

Some Adaptive Characteristics of Seeds, Germination, and Seedling Development in *Haloxylon salicornicum*.

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ABSTRACT. Seeds of *Haloxylon salicornicum* consist of an embryo axis which forms a compressed spirillum, and the young seedlings show a variety of irregular shapes. Germination is viviparous in nature and can take place any time after maturation if enough moisture is available. After heavy rains in November and December, germinating seeds are often observed on intact fruits still attached to the bush. Highly viable seeds, hydrated for several hours and redried for a week, maintained full germination capacity and produced normal seedlings upon rehydration. Very young seedlings survived drying for a week and became reactivated upon hydration.

To manage and improve the deteriorating desert range vegetation in Iraq, reseedling in favourable habitats, particularly with suitable indigenous species, must be considered for future management plans. *Haloxylon salicornicum* (Moq.) Bge., is a native, well adapted and widely distributed shrub in the arid regions of Iraq, and it is one of the few most valuable and promising species for this purpose (Al-Ani *et al.* 1970, 1971 and 1974, Clor *et al.* 1974 and 1976, Guest 1966, Thalen 1972, 1974, and 1979). An earlier communication (Clor *et al.* 1976) dealt with seed longevity as affected by timelapse and storage conditions. It was found also that large seeds produced more vigorous seedlings. Seeds collected in winter showed full germination capacity, but with advent of summer months they gradually lost their viability. Cold storage, however, preserved such viability. A thorough understanding of the eco-physiological requirements and the adaptive characteristics of this plant at the various stages of its life history is, therefore, very essential.

Materials and Methods

Seeds of *Haloxylon salicornicum* were collected from the western desert of Iraq, almost annually, for several years starting 1974. Collection was usually made

during November and December, when the seeds become ripe; the last collection was made in December 1987. Samples of seeds were usually kept at room temperature, others were stored in a refrigerator at about 5°C. Periodic germination tests were conducted in glass Petri dishes, 9 cm in diameter, lined with two layers of filter paper and moistened with 5 ml of distilled water. A dish containing 25 seeds was considered as an experimental unit, and four replications were usually made. Unless otherwise indicated, all germination tests were carried out in an incubator (Precision model 806) with two fluorescent tubes, and at 20°C. Morphological characterization of the seed and its early germination was also studied using a dissecting microscope.

Results and Discussion

1. Morphology of the Germinating Seed.

- a) *The seed:* The seed of *Haloxylon salicornicum* is a small semiconical structure with a maximum diameter of about 1.5 mm. The individual seed looks like a small turbinate cup. The convex narrow face appears dark, while the wider face, which is oriented upward in the intact fruit, is light brown. Viewed under the dissecting microscope, the narrow dark portion appears green, representing the two needle-like and compactly coiled cotyledons, on the lower narrow side which is attached to the ovary. The seed consists of only an embryonic axis and a thin membranous seed coat which is readily ruptured upon imbibition. The whole embryonic axis is a compressed spirillum, starting with the cotyledonary pole which forms about one and a half loops. Moving upward (in the intact fruit, the hypocotyl-radicle portion forms another one and half loops (Fig. 1a).
- b) *The Elongating Embryonic Axis:* As the seed imbibes enough water, the compactly coiled embryo axis is stretched, and within few hours the spiral arrangement is beautifully revealed (Fig. 1a). The radicle emerges from one side of the wider edge, Both clockwise and counter-clockwise spiralling were observed. Germination is epigeal. The emerged radicle extends to a length of about 5 mm in 12 hours and to a length of about 10 mm in 24 hours. In two days the total length of the seedling is 15-20 mm. The elongation of the embryonic axis at this stage occurs mostly at the radicle pole. After a few days a slender white root begins to develop (Fig. 1c) This pattern of hypocotyl-radicle extension, before the development of the slender root, offers the young seedlings certain protective advantages, because they are covered by a relatively thick cuticle and thus can resist drying out for sometime. The young seedling at this stage will be called the extended embryonic axis (Fig. 1b).

