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GROWTH RESPONSE OF *KOCHIA INDICA* WIGHT TO IRRIGATION WATER SALINITY LEVEL, MOSITURE STRESS AND CUTTING INTERVALS

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ABSTRACT : Two field trails were performed at Ras Sudr Experimental Station, Desert Research Center (DRC), during the two successive years 2002 and 2003, to investigate the effect of two salinity levels of irrigation water (4000 & 8000 ppm), three irrigation intervals (2, 4 and 6 weeks) and two cutting intervals (2 and 3 months between cuts) on some growth parameters of *Kochia indica* Wight plants. The obtained results could be summarized as follows:

Plant height, number of branches/plant, crown cover, crown volume and succulence were negatively affected by raising salinity level of irrigation water, whereas water saturation deficit, leaf/stem ratio and specific leaf weight showed insignificant response.

The highest values of most growth criteria were achieved when the plants were irrigated every 4 weeks. Although prolonging irrigation intervals up to 6 weeks, water saturation deficit percent and succulence were adversely affected.

There was a tendency of increase plant height, number of branches / plant, crown cover, crown volume, leaf/stem ratio and specific leaf weight as a result of extending the period between cuts from 2 to 3 months. Water saturation deficit and succulence had no responses to cutting intervals.

Leafy plants with more branching capacity as well as elongation, crown cover and volume were produced as water irrigation salinity level and irrigation intervals were decreased. High values of crown cover and water saturation deficit were obtained at 3 months and 4 weeks and 3 month and 2 weeks of irrigation and cutting intervals, respectively.

Key words: *Kochia indica* Wight, salinity, irrigation intervals, cutting periods and growth parameters.

INTRODUCTION

Natural vegetation grows in arid and semi-arid regions is dominated by species of genera *Kochia* " bluebushes" (Wilson, 1966). This annual halophytic shrub grown as a wild plant in Egypt (Draz, 1954) which is accepted and grazed by many species of grazing animals (Abd-Alla *et al*, 2002) and also used for hay production (Sherrod, 1971). It is considered to be invaluable as drought reserve and salt tolerant species (Francois, 1976)). Little detailed information, however, is available about its management practices especially under salt-affected soils as in Wadi Sudr area. Such region is an arid area situated in South Sinai Governorate in Suez Gulf coastal zone where rainfall is very rare and the brackish-saline water from wells is considered the sole source of irrigation water (El-Houssini, 2000). The flocks in this area suffer from lack of green forage particularly in summer season. Under these harsh condition, One of the promising solution is to propagate and establish such palatable xerophytic and/or halophytic shrub in dry deserts and/or salt-affected soils as an acceptable, nutritious and non-conventional productive forage species.

Zahran, *et al* (1999) conducted an experiment to study the combined effect of drought and salinity on plant growth of *Kochia indica* and *Kochia scoparia.* They revealed that *Kochia* species may be grown as non-conventional livestock-fodder shrub under aridity and/or salinity stress of the hot deserts of Egypt and Arabian Peninsula. Increasing conductances of NaCl and $CaCl_2$ solutions from 25 to 40 mmhos by 5 mmhos increments progressively reduced germination of *Kochia scoparia* (Everitt *et al* 1983). Two

accessions of *Kochia prostrate* L. were tested by Francois (1976) using different salinity levels. He concluded that both *Kochia* accessions proved to be highly salt tolerant. Also, increasing salinity caused an increase of water saturation deficit, proline content and osmotic pressure of *Limonium axillare* (Abo Sitta and Taisan 1997). Francois (1986) stated that the threshold salinity levels at which initial yield declines occurred for *Kochia prostrate* and *Kochia brevifolia* were 2.3 and 1.3 ds/m, respectively.

