Egyptian J. Desert Res., 54, No.2, 209-218 (2004)

EFFECT OF IRRIGATION SYSTEMS, CHEMICAL AND BIO-FERTILIZATION ON SOYBEAN YIELD AND YIELD COMPONENTS

Nezam, H.; Nemat A. Noureldin; Yahia Z. Ishac* and Ezzat M. Soliman**

Agronomy Department, Fac. Agric., Ain Shams University, Cairo, Egypt.

*Microbiology Department, Fac. Agric., Ain Shams University, Cairo, Egypt.

**Department of Agricultural Science, Institute of Environmental Studies and Research, Ain Shams University, Cairo, Egypt.

Field experiments were conducted to study the effect of application of different combinations of nitrogen fertilizer applied through different irrigation systems, different sources of phosphorous and vescular arbuscular mycorrhiza (VAM) on soybean yield and yield component in 1997. Biological yield and seed index was significantly enhanced by the addition of the lower rate amount of nitrogen application (35.7 ha^{-1}) in 1996. The application of super phosphate alone did not produce significantly high seed index. However, pod yield ha^{-1} and seed index were significantly increased, by the addition of VAM and using drip irrigation in 1996 and 1997. The combination of nitrogen, different irrigation systems, VAM and different forms of rock phosphates significantly enhanced crop and seed indexes in both seasons.

Keywords: Soybean, phosphorous forms, nitrogen fertilizer, irrigation systems, Mycorrhiza, Nodulation.

Soybean crop is considered as one of the most important legume seed oil and protein crops. Due to high contents of oil (20-25%) and protein (40%), great interest in soybean crop in Egypt has increased in recent years. Soybean is used for human consumption, livestock feed, improving soil properties, increasing fertility and for industrial purposes. The average of soybean seed yield in Egypt is about 2.85 ton ha^{-1}. Application of mineral nitrogenous fertilizer in excess quantities increase the soil nitrate accumulation which, have harmful human health, social and environmental impacts. The excessive use of inorganic nitrogen fertilizers increases nitrogen in the form of nitrates in the soil which when absorbed by plants and eventually consumed by humans, create health problems. Increasing nitrate accumulation also encourages the production of harmful organisms which reduce nitrates to ammonia. Ammonia evaporates leading to loss of nitrogen which could be used by plants. Consequently, heavy amounts of nitrogen are used in sowing soybean and other crops, nitrogen has reached the drinking water and become human health hazard. It has also led to environmental degradation and damage of vegetables and fruits. Abundant amounts of nitrogen in the body will react with amino acids creating products that cause cancer. Applying nitrogen fertilizer affects soybean nodulation efficiency, growth, chemical content, and seed yield (Jamro and Larik 1988), increased seed protein and grain oil content (El-Essawi *et al.*, 1986), increase in nitrogen and phosphorus uptake, protein and oil yield (Hasnabade *et al.*, 1990). The highest seed yield of soybean was obtained by adding 46.6 kg ha^{-1} (Mahmoud *et al.*, 1994 and Mansur *et al.*, 1996), 40 kg N/ha^{-1} (Joshi *et al.*, 1989 Jay Paul and Ganesaraja, 1990; Halvankar *et al.* 1994; and Vara *et al.*, 1994), 50 kg N ha^{-1} (Dahatonde and Shave, 1992) or 90 kg N ha^{-1} according to Howard *et al.*, (1998). The later found that the soybean nitrogen requirements is 73 g N for each kg of grain produced.

Phosphorus is a major plant nutrient which affects soybean foliage dry weight production (Trabulsi 1985), shoot weight (Dubey *et al.*, 1997), total biomass (Surenda *et al.*, 1995); and seed yield (Wu *et al.*, 1996. and Patel and Chandrvanshi, 1996). Phosphorus in the form of super phosphate and rock phosphate, affect the number of pods per plant, 100 seed weight, seed yield and seed oil concentration, when added at a rate of 100 kg P_2O_5 or 30 kg P_2O_5 ha^{-1} (Dubey *et al.*, 1997). Mycorrhizae enhance the uptake of fixed soil phosphorus (Young *et al.*, 1986), nitrogen and phosphorus uptake (Maksoud *et al.*, 1995). Soil infested with mycorrhizae increased soybean yield by 7-45% over the non-infested soil (Young *et al.*, 1986).

