J.Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 6 (4):433 - 444 , 2015

GROWTH AND SOME MACRONUTRIENTS UPTAKE BY CASTOR BEAN IRRADIATED WITH GAMMA RAY AND IRRIGATED WITH WASTEWATER UNDER SANDY SOIL CONDITION

Abbas, H. H.[1]; I. M. Farid[1]; S. M. Soliman[2]; Y. G. M. Galal[2]; M. M. Ismail[2]; E. A. Kotb[2]; and S. H. Moslhy[2]

[1] Soils and Water Department, Faculty of Agriculture, Moshtohor, Banha University, Egypt

[2] Atomic Energy Authority, Nuclear Research Center, Soil and Water Research Department, AbZaabl, 13759, Egypt, Fax: 202-2876031, Corresponding author:Solimanreh @yahoo.com.

ABSTRACT

A field experiment was carried out at Experimental Farm of Soil and Water Research Department, Nuclear Research Centre, Atomic Energy Authority, Inshas Egypt, to follow up the effects of different doses of gamma ray on castor bean (*Ricinus communis L.*) grown on a sandy soil and irrigated with either fresh water or wastewater from El-Gabal El Asfar. Irradiation resulted in higher values of both fresh and dry weight of castor bean. This effect seemed more obvious by increasing the dose of gamma ray up to 50 Gy beyond which a gradual decrease occurred. Nitrogen, phosphorus and potassium contents in castor bean under the effect of gamma irradiation were arranged in the following descending order; 50Gy > 100Gy > 150Gy > 200Gy > 0 > 250Gy> 300 Gy. Nitrogen, phosphorus, potassium and oil contents in castor bean plants irrigated with wastewater were higher than the corresponding ones in plants irrigated with fresh water.

Keywords: Castor bean, Gamma ray, Nitrogen, Phosphorus, Potassium and Wastewater.

INTRODUCTION

Castor bean (*Ricinus communis* L.) is an important drought-resistant shrub belonging to the family Euphorbiaceae a diverse and economically-important family of flowering plants. Castor bean probably originated from Africa and was used in ancient Egypt and by the Romans and Greeks (Scarpa and Guerci, 1982, Weiss, 2000). Castor bean is a plant of enormous significance and diversified uses of its products ranging from farm yard manure and fuel to its multiple uses like leaves for feeding silkworms. Castor bean oil is non- edible traditionally used as purgative and in the preparation of various cosmetic products, plastic industry, lubricants and manufacturing of biofuel. The oil extracted from castor bean already has a growing international market, assured by more than 700 uses (Weiss, 2000, Azevedo and Lima, 2001).

Wastewater is a preferred marginal water source, since its supply is reliable and uniform. Costs of this water source are low compared with those of other nonconventional irrigation water sources (e.g. desalinization) since agricultural reuse of urban wastewater serves also to dispose of treated urban sewage water (Haruvy and Sadan, 1994). The use of wastewater for irrigation is a viable option to reduce the use of water resources and to increase the supply of quality water for more restrictive uses, such as drinking water (Toze, 2006). In Egypt, sewage effluent has been used in irrigation long time ago in a desert sandy area northeast of Cairo. At present, small scattered plots are also irrigated with sewage effluent. Sewage effluent generated from sewer stations in both Lower and Upper Egypt, raw or treated, falls in a good permissible range for most crops according to their salinity and heavy metal contents. In addition, their high nitrogen and other nutrient element contents significantly reduce or even exterminate the exigency for chemical fertilizers (Hussein *et al.*, 2004, Hussein *et al.*, 2012). Crops with improved characteristics have successfully been developed by mutagenic inductions (Majeed and Zahir, 2010). Gamma rays generally influence plant growth and development by inducing cytological, genetically, biochemical, physiological and morphogenetic changes in cells and tissues (Rahimi and Bahrani, 2011). These effects can occur both spontaneously in nature and artificial by mutagens.

This work, therefore, aimed at following the effect of both gamma ray and irrigation with wastewater on macronutrients uptake by castor bean crop as well as its oil content.