However, *Kochia indica* could grow well and produce considerable vegetation yields with small amount of irrigation water (Zahran *et al* 1999). Moreover, Abohassan and Habib (1985) worked on four *Atriplex* species and noticed that all four species, particularly *Atriplex nummularia*, withstood moisture deficiency. Also, they pointed out that soil moisture stress decreased plant fresh and dry weight, plant height and leaf : stem ratio of *Atriplex* spp tested. They confirmed the findings of Everitt *et al* (1983) that germination of *Kochia scoparia* was reduced by moisture stress when osmotic potential reached 8 bar. Furthermore, Khalifa (1996) worked on two fodder shrubs i.e. *Atriplex* and *Acacia* at Ras Sudr region and revealed that plant height and WSD decreased by water stress while, the highest values of crown cover and crown volume were obtained at 20 days intervals.

Cutting intervals profoundly affect growth measurements of fodder shrubs and consequently herbage production. El-Houssini (2000) mentioned that prolonging that period between cuts caused an increase in plant height and specific leaf weight of canary grass plants. Moreover, plant height and leaf area of *Cenchrus ciliaris* were gradually increased with prolonging cutting interval (El-Houssini *et al* 1999).

Hence, the present investigation was designed to figure out the effect of irrigation with saline water, irrigation and cutting intervals on some growth criteria of *Kochia indica* Wight to evaluate *Kochia* plants as a fodder shrub in South Sinai.

MATERIALS AND METHODS

The present study was performed at the Experimental Station Farm of Desert Research

Center at Wadi Sudr, South Sinai Governorate during the two successive years 2002 and 2003. The experimental soil was sandy clay in texture and calcareous with 49.75 % $CaCO_3$. Electrical conductivity of soil was 25.61 mmhos/cm with pH of 7.85.

The plant material used in this investigation was *Kochia indica* Wight seeds which were collected from *Kochia* (bluebushes) plants grown naturally in the desert areas. Seeds were sown in polyethylene bags containing sand and clay soil (1 : 1) in January 1 and 12, 2002 and 2003, respectively under greenhouse conditions. Three months later, uniform and healthy seedlings (about 30 cm in height) were choicen and transplanted in the experimental site. *Kochia* seedlings were cultivated in rows 1 m apart and spaced 1 m within the row (1 m^2 was devoted to each seedling). Plants were regularly irrigated 2, 4 and 6 weeks by interval using under ground brackish saline water containing 4000 and 8000 ppm as dissolved salts. After good establishment and when the plants aged 4 months, the shrubs were cut at stubble height of 30 cm. Thereafter, cutting was repeated every 2 and 3 months where two cuts were harvested from each cutting treatment.

Twelve treatments which were the combinations between 3 irrigation intervals, 2 salinity levels of irrigation water and 2 cutting periods were arranged in split split-plot design with 4 replicates. The main plots were devoted to salinity levels and the sub plots were allocated irrigation intervals and sub sub plots were occupied by cutting periods.

Some growth criteria were measured immediately before each cut of both seasons. Plant height, number of branches per plant, leaf/stem ratio, specific leaf weight (SLW), Succulence as proposed by Dehan and Tal (1978) and water saturation deficit (WSD) of leaves according to Catsky (1963) were determined. Crown cover (m^2) and crown volume (m^3) were calculated using the following formulae proposed by Thalen (1979) :

Crown cover = $\frac{1}{4} \pi \times D_1 \times D_2$.

Crown volume=$1/6 \pi \times D_1 \times D_2 \times H$

Where, π = 3.14, D_1 and D_2 = the shortest and the longest diameters of the shrub, respectively and H = plant height.

The obtained data were subjected to the proper statistical analysis according to Snedecor and Cochran (1980). LSD was used to detect significant differences between treatment means.

RESULTS AND DISCUSSION

The response of some growth parameters of *Kochia indica* plants to different salinity levels, irrigation intervals and cutting periods in two cuts taken in both experimentation years namely 2002 and 2003 under Ras Sudr conditions is presented in Table (1).

