International Journal of Scientific Engineering and Technology (ISSN : 2277-1581)
Volume No.3 Issue No.12, pp : 1463-1467 01 Dec. 2014

Effect of Potassium Foliar Fertilizr on Mineral Status of Biofuel Plant (Jatropha) Grown Under Irrigation by Agricultural Drainage Water

Mohamed M. Hussein[1], Wafaa Haggag[2], Souad M. El-Ashry[3] and Nesreen H. Abou-Baker[3]
[1]Water Relations & Irrigation Dept., [2]Plant Pathology Dept.,[3]Soil and Water Use Dept., National Research Centre, Dokki, Giza, Egypt
Corresponding Email: mmoursyhus@gmail.com

Abstract : ***A pot experiment was conducted in the greenhouse of the National Research Centre, Egypt to investigate the effect of potassium foliar fertilizer and irrigation by agricultural drainage water (ADW) on mineral status of Jatropha plants. Plants sprayed twice with Mono potassium phosphate (MKP). Potassium foliar fertilizer (100 and 200 ppm) and irrigated by mixed drainage water (0, 25 and 50 % ADW). Irrigation by ADW adversely affected the mentioned growth characters. The highest effect was shown by irrigation of water contains 50 % FW+50 % ADW. Some macronutrients ratios were included.***

Keywords : **Jatropha- Drainage water- Potassium- Nutrients**

I. Introduction

The scarcity of fresh water in different countries especially in subtropical regions led to search about a new and nontraditional resources of water for overcome the damages of drought and salinity or to cultivate new areas. Agricultural and industrial drainage water or treated sewage water considered from these nonconventional resources of water. Some investigators suggested the use of these types of water for growing wood trees, landscape and biofuel crops in order to depressing the pollution of the environment and to achieve a new source of fuel particularly under the global continuous increases in the oil prices **(**Hunt, 2007; Zalesny *et al.*, 2007 and 2009 and Meyers, 2011). Jatropha (*Jatropha curcas L.*) has fruits contains a considerable content of oil and survive the heavy metals and can grow under adverse environmental conditions which raise the possibility to use it in production of biofuel under irrigation by poor quality water (World Agro-forestry Centre, 2007; Trabucco *et al.*, 2010, Abd El-Khader, et al., 2012 and Hussein, et al., 2013**)** and also can grow in contaminated soils (Jamil *et al.*, 2009**).** Different means and possibilities used for increasing the productivity and quality of yield of seeds.or/and oil such as application of fertilizers were used by Sabouir *et al.*, (2001); Inglese *et al.* (2002); El-Khawaga *et al.*, (2003) and Ben Mimoun *et al.*, (2004). Several attempts had been made using amendments and bio-regulators to improve productivity and oil quality (He *et al.*, 2003; Mostafa and Saleh, 2006; Tung*et al***.,** 2007; Abd El-Razek, 2011**).** Horticultural practitioners have realized for decades that foliar applications of fertilizers have potential benefits, including the possibility of supplying nutrients to the plant when soil conditions restrict root uptake, or during periods of rapid growth, when requirements may exceed root supply. The foliar application is helpful to satisfy plant requirement and has a high efficiency (Inglese *et al.*, 2002**).** Potassium is easily adsorbed and distributed trough leaf tissues (California Fertilizer Association, 1998**).** The foliar application is an attractive solution especially in arid zone under rainfall conditions where the lack of water in summer reduces drastically nutrient absorption by the tree.Fruit crop responses to foliar applications of N and K have been inconsistent. Some positive responses in pome fruits and citrus have been documented, but stone fruits are less responsive **(**Swietlik, 1984). Potassium also is absorbed and transported rapidly. In our greenhouse study, about one third of the K analog applied to the plant was absorbed into the leaf within 32 h and was transported throughout the plant within 7 days. Cakmak (2005) suggest that the improvement of K-nutritional status of plants might be of great importance for the survival of crop plants under environmental stress conditions, such as drought, chilling, and high light intensity. Several examples are presented here emphasizing the roles of K in alleviating adverse effects of different abiotic stress factors on crop production. Potassium addition was positively correlated with nutrient content (N, P and K) of bean plants under salt stress conditions and the superiority for potassium silicate; this may be due to the role of potassium in water regulation, intake and increase water use efficiency (Abou- Baker et al., 2011), in addition to the role of potassium in mitigating the toxic effect of Na (Abou-Baker et al., 2012).