MATERIALS AND METHODS

A field experiment was carried out in the experimental farm of Soil and Water Research Department, Nuclear Research Center, Inshas Egypt. Seeds of castor bean were exposed to six doses of gamma rays (Co-60 source) {50, 100, 150, 200, 250 and 300 Gray (Gy)} in addition to non-irradiated control. Castor bean seeds were divided into two parts, the first one was irrigated with wastewater which was gained from El-Gabal El-Asfar irrigation canals, while the second one was irrigated with fresh water. Castor bean seeds were cultivated on a sandy soil at distance of 3m x 3m between plants (1111 plant/ hectare). Some physical and chemical properties of the investigated soil are presented in Table1. Only plants which were irrigated with fresh water received chemical fertilization, where N, P and K were added at the rates of 150,110 and 110kg/ha in the forms of ammonium sulphate, supper phosphate and potassium sulphate, respectively. Plants were irrigated every 10 days in summer and 15 days in winter. After one year from cultivation, both the soil and plants were sampled, the sampled soil was prepared for physical and chemical analysis according to Carter and Gregreich (2008) (Table 2). Samples of irrigation water was transferred to laboratory in closed bottles and then filtered to remove any suspended materials. Irrigation water swere analyzed for EC, pH, cations and anions and heavy metals (Table 3) .The plants sampled were oven dried at $70^{o}{}_{C}$, digested using a mixture of H_2SO_4 and H_2O_2 and analyzed according to Hamdy (2005),

Table (1): Physical and chemical properties of the experimental soil.

pH (1:2.5)	EC (dS m^{-1})	$CaCO_3$ (g kg^{-1})	OM (g kg^{-1})		SP (%)		
7.91	1.11	0.00	0.30		31.96		
Soluble Ions (mmol$_c$ L^{-1})							
Cations			Anions				
Na^+	3.16		CO_3^{-2}	0.00			
K^+	3.21		HCO^{-3}	3.34			
Ca^{+2}	2.12		CL^-	4.55			
Mg^{+2}	2.61		SO_4^{-2}	3.21			
Available nutrients* (mg kg^{-1})							
N	P	K	Fe	Mn	Zn	Pb	Cu
2.11	1. 42	1.54	2.10	1.29	0.40	0.01	0.40
Particle size distribution(%)							
Sand		Silt		Clay		Texture	
90.5		2.7		6.8		Sand	

***Extracted by: KCl (N), Na_2CO_3 (P), NH_4-AOc (K) and DTPA (Fe, Mn, Zn and Cu).**
SP: Saturation percent.

Table 2. Physical and chemical properties of the soil used in the study after planting

pH (1:2.5)		EC (dS m^{-1})	$CaCO_3$ (g kg^{-1})	OM (g kg^{-1})	SP (%)		
7.1		1.67	0.00	0.65	38.91		
Soluble Ions (mmolc L^{-1})							
Cations				Anions			
Na+		5.16		CO_3^{-2}		0.30	
K+		4.21		HCO^{-3}		4.40	
Ca^{+2}		3.23		CL^-		5.80	
Mg^{+2}		4.10		SO_4^{-2}		6.20	
Available nutrients (mg kg^{-1})							
N	P	K	Fe	Mn	Zn	pb	Cu
4.14	3.51	2. 18	9.10	0.99	0.60	0.11	0.64
Particle size distribution(%)							
Sand		Silt		Clay		Texture	
86.5		4.7		8.8		Sand	

See footnotes of Table 1.

The treatments were statistically arranged in a complete randomized block design with three replicates. The final data were statistically analyzed using ANOVA system and the values of LSD at 0.05 level. by SPSS (ver. 22) according to Snedecor and Cochran (1982).

Table (3): Experimental wastewater and fresh water properties

Analysis	Fresh water	Waste water
EC (dS/m^{-1})	0.89	1.49
pH	7.58	7.33
BOD 5 mg/L	43.00	95.00
COD mg/L	30.00	78.00
Soluble anions ($mmol_cL^{-1}$)		
SO_4^{2-}	2.19	3.34
CO_3^{2-}	0.00	0.05
HCO_3^-	3.05	4.05
Cl^-	2.86	7.46
Soluble cations ($mmol_cL^{-1}$)		
K^+	2.82	4.06
Na^+	1.39	3.28
Ca^{2+}	2.70	4.17
Mg^{2+}	1.19	3.39
Soluble elements (mgL^{-1})		
Fe	0.12	1.21
Cu	0.02	0.03
Mn	0.09	0.24
Zn	0.06	0.15
Pb	0.00	0.16
Cd	0.01	0.03
P	0.02	3.02
NH_4^{-N}	0.00	10.89
NO_3^{-N}	0.01	2.10

