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Response of Jojoba (*Simmondsia Chinensis*) Seed Yield to Compost, Phosphorus, and Potassium Fertilization and Their Interactions under Salt Stress

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Abstract

Jojoba is a potential oil crop that is grown for a variety of purposes in several countries, and holds a potential in the newly reclaimed lands in Egypt. An experiment on jojoba was carried out at Moghra Oasis, northeast of the Qattara Depression in the Western Desert of Egypt. The experiment was carried out in two consecutive years (2020-2021 and 2021-2022) to investigate the jojoba seed yield response to in-organic and organic fertilizers in a split-split plot design.Irrigation water from the utilized well averaged 7.4 dS m^{-1}, implying that the trees were under salt stress. Main plots were assigned for three rates of compost as 0, 20 and 40 ton ha^{-1}. Sub-plots were assigned for four rates of phosphorus (P) fertilizer as 0, 80, 160, and 320 kg P_2O_5 ha^{-1}. While sub-sub plots were assigned for four rates of potassium (K) fertilizer as 0, 100, 200, and 400 kg K_2O ha^{-1}. The results indicated that jojoba seed yield responded positively with the increasing rates of all the studied factors in a linear fashion. Applying P, K, and compost at rates of 320 kg P_2O_5, 400 K_2O, and 40 ton ha^{-1} were the most effective treatments. In the first and second seasons, these rates resulted in jojoba seed yields of 637 and 773 kg ha^{-1}, respectively. Higher seed yield in the second season may be attributed to the residual effects of compost, P, and K, as well as the expansion of the trees. In conclusion, this study revealed that jojoba trees grown in hyper-arid condition and exposed to salt stress respond considerably to organic and mineral fertilizers.

Keywords: Jojoba, organic fertilizer, inorganic fertilizer, P, K

Introduction

The jojoba plant, also known as *Simmondsia chinensis*, is a member of the Buxaceae family. It is originated from the dry regions of the USA and Mexico. Currently, jojoba plants are gaining popularity due to their potential for cultivation in arid regions of the world. Even in high heat (35–40°C), the jojoba plant, a dioeciously, long-lived desert shrub, remains evergreen. It may grow well with 50 mm or even 100 mm of rainfall annually, but it only yields a small crop. Additionally, top individuals of recognized sexuality and particular significance were displayed through clonal propagation in order to guarantee the quantity of fruitful plants on a given plot. By using the common traditional techniques, its vegetative propagation is challenging **(Yermanos, 1979).**

Jojoba importance is gained because of its oil, a valuable liquid wax contained in its seeds. The liquid wax from jojoba is used as a natural base for a variety of cosmetic goods, including face creams, sunscreen compounds, and hair oils. It also possesses qualities that make it useful in the chemical industry and can withstand heat**.** As a suitable carrier or coating for some medical preparations, stabilizer of penicillin products, inhibitor of tubercle bacilli growth, low-calorie additive for salad oil, in varnishes, detergents, emulsifiers resins, plasticizers, protective coating on fruit, food preparation, and used as a cosmetic for lipsticks **(Sherbrooke and Hasse, 1974; Wisniak, 1975; National Research Council, 1985; Benzioni, 1996;Weiss, 2000)**. It can also act as an antioxidant, an antifoaming agent, and a fire retardant. The oil's high dielectric constant makes it a good insulator and a carrier for insecticides, plant hormones, leather-softening forms, paints and adhesives, and waterproofing and sizing solutions. Additionally, the waxy structure of jojoba oil suggests that it may be useful in the recovery of harmful heavy metals from industrial wastes. Additionally, the final suppressed jojoba meal typically includes more than 42% carbohydrates and 30% protein, making it appropriate for use as animal food once the toxicity of simonizing has been removed **(Abobatta 2017)**.