II. Material and Methodology

A pot experiments was conducted in the greenhouse of the National Research Centre, Dokki, Giza, Egypt to evaluate the effect of spraying with foliar fertilizer and irrigation by different concentration of mixed agricultural drainage water on the mineral status of jatropha plants. The treatments were as follows:

a) Irrigation by drainage water (Fresh water, 25% drainage water+75 %fresh water and 50 % drainage +50 % fresh water). Some chemical analyses of used were given in Table (1)

b) Spraying of MKP (Mono potassium phosphate) foliar fertilizer in the rate of 100 and 200 ppm, respectively, more than tap water as a control.

Table 1: **Chemical analysis of used agricultural drainage water**

Characteristics	Values
pH	8.66
EC (dSm^{-1})	1.60
Cations (g/L):	
Calcium	2.00
Magnesium	2.50
Potassium	0.09
Sodium	12.2
Anions (g/L):	
Bicarbonate	5.80
Chloride	5.00
Sulphate	5.99

The experiment included 3 percentages of mixed drainage water in combination with three foliar fertilizer treatments i.e. 9 treatments in 6 replicates. Pots 35 cm in diameter and 50 cm in depth were used. Every pot contained 30 Kg of air dried clayey soil. Some physical and chemical characteristics of the investigated soil were given in Table (2)

Jatropha (*Jatropha curcas L.*) seeds were sown and thinned twice, the 1st days after sowing and the 2nd two weeks later to leave three plants / pot. Calcium super phosphate (15.5 % P_2O_5) was added before sowing. Ammonium sulfate (20.5 % N) in the rate of 6.86 g / pot was added in two equal portions, the 1st after two weeks of transplanting and the 2nd two weeks later. Irrigation with mixed drainage water in different concentrations was started 21days days after sowing. Spraying foliar fertilizer were applied twice, the 1st spray was after 21 days from sowing and the 2nd two weeks later.

Plant samples were collected, cleaned, dried in ferns at 70° C and ground in a stainless steel mill. Digestion and determination of minerals were done using the methods described by Cottenee *et al*. (1982).

Data collected were subjected to the proper statistical analysis with methods described by Snedecor and Cochran (1990).

Table 2: Physical and chemical analysis of the used soil

A: Soil physical analysis

Sand		Silt	Clay	Soil
Course >200 µ %	Fine 200-20µ%	20-2 µ%	<2 µ%	Texture
7.20	14.25	30.22	48.33	Clayey

B . Soil chemical analysis

Characteristics	Values
pH (1:2.5)	7.15
EC dSm^{-1} (1:5)	1.3
$CaCO_3$%	2.53
OM%	33.5
Soluble cations (meq./100g):	
Sodium	1.3
Potassium	1.82
Calcium	0.23
Magnesium	2.38
Soluble anions (meq./100g):	
Carbonate	1.27
Bicarbonate	-
Chloride	0.91
Sulphate	1.89
Available macro-nutrients%:	
Nitrogen	0.47
Phosphorus	0.25
Potassium	0.95

III. RESULT AND DISCUSSION

Mixed agricultural drainage water effect

Phosphorus and calcium concentration did not showed any clear response with mixed drainage water while K concentration decreased slightly with that in plants irrigated by 25 % ADW+75 % fresh water (Table 3).

Table 3: Effect of potassium foliar fertilizer and irrigation treatments on mineral concentration of jatropha leaves.

Drainage water %	MKP Ppm	Macronutrients %				
		N	P	K	Na	Ca
0 (FW)	DW	2.07	0.20	1.45	0.22	1.41
	100	2.49	0.22	1.95	0.21	1.47
	200	1.76	0.28	2.03	0.22	1.37
25	DW	2.35	0.22	1.61	0.22	1.40
	100	2.03	0.19	1.74	0.22	1.40
	200	2.14	0.21	1.71	0.22	1.45
50	DW	1.93	0.15	1.02	0.20	1.35
	100	1.72	0.23	1.78	0.21	1.51
	200	1.04	0.24	1.86	0.21	1.38
Mean values of irrigation treatments	FW	2.09	0.23	1.81	0.22	1.42
	25	2.14	0.20	1.69	0.21	1.42
	50	1.56	0.21	1.87	0.21	1.41
Mean values of Foliar fertilizer	DW	2.12	0.19	1.36	0.21	1.39
	100	2.08	0.21	1.82	0.21	1.46
	200	1.60	0.24	1.87	0.22	1.41

FW: Fresh water DW = Distilled water, MKP= Mono potassium phosphate

Data in Table 3 indicated a negative response on P, K and Ca content to increase percentage of ADW in irrigation water. However, N concentration as well as content increased by irrigation with 25 % ADW+75 % fresh water and tended to decreased to be less than those of control treatment (irrigated by 100% fresh water). Wong and Leung (1989) mentioned that uptake of N, Na, Fe and Mn was evident for all test species after leachate irrigation. The degree of uptake was positively correlated (*p*< 0.05) with the leachate concentrations used for irrigation.

