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THE BIOPOLYMER, AGAR AGAR, AS A SOIL CONDITIONER
Part II: Field Trials

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Abstract

Four field trials were conducted, through the period from 1997 to 2000, to evaluate the beneficial effect of using Agar Agar (Agar) as a new soil conditioner under field conditions. Two wheat field trials were conducted at two sites, Sakha Experimental Station (clay soil) in 1997/ 1998 and Ismaielia Experimental Satiation (sandy soil) in 1998/1999. The two sites were cultivated with the two wheat varieties Sakha 61 and Sakha 69, respectively. Another two peanut (cv. Giza 5) field trials were conducted in 1997 and 2000 in sandy soil at Ismaielia Experimental Station. Agar solutions at very low rates, alone or in combination with a balanced compound fertilizer were applied by using two easy techniques, of either soaking seeds pre-sowing or spraying soil under the growing plants.

The obtained results emphasized that:

1- Applying Agar by soaking wheat seeds in Agar solution of 0.1% for four hours pre planting had an adverse effect on grain and straw yield in the clay soil at Sakha. Conversely, spraying the sandy soil (after one month from planting) at Ismaielia under the growing plants of wheat with Agar solution of 0.1% containing the compound fertilizer named Foliar-X at the rate of 0.25% significantly increased the yields of both grain and straw over those of control treatments by 37.0% and 58.9 % respectively.

2- Soaking peanut seeds in Agar solution for one hour pre planting significantly increased the yield. The lowest concentration of 0.01% was the most effective one wherein the seed yield increased by 101.5% then declined to 69.3% with 0.2%; while increasing such concentration to 0.4% in the second season increased it by only 40.4% over seed yield of control treatment.

Also, spraying sandy soil with Agar solution of 0.1% under growing peanut plants significantly increased the pod and seed yields over those sprayed with water in the second season. However the best seed yield was obtained when Agar solution, used for soaking seeds or spraying soil under plants after one month from planting, was combined with the balanced fertilizer Novatrin; wherein an increase of 49.7% and 48.2% over those treated with water was achieved, respectively. The N, P and K content as Kg/feddan in seeds exhibited the same pattern existed with the seed yield.

INTRODUCTION

Sandy soil reclamation is the only feasible solution for food shortage, hence it represents about 96% of the total area in Egypt. The regular applications of organic amendments are essential for sandy soil reclamation. Organic matter improves soil structure, soil fertility and increases water-holding capacity. But, there is not enough to be available, meanwhile the cost of its production and transportation is high. Thus, the soil scientists are concerned with the use of synthetic soil conditioners, either alone or in combination with organic amendments, to reclaim sandy soils. Wallace and Wallace (1986 a) noted that a small amount of polyacrylamide would accomplish the same amount of aggregation that a large amount of organic matter can do. However, most of the initial studies with polymers dealt with applying copious amounts of polymers (1000-4000 Kg/ha), either dry or by spraying and mixing to create soil aggregates. Thus it is important to innovate potentially active polymers that can be easily applied, as in irrigation water, at a relatively low concentration and yet have a significant effect on soil physical properties. Ben-Hur and Letey, (1989) found that the chemical polysaccharides, gaur derivatives, applied at the concentration of 0.01kg m^{-3} in the irrigation water during the entire season had an amendatory effect on infiltration and prevention of crust formation. Likewise, Mitchell (1986) found that application of polyacrylamide to increase infiltration rate was more effective as dilute solution of 150 mg/L in irrigation water than as dry powder at the rate of 42 kg/ha. Furthermore, Wallace and Wallace (1986 b) noted that the most popular procedure was to apply 467 to 1870 L/ha of solution containing 0.05% of polymer just over the seed row; that equals to 0.93 kg/ha. In another study, the same authors (1986 c) found that applying new polymers with sprinkler irrigation at seeding time at the rate of 2.8 kg/ha could give economic yield responses beside beneficial environmental effects. More recently, El Aggory and Abd El- Rasoul (in press) developed an effective and easy technique by soaking seeds in the solution of the biopolymer Agar of 0.1 or 0.2% before planting in greenhouse experiments.

The promising effect of applying Agar with seed soaking on growth of plants in greenhouse experiments in the first part of this investigation prompted us to conduct four field trials to study the beneficial effect of Agar as a soil conditioner in commercial practice.