Good fertilization, particularly P and K fertilizers, is critical in jojoba production. **Tikkoo et al. (2013)** concluded that the highest application of K (60 kg K_2O ha^{-1}) recorded the maximum seed textured loamy sand soils. According to **Benzioni and Ventura (1996)**, certain jojoba clones' root development was impeded by high P levels in the irrigation water. Low P did not affect the growth of the shoots or the concentration of chlorophyll, but it did cause a drop in the magnesium (Mg) and calcium (Ca) content of the leaves. This implies that using P fertilizer in moderation is necessary for jojoba production. In field trials conducted in 2008 and 2009 on five-year-old jojoba plants grown in sandy loam soil with fresh water irrigation, **Mohapatra and Panda (2011)** reported that treating trees with 80 g P/plant significantly increased seed yield (219.95 kg ha^{-1}) over the control treatment (80.08 kg ha^{-1}), whereas the treatment of 100 g P/plant resulted in 164.92 kg ha^{-1}. According to **Kalannavar's (2008)**, the rate of 100 kg P_2O_5 ha^{-1} considerably outperformed the rates of 150 kg P_2O_5 ha^{-1} (2593.06 kg ha^{-1}) and 200 kg P_2O_5 ha^{-1} (2422.69 kg ha^{-1}) to produce the maximum seed yield of Jojoba.

According to **Gomaa et al. (2015)**, applying farmyard manure at a rate of 20 m^3 fed^{-1} with 70 kg N fed^{-1} resulted in the highest percentages of N, P, and K in jojoba, which is resulted in high seed yield. In fact, applying farmyard manure not only affect plants due to its supply with essential nutrients, but also it enhances the physical characteristics of soil, including bulk density, total porosity, macro and micro pores, soil water retention, and hydraulic conductivity (**Shaaban, 2006)**. According to **Diacono and Montemurro (2015)**, organic materials (such as farmyard manures, various agro-industrial by-products, and composts) are useful instruments for enhancing various soil qualities in salt-affected soils, such as structural stability and permeability.

While land reclamation projects in Egypt are an important part of agricultural development plans, they necessitate crops that can withstand water and salt stress, like jojoba. However, neither the water regime nor the vegetative growth of this plant have been studied in the hyper-arid conditions present in Egypt. Balanced fertilization is an important factor in increasing the yield of jojoba trees under these conditions. Therefore, this study was carried out in order to design optimal fertilization programs for jojoba trees grown in Moghra Oasis, one of Egypt's targeted agricultural development regions. Specifically, determining the best P, K, and compost application rates to maximize seed yield, either individually or in combinations.

Material and Methods:

Experimental site:

The current investigation was conducted at the Moghra Oasis, northeast of the Qattara Depression. Location of the experimental site was 30° 07' 50.8' N, 28° 32' 53.7' E, and altitude 3 m. This area is one of the targeted areas in Egypt for agricultural development as a megaproject. Moghra Lake is located in the middle of the study area. The lake occupies around 400 ha area and contains brackish water. There are separated jojoba, olive and pomegranate orchards irrigated from wells. There is a plan to drill several wells in this area as a source of irrigation water by the Egyptian government. The climate is hyper-arid with annual rainfall between 25 to 50 mm $year^{-1}$. The mean daily temperature averages between 36.2º and 6.5º C during summer and winter months, respectively. The prevailing wind comes from the North varying between north-west and north-east directions.

Treatments:

The purpose of this study was to examine the effect of compost, P, and K application on seed yield of jojoba plants that are irrigated with high-salinity water (7.5 dS m^{-1}). The experiment was conducted on four-year-old bushes for two consecutive years (2020-2021 and 2021-2022). The experimental field was split into plots of 1.5 × 4 m dimensions. There were roughly 700 shrubs per fedden (1666 shrubs per hectare). K fertilizer was applied as K_2SO_4 (50% w/w K_2O) at four rates, i.e. 0, 100, 200, and 400 kg K_2O ha^{-1}. These rates were applied in three equal doses: the first at the start of the experiment during the winter service, the second during flowering, and the third one month following the second.

For P, the rates were 0, 80, 160, and 320 kg P_2O_5 ha^{-1}, as a single super phosphate (15 percent w/w P_2O_5) in a single dose. Compost was applied at three different rates: 0, 20, and 40 tons per ha^{-1} during the winter service. The used compost characterizes were pH = 7.4, EC (1:10) = 4.42 dS m^{-1}, organic carbon (C) = 12.83%, total N = 0.85%, C:N ratio = 15:1, total P = 0.61%, total K = 1.37%, and bulk density = 677 kg m^{-3}. The experiment was split-split plot design with three replications. Main plots were assigned for compost, P for the sub-plots, and K for the sub-sub plots.

