EFFECT OF POLYVINYL ACETATE SPRAYING BY ON SOIL WATER RETENSION AND PRODUCTIVITY OF POTATO

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ABSTRACT

Polyvinyl acetate was used as a soil conditioner and applied into sandy loam soil by a field sprayer in West Nubaria. Five different concentrations of polyvinyl acetate (0, 0.5, 1, 1.5 and 2.0 %) and two working pressures 50 and 150 kPa. The differences of soil moisture content among the annual crop season were greater at the bottom layer than the upper layer. Increasing the concentrations of polyvinyl acetate led to more soil moisture content through the annual crop season. The moisture content values found under working pressure of 50kPa ranged between 5.55 to 20.75, 23.19 to 32.93 and 17.73 to 27.25% after 1st irrigation, 2nd irrigation and before harvesting respectively. Using the polyvinyl acetate concentration of 2.0% gave the highest value for water retention. The moisture content values found under working pressure of 150 kPa ranged between 5.55 to 22.82, 23.19 to 36.78 and 17.73 to 30.11% after 1st irrigation, 2nd irrigation and before harvesting respectively. Increasing the working pressures led to increase energy consumed which were 6.48 and 15.79 MJ/fed for working pressures 50 and 150 kPa respectively. The highest values of plant emergency ratio and crop yield were 87% and 7606 kg/fed under concentration of 2.0% and 150 kPa. The obtained results prove that using the polyvinyl acetate as a soil conditioner gave a good effect in sandy loam soils characteristics.

INTRODUCTION

For the urgent need to meet food demands in Egypt, more desert areas have to be put under cultivation. Such soils are poor with respect to their soil-water-plant relationships. Previous studies indicated that surface mulching with some soil conditioners was considered as one of the applied techniques that can provide adequate conditions for sandy soil plantation.

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It reduces evaporation, increases the preserved moisture below the mulch layer, increases plant growth and nutrients uptake and stimulates the biological activity of the soil, **El-Hady (1999)**. On the other hand mixing some absorbent materials with sandy soil increases the soils capacity to store water. The water stored in this way is available to plants for some considerable time. The effect of the added materials improved the structure of the sandy soil. Besides, beneficial changes in soil porosity, the amount of the water retaining pores, were achieved by soil conditioning. Moreover, germination process, plant growth, nutrients uptake by the plants and water use efficiency were beneficially increased by mixing these materials with sandy soil, **El-Hady and Abo-Sedera (2006)**. Polyvinyl acetate is a thermoplastic polymer obtained by polymerization of vinyl acetate and can be used as suitable starter, its appear to be white powder or colorless granules or beads. Its practically insoluble in water, freely soluble in ethyl acetate, soluble in alcohol. It is hygroscopic and swells in water and can be softens at temperatures above 40-50 °c, **Natalja *et al.*(2010)**. Polyvinyl acetate can be used as a soil conditioner to conserve and increase the water retention in sandy soils. Effective use of appropriate spraying machinery during plant production can be used for applying soil conditioners using lower quantities with efficient distribution without reducing the work of the machines. Many boom sprayers process the spraying with nozzles creates fine drops, but the major disadvantage is the risk of drift to non target areas **Matthews (2004)**. Some operating factors were clearly affected material drift, such as working pressure and material viscosity **Nuyttens *et al.* (2009)** Investigated the effects of working pressure on spray drift from a field sprayer and reported that, by increasing the pressure from 2–5 bar to 10 bar drift increased from 1–4% to 2–9%. A significant positive correlation was found between drift damage on barley plants and the logarithm of the spray-liquid deposit. Under ideal conditions, and with correctly adjusted spray equipment, total spray drift was 14% of applied spray. Under unfavorable conditions, and with wrong adjustments of the sprayer such as pressure, drift was 37% of the applied spray. It is concluded that field spraying should be carried out on working pressure should not exceed 2–5 bar for herbicide spraying. **De Schampheleire *et al.*, (2009)**