Oil extraction

The seed kernels were ground using a mechanical grinder and defatted in a soxhlet apparatus according to the method described by Akbar et al. (2009). The extraction was carried out by using hexane (boiling point of 40–60◦C) as a solvent. The process continued for 6 h. The extracted lipid was obtained by filtrating the solvent lipid contained to get rid of the solid from solvent before the hexane was removed. The solvent was removed by vacuum evaporation and exposure to heat in a drying oven at 50°C. Extracted seed oil was stored in freezer at −2 ◦C for subsequent analysis. The amount of oil recovered was calculated as percentage of total oil present in seed kernels. Each extraction was run in triplicate and the final value is the average of all.

RESULTS AND DISCUSSION

Fresh weight

Data in Table 4 show that irrigation with wastewater resulted in higher fresh weights of roots, shoots, leaves, seeds and the whole plants than the corresponding ones irrigated with fresh water. This may be due to the wastewater contents of nutritive elements such as N, P and K beside of its higher content of organic material, which was reflected positively on the characteristics of the plant (Hussein *et al.*, 2012). Also, the results show that fresh weights of castor bean plants increased gradually with increasing dose of gamma ray and reached maximum values at the dose of 50 Gy, thereafter gradually declined until reached the minimum values at the dose of 300 Gy. The high doses of gamma irradiation were reported to be harmful in several studies. Nassar *et al.* (2004) reported that higher doses of gamma ray (120 k-rad) reduced plant height, number of leaves and branching capacity of safflower.(1k- rad=10 Gy).

Table (4): Effect of gamma rays irradiation (Gy) and irrigation with wastewater on fresh weight of castor bean (g plant^{-1}).

Plant part	Water type (B)	Gamma ray dose (A)							Mean
		0	50	100	150	200	250	300	
Seeds	FW	2500	5000	4500	4000	3000	1500	1000	3071
	WW	3000	6500	5500	4500	4000	2500	1500	3929
	Mean	2750	5750	5000	4250	3500	2000	1250	
L.S.D. at 005		A =350			B=654			A*B=92	
Leaves	FW	3800	6100	60	60	4020	3250	2500	4524
	WW	4100	6900	6850	6520	4450	3800	2200	4974
	Mean	3950	6500	6425	6260	4235	3525	2350	
L.S.D. at 005		A =355			B=664			A*B=939	
Shoots	FW	7240	9473	9460	9120	7500	60	5100	7699
	WW	7580	9587	9530	9380	7900	6800	5500	8040
	Mean	7410	9530	9495	9250	7700	6400	5300	
L.S.D. at 005		A =355			B=664			A*B=939	
Roots	FW	1645	2520	2510	2440	1870	1280	1012	1897
	WW	1840	2700	2580	2500	1980	1520	1200	2046
	Mean	1743	2610	2545	2470	1925	1400	1106	
L.S.D. at 005		A =64			B=119			A*B=169	
Whole	FW	15525	23093	22470	21560	16390	12030	9612	17240
	WW	16180	25687	24460	23900	18330	14620	10400	19082
	Mean	15853	24390	23465	22730	17360	13325	10006	
L.S.D. at 005		A =748			B=1399			A*B=1979	

FW: Fresh water **WW: Wastewater**

Dry weight

Dry weight values of the different plant organs as well as the corresponding whole plant dry weight have almost taken the same trend as in the fresh weight, where the wastewater resulted in higher dry weights of the roots, shoots, leaves, seeds and whole plants than the corresponding ones resulted due to the fresh water (Table 5). Also, the gamma irradiation at a dose of 50 Gray recorded the highest dry weight values whereas; at a dose of 300 Gray recorded the lowest dry weight ones. This may be due to the simulative effect of gamma ray irradiation on growth, especially at low doses. These results are in agreement with those of Khan (1970) who exposed seeds of *Cicer arietinum* to gamma rays at doses ranging from 5 to 15 k-rad, and found stimulating effect of irradiation on branching capacity, fresh weight and dry weight of plant.