Soil sampling and analysis:

Initial soil samples were collected from the experimental sites at two depths (0-30 and 30-60 cm). Table 1 shows some soil physical and chemical characteristics of the experimental site. The collected soil samples were air dried and gently ground, then sieved through a 2 mm sieve. Values of pH and electrical conductivity (EC) were measured in 1:1 soil-water suspension and supernatant, respectively as described by **Page et al. (1982)**. Soil organic matter was determined using the procedure of **Walkely and Black** as outlined by **Page et al. (1982)**. Total calcium carbonate content was measured using calcimeter according to **Page et al. (1982)**. Available N was extracted by 2 *M* KCl solution, according to **Dahnke and Johnson (1990)** and then determined by micro-Kjeldahl method. Available P, K, Fe, Mn, Zn, and Cu were extracted by 1 *M* NH_4HCO_3 in 0.005 *M* DTPA adjusted to a pH of 7.6 **(Soltanpour, 1991)**. P was estimated colorimetrically using ascorbic acid and ammonium molybdate using spectrophotometer. Potassium was measured using flamphotometer according. Iron, Mn, Zn, and Cu were determined using inductively coupled plasma-atomic emission spectroscopy as described by **Varma (1991)**.

Table1. Soil physical and chemical properties of the experimental site for the surface (0-30 cm) and subsurface (30-60 cm) layers**.**

Property	Soil depth (cm)	
	0 – 30	30 – 60
Very coarse sand (%)	5.17	1.62
Coarse sand (%)	11.59	7.97
Medium sand (%)	29.53	35.99
Fine sand (%)	44.54	48.99
Very fine sand (%)	5.39	4.88
Silt &clay (%)	3.79	0.53
Soil texture	Sand	Sand
Ca CO_3 (%)	2.51	0.72
O.M (%)	0.03	0.04
EC (dS m^{-1}) in 1:1 extract	7.8	12.5
SAR (sodium adsorption ratio)	11.38	10.59
pH in 1:1 suspension	7.9	7.8
Soluble anions (mmole L^{-1})		
HCO_3^-	4.35	7.55
Cl^-	36.45	63.04
SO_4^{2-}	48.88	84.51
Soluble cations (mmole L^{-1})		
Na^+	49.36	85.38
K^+	2.72	4.70
Ca^{2+}	30.75	53.18
Mg^{2+}	6.85	11.84
Available macronutrients and micronutrients (mg kg^{-1})		
Available N	18.60	15.28
Available P	2.92	2.77
Available K	27.00	21.00
Available Fe	6.78	4.25
Available Mn	0.50	0.32
Available Zn	0.27	0.55
Available Cu	0.22	0.01

Water analysis:

A water sample was obtained from the study field's well in both seasons. The collected sample was analysed for EC, pH and soluble cations and anions as described by **Richards (1954)**. Irrigation water EC was 7.4 dS m^{-1}, indicating that water salinity is very high according to **FAO (1985)**. The pH value was 6.7 in average, seemingly because of the high water salinity that hampers the increase in pH.

Table2. Some chemical properties of irrigation water utilized in both seasons of the study.

Parameter	EC (dSm^{-1})	pH	SAR*	Soluble anions (mmolc L^{-1})				Soluble cations (mmolc L^{-1})			
				CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	Na^+	K^+	Ca^{2+}	Mg^{2+}
First season	7.12	6.65	6.45	n.d.*	2.81	55.6	12.8	29.42	0.19	19.11	22.51
Second season	7.69	6.82	7.44	n.d.	2.61	66.72	7.58	34.26	0.23	23.91	18.52

* Sodium adsorption ratio

Seed yield estimation:

This study focused on seed yield production as an indicator of fertilizer response. The seed yield from all trees within the plots was measured by hand picking at full maturity in July. Harvested seeds were cleaned and weighted in the field. Following that, a sample was collected from each tree for further analysis.

Statistical analysis:

The analysis of variance (ANOVA) was performed to determine the effects of treatments on the obtained data **(Gomez and Gomez, 1984)**. The difference between means at probability level of 0.05 was conducted using least significant difference test (LSD).