reported that, viscosities of the spray liquids, affected on droplet formation through resistance to flow, which can include elongation flow if a polymer or other extensional viscosity modifying could be added. An increase in viscosity tends to cause an increase in droplet size, depending on the spray pressure applied and the nozzle used. For example with low spray pressures and coarse nozzles showed more of the viscous effect. Increasing the viscosity of the spray liquid leads to a decrease of drift occurrence through the formation of coarser droplets or addition of a drift-reducing polymer. **Refik *et al.*, (2006)** summarized that the energy consumed for machinery field spraying was 18.83 MJ ha^{-1}. The average fiber and seed yield of the cotton crop were 1320 and 2380 kg ha^{-1}, respectively, with a specific energy of 95800 MJ kg^{-1}. While **Sahr *et al.*, (2005)** reported that, fertilizing and pesticide spraying did not make any significant contributions to the operational energy consumption.

The main objectives of this study were: to (1).Evaluate the effect of working parameters affecting the performance of spraying machines to spray Polyvinyl acetate as liquid soil conditioners in new reclaimed areas, such as working pressure and concentration material for spraying, (2). Compare between different treatments for improving soil water retention and the tuber germination.

MATERIALS AND METHODS

The experiments were carried out at a private farm in West Nubaria on sandy loam soil with sprinkler irrigation system cultivated with potato. Table (1) shows the particle size of distribution of the studied soil according **Klute, (1986)**.

Table (1): Particle size distribution of the studied soil.

oil Depth (cm)	Clay (%)	Silt (%)	Sand (%)	Texture class.	soil moisture content (%)	
					0 - 5 cm	5 -10 cm
0 -30	16.1	2.5	81.4	Sandy loam	5.55	15.77

The design of the experiment was split, with three replications for 10 investigated treatments. The area of the experiment was (5x10m) $50m^2$. Two working pressures of 50 and 150 kPa and five different

concentrations of polyvinyl acetate (0, 0.5, 1, 1.5 and 2.0 %) were applied as shown on the following table:

Table (2): Applied treatments representing the experimental site.

Treatments	Working pressures(kPa)	Polyvinyl acetate concentrations (%)
A	50	0.0
B		0.5
C		1.0
D		1.5
E		2.0
F	150	0.0
G		0.5
H		1.0
I		1.5
J		2.0

A laboratory tests were accomplished on different concentrations of polyvinyl acetate by viscosity meter (Poise) to figure out the viscosity of the material used under different concentrations. Figure (1) illustrated the relation between different concentrations and viscosity readings.

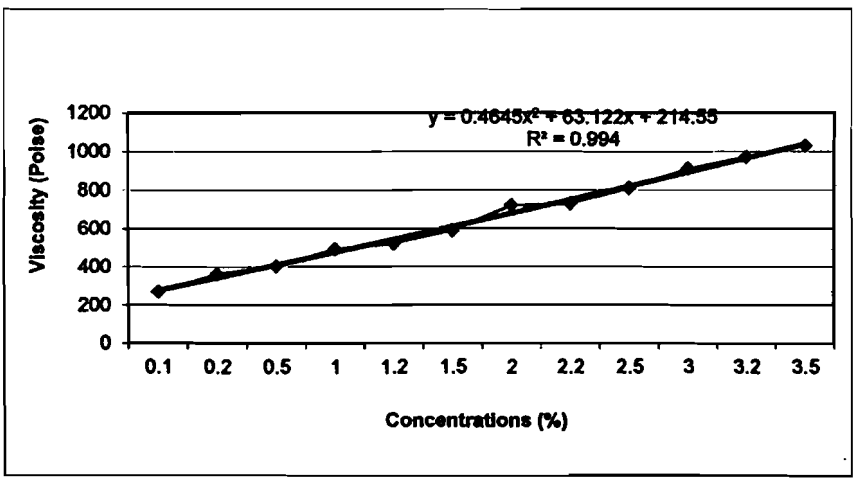

Fig. (1): Relation between concentrations of polyvinyl acetate and viscosities.