Table (4) showed that increased the percentage of ADW decreased the K:Na and Ca:Na (with concentration Data basis) however, did not affected the Ca:(Na+K). Irrigation using ADW negatively affected the K:Na and Ca:Na ratios (with uptake Data basis) but positively affected the Ca:(Na+K) ratio (Table 5).This means that with the increase in percentage of ADW the Na percentage increased and affected these ratios.

Table 4: **Effect of potassium foliar fertilizer and irrigation by industrial drainage water on Na ratios of jatropha leaves**

Drainage water %	MKP ppm	K:Na	Ca/Na	Ca(Na+K)
0 (FW)	DW	6.60	6.41	0.84
	100	9.29	7.00	0.89
	200	9.23	7.14	0.85
25	DW	7.32	6.36	0.86
	100	7.99	6.36	0.68
	200	7.77	6.60	0.87
50	DW	5.10	6.75	0.87
	100	8.48	7.10	0.88
	200	8.81	6.57	0.85
Mean values of irrigation treatments	FW	8.37	6.85	0.86
	25	7.69	6.44	0.86
	50	7.46	4.56	0.87
Mean values of Foliar fertilizer	DW	6.34	6.51	0.86
	100	8.59	6.82	0.88
	200	8.68	6..81	0.86

FW: Fresh water DW = Distilled water, MKP= Mono potassium phosphate

Table 5: Effect of Potassium foliar fertilizer and irrigation by mixed agricultural drainage water on the mineral content of jatropha leaves.

Drainage water %	KMP ppm	Macronutrients mg/plant				
		N	P	K	Na	Ca
0 (FW)	DW	164	15.8	114	17.35	112
	100	231	20.1	178	19.12	134
	200	147	24.8	169	18.24	114
25	DW	153	14.6	89	14.96	98
	100	168	15.8	144	18.20	116
	200	124	17.9	145	18.32	123
50	DW	77	6.0	41	8.10	54
	100	118	15.7	120	13.90	103
	200	85	19.6	152	17.10	112
Mean values of irrigation treatments	FW	131	20.2	154	18.24	120
	25	148	16.1	126	17.16	112
	50	93	13.6	104	13.03	116
Mean values of Foliar fertilizer	DW	131	12.7	81	13.47	88
	100	172	17.2	147	17.07	118
	200	119	20.8	155	16.53	116
LSD at 5 % IDW		2.51	N.S	7.77	2.98	N.S
FF		1.17	4.56	3.04	3.07	10.0
IDW x FF		N.S	N.S	N.S	5.41	17.3

FW: Fresh water DW = Distilled water, MKP= Mono potassium phosphate

K foliar fertilizer effect

Data presented in Table 3 indicated that K concentration increased parallel to the increased of K fertilizer as a spray on foliage. Nevertheless, the all other elements determined in this work did not showed any clear response.

The content of P and K content in jatropha leaves increased as the K foliar increased up to 200 ppm. However, both K treatments showed the same effect on the content of Na and Ca but N content increased by application of 100 ppm K fertilizer and tended to decreased to be less than the control treatment (Table 5).

Effect of potassium fertilizers via leaves on mineral status were studied by: Marschener, (1995); Hussein, *et al.* (2008); Hussein, *et al*. (2012) a & b; Hussein, *et al.* (2010); Hussein, *et al.*(2013), El-Dewiny, *et al*. (2013) and Hussein and Abou-Baker, (2014)

Table 6: **Effect of potassium foliar fertilizer and irrigation by industrial drainage water on Na ratios of jatropha plants**

Drainage water %	MKP	K:Na	Ca/Na	Ca(Na+K)
0 (FW)	DW	6.57	6.46	0.87
	100	9.31	7.01	0.68
	200	9.27	7.62	0.61
25	DW	5.95	6.55	0.94
	100	7.91	6.37	0.72
	200	6.92	6.71	0.75
50	DW	5.06	6.67	1.10
	100	8.63	7.41	0.77
	200	8.89	6.55	0.66
Mean values of irrigation treatments	FW	8.38	7.03	0.72
	25	6.93	6.54	0.80
	50	7.53	688	0.84
Mean values of Foliar fertilizer	DW	5.86	6.56	0.97
	100	8.62	6.93	0.72
	200	8.36	6.93	0.67