Table (5): Effect of gamma rays irradiation (Gy) and irrigation with wastewater on dry weight of castor bean (g plant^{-1}).

Part of plant	Water type (B)	Gamma ray dose (A)							Mean
		0	50	100	150	200	250	300	
Seeds	FW	2225	4500	4250	3600	2700	1350	900	2789
	WW	2700	5900	4950	4050	3600	2250	1350	3543
	Mean	2463	5200	4600	3825	3150	1800	1125	
L.S.D. at 005		A =322			B=602				A*B=851
Leaves	FW	1377	2576	2300	2119	1540	1150	540	1657
	WW	1480	2914	2440	2260	1763	1290	637	1826
	Mean	1429	2745	2370	2190	1652	1220	589	
L.S.D. at 005		A =79			B=147				A*B=208
Shoots	FW	3240	3515	3500	3480	3010	2065	1925	2962
	WW	3500	3654	3620	3600	3020	2180	1985	3080
	Mean	3370	3585	3560	3540	3015	2123	1955	
L.S.D. at 005		A =71			B=133				A*B=18
Roots	FW	524	1050	1045	1005	515	435	400	711
	WW	635	1230	1225	1215	720	550	420	856
	Mean	580	1140	1135	1110	618	493	410	
L.S.D. at 005		A =63			B=118				A*B =167
Whole	FW	7366	11641	11095	10204	7765	50	3765	8119
	WW	8415	13698	12235	12575	9103	5270	4392	9384
	Mean	7891	12670	11665	11390	8434	5135	4079	
L.S.D. at 005		A =687			B=1286				A*B=1819

FW: Fresh water **WW: Wastewater**

Similar results were observed by Kaul and Bradu (1972) on *Atropa belladonna*, Suhas *et al.* (1976) on *Cassia angustifalia*, Selenina and Stepanenko (1979) on *Matricaria recutita* and Youssef *et al.* (2000) on Geranium. In this respect, Pitirmovae, (1979) explained that the stimulating effect of low doses of gamma ray irradiation on plant growth may be due to stimulation of cell division or cell elongation, alteration of metabolic processes that affect synthesis of phytohormones or nucleic acids.

Nutrient uptake

Irrigation of castor bean plants with wastewater, recorded higher nitrogen uptake values than those irrigated with fresh water (Table 6). This result is on line with those of Mohammad and Ayadi (2004) who found that N uptake values by maize grains and stover were significantly increased by wastewater irrigation. Moreover, there was a gradual increase in nitrogen uptake by castor bean plants due to increasing irradiation dose until it reached a maximum value at the dose of 50 Gray where a gradual decline occurred in N uptake by increasing irradiation dose until it reached the minimum value at the dose of 300 Gray. Gamma irradiation was reported to affect the mineral content of several plants. An increase in nitrogen content was found by Maltseva and Kuzin (1975) when *Vicia faba* seeds were irradiated with 0.1 and 10 k-rad of gamma rays. Habba (1989) exposed seeds of Hyoscyamus and Atropa spp. to 1-2.5 k-rad G.I. and found an increase in nitrogen percentage. Also Deaf (2000) reported an increase in nitrogen contents of lemongrass when seeds were exposed to 1-4 k-rad of gamma irradiation.

Table (6): Effect of gamma rays irradiation (Gy) and irrigation with wastewater on nitrogen uptake (mg plant-1) by castor bean plants.