Results and discussion

The influence of compost, P, and their interaction on jojoba seed yield:

Seed yield responded substantially to the compost and P applications in both seasons (Table 3 and Figure 1). The highest significant seed yield was obtained in OM2 treatment in both season. This is owing to compost's increased ability to buffer temperature and moisture changes, as well as the fact that it provides essential macro- and micronutrients to the rhizosphere. This was is in line with the finding of **Shadrack et al. (2016),** who found that a combination of manure, and in-organic fertilizers had a positive impact on Jojoba seed production. Similarly, **Huda et al. (2021)** stated that the application of humic acid and bread yeast considerably enhanced the seed yield of jojoba and the dry weight of the shoot. Furthermore, according to **Shaaban (2006),** organic residues increased the bulk density, total porosity, macro and micro pores, soil water retention, and hydraulic conductivity of the soil, which all have positive impact on plant's performance. Pertaining to P, the highest significant seed yield was obtained in P3 treatment in both seasons. P levels' effects on jojoba seed yield can be ranked in the order of the following ascending list: 0 < P1 < P2 < P3. Accordingly, the highest significant seed yield was obtained by the interaction between OM2 and P3.

Table 3. The effect of compost, P, and their interaction on jojoba seed yield (kg ha^{-1}) in the two studied seasons**.**

P rates	First season			Mean	Second season			Mean
	OM0	OM1	OM2		OM0	OM1	OM2	
P0	52	392	531	325	61	449	617	376
P1	127	425	557	370	150	501	658	436
P2	221	453	576	417	258	537	693	496
P3	292	495	629	472	348	578	761	562
Mean	173	441	573	396	204	516	682	468
LSD 5%	OM=1.28	P= 1.47	OMxP= 2.55		OM=1.54	P= 1.78	OMxP= 3.08	

P0:0 kg P_2O_5 ha^{-1} P3:160 kg P_2O_5 ha^{-1} OM0: 0 ton ha^{-1} OM2: 40 tons ha^{-1}
P1:80 kg P_2O_5 ha^{-1} P4:320 kg P_2O_5 ha^{-1} OM1: 20 tons ha^{-1}

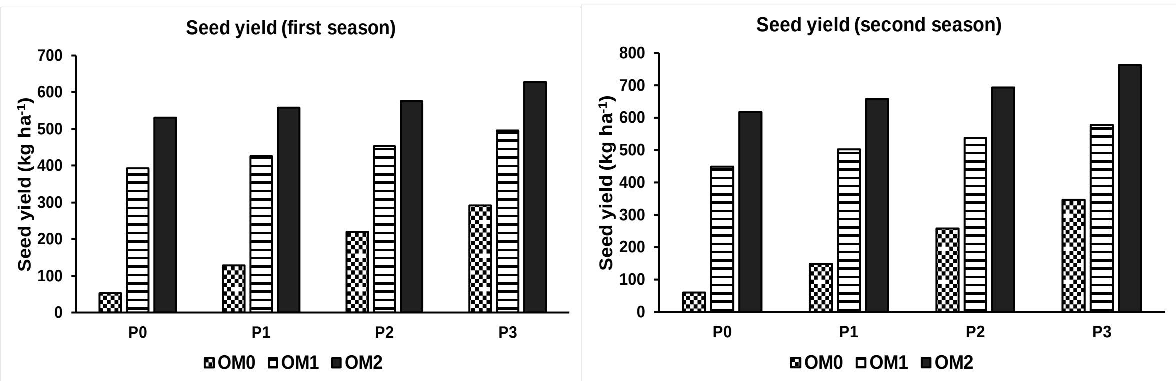

Fig.1: The effect of compost, P, and their interaction on jojoba seed yield in the two studied seasons. .

It is clear that high compost application improved P level performance in seed production. These findings are consistent with the findings of **El-Maadawy and Moursy (2007)**, who suggested that jojoba bushes grow best when a high level of organic manure is present. It may be inferred that jojoba shrub responded to P applications when the compost was increased **(Table 3 & figure 1)**. It is noteworthy that there were more seeds produced in the second season than the first. This might be because the residual effects of compost and P are high, implying that their application in one season may have an impact on succeeding seasons. Another reasonable explanation may be increased tree production over years, owing to the increased branches.

The influence of compost, K, and their interaction on jojoba seed yield

Table 4 and Figure 2 show the impact of compost, K, and the interaction effects on jojoba seed yields in both seasons. Seed yield responded to K and compost applications linearly. This finding was consistent across both seasons. The application of 400 kg K_2O ha^{-1} resulted in the highest significant seed yield, whereas application of 40 ton ha^{-1} compost resulted in the highest Generally, increasing rates of NPK fertilizers promote vegetative growth of jojoba (**Inam et al., 2017**). Seed yield of the second season outperformed the first season in all treatments. This is owing to the residual effect and the increased trees size, as observed previously.