1- Effect of salinity :

It is clear from data in Table (1) that raising salinity level of water irrigation from 4000 to 8000 ppm decreased plant height of *Kochia* plants. Such effect was noticed in the two cuts taken in both years with significant decrease in the first season only. Increasing salt concentration of irrigation water did not exhibit any significant decrease on number of branches per plant except in the first season where this number of branches per individual plant was significantly decreased. Crown cover and crown volume were affected negatively by raising salinity level. This harmful effect on crown cover and crown volume was observed in all cuts harvested in both seasons. However, the two formar traits were insignificantly decreased in the second cut of the second season.

Changing salinity level of irrigation water had insignificant effect and no clear trend on water saturation deficit, leaf/stem ratio and specific leaf weight. This was true in the first and second cuts of both seasons (Table 1). In this connection, Abo Sitta and Taison (1997) pointed out that water saturation deficit of *Limonium axillare* was increased by increasing salinity. Whereas, succulence was significantly affected in both cuts of the second season only. The harmfull effect of salinity which observed on all growth parameters studied might be attributed to the increasing in the amount of energy required for absorption of water and minerals. Moreover, increasing salt concentration in irrigation water resulted in a decrease in partial molar free energy of water by increasing its osmotic pressure and decreasing its availability to the plants. Consequently, plants must expend more energy to absorb a

particular amount of water. The present data could be substantiated by those reported by Francois (1976), Everitt *et al* (1983) and Francois (1986).

2- Effect of irrigation intervals :

Data given in Table (1) show that irrigation every four weeks in shead of two or six weeks seems to be the best irrigation interval for *Kochia* plants which gave the highest values of most growth criteria tested.

It was noticed that prolonging irrigation intervals from 2 to 6 weeks had a significant effect on plant height in favour of irrigation every 4 weeks. Such trend was observed in the second cut of both seasons whereas, in the first one the abovementioned trait was responded insignificantly. Although number of branches per plant was markedly decreased by prolonging the period between irrigations in the second season, it was insignificantly affected in the first one. Extending irrigation intervals did not exert any statistical significant effect on both of crown cover and crown volume of *Kochia* shrubs. This trend was true in all cuts of both seasons except in the second cut of the first season. It could be concluded that water deficit affected negatively *Kochia* plants growth and this may be attributed to the higher soil moisture stress which deceased the amounts of metabolites synthesized by leaves that were decreased and been reflected in growth inhibition.

The increase in water saturation deficit percent which occurred by prolonging irrigation intervals from 2 weeks to 6 weeks in the first and second cuts of the first season was not significant (Table 1). However, extending irrigation intervals up to 6 weeks caused a significant increase in water saturation deficit in both cuts taken in the second season. On the other side, succulence was adversely affected by increasing the period between irrigations. Such decrease in values of succulence was significant in the second season only. It could be concluded that water saturation deficit increased and succulence decreased with moisture stress. Data in Table (1) showed also that the differences between means of leaf/stem ratio due to irrigation intervals were not great enough to reach the significance level. This effect was true in all cuts of both seasons except in the first cut of the first season which leaf/stem

ratio significantly increased with water stress. Shortening or prolonging irrigation intervals than 4 weeks tended to decrease specific leaf weight which the highest values of this trait were obtained when *Kochia* plants irrigated every 4 weeks. Such effect was significant only in the second cut of the first season. In this concern, Khalifa (1996) stated that plant height and water saturation deficit of *Atriplex* and *Acacia* shrubs decreased by water stress. At the same time, he found also that the highest values of crown cover and crown volume were obtained at 20 days irrigation intervals.

