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Response of Five Wild Colocynth [*Citrullus colocynthis* (L.) Schrad.] Ecotypes to Sowing Date, Regarding Their Growth, Seed Yield and Seed Oil Content.

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Abstract: The rational exploitation of medicinal and aromatic plants can be through cultivation to conserve them as potential high economic value crops. The objective of this research was to evaluate the response of wild ecotypes of colocynth plants to sowing date regarding their growth, seed yield and seed oil content. The layout of the experiment was a split plot design with three replications. Treatments were two sowing dates and five wild ecotypes. Sowing dates of mid-July (autumn) And mid-March (summer) were randomized in the main plots. The five ecotypes were randomized in the sub-plots. The experiment was carried out for two seasons, 2013/14 and 2014/15. Parameters measured were ,days to 50 % emergence, days to 50 %flowering, mean number of fruits per plant, mean number of seeds per fruit,, weight of 1000 seeds, seed yield and seed oil content. Number of days to 50 % emergence was significantly different between sowing dates only in the first season; however ecotypes were significantly different in both seasons. Number of days to 50 % flowering was not significantly different between sowing dates in both seasons, but was significantly different among ecotypes.

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Numbers of fruits per plant, number of seeds per fruit and seed yield were significantly different between sowing dates and among ecotypes in both seasons. Most importantly, mean seed oil content of cultivation (sowing dates) was higher (16.4 %) than wild seed oil content (12.05). In conclusion, cultivation of colocynth was advantageous regarding plant growth, seed yield and oil content.

Key words: *Citrullus colocynthsis*, sowing date, ecotype, colocynth, oil percent, bitter apple

INTRODUCTION

About 50000 to 70000 plant species are known to be used in traditional and modern medicinal systems throughout the world; the majority of which are still being obtained by collection from the wild vegetation (Srivastava 1996). Such situation endangers their existence as a result of over-harvesting; land conversion policies and habitats loss resulting from climate change. Family Cucurbitaceae is one of the greatest genetically diverse sources for collection of medicinal plants in Plant Kingdom.

Colocynth [*Citrullus colocynthsis* (L.) Schard.] is one of the species of the family which is commonly found wild in arid climates of tropical Africa and the Mediterranean region. Its use in folk medicine cannot be over emphasized in Sudan and other countries (Boulas 1983; El-Gazali *et al.*1997 and Evans 2004). It has tumer-necrosing (Evans1989), anti-diabetes (Sebbagh *et al.*2009), anti bacterial (Elamin 1999; Marzouk *et al.* 2009); antifungal (Hadizadeh *et al.* 2009); and larvicidal (Roy *et al.* 2007; Abdul Rahman *et al.* 2008) activities some of which can be used in agricultural and veterinary protection purposes. So its rational exploitation as a medicinal plant necessitates its conservation through, among other means, cultivation as a field crop. The objective of this research, therefore, was to evaluate the response of five wild ecotypes of colocynth to sowing date regarding their growth, seed yield and seed oil content.

MATERIALS AND METHODS

The experiment was carried out at Shambat which lies at 15° 40' N and 32° 32' E. The climate is semi-arid, tropical. Mean maximum and minimum temperatures are as high as 41.6°c in summer and as low as 14.1°c in winter (Adam 1996).

Seed source:

Seeds were collected from wildly growing colocynth plants in five diverse ecologies as follows:

- Acacia Forest on eastern bank of the White Nile, Khartoum State (SF).

- North Kordofan desert of sandy soil, North Kordofan State (NK).

- Gadarif with heavy clay soil, poor savanna, Gadarif State (G).

- Gash River delta with alluvial deposit soil, semi-desert, Kassala State (GD).

- Southern Darfur with clay loam soil and rich savanna, Darfur State (SD).

Treatments comprised two factors *i.e.* two sowing dates (autumn, mid July and summer, mid March) and five colocynth ecotypes (SF, NK, G, GD and SD). Treatments were arranged in a split plot design with three replications, such that sowing dates were randomized in the main plots and ecotypes in the sub-plots.