Table 4. Influence of compost, K, and their interaction on jojoba seed yield (kg ha^{-1}) in the two studied seasons.

	First season			Mean	Second season			Mean
K rates	OM0	OM1	OM2		OM0	OM1	OM2	
K0	165	438	570	391	195	512	676	461
K1	170	441	572	394	201	515	680	465
K2	176	443	574	398	207	518	785	470
K3	181	445	577	401	214	521	688	474
Mean	173	441	573	396	204	516	682	468
LSD5%	OM=1.28	K= 1..47	OMxK= 2.55		OM=1.54	K= 1.78	OMxK= 3.08	

K0: 0 kg K_2O ha^{-1} K2:200 kg K_2O ha^{-1} OM0: 0 ton ha^{-1} OM2: 40 tons ha^{-1}
K1: 100 kg K_2O ha^{-1} K3:400 kg K_2O ha^{-1} OM1: 20 tons ha^{-1}

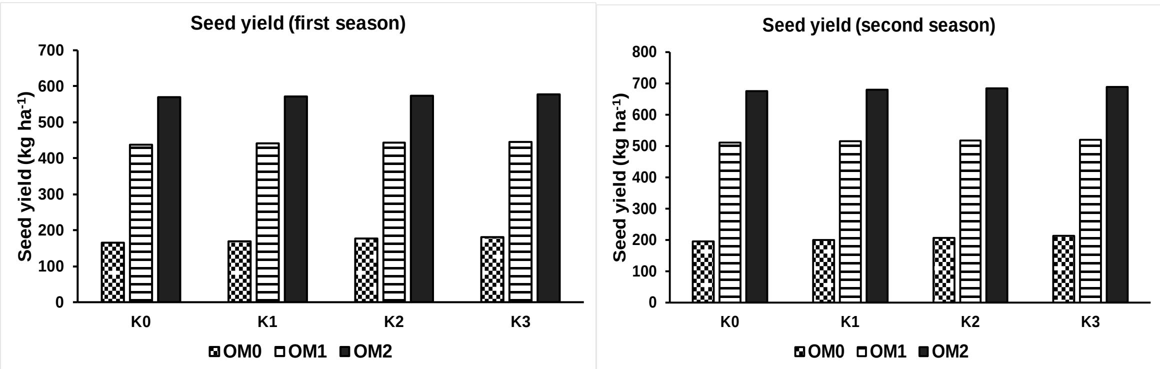

Fig.2 Influence of compost, K, and their interaction on jojoba seed yield in the two studied seasons.

According to Table 4, the interaction effect between compost and K had a considerably positive effect in the second season but not the first. It is clear that applying compost at high levels improved K levels' performance in seed production. Both seasons showed that this was the case. In the findings published by **El-Maadawy and Moursy (2007)**, the interaction of compost and K appeared in a fluctuating mode, with a tendency to respond positively with high rates

The influence of P, K, and their interaction on jojoba seed yield

Data in **Table 5 & Figure 3** show the effect of interaction effect between P and K fertilizers on seed yield of jojoba in both seasons. As inferred from the previous treatments, the highest significant seed yield was obtained under the interaction effect of P3 (320 kg P_2O_5 ha^{-1}) and K3 (400 kg K_2O ha^{-1}) in both seasons. Similar to the previous finding, the second season produced more seed than the first. It is commonly known that increased plant growth necessitates P and K, resulting in growth stimulation and higher absorption of both elements, particularly because both nutrients are lacking in the studied soil.

Table 5. Influence of P, K, and their interaction on jojoba seed yield (kg ha^{-1})in the two studied seasons.