Part of plant	Water type (B)	Gamma ray dose (A)							Mean
		0	50	100	150	200	250	300	
Seeds	FW	20530	40910	32810	27280	19950	9153	5796	22347
	WW	27320	77990	63450	49730	39560	24590	14530	42453
	Mean	23925	59450	48130	38505	29755	16872	10163	
L.S.D. at 005		A =10224		B=19128				A*B=27051	
Leaves	FW	578	2808	2024	1779	1170	644	362	1338
	WW	1968	4255	3440	3141	2380	1702	777	2523
	Mean	1273	3532	2732	2460	1775	1173	570	
L.S.D. at 005		A =339		B=634				A*B=896	
Shoots	FW	3143	4323	3850	3375	2799	1425	1078	2856
	WW	3325	9683	9122	8964	6946	3400	2501	6277
	Mean	3234	7003	6486	6170	4873	2413	1790	
L.S.D. at 005		A =2033		B=3803				A*B=5379	
Roots	FW	759	3076	2916	2774	1380	1148	1020	1868
	WW	3258	10980	9616	9526	5508	4015	3198	6586
	Mean	2009	7028	6266	6150	3444	2582	2109	
L.S.D. at 005		A =2181		B=4080				A*B=5770	
Whole	FW	25010	51110	41600	35210	25290	12370	8256	28407
	WW	35870	102900	85620	71360	54390	33710	21010	57837
	Mean	30440	77005	63610	53285	39840	23040	14633	
L.S.D. at 005		A =14360		B=26866					A*B=37994

FW: Fresh water **WW: Wastewater**

Phosphorus uptake

Phosphorus of castor bean plants generally had similar trend as N uptake, where plants irrigated with wastewater, accumulated higher values of P uptake than fresh were irrigated ones (Table 7). Furthermore, there was a gradual increase in P uptake values of castor bean plants until reached a maximum at the dose of 50 Gy and then a gradual decline occurred with increasing irradiation dose until reached the minimum P uptake at the dose of 300 Gray. Similar results were reported by Rennie and Nelson (1975) who found that phosphorus contents of cabbage, onion and carrot were increased due to irradiation with 0.1 to 1.25 k-rad. Deaf (2000) also reported increases in phosphorus contents of lemongrass when seeds were exposed to 1-4 k-rad , while Mahmoud (2002) indicated that gamma irradiation increased phosphorus content of delphinium plants.

Table (7): Effect of gamma rays irradiation (Gy) and irrigation with wastewater on phosphorus uptake (mg plant^{-1}) by castor bean plants.

Part of plant	Water type (B)	Gamma ray dose (A)							Mean
		0	50	100	150	200	250	300	
Seeds	FW	1157	5895	5227	4392	2997	1458	936	3152
	WW	3969	13510	10440	7816	6912	4252	2065	6995
	Mean	2563	9703	7834	6104	4955	2855	1501	
L.S.D. at 005		A=1918			B=3589			A*B=5076	
Leaves	FW	82	569	368	317	215	161	064	254
	WW	163	9471	7466	6486	4989	3147	1127	4693
	Mean	123	5020	3917	3402	2602	1654	596	
L.S.D. at 005		A=2987			B=5589			A*B=7904	
Shoots	FW	388	703	630	487	391	248	212	437
	WW	2345	11290	10425	9504	7583	5450	4406	7286
	Mean	1367	5997	5528	4996	3987	2849	2309	
L.S.D. at 005		A=2953			B=5524			A*B=7813	
Roots	FW	199	1019	815	734	371	283	248	524
	WW	851	4145	3956	3815	1973	1419	642	2400
	Mean	525	2582	2386	2275	1172	851	445	
L.S.D. at 005		A=1128			B=2111			A*B==2986	
Whole	FW	1826	8186	7040	5930	3974	2150	1460	4367
	WW	7328	38410	32280	27620	21450	14260	8240	21370
	Mean	4577	23298	19660	16775	12712	8205	4850	
L.S.D. at 005		A=8656			B=16194			A*B=22902	

FW: Fresh water **WW: Wastewater**

Potassium uptake

Data in Table (8) revealed that K uptake values by roots, shoots, leaves, seeds and the whole castor bean were significantly higher due to irrigation with the wastewater than the corresponding K uptake values achieved by irrigation with the fresh water. It is worthy to mention that potassium is important and the most abundant macronutrient cation in plant tissues (Zhao *et al.*, 2003, Jordan- Meille and Pellerin, 2008). In addition, Galavi *et al.* (2010) found that potassium uptake values increased due to irrigation with wastewater as compared with the well water. Total soil potassium increased in the soil as a result of wastewater application (Monnett *et al.*, 1996., Fuentes *et al.*, 2002). The gamma irradiation at a dose of 50 Gray recorded the highest K uptake values in all plant parts. Similar effects were reported by Deaf (2000) who found an increase in potassium contents of gamma irradiated lemongrass.