MATERIAL AND METHODS

Four field trials were conducted through the period from 1997 – 2000 to study the effect of two methods of applying Agar solution (seed soaking and spraying soils under the growing plants) on the growth, yield and chemical composition of two crops, wheat and peanut.

Wheat trials:

Two field trials were conducted during the winter season of 1997/1998 and 1998/1999 on wheat (***Triticum aestivum***) cv. Sakha 61and Sakha 69 at Sakha and Ismaelia Experimental Stations, respectively.

Sakha wheat trial

In this study, wheat (c.v. Sakha 61) was grown in a clay soil of E.C of 1.5 mmohs/cm (1:5 soil : water extracts) and pH 8.2 (1:2.5 soil : water suspension). Four treatments, (soaking seeds in Agar solution of either 0.0 or 0.1% with two levels of N (50 and 70 kg N/feddan as urea) were designed in a complete randomized block design with three replicates. The treated seeds were sown in rows 20 cm apart in a plot area of $10m^2$. Pre-planting, all plots received superphosphate and potassium sulphate at the rates of 15 kg P_2O_5 and 24 kg K_2O / feddan, respectively. Urea was applied in two equal doses 30 days after sowing and 15 days later. At harvest, yields of grain and straw were recorded as ardab/feddan and t/feddan, respectively.

Ismaielia wheat trial:

In the season 1998/1999, wheat seeds (cv. Sakha 69) were cultivated at Ismaielia Experimental Station in a sandy soil (95%coarse and fine sand), pH 7.7 (1:2.5 soil : water suspension) and E.C. 0.22 mmohs/cm (1:5 soil : water extracts). The soil was very poor in its content of available N, P, and K, (16, 2 and 30 ppm in 1% K_2SO_4, 1M Na HCO_3 and 1M NH_4Oac, respectively). Seeds were sown in rows 20 cm apart in plots with an area of 10m2 . In this study Agar solution of 0.1%, either alone or in combination with the compound fertilizer named Foliar-X, at the rate of 0.25% (2.5g/L), were sprayed under the growing plants after one month from sowing time while the soil was still wet at the rate of 2.5L/plot, i.e. 1000L/feddan. A control treatment was in-

cluded and sprayed with water only. Thus there were three treatments replicated three times in a complete randomized block design. The balanced compound fertilizer Foliar-X was locally produced by El Nasr Co. for pesticides and chemicals, Cairo. It contains 10%N, 7% P, 8% K, 2500ppm of each of chelated Fe and Zn, and 3000 ppm of chelated Mn in addition to traces of Mg, S, B and Cu.

All plots received 75 kg N and 48 Kg K_2O per feddan as ammonium sulphate and potassium sulphate, respectively, in two equal doses at 30 and 45 days after planting. Superphosphate, at the rate 15 kg P_2O_5 /feddan was applied pre planting.

After 60 days from planting, height of plants and no. of spikes/plant were recorded. At harvest, no. of spikes/plant, weight of 1000 grains and yield of both grain and straw were determined.

Peanut trials:

As previously mentioned, two field trials were conducted in 1997 and 2000 at Ismaielia Experimental Station. The peanut (***Arachis hypogea*** cv. Giza 5) was cultivated in a sandy soil (95% coarse and fine sand), pH of 7.7 (1:2.5 soil water suspension) and E.C . 0.22 mmohs/cm (1:5 soil water extracts).

The first trial was a preliminary one, wherein Agar was applied by soaking seeds in Agar solution of either 0.0, 0.1 or 0.2% for one hour then air dried and inoculated with the specific Rhizobia before planting. These three treatments were replicated two times in a complete randomized block design.

In the second season, 2000, Agar was applied by two methods; seed soaking or spraying the soil under the growing plants, after one month or two months from planting alone or in combination with the compound fertilizer Novatrin. Thus, there were 13 treatments replicated three times in a complete randomized block design. The treatments were as follows:

Seed treatments:

1. Dry seeds
2. Soaking seeds in water.
3. Soaking seeds in Novatrin solution of 10 ml/L (N.Sol.1)

4. Soaking seeds in agar solution of 4 g/L (0.4%).
5. Soaking seeds in Agar solution of 0.4% plus N.Sol.1

Soil treatments:

(The following treatments 6,7,8,9 were applied after one month from planting.)

6. Spraying soil with water.
7. Spraying soil with Novartin solution of 5 ml/L (N.Sol2)
8. Spraying soil with Agar solution of 1 g/L (0.1%)
9. Spraying soil with Agar solution of 1 g/L plus N.Sol2

Treatments, 10, 11, 12 and 13 were like 6, 7, 8 and 9 treatments but were applied after two months.from planting.