To overcome seed dormancy, which is a common feature of colocynth, seeds were treated by shaking with sand for 10 minutes as a scarification technique, soaked in water overnight and planted in one meter wide and four meters long beds on mid of July 2013 and mid of March 2014 for autumn and summer sowing, respectively in both seasons. Emerged seedlings were thinned two weeks after planting to two plants per hole. Spacing between holes was 40cms. Plots were irrigated immediately after sowing and when needed thereafter depending on weather conditions. All plots were fertilized using NPK granules at the rate of 240 Kg/ ha. one month after planting. Plants were protected as needed against infestation of aphids and white flies.

Number of days when 50 % of the plants in a plot had emerged and flowered was recorded. One week before harvesting, five plants were randomly selected to record number of fruits per plant and number of seeds per fruit. At harvest weight of 1000 seed and seed yield (t/Ha) and seed oil content were recorded. Seed samples, from the collected lot from the wild, and those from cultivated experiment were analyzed to determine their oil content using soxhlet extractor apparatus using petroleum ether according to the method described by Harborne (1984). Collected data were statistically analyzed using Statistical analysis System (SAS 2002) version 9.00.

RESULTS AND DISCUSSION

To the best of our knowledge, no work has been carried out locally and very few, if any, globally on cultivation of colocynth. Hence, results presented in this research provide novel information to build on with no or meager relevant research to cite in discussion as comparison.

Number of days to 50 % emergence of seedlings was significantly different between planting dates in the second season; ecotypes were, however, significantly different in both seasons. The earliest emerging ecotype was SD followed by GD, G, SF and NK. Interaction between sowing date and ecotype was not significantly different in both seasons (Table 1). There was no significant difference between sowing dates in number of days to 50 % flowering in both seasons. Ecotypes were significantly different with SD as the earliest to flower in both seasons; the latest to flower was NK in the first season and GD in the second. Early emergence and flowering are vital survival mechanisms for growth and completion of plant life cycle before the ensue of drought hazards expected in arid climates.

Table 1. Days to 50 % emergence and days to 50 % flowering in response to sowing dates of five wild ecotypes of colocynth in 2013/14 and 2014/15.

Treatments	2013/14	2014/15
(i) Sowimg dates (S)	Days to 50 % emergence	
Autumn	7.4[a]	4.5[b]
Summer	8.7[a]	8.2[a]
Means	8.0	6.3
(ii) Ecotypes (E)		
G	8.5 [ab]	7.0 [a]
SF	9.2 [a]	6.8 [a]
SD	5.3 [c]	4.8 [c]
GD	7.5 [b]	5.8 [b]
NK	9.7 [a]	7.2 [a]
Means	8.0	6.3
(iii) SxE	NS	NS
(i) Sowing dates (S)	Days to 50 % flowering	
Autumn	39.6 [a]	43.5 [a]
Summer	41.6 [a]	41.9 [a]
(ii) Ecotypes (E)		
G	41.3 [b]	44.0 [a]
SF	41.8 [b]	44.5 [a]
SD	33.3 [c]	37.3 [b]
GD	42.2 [b]	44.8 [a]
NK	44.3 [a]	43.0 [a]
Means	40.6	42.7
(iii) SxE	NS	**

- Means within columns followed by the same letter(s) are not significantly different at P< 0.05 according to Duncan's Multiple Range Test.

Number of fruits per plant was significantly different between sowing dates in both seasons, with autumn planting producing higher number than summer planting. Also number of fruits per plant was significantly different among ecotypes in both seasons. The highest number was produced by SF and the lowest by SD in both seasons. Interaction between sowing date and ecotype was significantly different in both seasons (Table 2). Although ecotype SD was the earliest to flower(Table 1),it produced the lowest number of fruits per plant, which could be attributed to the lower fruit setting as a result of the high early season temperature. Autumn planting produced significantly higher number of seeds per fruit than summer planting in both seasons (Table 2). In autumn plants flower at a relatively low temperature, rainy environment, cool humid winds and abundant pollinating insects, all of which are conducive for pollination and fruit setting consequently increasing number of fruits per plant as well as number of seed per fruit. On the other hand, summer planting is associated with prevailing hot dry weather which interferes with pollination, fertilization and fruit setting.