Rock phosphate is a powder used without any further treatment as a fertilizer. Phosphorus becomes available in acid soils by reacting with hydrogen ions and dissolving micro-organisms such as VAM that may play a role in affecting the soil pH. Root of mycorrhizal plants are branched and comparatively thicker than normal roots. Thus they have increased surface area. The mycorrhizal plants show improved growth and development mostly because of increased mineral nutrient uptake. Mycorrhizal roots are more efficient than the normal one in terms of P uptake (Mukerji *et al.*, 1991). Plant dry weight and its phosphorus content were affected significantly with VAM inoculation. Similar results were obtained by the interaction between phosphorus and VAM infestation as reported by Badr El Din and Moawad (1988). Therefore, this study was performed to investigate the effect of irrigation systems, chemical and bio-fertilization on soybean yield and yield components.

MATERIALS AND METHODS

Two field experiments were carried out in the summer of 1996 and 1997 in the Experimental Farm of Ain Shams University at Shalakan, Kalubia Governorate to study the soybean production under different irrigation systems and biofertilizer treatments. Each experiment included 24 treatments arranged in split-split-split plot design in four replicates. They were the combination of three irrigation systems i.e.; sprinkler, drip and modified furrow as main plots, two levels of inorganic nitrogen fertilizer, 0 and 35.7 kg N ha^{-1} as sub plots, edtwo forms of inorganic phosphorus fertilizer at a rate of 53..55 kg P_2O_5 ha^{-1} as calcium super phosphate- (15.5 % P_2O_5) and rock phosphate (26 % P_2O_5) as sub-sub plots and two mycorrhizal inoculation without or with VAM fungus as sub-sub-sub plots. Soybean seeds were sown after inoculation with Bradyrhizobium japonicum 110, plot area was 14.0 m^2 (4 rows 5×0.7 m) two plants were thinned .Phosphorus and a mixture of VAM spores genera (Glomus and Gigaspora) and ammonium nitrate (33.5%) were added, immediately before planting and seedling.

At harvest, about 250 plants from middle ridges were chosen randomly. Biological, straw, pods and seed yield (ton ha^{-1}), as well as seed were used to determine harvest index and crop index which calculated as follows

$$\text{Harvest index} = \frac{\text{Seed yield ton ha}^{-1}}{\text{Biological yield ton ha}^{-1}} \times 100$$

$$\text{Crop index} = \frac{\text{Seed yield ton ha}^{-1}}{\text{Straw yield ton ha}^{-1}} \times 100$$

Oil and total nitrogen in dry seed were determined according to (Association of Official Analytical Chemists 1995) and crude protein content was calculated by multiplying total N by 6.25. The data were subjected to the statistical analysis for split-split split plot design according to Snedecor and Cochran (1980). In addition, mechanical and some chemical analysis of soils were determined before sowing according to Page *et al* (1982), i.e total nitrogen (0.24%), available nitrogen (21.3) ppm, available phosphorus (20.4 ppm), pH(7.73) and EC dS/m (1.6) and clay (44.2%), silt (32.2%), sand (23.2%) and soil texture (clay loam).

RESULTS AND DISCUSSION

The addition of nitrogen fertilizer at the low rate (35.7 kg ha^{-1}) significantly increased biological, straw, pod, and seed yield ha^{-1} in 1996 season, and the biological yield and seed indexes in 1997 (Table1). Differences were not significant for harvest, crop, seed indexes in 1996 and 1997 and for straw, pod, seed yield ha^{-1} in 1997. The increase in the straw yield, by providing plants with low dose of nitrogen fertilizer (35.7kg ha^{-1}), may be attributed to the increase in the dry weight of both leaves and stems. The increase in the biological yield may also be attributed to the increase in the dry weight of stems and leaves in addition to the increase in the number and dry weight of pods. Increasing the pod yield ha^{-1} that occurred in 1996 by adding 35.7 kg ha^{-1} nitrogen fertilizer resulted by increasing the number and dry weight of pods. Similar results were observed by Wesley *et al.* 1998, who studied the effect of nitrogen sources and rates (88 and 177 kg ha^{-1}) applied at the after full bloom (R2) growth stage to irrigated soybeans at four locations for two years in Kansas. Shibles and Richard (1998) pointed out that soybean nitrogen needs cannot be completely met by N_2 fixation because it takes several weeks for an effective N_2 fixation system to develop after soybean emergence.

TABLE (1). Effect of nitrogen fertilization and irrigation system on soyabean yield and its components in 1996 and 1997.