Spraying soil with the different solutions was applied while it was still wet.

It is worth to mention that Novtarin is a locally commercial compound fertilizer in a liquid form produced and purchased by the General Authority of Agricultural Fund and Equalization, Ministry of Agriculture, Egypt. It contains 5% from each of N, P, and K and 0.15% of each of chelated Fe,Mn and Zn while B and Mo are 0.05 and 0.02% respectively.

In the two seasons, seeds of peanut were inoculated with the specific Rhizobia before sowing in rows, 60cm apart, in plots of $10m^2$. Ammonium sulphate and potassium sulphate were applied at rates of 15 kg N and 24 kg K_2O per feddan in two equal doses after 45 and 60 days from planting. Superphosphate was applied at the rate of 30 kg P_2O_5 /feddan befor planting.

At harvest, the fresh weight of pods and seed yield as kg/feddan were recorded. Analyses of soil and plant materials were run according to Jackson (1967).

Statisical analysis of the data were carried out according to Snedcor and Cochran (1980). L.S.D. was used to compare among treatment means.

RESULTS AND DISCUSSION

Wheat trial at Sakha

Yield data reported in Table 1 emphasized that application of Agar by soaking seed method produced negative results in clay soil with permeability problems. Yields of grains and straw were decreased under the two levels of N fertilizer. Such negative effect could be explained as a result of inducing anaerobic conditions around the emerged seedlings caused by excess water retention by Agar. Such conditions would hinder plant growth at first stages and, in turn, crop yield. Mitchell (1986) postulated that use of dilute polymer solution in irrigation water did not increase infiltration rate in soils with a high fraction of swelling clay.

Further examination of yield data showed that raising nitrogen level, from 50 to 70 kg N/feddan, increased both grains and straw yields considerably but the variability precluded the establishment of significant differences among treatments. However, that results obtained from greenhouse experiments in the first part of the present study (El-Aggory and Abd El-Rasoul, in press) indicated a positive effect of seed soaking technique in Agar solution on growth of wheat and seed cotton yield grown in clay soils. Mitchell (1986) pointed out the limitation of laboratory and greenhouse work in characterizing the effectiveness of polymers on clay soils under field conditions.

Table 1. Effect of soaking wheat grains in Agar solution of 0.1% on grain and straw yield of wheat grown on a clay soil at Sakha under the two levels of N fertilizer.

Treatments		Grain yield	Straw yield
N-levels kg/fed.	Agar	(ardab/fed.)	(ton/fed.)
50	- -	7.23	4.43
70	- -	8.24	5.52
50	+	6.81	4.03
70	+	7.53	5.4
L.S.D. 0.05		1.42887	1.331

Fed. = Feddan = 4200m^2

Ardab = 150 kg

Wheat trial in sandy soil at Ismaielia Station:

Data presented in Table 2 indicate that spraying soil with Agar solution of 0.1% alone or in combination with the fertilizer Foliar-X under the growing plants after one month from sowing had an improving effect, though insignificant, on the different growth parameters. Sadek (1998) ascribed the response of sudan grass growth to the RAPG gel polymer to the better use of water and nutrients, that led to the enhancement of endogenous auxins, gibberellins, cytokinins and the decrease of growth inhibitors. The most interesting results in Table 2 is the significant favourate effect of spraying Agar solution containing the fertilizer Foliar-X on the grains and straw yields, wherein the increase amounted to 37.0 and 58.9% over the control treatment values respectively. However, the increase due to Agar alone was not so pronounced. This was also so with 1000 grain weight, indicating that the increase in grain yield obtained with such combined treatment was a reflection to the increase in no. of spikes and grain weight. Also, the favourite effect of such treatment confirmed those obtained in greenhouse experiments on soaking wheat seeds in Agar solution (0.2%) containing the micronutrients Fe, Mn and Zn (0.2% of each) pre sowing in sandy soil, by El Aggory and Abd El-Rasoul (in press), indicating that greenhouse results in sandy soils, contrary to clay soils, may be useful in characterizing the effectiveness of Agar under field condition.