A field sprayer of 600 lit., with single axle sprayer and working forward speed of 4.0 km/h was used of all previous selected treatments. Soil moisture contents were estimated for each treatment according **Klute, (1986)**, which was taken three times through the potato crop annual cycle, the first record was taken after first irrigation by 1 day, the second record was taken after third irrigation by 1 day and the third record was taken before harvesting by about 7 days. All records were taken at depth of 10 cm from the soil surface. Plant emergency and yield were carried out for each treatment. A 60 hp (47.84 kW) tractor was used for the spraying operations of all studied treatments and estimate the power consumed according to **Hunt (1983)** through planting operations.

RESULTS AND DISCUSSION

Effect of polyvinyl acetate concentration on soil moisture content:

The applied treatments were affected the soil moisture content which is a function of soil water retention detected among the crop season as clarified in Fig. (2,3,4 and 5). Differences were greater at the upper layer (0-5 cm) of the soil as compared with the bottom layer (5-10 cm). The higher moisture content value was found with the working pressure of 150 kPa and polyvinyl acetate concentration of 2.0% in treatment of (J), while the lower values of moisture content was found under treatment of (A) with working pressures used 50 and 150 kPa and no addition of polyvinyl acetate, this trend went to be similar in the first, second and third record through the crop season. That is may be due to the ability of the polyvinyl acetate to conserve the moisture as a hydrophobic material, which help to increase the surface tension and then absorbed more water through the irrigation operations. From other point of view, the ability of water retention into the soil was clearly obvious in the second layer (5 – 10cm) higher than of the first layer (0 -5 cm), because of the solution infiltration through the soil profile movement which facilitate keeping more moisture content, but in general, the second irrigation was higher than both of first irrigation and before harvesting. Data collected were similar as **El-Hady and Abo-Sedera (2006), and Ibtesam and AL Zhra (2014).**

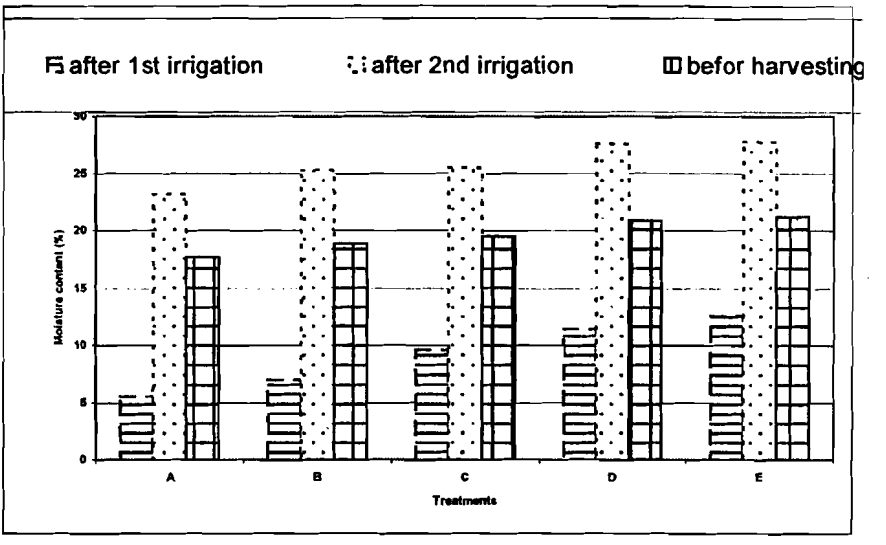

Fig. (2): Effect of polyvinyl acetate concentrations on soil moisture content of the depth (0–5 cm) using the working pressure of 50 kPa.