Table (8): Effect of gamma rays irradiation (Gy) and irrigation with wastewater on potassium uptake (mg plant^{-1}) by castor bean plants.

Part of plant	Water type (B)	Gamma ray dose (A)							Mean
		0	50	100	150	200	250	300	
Seeds	FW	1379	8865	6502	5400	2916	1363	891	3902
	WW	5778	16630	12770	10080	8784	5467	3253	8966
	Mean	3579	12748	9636	7740	5850	3415	2072	
L.S.D. at 005		A=161			B=301			A*B=426	
Leaves	FW	82	1597	644	529	369	230	065	502
	WW	503	2476	1610	1649	1286	928	420	1267
	Mean	293	2037	1127	1089	828	579	243	
L.S.D. at 005		A=265			B=496			A*B=702	
Shoots	FW	388	879	776	554	482	268	154	500
	WW	2240	10816	9427	8460	6553	4665	3871	6576
	Mean	1314	5848	5102	4507	3518	2467	2013	
L.S.D. at 005		A=2699			B=5050			A*B=7142	
Roots	FW	288	777	721	683	339	274	252	476
	WW	724	4354	3675	3584	2045	1436	1025	2406
	Mean	506	2566	2198	2134	1192	855	639	
L.S.D. at 005		A=1127			B=2109			A*B=2983	
Whole	FW	2137	12110	8643	7166	4106	2135	1362	5380
	WW	9245	34270	27480	23770	18660	12490	8569	19212
	Mean	5691	23190	18062	15468	11383	7313	4966	
L.S.D. at 005		A=539			B=1008			A*B=1426	

FW: Fresh water **WW: Wastewater**

Oil content

Table (9) shows that the increments in the amount of oil produced by castor bean irradiated with gamma rays could be arranged in the following descending order; 50 Gy > 100 Gy > 150 Gy > 200 Gy > 0 > 250 Gy> 300 Gy. These occurred regardless of the type of irrigation water used. Our results are in agreement with those of Sarwar *et al.* (2010).

Table (9): Effect of gamma rays irradiation (Gy) and irrigation with wastewater on oil content (kg plant^{-1}) produced by castor bean plants .

Water type (B)	Gamma ray doses (A)							Mean
	0	50	100	150	200	250	300	
FW	712	1665	1530	1260	864	405	225	951.6
WW	891	2360	1881	1539	1368	675	337.5	1293
Mean	801.5	2012.5	1705.5	1399.5	1116	540	1800	
L.S.D. at 005	A =184.7				B=354.57			A*B=691.14

FW: Fresh water **WW: Wastewater**

CONCLUSION

Use of wastewater as a source of water for irrigation either individually or in a combination with gamma irradiation achieved significant positive effects on castor bean growth and N, P and K uptake. There were considerable increases in nitrogen, phosphorous and potassium uptake by roots, shoots, leaves, seeds and whole plant as affected by wastewater irrigation (treated sewage water), especially when plants were exposed to low dose (50 Gy) of gamma rays. The increases of nitrogen, phosphorous and potassium uptake by castor bean under the effect of gamma radiation could be arranged in the following descending order; 50Gy > 100Gy > 150Gy > 200Gy > 0 > 250Gy> 300 Gy. Generally, use of wastewaters in irrigation can improve castor bean plant growth because they are considered as natural conditioners through their contents of nutrients and organic matter which affect the productivity of plants.

From the above mentioned results, we can conclude that castor bean growth and nutrients uptake as well as oil production were enhanced due to synergetic effect of wastewater irrigation. Irradiated seeds with gamma rays at dose of 50 Gy resulted in the highest values of the estimated parameters.

REFERENCES

Akbar E, Yaakob Z, Kamarudin S, Ismail M (2009). Characteristics and Composition of Jatropha curcas oil seed from Malaysia and its potential as Biodiesel Feedstock. Eur. J. scientific Res. 29: 396-403.

Azevedo, D.M.P. and Lima, E.F. (2001). O Agronegócio da mamona no brasil [The castor plant agribusiness in brazil]. ist edn., embrapa informação tecnológica, brasília, ISBN: 8573831162.

Carter, M. R. and Gregorich, E. G. (2008). Soil sampling and methods of analysis. 2 nd ed. CRC, boca ratan, FL. 1224 pp.