FW: Fresh water DW = Distilled water, MKP= Mono potassium phosphate

The mineral nutrition status of plants might affect the accumulation of heavy metals, which in turn could be reflected in altered plant sensitivity (Gill *et al.*, 2012).In addition; organic amendments provided nutrients such as carbon, N, P and K to support plant growth and reduced the metal toxicity to plant. They showed also that metal contaminated lands/soils could be suitably re-mediated by adapting appropriate measures (Kumar *et al*., 2008**)**. All treatments, except MKP3% at daylight, improved the K nutritional state of olive in July, but not in November or April. In general, the addition of urea and surfactant to the MKP 3% solution and its application in July improved its efficiency on olive trees, most likely due to the higher proportion of young leaves present during this period

(Barranco *et al*,,. 2010**).** Ben Mimoun *et al.*(2004) pointed out that leaf mineral analysis revealed that K fertilization increased significantly K foliar content with no differences for the others mineral elements (N and Mg) Reickenberg and Pritt (1992) conclude that significant uptake of foliar applied N and K occurs in raspberry, but the absolute amount delivered through a single foliar application is small. The percentage of total plant nutrient supplied through a foliar application is reduced to < 5% over time as the plant grows, so multiple applications would be required to maintain levels significantly higher than would exist through root uptake alone. As shown in Table 3 K:Na ratio increased by K treatment, however, Ca:Na and Ca:(K+Na) ratios seemed to be without response. This means that the Ca and K increases by foliar application of K. Concerning the Na uptake and its ratios with the other elements, foliar spray of potassium increased the K:Na ratio and the vise versa for Ca:(K+Na) ratio. Ca:Na ratio seemed to be without effect by potassium treatment(Table 5).

Mixed agricultural drainage water x K foliar fertilizer

The response of nutrients concentration to K spraying and mixed drainage water irrigation was presented in Table 3. The highest value of K concentration was by 200 ppm rate. This was true under different irrigation treatments. P concentration showed the same response when plants irrigated by mixed 50 % of ADW or fresh water irrigation. The reverse was true for nitrogen concentration. Meanwhile, P, N and Na concentration gave its higher values in plants without K treatment and irrigated by 255 mixed ADW. Furthermore, the lowest concentration of P, K, Na and Ca was obtained by irrigation plants by 50% ADW and without K application.

The interaction effects of foliar spray and irrigation by mixed drainage water on mineral content of jatropha were illustrated in Table 4. This Data emphasized that the content of estimated minerals showed continuous increases when plants irrigated by mixed drainage water as the rate of K concentration increased in the sprayed solution except for N content. For the P, K, Ca and N under fresh water regular irrigation and N content under all irrigation treatments showed its higher values by 100 ppm K treatment. Regarding the Na ratios, addition of K improved the K:Na and Ca:Na ratios under different irrigation treatment while the opposite was true for Ca:(K+Na) ratio**.** The highest K:Na ,and Ca:(K+Na) ratios were by spraying 100 ppm K and for Ca:Na by spraying 200 ppm K and plants irrigated regularly by fresh water. However, the lowest values of K:Na, Ca:Na and Ca:(K+Na) were in samples taken from plants without K application and irrigated by %0% mixed water, 25% mixes water and those plants received fresh water, respectively (Table 4 & 6).

The results indicate that WW irrigation increased the yield of both corn and vetch. Both rates of WW application had similar effect on crop production. Supplemental fertilization with the potable water irrigation (PWF) enhanced vetch production and increased grain weight for corn in the second season. The uptake of macronutrients and micro nutrients by corn increased with WW irrigation, while the uptake by vetch increased with both WW irrigation and PW supplemented with fertilization. Kumar *et al.*, (2008) stated thatthat the plants survival rate in heavy metal contaminated soil increased with addition of amendments. Barranco*et al.*, (2010**)** found that all treatments, except MKP 3% improved the K nutritional state of olive in July. In general, the addition of urea and surfactant to the MKP3% solution and its application in July improved its efficiency on olive trees, most likely due to the higher proportion of young leaves present during this period**.** Morgan *et al.*, (2008) revealed that irrigation with reclaimed water generally increases soil P and Ca, and reduces soil K. Reduction of P and Ca and increases in K applied to citrus orchards irrigated with reclaimed water may be required adjustments in fertilizer applications to citrus orchards irrigated with reclaimed water. Heidari and Jamshidi (2011) demonstrated that salinity treatment decreased potassium uptake but application potassium increased potassium content in leaves at two stages.

IV. CONCLUSION

From the aforementioned data it could be concluded that used of agricultural drainage water in jatropha plants increased most minerals in its leaves especially with the Na and its ratios to the other nutrients. The nutrients content of plant leaves are depend on its concentration in the water irrigation and the period of subjection to this type of irrigation water.

AKNOLOGMENT
Authors express their deep thanks to the National Research Centre who financed the project of "growing and improving of some biofeul crops using poor quality water in less fertile soil "which support this work.

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