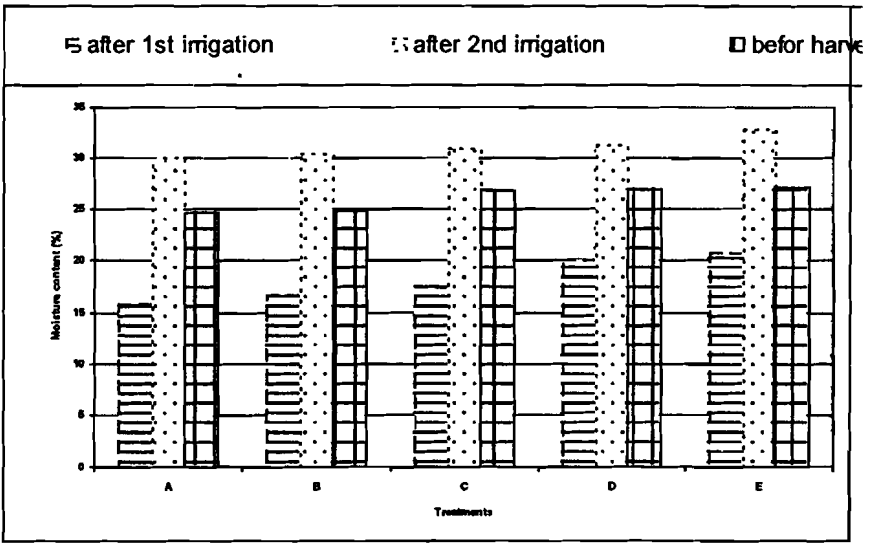

Fig. (3): Effect of polyvinyl acetate concentrations on soil moisture content of the depth (5-10 cm) using the working pressure of 50 kPa.

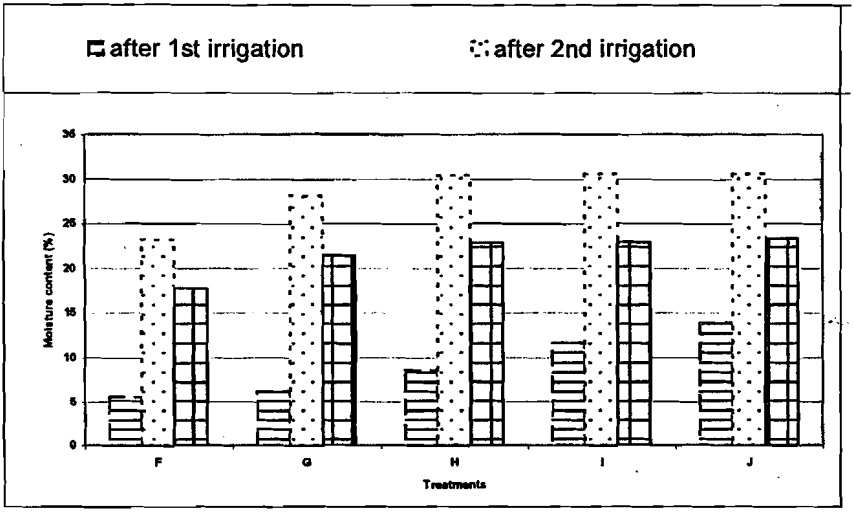

Fig. (4): Effect of polyvinyl acetate concentrations on soil moisture content of the depth (0-5 cm) using the working pressure of 150 kPa.