Table 2. Number of fruits per plant and number of seeds per fruit of five wild colocynth in 2013/14 and 2014/15.

Treatments		2013/14	2014/15
(i)	Sowing dates (S)	Number of fruits per plant	
	Autumn	13.1 [a]	12.0 [a]
	Summer	3.3 [b]	5.3 [b]
	Means	8.2	8.6
(ii)	Ecotypes (E)		
	G	8.7 [b]	10.1 [a]
	SF	11.1 [a]	10.1 [a]
	SD	3.4 [c]	6.1 [b]
	GD	8.5 [b]	6.8 [b]
	NK	9.1 [a]	10.0 [a]
	Means	8.2	8.0
(iii)	SxE	**	**
(i)	Sowing dates	Number of seeds per fruit	
	Autumn	356.0 [a]	499.0 [a]
	Summer	212.3 [b]	320.0 [b]
	Means	284.2	409.4
(ii)	Ecotypes (E)		
	G	275.3 [b]	447.3 [b]
	SF	379.2 [a]	421.5 [bc]
	SD	89.3 c	288.2 [d]
	GD	422.3 [a]	567.9 [a]
	NK	254.9 [b]	322.2 [cd]
	Means	284.2	409.4
(iii)	SxE	NS	NS

Means within columns followed by the same letter(s) are not significantly different at P< 0.05 according to Duncan Multiple Range Test.

Ecotypes and sowing dates were significantly different regarding 1000 seed weight and seed yield in both seasons (Table 3). Response pattern of 1000 seed weight was almost similar to that of number of seed per fruit and number of fruits per plant. The highest seed yield was produced by ecotype GD in both seasons and the lowest yield by G in the first season and by NK in the second season. Seed yield in autumn sowing was significantly higher than summer sowing in both seasons; increase was 466% and 237 % in 2013/14 and 2014/15 respectively.

Table 3. Effect of sowing date on 1000 seed weight (g) and seed yield (t/ha.) of five wild colocynth ecotype in 2013/14 and 2014/15.

Treatments		2013/14	2014/15
(i)	Sowing dates (S)	1000 seed weight	
	Autumn	26.7 [a] (+9)	28.3 [a] (+11)
	Summer	24.5 [b]	25.6 [a]
	Means	25.6	27.0
(ii)	Ecotypes (E)		
	G	22.1 [c]	23.1 c
	SF	15.5 [d]	18.8 [d]
	SD	45.2 [a]	45.9 [a]
	GD	28.6 [b]	28.6 [b]
	NK	16.7 [d]	18.4 [d]
	Means	25.6	27.0
(iii)	SxE	**	NS
(i)	Sowing dates (S)	Seed yield	
	Autumn	5.6 [a] (+466)	7.6 [a] (+237)
	Summer	1.0 [b]	2.2 [b]
	Mean	3.3	4.9
(ii)	Ecotypes (E)		
	G	3.2 [c]	5.8 [a]
	SF	4.4 [b]	4.5 [b]
	SD	1.1 [e]	5.0 [a]
	GD	5.4 [a]	5.8 [a]
	NK	2.3 [d]	3.3 [c]
	Means	3.3	4.9
(iii)	SxE	**	NS

Means within columns followed by the same letter(s) are not significantly different at $P < 0.05$

According to Duncan Multiple Range Test.

Values between parentheses are percent increase.

By and large, the above results are in line with reports (Mohamed 2002) on effect of sowing date on the growth of *Monecha ciliatum* where autumn planting resulted in more fast vigorous growth than winter *i.e.* less days to 50 % seed emergence and to 50 % flowering. However, Mohamed (2010) reported that highest number of fruits and seed yield of *Proboscidea parviflora* was recorded in summer sowing. Moreover, Mohamed and Ali