K rates	**First season**				**Mean**	**Second season**				**Mean**
	P0	P1	P2	P3		P0	P1	P2	P3	
K0	320	367	412	466	391	369	431	491	553	461
K1	323	369	415	470	394	374	435	493	559	465
K2	326	371	419	474	398	378	437	499	566	470
K3	330	373	421	480	401	382	441	502	571	474
Mean	325	370	417	472	396	376	436	496	562	468
LSD5%			K= 1.47	P= 1.47	PxK= 2.95		K= 1.78	P= 1.78	PxK= 3.55	

K0: 0 kg K_2O ha^{-1} K2:200 kg K_2O ha^{-1} P0:0 kg P_2O_5 ha^{-1} P3:160 kg P_2O_5 ha^{-1}

K1: 100 kg K_2O ha^{-1} K3:400 kg K_2O ha^{-1} P1:80 kg P_2O_5 ha^{-1} P4:320 kg P_2O_5 ha^{-1}

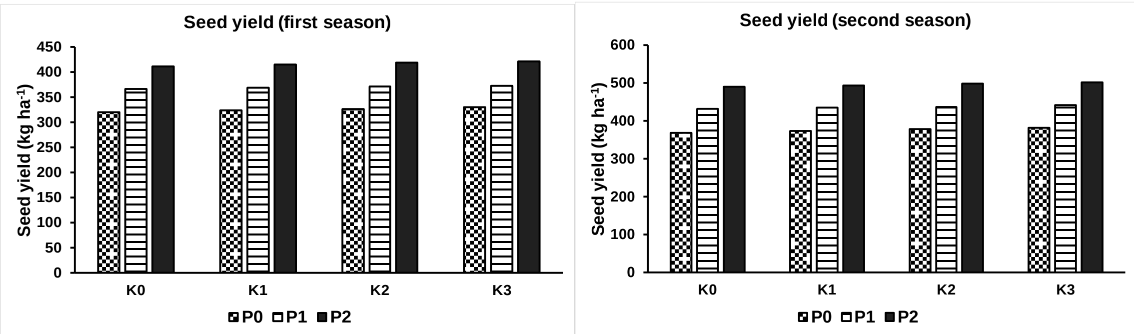

Fig.3: Influence of P, K, and their interaction on jojoba seed yield in the two studied seasons.

The influence of compost, P, K, and their interaction on jojoba seed

Table 6 and Figure 4 show the effects of compost-P-K interactions on the mean seed yield of jojoba Mean seed yield was considerably influenced by compost-P-K interactions. The best combination was OM2-P3-K3. Comparing this treatment to the control treatment OM0, P0, and K0, the increase in mean seed yield was about 637 kg ha^{-1} in the first season. The same pattern was observed in the second year as well. The mean seed yield in the second year, however, was higher than in the first year (773 kg ha^{-1}) than in the control treatment (OM0-P0- K0), which was 52 kg ha^{-1}.

Table 6. Influence of compost-P-K interaction on jojoba seed yield (kg ha^{-1}) in the two studied seasons.

P Rates	K rates	First Season Mean seed yield g/Tree OM rates OM0	 OM1	 OM2	Means of P rates	Second Season Mean seed yield g/Tree OM rates OM0	 OM1	 OM2	Means of P Rates
P0	K0	45	386	528	325	52	442	612	376
	K1	49	391	530		58	446	617	
	K2	53	395	532		63	452	619	
	K3	60	397	533		71	456	620	
P1	K0	121	424	555	370	142	498	654	436
	K1	125	425	557		148	501	657	
	K2	130	426	558		151	503	659	
	K3	134	427	559		158	504	662	
P2	K0	211	449	575	417	250	533	689	496
	K1	216	452	576		251	536	691	
	K2	226	454	577		262	539	695	
	K3	229	456	578		269	541	697	
P3	K0	284	491	622	472	337	574	749	562
	K1	288	495	626		345	576	756	
	K2	296	496	631		352	579	768	
	K3	302	500	637		357	582	773	
Means of OM rates		173	441	573	396	204	516	682	468
Means of K rates									
K0			390				461		
K1			394				465		
K2			398				470		
K3			401				474		
LSD 5%			5.11				6.15		

K0: 0 kg K_2O ha^{-1} K2:200 kg K_2O ha^{-1} P0:0 kg P_2O_5 ha^{-1} P2:160 kg P_2O_5 ha^{-1}
OM0: 0 ton ha^{-1}
K1: 100 kg K_2O ha^{-1} K3:400 kg K_2O ha^{-1} P1:80 kg P_2O_5 ha^{-1} P3:320 kg P_2O_5 ha^{-1}
OM1: 20 tons ha^{1} OM2: 40 tons ha^{-1}

Conclusion

The purpose of this study was to determine the best fertilizer rates for jojoba trees. The study was particularly important since the trees grown in the study field were exposed to salt stress as a result of the high salinity in the water well used. To accomplish this, successive rates of compost and inorganic P and K fertilizers were used to determine the best rate of application for each fertilizer alone and in combination. Applying compost at a rate of 40 ton ha^{-1}, P at 320 kg P_2O_5 ha^{-1}, and K at 400 kg K_2O ha^{-1}, resulted in the highest significant seed yield in both seasons. In general, the second season produced more seed than the first. This might be because to the substantial residual effects of compost, P, and K, meaning that their application in one season may have an influence on subsequent seasons. Another possible explanation might be increasing seed yield with increasing trees size.