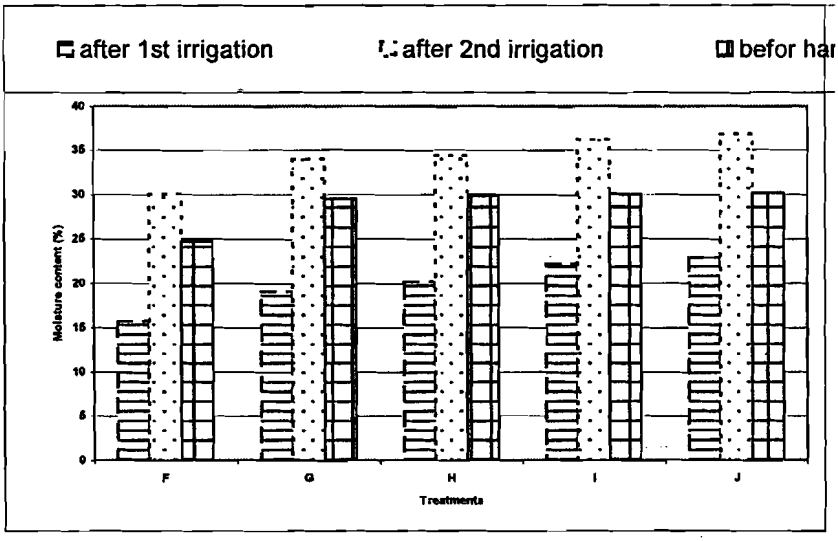

Fig. (5): Effect of polyvinyl acetate concentrations on soil moisture content of the depth (5-10 cm) using the working pressure of 150 kPa.

Effect of working pressure on energy consumed:

Energy consumed of all treatments was measured and the obtained results were shown in figure (6). The energy consumed of field spraying operations was varied between 6.48 and 15.79 MJ/fed. It can be noticed that, by increasing the working pressures from 50 to 150 kPa, the energy consumed increased, that is due to more energy of pumping the liquids through the spraying operation. On the other hand, increasing the polyvinyl acetate concentrations, led to more energy consumed, this could be explained due to the increment of viscosity which need more pumping energy. As a result from previous clarifications, the highest values of energy consumption were found in treatments of (E) and (J) under working pressures of 50 and 150 kPa respectively, while the lowest values were found with treatments (A) and (F). These results were in agreement with the finding of **Refik et al., (2006).**

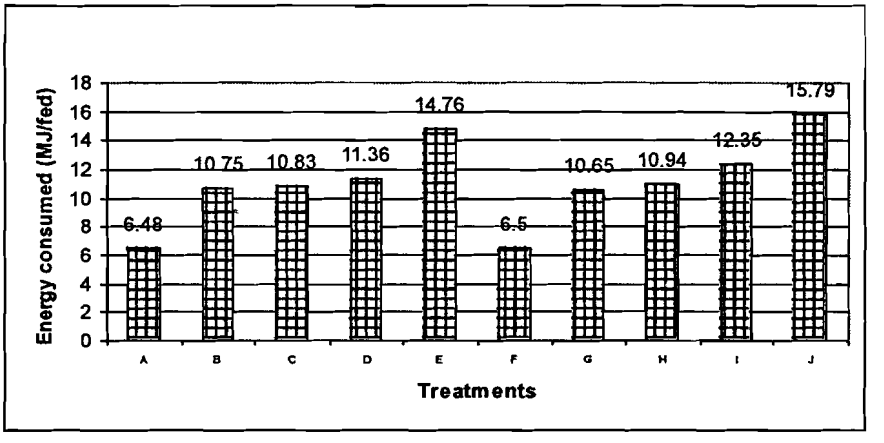

Fig. (6): Effect of working pressure and concentration of Polyvinyl acetate on energy consumed.

Effect of polyvinyl acetate concentration on plant emergency and yield:

Table (3) shows the effect of the used different polyvinyl acetate concentrations on both plant emergency and the yield of potato. It was obvious that the increasing of polyvinyl acetate concentrations led to, increase the emergency ratio of potato crop in all the studied treatments. That is due to the ability of the polyvinyl acetate to conserve the moisture