Yield criteria							Irrigation system							
	1996			1997			1996				1997			
	+N	-N	L.S.D 0.05	+N	-N	L.S.D 0.05	Drip	Furrow	Sprinkler	L.S.D. 0.05	Drip	Furrow	Sprinkler	L.S.D. 0.05
Biological yield ton ha^{-1}	23.8	21.4	S	25.82	24.56	S	23.27	24.06	20.53	0.26	25.37	27.06	23.15	0.32
Straw yield ton ha^{-1}	16.6	15.1	S	17.65	16.99	NS	15.61	17.49	14.61	0.25	20.42	18.96	16.35	0.12
Pod yield ton ha^{-1}	10.7	9.9	S	13.06	12.49	NS	11.37	9.90	9.61	0.12	13.47	13.35	11.54	NS
Seed yield ton ha^{-1}	6.94	6.28	S	7.52	7.18	NS	7.35	6.56	5.95	0.06	8.30	7.30	6.49	0.13
harvest index	165.38	166.52	NS	165.38	165.71	NS	178.9	154.05	165.38	2.01	185.78	153.48	159.22	3.30
Crop index	235.62	236.1	NS	241.28	239.59	NS	265.6	233.83	230.40	4.26	284.17	218.07	225.43	6.39
Seed index	166.87	133.11	NS	128.85	122.78	S	131.9	138.37	130.28	1.20	131.73	125.56	120.23	NS
Oil yield Kg ha^{-1}	-------	-------	-------	1812.60	1753.17	NS	------	------	------	------	2036.32	1864.70	1447.87	NS
Protein yield Kg ha^{-1}	------	------	------	3143.62	3004.44	NS	------	------	------	------	3524.78	3311.96	2384.7	NS

NS = not significant S= significant

Significant difference among irrigation systems were reported on soybean yield characters. Drip irrigation greatly increased biological, pod, seed oil and protein yields in both 1996 and 1997 seasons. Drip irrigation significantly produced greatest harvest index compared to the other two irrigation systems, indicating the highest capacity of soybean plants for producing seed yield than biological yield under drip irrigation system in

1997. The lowest values of biological, straw, pod, seed, oil and protein yields were produced by using sprinkler irrigation (Table1). Similar trend was observed on crop index in 1996. The data clearly show that drip irrigation provides soybean plants with its water requirements during all stages without exposing them to moisture stress. (Hodgson *et al.*, 1990) reported that drip irrigation can maintain adequate levels of soil air and soil water, and might improve yields by avoiding water deficit before irrigation and unable water logging after irrigation. (Ashlock *et al.*, 1999) reported that a soybean crop requires 50 cm of soil water during the critical V4-R7 growth stages in order to produce grain yield of 40 bushels (about 1500 kg) per acre as the soil moisture tension increases beyond 50 centibars, plant growth rate slows and height decreases. Extended moisture stress can affect pod set, seeds per pod and seed size. Also the time of irrigation has its great influence on grain yield. Irrigation during the R5-R6 growth stage can increase grain yield by as much as 5 kg ha^{-1}. Yield and its component were increased significantly by colonization with mycorrhizal fungi in 1996 and 1997 (Table2), except for harvest index and crop index in 1996. Insignificant differences between calcium super phosphate and rock phosphate on soybean yield and its components were recorded in 1996 and 1997, however biological yield as well as seed yield ha^{-1} in 1996 were significantly increased with the addition of super phosphate (Table2).

TABLE (2). Effect of colonization with mycorrhizal fungi and phosphorus forms on soybean yield and yield components in 1996 and 1997.

Yield criteria	Colonization with mycorrhizal fungi						Phosphorus forms					
	1996			1997			1996			1997		
	+VAM	-VAM	L.S.D 0.05	+VAM	-VAM	L.S.D 0.05	Rock P_2O_5	Super P_2O_5	L.S.D 0.05	Rock P_2O_5	Super P_2O_5	L.S.D 0.05
Biological yield ton ha^{-1}	24.18	21.06	S	26.03	24.29	S	21.91	23.49	S	24.91	25.41	NS
Straw yield ton ha^{-1}	16.92	14.87	S	17.94	16.70	S	15.32	16.46	NS	17.20	17.44	NS
Pod yield ton ha^{-1}	10.85	9.73	S	13.42	12.23	S	10.01	10.59	NS	12.56	12.94	NS
Seed yield ton ha^{-1}	7.23	6.04	S	7.80	6.94	S	6.44	6.83	S	7.23	7.52	S
Harvest index	169.93	162.55	NS	169.93	167.64	S	168.09	165.10	NS	165.50	166.74	NS
Crop index	242.42	229.99	NS	246.37	235.62	NS	238.11	233.97	NS	243.04	248.04	NS
Seed index	135.94	131.18	S	129.75	122.02	S	131.92	134.35	NS	125.61	122.57	NS
Oil yield kg ha^{-1}	------	------	------	1901.52	1659.57	S	------	------	------	1774.64	1791.06	NS
Protein yield kg ha^{-1}	------	------	------	3323.86	2824.10	S	------	------	------	3040.64	3107.47	NS