Corwin, D.L. and Bradford, S.A. (2008). Environmental impacts and sustainability of degraded water reuse. J. environ. quality., 37: 1-7.

Deaf, N.S.D. (2000). Chemical and biological studies on some wild plants. M.Sc. thesis, Fac. Agric., zagazig univ., zagazig, Egypt.

Fuentes, E.R., Constantino, C.L., Silva, E.E. and Dendooven, L. (2002). Characteristics, and carbon and nitrogen dynamics in soil irrigated with wastewater for different lengths of time. bioresource technology, 85, 179-187.

Galavi M., Jalali A. and Ramroodi M. (2010). Effects of treated municipal wastewater on soil chemical properties and heavy metal uptake by sorghum (Sorghum bicolor L.) J. Agric. Sci., 2 (3) : 235 - 241.

Habba, I.E. (1989). Physiological effect of gamma rays on growth and productivity of *Hyoscyamus muticus* L. and *atropa belladonna* L. Ph.D. Thesis, Fac. Agric., Cairo Univ., Cairo, Egypt.

Hamdy, A. (2005). Soil, Water and Plant analysis manual for arid and semiArid countries of the mediterranean.210 p. IAM-Bari, Italy.

Haruvy, N. and Sadan, E. (1994). Cost benefit analysis of wastewater treatment in the water scarce economy of israel: a case study. J. financial management and analysis., 7(1): 44-51.

Hussein, H.F., Saber, M.S., Radwan, S.M. and Abu-Seda, M. (2004). Use of treated domestic sewage effluent for growing summer oil crops in arid lands. international conf. on water resources and arid environment.

Hussien, M.M., Rezk, A.I., Mehanna, H.M. and El-Nasharty, A.B. (2012). Response of castor bean plants to potassium foliar application and treated sewage water australian journal of basic and applied sciences., 6(7): 611-616.

Jordan-Meille, L. and Pellerin, S. (2008). Shoot and root growth of hydroponic maize (*Zea mays* L.) as influenced by K deficiency. Plant Soil 304: 157–168.

Kaul, B.L. and Bradu, B. L. (1972). Studies on the induced mutation in medicinal plant. I.Spectrum of adult plant mutations in Atropa belladonna. Planta Medica, 20: 205–10.

Khan, B.M., (1970). Effect of gamma rays irradiation on yield and the incidence of blight disease of gram. *Agric. J. Pakistan*, 21: 43–6.

Leal, R.M.P., Herpin, U., Fonseca, A.F., Firme, L.P.,Montes, C.R., Melfi, A.J. (2009b). Sodicity and salinity in a brazilian oxisol cultivated with sugarcane irrigated with wastewater. agriculture water management., 96: 307-396.

Majeed, A . and Zahir, M. (2010). Gamma irradiation effects on some growth parameters of *Lepidium sativum* L. world J fungal and plant biol. 1(1): 08-11.

Mahmoud, F.A.N. (2002). Effect of gamma radiation and some agrochemicals on germination, growth and flowering of delphinium ajacis and mathiola incana plants. M.Sc. Thesis. Fac. Agric., Moshtohor, Zagazig Univ., Egypt.

Mohammad, M.J. and Ayadi, M. (2004). Forage yield and nutrient uptake as influenced by secondary treated wastewater . J. Plant Nutr., 27, 351-364.

Maltseva, A.V. and Kuzin, M. A. (1975). Effect of gamma irradiation on some physiological properties of histones in *Vicia faba* and *Trifolium pratense*. Radiobiol., 14: 480–5.

Monnett, G.T., Reneau, R.B. and Hagedorn, C. (1996). Evaluation of spray irrigation for on-site wastewater treatment and disposal on marginal soils. Wat. Enviro Res., 68, 11–18.

Nassar, A.H., Hashim, M.F., Hassan, N.S. and Abo-Zaid, H. (2004). Effect of Gamma Irradiation and Phosphorus on Growth and Oil Production of Chamomile (*Chamomilla recutita* L. Rauschert). Int. J. Agri. Bio., 6(5): 776–780.

Pitirmovae, M.A.,(1979). Effect of gamma rays and mutagens on barley seeds. *Fiziol. Res.*, 6: 127–31.