content around the potato tubers and help to increase and absorbed more water through the irrigation operations in the beginning and through the cultivation season. From other point of view, the emergency ratio was clearly increased with increasing the polyvinyl acetate concentrations, because of solution infiltration after 1st and 2nd irrigation periods through the soil profile movement which facilitate keeping more moisture content, and as a result encourage the tubers for emergence. Concerning the yield, the obtained results seemed to be similar with resulted with emergency ratio. Under the addition of 2.0% of polyvinyl acetate under both of working pressures of 50 and 150 kPa showed the highest crop yield for treatments of (F) and (J) as compared with all experimental treatments. This may be due to the higher soil moisture content with consequent improvement of tuber emergence compared to other different treatments. The variation in the crop yield could be described to the difference in soil moisture content during the cultivation process and emergence as good growth. The obtained results prove that the polyvinyl acetate concentrations showed appreciably effect on the yield of potato. These results were in agreement with **El-Hady and Abo-Sedera (2006)**.

Table (3): Effect of polyvinyl acetate concentration on plant emergency and yield.

Treatments	Emergency ratio(%)	Yield (kg/fed)
A	64	5543
B	65	5641
C	74	5811
D	78	5821
E	83	5907
F	64	5543
G	65	5708
H	85	6300
I	85	6939
J	87	7606
L.S.D	6.55	568.82

CONCLUSION

From the obtained results, it can be concluded the following:

1. Soil moisture content differences through the crop season were greater at the bottom layer (5-10 cm) of the soil as compared with the upper layer (0-5 cm). The higher moisture content was found with the working pressure of 150 kPa and polyvinyl acetate concentration of 2.0%, the lower moisture content was found without addition of Polyvinyl acetate even was the working pressure of 50 or 150 kPa respectively.

2. The energy consumed of field spraying operations was varied between 6.48 and 15.79 MJ/fed. Increasing the of working pressures led to increased energy consumed. The highest value of energy consumption was found of energy treatments, while the lowest ones were found with (A) and (F) treatments.

3. It is obvious that the increasing of polyvinyl acetate concentrations led to more emergency ratio and productivity of potato crop of all studied treatments. That is due to the ability of the polyvinyl acetate to conserve the moisture content around the potato tubers through the irrigation operations. The variation of the crop yield could be described to the difference in soil moisture content during the cultivation process and emergence as good growth. The obtained results proved that the Polyvinyl acetate concentrations showed appreciably effect on yield in sandy loam soils.

4. It is important to mention that, all studied parameters such as moisture content, emergency ratio and crop yield had the same values when using 50 or 150 kPa, especially when no addition of polyvinyl acetate, that is mean the working pressure had no effect on the values of these parameters, otherwise in the existence of Polyvinyl acetate.

REFERENCES

De Schampheleire M., D. Nuyttens, K. Baetens, W. Cornelis, D. Gabriels and P. Spanoghe (2009) Effects on pesticide spray drift

of the physicochemical properties of the spray liquid. J. Precision Agric . 10:409–420

El-Hady, O.A., (1999) Twenty five years of research with asphalt emulsions for soils reclamation, conditioning, fertilization, remediation and conservation. The 3 International Conference on Petroleum and Environment. Fac. Petroleum and Mining Eng. Suez Canal Univ. EPRI, VEA and ISA. 4-6 Dec., pp: 295-300.

El-Hady, O.A. and S.A. Abo-Sedera (2006) Conditioning effect of composts and Acrylamide Hydrogels on a Sandy Calcareous Soil. II. Phisico- Bio-chemical properties of the soil. International Journal of Agri. Biology. 1560-8530 / 2006 / 08-6-876- 884. http://www. Fs Publichers.org.

Gehan G. Abd El Ghany (2000). Evaluation of the performance of epands sprayers. M.Sc. thesis, Fac. of Agric.,Zagazig Univ., Egypt.

Hunt R. D. (1983). Farm power and machinery management. 9th ed., Cushing-Malloy Inc.,NY.

Ibtesam Abdul and AL Zhra AL Rasslany (2014) Effects of polyvinyl alcohol/starch as Soil Conditioners on the physical properties of loamy sand and loam soils following different wetting and drying cycles. J. Natural Sci. Res. 4 (24), 36-41

Klute, A. (ed.) (1986). Methods of Soil Analysis. Part 1. Physical and Minerological Properties. Am. Soc. Agron. Inc., Agronomy Series 9. USA. 1173 pp.