The yield of seed oil and protein ha^{-1} for seeds of the plants fertilized with phosphorus in the form of calcium superphosphate exceeded those fertilized with rock phosphate. The increases were 16.42 and 66.83 kg ha^{-1} for oil and protein content, respectively.

The second order interaction of the data indicated that interaction between nitrogen fertilizer and irrigation systems on biological yield in 1996 and seed index in 1997 indicate that maximum values for both criteria were obtained by adding nitrogen fertilizer through drip irrigation system (Table3). Also irrigation systems and colonization by mycorrhizal fungus enhanced soybean pod set in 1996 increased seed index in 1997 indicating that the combination between drip irrigation and VAM increase soybean yield (Table 4). In addition, the interaction between mycorrhizal colonization and phosphorus forms on seed yield ha^{-1} in 1996 (Table4) clearly shows that VAM and rock phosphate gave the greatest crop. Plants are affected positively with VAM inoculation through increasing their dry matter and phosphorus content (Badre-El Din and Moawad, 1988). They have the ability to uptake phosphorus more efficiently than uninoculated (Mukerji *et al.*, 1991).

TABLE (3). Effect of nitrogen application and irrigation systems on biological yield and seed index of soybean.

	Biological yield (1996)			Seed Index (1997)		
	Irrigation systems					
	Drip	Furrow	Sprinkler	Drip	Furrow	Sprinkler
Nitrogen	10.59	10.16	3.91	23.46	22.00	22.80
Control	8.94	10.00	7.97	23.06	22.35	19.65
Mean	9.78	10.11	8.63	23.26	22.17	21.23
L.S.D(0.05)=		0.32			2.03	

TABLE(4). Effect of colonization with mycorrhizal fungi (VAM), irrigation systems, phosphorus forms and their interaction on pod yield, seed index, and seed yield of soybean.

	Irrigation systems						Seed yield 1996	
	Pod yield 1996			Seed Index 1997			Phosphorus forms	
	Drip	Furrow	Sprinkler	Drip	Furrow	Sprinkler	Rock P_2O_5	Super P_2O_5
VAM	11.99	10.80	9.73	55.93	52.43	55.07	7.35	5.54
-VAM	10.75	9.04	9.42	54.50	53.09	45.95	7.11	6.56
Mean	11.37	9.90	9.61	55.35	52.76	50.52	7.23	6.04
LSD (0.05)= 0.15				1.94			0.11	

Drip irrigation was the most effective factor on pod yield ha^{-1} in 1996 and seed index in 1997 for plants colonized with VAM. Also significant seed yield ha^{-1} in 1996 was obtained by colonization with VAM and treated with rock phosphate.

The second order interactions among the studied factors indicated that VAM colonization in combination with super phosphate application increased harvest index, also, VAM with rock phosphate increased crop index (Table 5). Seed index significantly increased by applying nitrogen fertilizer, colonization with VAM and fertilizing with super phosphate.

It can be concluded that using drip irrigation, low dose of nitrogen, colonization with VAM, phosphorus application in the form of super phosphate were promising for producing high yield and yield contributes i.e biological, pod, seed, oil and protein in the two seasons with some exceptions. Higher crop yield and seed indexes in 1997 were obtained with no N-fertilization and VAM colonization in combination with either super phosphate application for the harvest index or rock phosphate for the crop index, or by applying nitrogen fertilizer and VAM colonization + fertilizing by super phosphate for the seed index. Various inoculation between nitrogen, VAM application, and form of phosphate in 1997 were significant for harvest, crop and seed index.

TABLE (5). Effect of interaction nitrogen × mycorrhizal × phosphorus forms on harvest index, crop index and seed index of soybean in 1997.