Rahimi, M.M. and Bahrani, A. (2011). Effect of gamma irradiation on qualitative and quantitative characteristics of canola (*Brassica napus* L.). Middle-East J. Sci. Res., 8(2): 519-525.

Rennie, D.A. and Nelson, S.H. (1975). Low dose irradiation of vegetable seeds : The effects on N and P uptake. Cana. J.Plant Sci., 55:761–9.

Sarwar, G., Ahmed, H.A. and Hussain, J. (2010). Evaluation of Castor bean (*Ricinus communis* L.) Mutants for Genetic Parameters and Cluster Analysis. J.Agric. Resh., 48(3).

Scarpa, A. and Guerci, A. (1982). Various uses of the castor oil plant (*Ricinus communis* L.). A review. J. Ethnopharmacol., 5: 117–137.

Selenia, L.V. and Stepanenko, O. G. (1979). Effect of pre–sowing gamma irradiation on the productivity and active principle content of Matricaria recutita. Rastitel'nye Ressusy, 15: 143–54.

Snedecor, G.W. and Cochran, W.G. (1982). Statistical Methods. 7th ed., Iowa State. Univ. Press, Amer., USA, pp. 255-269.

Suhas, K., V.K. Deshumukh and Saoji, A. N. (1976). Stimulating effect of gamma radiation on growth of senna (*Cassia angustifolia*) vahl. Referativenys Zhumal, 8: 882–7.

Toze, S. (2006). Reuse of effluent water-benefits and risks. Agric. Water Manage, 80: 147-159.

Weiss, E.A. (2000). castor. in "oilseed crops, 2nd edition", blackwell scientific Ltd, oxford, pp: 13-52.

Youssef, A. A., Aly M. S. and Hussein, M. S. (2000). response of geranium (*Pelargonium graveolenus* L.) to gamma irradiation and foliar application of Speed Grow. Egyptian J. Hort., 27: 41–53.

Zhao, Z.Q., Zhu, Y.G., Li, H.Y., Smith, S.E. and Smith; F.A., (2003). Effects of forms and rates of potassium Fertilizers on cadmium Uptakebytwo cultivars of spring wheat (*Triticum aestivum* L.). Environ . Inter 29: 973-978.

نمو وامتصاص بعض المغذيات الكبرى بواسطة الخروع المـــشعع بأشـــعة جامـــا والمروى بالمياه العادمة تحت ظروف الأرض الرملية

حـــسن حمـــزه عبـــاس *، إيهـــاب محمـــد فريـــد*، ســـليمان محمـــد ســـليمان**، يحيى جلال محمد جلال**، مازن مصطفى اسماعيل**، عزت عبد المحسن قطـــب** و سامى حسن مصلحى حسن**

* قسم الأراضى والمياه – كلية الزراعه بمشتهر – جامعة بنها

** قسم بحوث الأراضى والمياه – مركز البحوث النوويه – هيئة الطاقه الذريه المصريه

أجريت تجربة حقلية في مزرعه قسم بحوث الأراضى و المياه، مركز البحوث النووية، هيئة الطاقة الذرية، مصر. لتقييم تأثير جرعات مختلفة من أشعة جاما على نبات الخروع المنزرع فى التربه الرمليه مع الرى بالمياه العادمه (الصرف الصحي) وذلك كمحاوله لأدخـــال وتأســـيس زراعه هذا المحصول الغير غذائى في التربة الرملية والأراضى الصحراويه مع الأســـتفاده مـــن المياه العادمه. وتم تقدير الوزن الطازج والجاف للنباتات تحت الفحص كما تم تقييم محتوى نبـــات الخروع من عناصر النيتروجين والفوسفور والبوتاسيوم وانتاجيه الزيت تحت تأثير أشعة جاما وقد اوضحت النتائج الترتيب التنازلى تبعا لتأثير التشعيع كما يلـــي 150Gy>، 100Gy> 50Gy> . 300 250Gy> 0> 200Gy>جراي . ايضا زاد محتوى نبات الخروع من عناصر النيتروجين والفوسفور والبوتاسيوم وانتاجيه الزيت المروي بمياه الصرف الصحي مقارنه بتلك المرويه بالماء العذب.