References

Abobatta W. F *Simmondsia chinesis* jojoba tree. (2017). Journal of advanced trends in Basic Applied Science.Vol., No.1 : 160:165

Aliza Benzioni, A. and M. Ventura (1996). Effect of phosphorus concentration in irrigation water on the development of jojoba cuttings, Journal of Plant Nutrition, 21:12, 2697-2706, DOI: 10.1080/01904169809365598

Benzioni A. and M. Ventura (1996). Effect of phosphorus concentration in irrigation water on the development of jojoba cuttings, Journal of Plant Nutrition, 21:12, 2697-2706, DOI: 10.1080/01904169809365598

Dahnke, W.C. and Jahnson, R.A. 1990: Soil test correlation calibration and recommendation. P. 45-71. In: R.L. Westerman (ed.) Soil Testing and Plant Analysis, 3rd ed., SSSA Book Series, Soil Science Society of America, Madison WI.

Diacono, M. and Montemurro, F.(2015).Effectiveness of organic wastes as fertilizers and amendments in salt-affected soils. Agriculture 5(2) :221-230

E.I. El-Maadawy and Kh. S. Moursy (2007). Bio-fertilizers as a partial alternative to chemical NPK fertilization of jojoba (Simmondsia chinensis Link.) plants grown in different soil types. J. Product. & Dev., 12(1): 211- 236 (2007).

FAO(1985).Water quality for agriculture,vol 29.Food and agriculture Organization of the United Nations,Rome.

Gomaa, M.A., F. I. Radwan, I. F. Rehab and W. S. Mabrouk (2015). Response of Bread Wheat to Organic and Nitrogen Fertilization. Middle East Journal of Agriculture Research ISSN 2077-4605 Volume: 04(4), Oct.-Dec., 2015, pp. 712-716.

Gomez, K. A. and Gomez A. A. (1984). Statistical Procedure for Agricultural Research. 2nd Edn. John Wiley and Sons, New York, USA. ISBN: 0471870927, Pages: 704.

Hegab H., Attia F.and Doaa Eissa (2021) The Growth and Production of Jojoba Plant under NPK Fertilization and Irrigation with Industrial Wastewater
Egypt. J. Soil. Sci. Vol. 61, No. 1, pp. 45-62 .

Huda M. Abusaief, Saleh A. Abugarsa, Mohamed M. Al-Naby and Amna T. Abdul-Qader (2021). Effect of soil type and organic farming on jojoba growth. Plant Cell Biotechnology and Molecular Biology 22(63&64):73-86; 2021.

Inam Ali Shah, Sultan Mehmod Wazir and Rahmat Ali Khan (2017). Effects of Different Doses of Fertilizers on Growth and Yield Components of Biodiesel Plant (Jatropha curcas L.). Sains Malaysiana 46(1) (2017): 117–122.

Kalannavar, V. N. (2008). Response of Jatropha curcas to nitrogen, phosphorus and potassium levels in Northern transition zone of Karnataka. M.Sc. Thesis submitted to the University of Agricultural Sciences, Dharwad.

Mohapatra, S. and Panda P. K. (2011). Effects of Fertilizer Application on Growth and Yield of Jatropha curcas L. in an Aeric Tropaquept of Eastern India. Not. Sci. Biol. 3: 95–

National Research Council (1985): Jojoba: new crop for arid Land, new material for industry. National Academy Press, Washington, D.C. Cited by Nerd & Benzsioni.

Page, A.L., Miller H. and Keeney D.R. 1982: Methods of Soils Analysis. PartII: Chemical and Microbiological Properties (2nd Ed.). Amer. Soc. of Agron. Madison, Wisconsin, USA.

Richards, L.A. (1949). Filter funnels for soil extracts. Agron.J. 41:446.