		Harvest index		Crop index		Seed index	
		Rock P_2O_5	Super P_2O_5	Rock P_2O_5	Super P_2O_5	Rock P_2O_5	Super P_2O_5
Nitrogen	VAM	68.87	73.13	100.05	102.24	54.59	54.81
	-VAM	73.13	65.09	109.40	101.81	53.40	43.81
Control	VAM	71.99	74.35	109.95	108.12	54.38	54.31
	-VAM	64.14	67.73	89.10	104.5	52.76	44.95
L.S.D (0.05) =3.40				5.81		2.01	

CONCLUSION

Low dose of nitrogen fertilizer (35.7 kg ha^{-1}) colonization with VAM, phosphorus in the form of super phosphate under drip irrigation produced high yield and yield contributes i.e. biological, pod, seed, oil and protein of soybean plant cultivar Giza 21.

REFERENCES

A.O.A.C. (1995). Association of Official Analytical Chemists. 17^{th} ed., Washington DC, USA.

Ashlock, L. O.; E. D. Vories; P. I. Tacker and T. E. Windham (1999). Soybean production with irrigation. *Proceedings World Soybean Research Conference*, VI p243-244, August 4-7, Chicago, Illinois, USA.

Badr-EL-Din and. H. Moawed (1988). Enhancement of nitrogen fixation in lentil, faba bean and soybean and dual inoculation with Rhizobia and mycorrhizae. *Plant and Soil*, 108:117-124.

Dahatonde, B.B. and S.V. Shave (1992). Response of soybean (Glycine max) to nitrogen and Rhizobium inoculation. *Indian. J. of Agron.*, 37 (2): 370-371.

Dubey, S.K.; V.R. Blaas Undaram; L.M. Pant; N. Jayasheela; B.R. Kawale and B. Mishra (1997). Effect of phosphate dissolving bacteria applied with rock phosphate on nodulation and yield of rained soybean under different agro climatic conditions. *J. Indian Soci. Soil Science*, 45 (3): 503-505.

El-Essawi, T. M.; S. E. D. Faiza and F. M. Hammoude (1986). Response of soybean green yield to inoculation and different levels of nitrogen fertilization *Proceeding of the 2nd Breeding Conf.*, Cairo, Egypt, Dec.15-19.

Halvankar, G.B.; V.M. Raut and V.P. Patil (1994). Response of soybean to nitrogen and phosphorus doses. *J. of Maharashatra Agric. Univ.*, 19(2): 198-200.

Hasnabade, R.; P.R. Bharambe; V.S. Hudge and G. Chimanshette (1990). Response of soybean to N, P and irrigation application in Verti soil. *Annals of Plant Physiol.*, 4:205-210.

Hodgson, A. S.; G. A. Constable; G. R. Duddy and I. G. Daniells (1990). A comparison of drip and furrow irrigation cotton on a cracking clay soil. 2. Water use efficiency, water logging, root distribution and soil structure. *Irrigation Sci.*, 11:143-148.

Howard, J. Wood and B. Anthony (1998). Nitrogen fertilizer management of soybean in South Dakota. *Proceedings World Soybean Research Conference*, VI. p.604, August 407, Chicago, Illinois. USA.

Jamro, G.H. and A.S. Larik (1988). Effect of nitrogenous fertilizer on photosynthesis, growth and yield on nodulated and non nodulated Soybean. *Genetica Agraria*, 42(3): 331-336.

Jay Paul P. and V. Ganesaraja (1990). Studies on response of soybean varieties to nitrogen and phosphorus. Department of Agronomy, Agricultural College and Research Institute, Madurai 62.5104, Tamil Nadu, India.

Joshi, S.S.; P.V. Throve and K.T. Nagre (1989). Effect of Rhizobium and nitrogen on the yield and quality of groundnut and soybean. *PKV Research Journal*, 13(2):152-155.

Mahmoud, S.M.; F.H. Badawy; H.C. Hassnein and M.M. El-Dosoky (1994). Effect of inoculation and level of N fertilization on nodulation and yield of soybean. *Assiut J. Agric. Science*, 25:191-198.

Maksoud, E; H. Moawad and N. Saad (1995). Performance of soybean as affected by Bradyrhizobium japonicum and VAM under different levels of P and N fertilization. *Egyptian J. of Microbiology*, 30(3): 401-414.