(2017) showed that sowing date significantly affected linseed plant height, number of days to 50 % flowering, seed yield and 1000 seed weight.
Seed oil percentage of ecotypes when cultivated was higher (16.13) than when seeds were collected from the wild (12.05) (Table 4). Even when cultivated, seeds from autumn sowing date produced higher oil (16.44 %) than seeds from summer sowing (15.81 %). Best seed oil from the wild seeds was produced by SD ecotype (16.0 %), and the lowest by NK ecotype (6.4). Surprisingly, however, in autumn sowing, the highest oil percentage was produced by NK (19.1 %), and the lowest by GD (14.6 %) , while the seed yield was the reverse in both seasons. This might indicate that seed yield is probably inversely proportional to seed oil content when colocynth is cultivated. The highest summer planting oil percentage was produced by SD (27.2 %) and the lowest by GD (10.9 %). This clearly indicates that for seed oil production, cultivation of colocynth is better than collection from the wild. Moreover, autumn sowing is better than summer sowing. Oil percentage determined in this research is corroborated by reports of Abdalla (1997), Jarret and Levy (2012), Nahdi *et al.* (2013) and Riag *et al.* (2015).

Table 4. Wild and cultivated seed oil % of five wild colocynth ecotypes

Ecotypes	Wild seed oil %	Cultivated seed oil %	
		Autumn	Summer
G	11.5	15.2	11.5
SF	15.2	17.0	12.1
SD	16.0	16.2	27.2
GD	11.2	14.6	10.9
NK	6.4	19.1	17.4
Means	12.1	16.4	15.8
Wild mean	12.1		
Cultivated mean		16.1	

CONCLUSIONS

- Sowing date does not affect seed germination and plant flowering.
- Ecotypes and sowing date significantly affect number of fruits/plant, number of seeds/fruit and seed yield.
- Oil content from cultivated seeds is higher than in seeds collected from the wild.
- Cultivation of colocynth is advantageous than collection from the wild in terms of plant growth, seed yield and seed oil content; autumn planting in July 15 is better than summer planting in March 15.

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إستجابة خمسة أنواع إيكولوجية برية من نبات الحنظل *Citrullus colocynthis* [(L.) Schrad.] لتاريخ الإستزارع فيما يتعلق بالنمو، إنتاج البذور ومحتوى زيت البذور.

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المستخلص: الغالبية العظمى من النباتات الطبية والعطرية تزود للإستخدام عن طريق الجمع من النباتات البرية، مما يهدد بقاءها نتيجة الجمع الجائر، التوسع فى الزراعة وبالتالى التعامل الخاطىء للبيئة. عليه يمكن للإستغلال العقلانى لهذه النباتات أن يكون، ضمن طرائق أخرى، بالإستزراع لحمايتها وصيانتها. هدفت هذه التجربة لتقييم إستجابة بعض الأنواع الإيكولوجية البرية لنبات الحنظل للإستزراع من حيث أثر تاريخ الزراعة على التمو وإنتاج البذور ومحتوى البذور من الزيت. تصميم التجربة كان القطاعات المنشطرة بثلاثة مكررات، حيث توزعت معاملات تاريخ الزراعة (منتصف يوليو- زراعة خريفية؛ منتصف مارس- زراعة صيفية) عشوائيا على القطاعات الرئيسة وأنواع الحنظل البرية الخمسة عشوائياعلى القطاعات المنشطرة. أجريت التجربة لموسمين 2013/14 و2014/15. البيانات التى جمعت وحللت كانت عدد الأيام للوصول ل50% من الإنبات، عدد الأيام للوصول ل 50 % من الإزهار، متوسط عدد الثمار فى النبات، متوسط عدد البذور فى الثمرة، وزن ال1000 بذرة، إنتاج البذور ومحتوى البذور من الزيت. أظهرت النتائج إختلافات معنوية بين الأنواع فى عدد الأيام ل 50 % إنبات و50 % إزهار،بينما لم تكن الإختلافات معنوية بين تواريخ الزراعة. عدد الثمار فى النبات وعدد البذور فى الثمرة وإنتاج البذور إختلفت معنويا بين تواريخ الزراعة والأنواع. محتوى الزيت فى البذور النا تجة من الإستزراع كان أعلى من محتواها فى البذور البرية. خلاصة البحث أن إستزراع نبات الحنظل كان أفضل كما ونوعا من الجمع البرى من ناحية النمو ،إنتاج البذور ومحتواها من الزيت.