3- Effect of cutting intervals:

It can be observed from results in Table (1) that plant height and number of branches of *Kochia* plants were increased by prolonging clipping interval from 2 to 3 months. This increment was significant in the second cut of the second season for both mentioned characters whereas, it was significant in the second cut of first season for number of branches/plant only. Crown cover and crown volume took similar trend in their response to changing cutting intervals. There was a tendency to increase in these traits as a result of extending the period between cuts from 2 to 3 months. It can be observed also that both of crown cover and crown volume were insignificantly affected by cutting intervals in the first cut of both seasons, however, these characters were significantly increased in the second cut of both seasons as cutting interval increased. The increase in growth parameters of *Kochia* plants may be due to the longer growth period, which accompanied with clipping every 3 months. These results are in good agreement with those obtained by El-Houssini (2000).

Data listed in Table (1) showed that water saturation deficit was unaffected by cutting intervals in both cuts taken except in the second cut of the second season in which it was decreased by about 55 %. Succulence had no clear trend in its response to cutting intervals. Leaf/stem ratio was increased as cutting interval was prolonged and this hold fairly true over both seasons with a significant increase for leaf/stem ratio in the second cut merely. On the other hand, cutting intervals had no significant effect on specific leaf weight. This result was noticed in two years of experimentation. In this concern,

El-Houssini *et al* (1999) recorded that there was a reciprocal relationship between leaf/stem ratio of *Cenchrus ciliaris* and cutting intervals.

4- Interaction effects :

Data of the interactions between the main investigated factors (irrigation water salinity, irrigation intervals and cutting periods) were divided into significant and insignificant effects. In this respect, it has to be mentioned that the insignificant interactions were excluded and the significant ones will only be presented and discussed. It can be also noticed that the effects of the interactions were significant in the first season only.

a) Interaction between water irrigation salinity levels and irrigation intervals:

Results in Table (2) indicted that the interaction between water irrigation salinity and irrigation intervals had a significant effect on plant height, crown cover and crown volume in both cuts taken in the first season only. The maximum values of these traits were achieved when *Kochia* plants were irrigated every 2 weeks with low salinity level (4000 ppm) in irrigation water. Whereas, the lowest values were obtained by more frequency irrigation (2 weeks intervals) using high salinity level in irrigation water. Such trend was found in both cuts of 2002 season.

It seems from the above finding that using low salinity level (4000 ppm) and irrigation at 2 weeks act together to produce highest *Kochia* shrubs with greatest crown cover and crown volume. Leaf/stem ratio and number of branches/plant were significantly responded to that interaction in the first cut of the first season merely. It was noticed that leafy plants with more branching capacity were produced with decreasing both of salinity level in irrigation water and the period between irrigations.

b) Interaction between irrigation and cutting intervals :

Crown cover and water saturation deficit were significantly responded to interaction between irrigation intervals and cutting periods. This significant effect was observed in the second cut of the first season only (Table 3). Clipping *Kochia* plants every 3 months with irrigation interval of 4 weeks resulted in higher value of crown cover than other treatments.

Table: (1) Effect of irrigation water salinity, irrigation intervals and cutting periods on some growth parameters of *Kochia* in 2002 and 2003 growing seasons.