Mansur, C.P.; A.R. Hundekar; V.S. Kubsad; D.S.M. Gowda and C.S. Hunshal (1996). Response of black seeded soybean to nitrogen and phosphorus fertilizer. Farming System 12(1-2): 46-48.

Mukerji, K.G.; R. Jagpal; M. Bali and R .Rani (1991). The importance of mycorrhizae for roots. Dep. Agric. Mange. For. Ecol.. Elsevier Scientific publishing Company Amsterdam. V.24 p.290-308.

Patel, S.P. and B.R. Chandrvanshi(1996). Nitrogen and phosphorus nutrition of soybean (Glycine max) grown in vertisol. *Indian. J Agron.*, 41(4): 601-603.

Page, A.I.; R.H. Miller and D.R. Veeny (1982). Methods of Soil Analysis (2nd Ed), Amer. Soc. Agron. Inc. Soil Sci. of Amer. Inc

Shibles, R. and M. Richard (1998). In "*Soybean nitrogen acquisition and utilization*". Proceedings North Central Extension Industry Soil Fertility Conference, Vol.14, 5-11, Nov.11-12, St. Louis, Mo. USA.

Snedecor, G.W. and W.G. Cochran(1980). In "*Statistical methods*". Iowa State Univ. Press, Ames, U.S.A.

Surenda, S; A.S. Chandel; S.C. Saxena and S. Singh (1995). Effect of phosphorus on total biomass grain yield and nitrogen uptake in soybean (Glycine max). *Indian J. Agric. Sci.*, 65:431-432.

Trabulsi, I.Y. (1985). Effect of fertilization with phosphorus on nodule formation in soybean cultivars "Wiliam and Davis". *J. College of Agriculture*, King Saud University, 7(1): 8:8.

Vara, J.A.; M. M. Modhwadia; B.S. Patel; J. C. Patel and V.D. Khanbara (1994). Response of soybean (Glycine max) to nitrogen, phosphorus and Rhizobium inoculation. *Indian J. Agron.*, 39(4): 678-680.

Wesley, T.; L. Lamond; V.L. Marin and S. R. Duncan (1998). Effects of Late season nitrogen fertilizer on irrigation soybean and composition. *J. Proc. Agric.*, 11:331-336.

Young, C.C.; T.C. Juang and H.Y. Guo (1986). The effect of inoculation with vesicular arbescular mycorrhiza fungi on soybean yield and mineral phosphorus utilization in subtropical-tropical soils. *Plant and Soil*, 95 (2): 245-253.

Wu, Y.; N. Han and Y. H. Wu (1996). A study on the effect of yield increase by inoculation of Rhizobium japonicum combined with application of phosphate fertilizer to soybean. *Acta Agriculture Boreali Sinica*, 11: 32-35.

Received: 18/03/2003
Accepted: 23/03/2004

تأثير نظم الرى والتمسيد الحيوى والمعدنى على إنتاج فول الصويا ومكوناته

محمد نظام حسن، نعمت عبد العزيز نور الدين، يحى زكــى إســحاق*،عــزت محمــد سليمان**

قسم المحاصيل- كلية الزراعة - جامعة عين شمس- القاهرة - مصر

* قسم الميكروبيولوجى- كلية الزراعة- جامعة عين شمس - القاهرة - مصر

**معهد الداسات والبحوث البيئية- جامعة عين شمس - القاهرة - مصر

أقيمت تجربتان حقليتان بمحطة التجارب الزراعية بكلية الزراعة جامعة عين شمس لدراسة تأثير التوافق بين السماد النيتروجينى ومصادر السماد الفوسفاتى والتلقيح البكتيرى بالميكورهيزا تحت نظم مختلفة من الرى على المحصول ومكوناته عامى ١٩٩٦، ١٩٩٧ حيث اتضح تفوق المحصول البيولوجى لفول الصويا معنويا بإضافة المعدل المنخفض من النيتروجين (٣٥٫٧كجم ن) للهكتار عام ١٩٩٦ دليل البذور عام ١٩٩٧ كذلك أمكن الحصول على زيادة معنوية لكلا من محصول القرون للهكتار ومعامل البذور عام ١٩٩٦، ١٩٩٧ على الترتيب بالتلقيح بالميكورهيزا مع الرى بالتنقيط. كان لتوافق النيتروجين ونظم الرى والتلقيح بالميكورهيزا والصور المختلفة للسماد الفوسفاتى تأثيرا معنويا على زيادة كمية المحصول ودليل البذور فى العامين المذكورين.