلاصة: تحت ظروف هذه الدراسة (الأراضي الطينية الطميه بمحافظة الجيزة) يمكن الحصول على أعلى محصول بذور وأعلى جودة في البذرة في فول الصويا صنف جيزة ١١١ من الري كل ١٢ يوم وإضافة ٧٥% من السماد (٢٢.٥ فوسفور +٣٦ كج بوتاسيوم + ١٥ كج نيتروجين) كإضافة أرضية + ٦.٥ % فوسفور + ٤ %بوتاسيوم +١٠% نتروجين إضافة بالرش على جرعتين متساويتين فى مرحلتى التزهير وإمتلاء القرون بإجمالى ٢٤.٥كج فوسفور + ٣٨ كج بوتاسيوم +١٧ كج نيتروجين مقارنة بالجرعة الموصى بها (٣١ كج فوسفور + ٤٨ كج بوتاسيوم + ٢٠ كج نيتروجين/ فدان).نستنتج من هذا أنه أمكن الحصول على أعلى محصول فول الصويا مع توفير فى الأسمدة عن الجرعة الموصى بها بمقدار ٢٣% فوسفور +٢١% بوتاسيوم + ١٥% نيتروجين نتيجة إضافة جزء من العناصر السمادية الثلاثة بالرش على جرعتين متساويتين فى مرحلتى التزهير وإمتلاء القرون مع ضرورة الرى كل ١٢ يوم.

قام بتحكيم البحث

أ.د / احمد نادر السيد عطيه	**كلية الزراعة – جامعة المنصورة**
أ.د / المتولى عبد الله المتولى	**كلية الزراعة – جامعة القاهره**