Shaaban, S.M. (2006). Effect of Organic and Inorganic Nitrogen Fertilizer on Wheat Plant under Water Regime. Journal of Applied Sciences Research, 2(10): 650-656, 2006.

Shadrack Inoti, Lulther Lulandala, Shabani Chamshama, Wilson Thagana and Rob Dodson (2016). Effect of some Agricultural Practices on Field Performance of Jojoba (Simmondsia Chinensis L.) Seedlings in Semi-Arid Areas of Voi, Kenya. Merit Research Journal of Agricultural Science and Soil Sciences (ISSN: 2350-2274) Vol. 4(1) pp. 014-022, January, 2016 Available online http://meritresearchjournals.org/asss/index.htm.

Sherbrooke, W.C. and Hasse, E.F. (1974): Jojoba: away producing shrub of the Sonoran desert. Arid Land Res. Inform. Paper 5, 1-132. Office of Arid Studies. Univ. of Arizona, Tucson Yermanos 1974.

Soltanpour, P.N. and Workman, S.M. 1991: Modification of AB-DTPA soil test to omit carbon black. Commun. Soil Sci. Plant Anal. 10: 1411-1420.

Tikkoo, A.; Yadav, S. S. and Kaushik, N. (2013). Effect of irrigation, nitrogen and potassium on seed yield and oil content of Jatropha curcas in coarse textured soils of northwest India. Soil & Tillage Research 134: 142-146.

Walkley,A., and Blake,I. A., (1934).An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil science 37 (1):29-38.

Weiss, E.A. (2000): Crambe, Niger & Jojoba. In: „Oliseed Cropps“, Blackwell Science, 2nd edition, P. 273-286.

Wisniak, J. (1975): Investigation of chemical properties & Possible uses of jojoba oil. Ben Gwion Univ. of Negu. United States – Istrael binational Science foundation. Grant No. 349, P. 112.

Yermanos, D.M. (1982). Jojoba: Out of the ivory tower and into the real world of agriculture. Annual Report, Agron. Dept., UCR, Riverside, California, USA, p. 101.

استجابة محصول بذور الجوجوبا (Simmondsia chinensis) للتسميد بالكمبوست والفوسفور والبوتاسيوم وتفاعلاتها تحت الاجهاد الملحى

يُعد الجوجوبا من المحاصيل الزيتية الواعده التي تتم زراعتها لأغراض متنوعة في العديد من البلدان ، وهو ملائم للزراعه في الأراضي المستصلحة حديثًا في مصر. تم إجراء تجربة على الجوجوبا في واحة المغرة شمال شرق منخفض القطارة في الصحراء الغربية بمصر. أجريت التجربة في عامين متتاليين (2020-2021 و 2021-2022) للتحقق من استجابة محصول بذور الجوجوبا للأسمدة العضوية والمعدنيه في تصميم قطع منفصلة. بلغ متوسط ملوحة مياه الري من البئر المستخدم 7.4 $dS\ m^{-1}$ ، مما يعني أن الأشجار كانت تحت اجهاد ملحى. العامل الرئيسى الكمبوست بثلاث معدلات 0 و 20 و 40 طن هكتار-1. والعامل الثانى الفوسفور(P) بأربعة معدلات 0 و 80 و 160 و 320 كجم P_2O_5 هكتار -1. بينما العامل الثالث البوتاسيوم (K) بأربعة معدلات 0 ، 100 ، 200 ، و 400 كجم K_2O هكتار -1. أشارت النتائج إلى أن محصول بذور الجوجوبا استجاب بشكل إيجابي للمعدلات المتزايدة لجميع العوامل المدروسة بشكل خطي. كان استخدام الفوسفور والبوتاسيوم والسماد العضوي بمعدلات 320 كجم P_2O_5 و 400 K_2O و 40 طن هكتار-1 من أكثر المعاملات فعالية. في الموسمين الأول والثاني ، نتج عن هذه المعدلات محصول بذور الجوجوبا 637 و 773 كجم هكتار على التوالي. يمكن أن يعزى ارتفاع إنتاج البذور في الموسم الثاني إلى الآثار المتبقية من السماد العضوي ، P ، و K ، وكذلك حجم الأشجار. في الختام ، كشفت هذه الدراسة أن أشجار الجوجوبا التي تنمو في حالة شديدة الجفاف وتتعرض لإجهاد الملح تستجيب بشكل كبير للأسمدة العضوية والمعدنية.