In this line, Wallace and Abuzamzam (1986) noted that the most pronounced response to the soil conditioner was when added with N and P, and the combined effect appeared to be synergestic

It appeared that Agar containing nutrients could be adsorbed on the surface of the soil particles and did not move down with irrigation water, to act as storehouse for nutrients and moisture due to its stabilizing and undegradable characteristics. Ben-Hur and Letey (1989) pointed out the adsorbance of the biopolymer gaur on the surface of the primary soil particles and its role to hold them together to improve soil surface structure.

Table 2. Effect of spraying Agar solution (0.1%) alone or with Foliar- X (0.25%) on the soil under growing plants on some growth parameters and yields of grains and straw.

Soil treatmens	Growth parameters				Yield		
	Plant height (cm)	No. of spikes/plant	Dry weight of shoot/plant (g)	Dry weight of root/plant (g)	Grain ardab/fed.	1000 grain weight (g)	Straw Ton/fed
Control	58.9	2.33	7.63	2.75	11.97	34.8	2.245
Sp Agar sol.	59.4	2.33	8.59	3.03	12.92	35.63	2.714
Sp Agar sol. plus F-X	62.8	3.00	9.71	2.94	16.40	38.50	3.567
L.S.D	N.S.	N.S.	N.S.	N.S.	1.826	N.S.	0.370

Sp = Spraying F-X= Foliar X fertilizer Sol. = solution

Further, Azzam (1985), using radioactive tracer technique, observed an interaction between the elements and conditioned sandy soil that increase the efficiency of fertilizer use. Additionally, Mikkelson *et al.* (1993) noted that the addition of the gel-forming polymer with urea ammonium nitrate retained N for several weeks against leaching loss in highly leaching conditions.

Table 3. Effect of spraying Agar solution (0.1%) alone or with Foliar-X (0.25%) on the soil under growing plants on the concentration of nutrients in grains and straw yield.

Soil treatment	Nutrient concentrations							
	Grains						Straw	
	N (%)	P (%)	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)	N (%)	P (%)
Control	1.47	0.33	113.5	47.7	18.3	32.7	0.51	0.17
Sp Agar sol.	1.57	0.32	112.8	44.3	48.7	35.3	0.51	0.20
Sp Agar sol. Plus F-X	1.65	0.34	145.1	46.0	39.3	28.3	0.57	0.14

Sp = Spraying F-X= Foliar X fertilizer Sol. = solution

Regarding the effect of applying Agar alone or with Foliar-X fertilizer on nutrient concentrations in grains and straw (Table 3) ,only N concentration in grains tended to increase with applying Agar in combination with Foliar-X. Other nutrient concentrations were inconsistent in both grain and straw material.

Peanut trial:

As has been previously mentioned, two peanut field trials were conducted in a sandy soil at Ismaielia Experimental Station in 1997 and 2000 seasons, respectively.

The preliminary study conducted in 1997 shows that applying Agar with seed soaking method had a significant improving effect on seed yield production (Table 4). Moreover, the best yield was achieved at the lower concentration of 0.1%; wherein the increase over control amounted to 101.5%, but 69.3% with the higher concentration (0.2%). It seems that higher concentration increased the retention of water around the germinating seeds more than that suitable as compared to the lower concentration. Anyhow, the improving effect of Agar can be due to the increase in N_2 fixation by Rhizobia. It appeared that Agar furnished a suitable media for bacterial growth and in the meantime saved them from being washed away. Such results confirmed the improving effect of Agar on the biofertilizer Cerealin in wheat grown on sandy and calcareous soils in greenhouse experiment conducted by El Aggory and Abd El-Rasoul (in press) Azzam *et al.* (1987) emphasized that the addition of the polymeric RAPG up to 300 kg/h. to sandy soil increased the nodules fresh weight as well as the protein content of peanut.

Table 4. Effect of applying Agar by seed soaking method (0.1 and 0.2%) on seed yield of peanut grown on a sandy soil at Ismaielia Station.

Treatments	Yield of seeds (kg/feddan)	Increase % over control
Control	402.1	0.0
S. in Agar sol. (0.1%)	810.3	101.5
S. in Agar sol. (0.2%)	680.5	69.3
L.S.D. 0.05	150.0	

S = soaking Sol. = solution

Data of the second peanut field trial conducted in the 2000 season are presented in Table 5. Again Agar material as a soil conditioner showed to be promising. Soak-

ing peanut seeds in Agar solution of 0.4% significantly increased the pod and seed yields over using dry seeds or soaked seeds in water. However, the lower concentrations of Agar used in the preliminary field trial in 1997 season, (0.1 or 0.2%) were more effective than 0.4% used in this trial. Also, soaking seeds in Novatrin compound fertilizer solution of 10 ml/L was also effective but less than that obtained with Agar alone. The best yield was obtained when seeds were soaked in Agar solution containing the compound fertilizer Novatrin indicating the beneficial effect of Agar on water and fertilizer use and confirmed the results of soaking wheat seeds in Agar solution enriched with micronutrients in greenhouse experiment in sandy soil conducted by El Aggory and Abd El Rasoul (in press).