Traits	No. of cut	Irrigation water salinity levels (ppm)		LSD 5 %	Irrigation intervals (weeks)			LSD 5 %	Cutting periods (month)		LSD 5 %
		4000	8000		2	4	6		2	3	
2002											
Plant height (cm)	1st	101	87	8	95	95	92	NS	94	95	NS
	2nd	101	86	8	94	98	89	8	92	94	NS
No. of branches per plant	1st	44	37	1	41	41	4	NS	40	41	NS
	2nd	45	36	7	39	42	41	NS	29	52	5
Crown cover (m^2)	1st	1.05	0.83	0.10	0.96	0.99	0.89	NS	0.96	0.93	NS
	2nd	1.04	0.80	0.06	0.92	0.96	0.88	NS	0.75	1.09	0.09
Crown volume (m^3)	1st	0.77	0.50	0.11	0.67	0.65	0.58	NS	0.64	0.62	NS
	2nd	0.71	0.47	0.08	0.61	0.64	0.53	0.11	0.49	0.70	0.10
Water saturation deficit %	1st	11.86	13.27	NS	11.73	12.30	13.67	NS	13.22	11.91	NS
	2nd	22.94	25.09	NS	23.83	23.83	24.37	NS	24.26	23.76	NS
Succulence	1st	3.52	3.30	NS	3.48	3.44	3.31	NS	3.54	3.28	0.21
	2nd	2.97	2.93	NS	2.96	3.00	2.88	NS	2.91	2.98	NS
Leaf / Stem Ratio	1st	0.77	0.82	NS	0.75	0.79	0.84	0.08	0.79	0.80	NS
	2nd	0.99	1.07	NS	0.99	1.03	1.08	NS	0.94	1.12	0.13
Specific leaf weight (mg/cm^2)	1st	1.45	1.44	NS	1.33	1.49	1.51	NS	1.43	1.46	NS
	2nd	0.89	0.82	NS	0.80	0.99	0.78	0.16	0.80	0.92	NS

Table (1) Conti.

		2003									
Plant height (cm)	1st	116	107	NS	117	113	104	NS	112	111	NS
	2nd	83	77	NS	86	97	76	9	73	87	5
No. of branches per plant	1st	26	24	NS	30	29	18	5	26	24	NS
	2nd	24	20	NS	28	19	19	5	20	23	3
Crown cover (m^2)	1st	0.98	0.83	0.08	0.92	0.93	0.86	NS	0.91	0.91	NS
	2nd	0.69	0.63	NS	0.70	0.95	0.63	NS	0.50	0.82	0.09
Crown volume (m^3)	1st	0.78	0.60	0.12	0.73	0.73	0.62	NS	0.69	0.69	NS
	2nd	0.41	0.40	NS	0.42	0.36	0.34	NS	0.25	0.50	0.08
Water saturation deficit %	1st	18.26	16.61	NS	13.00	16.47	22.81	5.99	16.03	18.84	NS
	2nd	30.12	32.87	NS	28.30	30.26	35.26	5.47	38.35	24.65	3.70
Succulence	1st	3.66	3.55	0.31	3.74	3.56	3.52	0.36	3.58	3.63	0.23
	2nd	3.42	3.60	0.62	3.80	3.34	3.39	0.29	3.62	3.40	0.32
Leaf / Stem Ratio	1st	1.03	1.23	NS	1.20	1.17	1.01	NS	1.06	1.20	NS
	2nd	1.42	1.53	NS	1.69	1.36	1.37	NS	1.29	1.66	0.24
Specific leaf weight (mg/cm^2)	1st	1.95	2.04	NS	1.98	2.06	1.96	NS	2.01	1.99	NS
	2nd	0.91	0.72	NS	0.79	0.92	0.73	NS	0.70	0.93	NS

Table (2): Effect of interaction between irrigation water salinity levels and irrigation intervals on some growth parameters of *Kochia* in first growing season.

Treatments		No. of cut	Traits				
			Plant height (cm)	Crown cover (m^2)	Crown volume (m^3)	Leaf / stem ratio	No. of branches /plant
S_1	I_1	First cut	118	1.32	1.04	0.69	49
	I_2		92	0.97	0.64	0.70	42
	I_3		95	0.87	0.61	0.91	41
S_2	I_1		73	0.60	0.29	0.80	33
	I_2		97	1.00	0.66	0.88	40
	I_3		90	0.90	0.54	0.78	39
LSD 5 %			9	0.61	0.21	0.11	5
S_1	I_1	Second cut	107	1.15	0.83	-	-
	I_2		110	1.10	0.81	-	-
	I_3		86	0.87	0.50	-	-
S_2	I_1		80	0.70	0.39	-	-
	I_2		86	0.83	0.48	-	-
	I_3		92	0.89	0.56	-	-
LSD 5 %			14	0.52	0.58	-	-

S_1 = 4000 ppm S_2 = 8000 ppm I_1 = Two weeks irrigation interval
I_2 = Four weeks irrigation interval. I_3 = Six weeks irrigation interval

Table (3): Effect of interaction between irrigation and cutting intervals on some growth parameters of *Kochia* in 2002 growing season.