Matthews GA (2004) How was the pesticide applied? Crop Prot 23: 651-653.

Natalja J., K. Martins, T. Velta and D. Anda (2010) Poly (Vinyl Alcohol)/Poly (Vinyl Acetate) blend films. J. *Riga Technical University*. 21, 55-61

Nuyttens D., M. De Schampheleire, P. Verboven, E. Brusselman and D. Dekeyser (2009) Droplet size and velocity characteristics of agricultural sprayers. Trans. ASAE 52(5): 1471-1480.

Refik P., O. Copur, R. Saglam and C. Saglam (2006) Energy Use Pattern and Cost Analysis of Cotton Agriculture: A Case Study for Sanliurfa, Turkey. The Philippine Agricultural Scientist.89 (4), 368-371

Sahr M., W. Ismail, A. Yahya and C. Chee Wan (2005) Analysis of energy consumption in lowland rice-based cropping system of Malaysia. Songklanakarin J. Sci. Technol. 27(4), 820-826.

الملخص العربي

تاثير رش البولى فينيل اسيتات على حفظ رطوبة التربة و انتاجية البطاطس

إسلام محمد منير خاطر*

أجريت الدراسة على تربة رملية لومية لاضافة مادة البولى فينيل اسيتات كمحسن للتربة باستخدام الة الرش مقطورة خلف الجرار عند إنتاج محصول البطاطس بمنطقة غرب النوبارية وذلك عند ضغطى تشغيل ٥٠و١٥٠ كيلوباسكال مع خمسة تركيزات مختلفة من مادة البولى فينيل اسيتات ٠,٠ ، ٠,٥ ، ١,٠ ، ١,٥، ٢,٠ %. وقد اظهرت قياسات رطوبة التربة على عمقين (٠-٥) و (٥-١٠) سم بعض الاختلافات, حيث كانت رطوبة التربة فى الطبقة السفلية اعلى من مثيلتها فى الطبقة العلوية وبشكل عام فانة عند اجراء التجارب تحت ضغط التشغيل ٥٠ كيلوباسكال فقد تراوحت قيم الرطوبة مابين ٥,٥٥ الى ٢٠,٧٥ و ٢٣,١٩ الى ٣٢,٩٣ و ١٧,٧٣ الى ٢٧,٢٥ % بعد اجراء الرية الاولى , الرية الثانية وقبل الحصاد على التوالى وقد ادى استخدام التركيز (٢,٠%) الى تحقيق النسبة الاعلى من الرطوبة. وعند تنفيذ المعاملات التجريبية تحت ضغط التشغيل١٥٠ كيلوباسكال تراوحت قيم الرطوبة مابين٥,٥٥ الى ٢٢,٨٢ و ٢٣,١٩ الى ٣٦,٧٨ و ١٧,٧٣ الى ٣٠,١١ % بعد اجراء الرية الاولى , الرية الثانية وقبل الحصاد على التوالى وكان التركيز (٢,٠%) هو الافضل فى تحقيق النسبة الاعلى من الرطوبة. وقد اوضحت النتائج ان استخدام ضغط التشغيل ١٥٠ كيلوباسكال ادى الى زيادة فى الطاقة المستهلكة بمقدار ١٥,٧٩ ميجاجول / فدان عند المقارنة بضغط تشغيل ٥٠ كيلوباسكال معطيا ٦,٤٨ ميجاجول/فدان الا ان استخدام التركيز (٢,٠%) قد حقق اعلى نسبة انبات (٨٧%) واعلى انتاجية (٧٦٠٦ كجم/فدان). وبشكل عام قد اشارت النتائج الى وجود تاثير جيد عند استخدام مادة البولى فينيل اسيتات كمحسن للتربة الرملية اللومية.

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