Table 5. Effect of applying Agar alone or in combination with Novatrin fertilizer by the two methods, soaking seeds and spraying soil under the growing plants, in a sandy soil at Ismaielia Station.

Treatments	Yield kg / fed		Shelling %	Nutrients in seeds					
				Concentration %			Content Kg/fed.		
	Pod	Seeds		N	P	K	N	P	K
Seed treatments:									
1. dry seeds	1425.9	1002	70.3	4.39	0.34	0.44	44.1	3.42	4.41
2. S. in water	1165.9	919.8	78.9	4	0.36	0.45	36.8	3.32	4.14
3. S. in N.Sol.$_1$	1500	1184.2	78.9	3.96	0.35	0.38	46.9	4.1	4.49
4. S. in A. Sol. of 0.4	1687.3	1291.3	72.2	3.66	0.4	0.41	47.3	3.85	5.03
5. S. in A. N.Sol.$_1$	1912.4	1376.6	72	3.9	0.21	0.47	83.7	5.35	6.47
Soil treatments:									
* spraying after one month									
6. with water	1270.4	911	71.7	3.12	0.33	0.39	28.2	3	3.58
7. with N.Sol.$_2$	1580.2	1126.6	71.3	3.7	0.3	0.4	41.7	3.38	4.5
8. with A.Sol. of 0.1%	1905.3	1245.6	65.4	4.49	0.26	0.45	55.9	3.26	6.77
9. with A.+ N.Sol.$_2$	1881.2	1350.2	71.8	3.94	0.32	0.47	53.2	4.32	6.4
* spraying after two month									
10. with water	1097.9	791.4	65.5	4.69	0.35	0.56	37.1	2.78	4.46
11. with N.Sol.$_2$	1651.9	1210	73.2	4.8	0.38	0.39	58.1	4.57	4.72
12. with A.Sol. of 0.1%	1766.1	1265.6	71.7	4.67	0.31	0.43	54.4	3.92	5.44
13. with A.+ N.Sol.$_2$	1724.9	1192.5	69.1	4.21	0.33	0.44	50.2	3.97	5.24
L.S.D. (0.05)	265.47	232.87					11.3	1	1.31

S = Soaking Sol. = Solution A.= Agar N. = Nutrient

$$\text{Shelling} = \frac{\text{weight of seeds(kg/fed. X100}}{\text{weight of pod (kg/fed)}}$$

Spraying soil under growing plants with either Agar solution of 0.1% , Novatrin solution of 5 ml/L or their combination significantly improved pod and seed yields, over those obtained from spraying water treatment, with the superiority of Agar alone except with the combination treatment after one month from planting. It seems that the favourate effect of spraying Agar over the soil under growing plants on yield of pods, seed and nutrient content, especially after two months from sowing might be due to the better use of water by decreasing surface evaporation of soil due the soil mulch effect as has been explained by Wallace *et al.* (1986) using the synthetic polymer anionic polyarylamide.

Generally, it can be noted that the best seed yield was achieved when Agar solution was used for soaking seeds or spraying soil under plants after one month from planting combined with the compound fertilizer Novatrin, wherein the increase over those treated with water amounted to 49.7% and 48.2%, respectively.

Discussing further N, P and K percentages in seeds (Table 5), no clear trend can be observed due to different treatments, while their content as kg/feddan in seeds exhibited the same trend existed with the seed yield, showing that treated seeds or soil with Agar solution or Agar solution containing the compound fertilizer Novatrin enhanced the absorption of nutrients from the soil as has been reported by Azzam *et al.* (1987) on peanut, Khadr *et al.* (1988) on alfalfa and Sadek (1998) on sudan grass using the synthetic hydrogel polymers.