Treatments		No. of cut	Traits	
			Crown Cover (m^2)	Water saturation deficit (%)
I_1	C_1	Second cut	0.83	20.85
	C_2		1.01	26.82
I_2	C_1		0.79	25.47
	C_2		1.13	22.19
I_3	C_1		0.63	26.48
	C_2		1.13	22.26
LSD 5 %			0.35	3.67

C_1 = Two months cutting interval C_2 = Three months cutting interval

Whereas, the highest value of water saturation deficit (26.82) was achieved by cutting every 3 months and irrigation each 2 weeks by interval.

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استجابة نمو نباتات الكوخيا لمستوى ملوحة مياه الرى والإجهاد الرطوبي وفترات الحش

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** وحدة المراعي – مركز بحوث الصحراء – المطرية – القاهرة – مصر .

أقيمت تجربتان حقليتان بمحطة التجارب الزراعية برأس سدر التابعة لمركز بحوث الصحراء خلال عامي ٢٠٠٢ ، ٢٠٠٣ وذلك لدراسة تأثير مستويان لملوحة مياه الري (٤٠٠٠ ، ٨٠٠٠ جزء في المليون) وثلاث فترات للري (٢ ، ٤ ، ٦ أسابيع) وفترتان للحش (٢ ، ٣ شهور) . علي بعض مقاييس نمو نباتات الكوخيا.

ويمكن تلخيص أهم النتائج المتحصل عليها كالأتي:

- استجابة بعض صفات النمو مثل ارتفاع النبات وعدد الأفرع بالنبات والغطاء التاجي والحجم التاجي والعصاريه سلبيا عند رفع مستوي الملوحة بمياه الري إلى ٨٠٠٠ جزء فى المليون. في حين لم تتأثر كل من درجة نقص التشبع المائي ونسبة وزن الأوراق إلى السيقان وكذلك الوزن النوعي للورقة تأثرا معنويا و أيضا لم تظهر تلك الصفات استجابة للتغير في مستويات ملوحة ماء الري.
- كان ري نباتات الكوخيا كل أربع أسابيع أفضل فترة للري. حيث أدي ذلك إلي الحصول علي أعلي القيم لمعظم صفات النمو تحت الدراسة. ويلاحظ أنه علي الرغم من أن إطالة فترات الري حتى ٦ أسابيع قد أدي إلى زيادة درجة نقص التشبع المائي للأوراق إلا أن العصاريه قد تأثرت عكسيا بزيادة فترة الري .
- أدت زيادة الفترة بين الحشه والأخرى من شهرين إلى ثلاثة أشهر إلى وجود منعطف نحو الزيادة في ارتفاع النبات وعدد الأفرع وكل من الحجم التاجي والغطاء التاجي للشجيرة ونسبة الأوراق إلى السيقان و أيضا الوزن النوعي للورقة . ولم تتأثر درجة نقص التشبع المائي و العصاريه نتيجة التغير في الفترة بين الحشه والأخري .
- أدي نقص كل من ملوحة مياه الري وكذلك فترة الري إلى إنتاج نباتات مورقة وذات قدرة أكبر علي التفريع كما أدي أيضا إلى زيادة استطالة النباتات والحصول علي أعلي قيمة لكل من الحجم والغطاء التاجي. أمكن الحصول علي أعلي قيمة غطاء تاجي عند ري النباتات كل أربع أسابيع والحش كل ثلاثة أشهر وكذلك الحصول علي أعلي قيمة لدرجة نقص التشبع المائي عند الري كل أسبوعين والحش كل ثلاثة أشهر .