CONCLUSION

The results and discussions reported in the present investigation (Part I &II) indicated that using the natural biopolymer Agar, as a soil conditioner, was very promising in sandy and calcareous soils, due to its stabilizing and gellifying power and being biologically undegradable. Agar solution of 0.1%, containing a balanced compound fertilizer like Foliar-X had a favorable effect on crop yield when applied by either of the two easy techniques, seed soaking or spraying soil under the growing plants; combination of the two techniques in further investigation may lead to better yield.

The economics would be extremely favorable, since 0.1 kg /feddan was needed for seed soaking and 1 kg even less would be required for spraying soil under growing

plants. Besides, Agar can be re-manufactured by Edfina Company For Preserved Foods, Alexandria, Egypt from red algae found in the Mediterranean Sea coast. The use of the product at the final stages of process would be more economical.

On the other hand, the obtained results indicated that biopolymer Agar as a soil conditioner was not promising with the clay soils.

However, additional studies of applying Agar at very low rates (10-50 mg/L) through fertigation system using sprinkler or drip irrigation will be worthwhile.

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استخدام البوليمر الحيوي ، آجار أجار كمحسن للتربة
الجزء الثاني: التجارب الحقلية

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معهد بحوث الأراضي والمياه والبيئة – مركز البحوث الزراعية – جيزة

أقيمت أربع تجارب حقلية خلال الفترة من سنة ١٩٩٧ ألي ٢٠٠٠ لتقييم استخدام مادة الآجار كمحسن للتربة تحت ظروف الحقل . أقيمت تجربتان حقليتان لزراعة القمح في جهتين هما محطة بحوث سخا حيث التربة طينية وتم زراعة الصنف سخا ٦١ في الموسم ١٩٩٧/١٩٩٨ ثم أقيمت تجربة أخرى بمحطة بحوث الإسماعيلية حيث تم زراعة الصنف سخا ٦٩ في الأرض الرملية في موسم ١٩٩٨/١٩٩٩ . كذلك أقيمت تجربتان حقليتان لزراعة الفول السوداني الصنف جيزة ٥ في محطة بحوث الإسماعيلية في موسم١٩٩٧ وموسم ٢٠٠٠ في ارض رملية وقد تم إضافة محلول الآجار فقط بتركيزات منخفضة أو الآجار مضاف إليه سماد مركب متزن إما بطريقة نقع البذور أو الرش على سطح التربة تحت النباتات النامية .

وقد أوضحت النتائج المتحصل عليها ما يلي:

١- أدى نقع تقاوي القمح لمدة أربع ساعات قبل الزراعة في الأرض الطينية بسخا ألي حدوث نقص في محصولي الحبوب والقش ، وعلى العكس أدى رش التربة الرملية في الإسماعيلية تحت نباتات القمح بعد شهر من الزراعة بمحلول الآجار ٠,١٪ المضاف إليه السماد المركب فوليار-X بمعدل ٠,٢٥٪ ألي زيادة مؤكدة في كل من محصول الحبوب والقش بلغت٣٧٪ ، ٥٨,٩٪ عن محصول المقارنة.

٢- أدى نقع بذور الفول السوداني لمدة ساعة واحدة قبل الزراعة في الأرض الرملية بالإسماعيلية في محلول الآجار إلى زيادة مؤكدة في محصول البذور، وكان التركيز المنخفض ٠,١٪ أفضلها حيث زاد محصول البذور بنسبة ١٠١,٥٪ بينما نقصت هذه النسبة إلي ٦٩,٣٪ عند استخدام الآجار بنسبة ٠,٢٪ في الموسم الأول والي ٤٠,٤٪ عند رفع تركيز الآجار إلي ٠,٤٪ في الموسم الثاني عنها في محصول المقارنة كذلك أدي رش التربة الرملية تحت نباتات الفول السوداني النامية بمحلول الآجار ٠,١٪ في الموسم الثاني إلى زيادة محصول البذور والقرون زيادة مؤكدة عما لو تم رشها بالماء فقط ولكن افضل زيادة مؤكدة تم الحصول عليها كانت عند إضافة محلول السماد المتزن نوفاترين ألي محلول الآجار سواء في محلول النقع أو محلول الرش حيث بلغت الزيادة في محصول البذور ٤٩,٧٪ و ٤٨,٢٪ علي التوالي عما لو استخدم الماء فقط.

أوضحت النتائج أن تأثير المعاملات المختلفة على محتوى البذور (كجم/فدان) من كل من النيتروجين والفوسفور والبوتاسيوم يماثل تأثيرها علي محصول البذور.