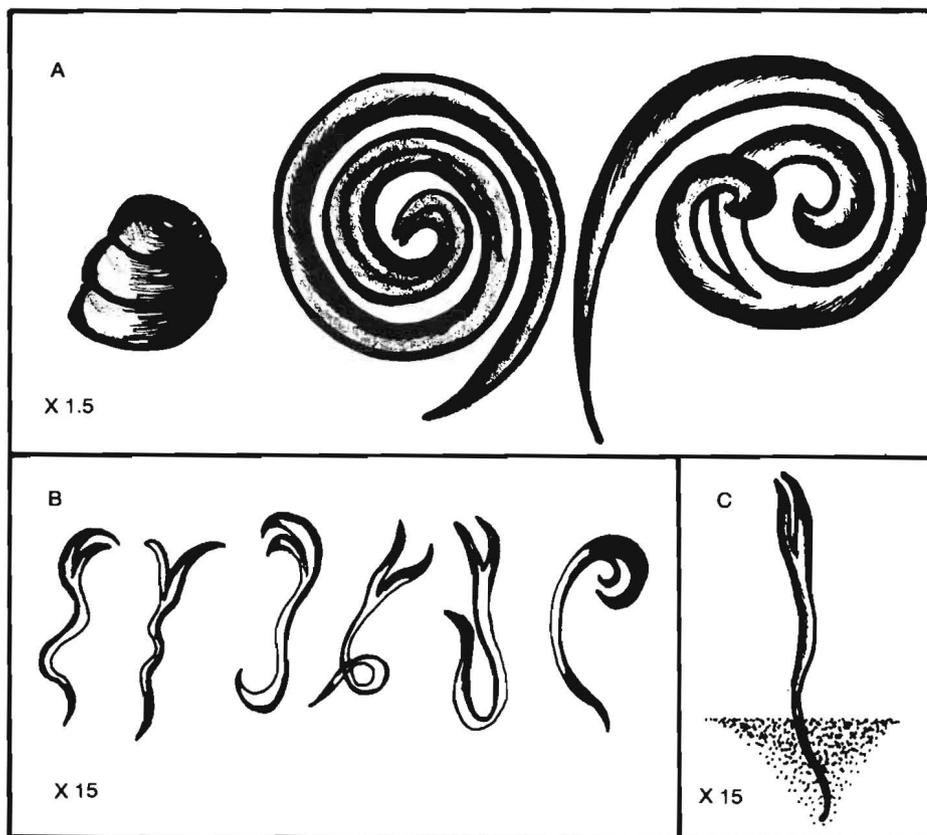


Fig. 1. Diagrammatic representation of seed morphology and seedling development of *Haloxylon salicornicum*. A, The spiral arrangement of the embryo and early stages of seedling development; B, various forms of the seedling at the embryo - extended stage; C, primary root development.

- c) *Tropism of the extended embryo axis:* The most characteristic behavior of the seedlings at this stage is that they are not straight, but rather twisted, bent, coiled or curved in various patterns (Fig. 1b). Germinated on a horizontal surface, the radicle pole was sometimes lifted upward while the cotyledonary pole lies horizontally.

2. Some Adaptive Characteristics of the Seeds and Seedlings

- a) *The viviparous nature of germination:* The seeds of *Haloxylon salicornicum* can germinate immediately after their maturation, as a continuous

process in the growth cycle. This is a known phenomenon (Bewly and Black 1984). The seeds mature in about October, and the rain in the area where *Haloxylon* is dominant, begins usually in November. Thus, the seeds are ready to germinate at anytime when enough moisture is available. Repeated experiments showed that the fresher the seeds the higher their germination rate. In fact we have encountered many cases where the radicle was extended from the intact fruit that was still attached to the bush, after a heavy or extended rain (Fig. 2). During a field trip in late October 1987, several twigs of *Haloxylon* bearing fruits were brought to the laboratory. Some of the twigs were sprayed with water, and within few days numerous seeds were germinated on the intact branches (Fig. 2). It appears, therefore, that the seeds of *Haloxylon salicornicum* are adapted to germinate after their maturation depending on the same season's rain, and they lose their germinability when left for the next season.

b) *Hydration and dehydration of the seeds:* One of the difficulties encountered by the germinating seeds in the desert areas is the limited and erratic

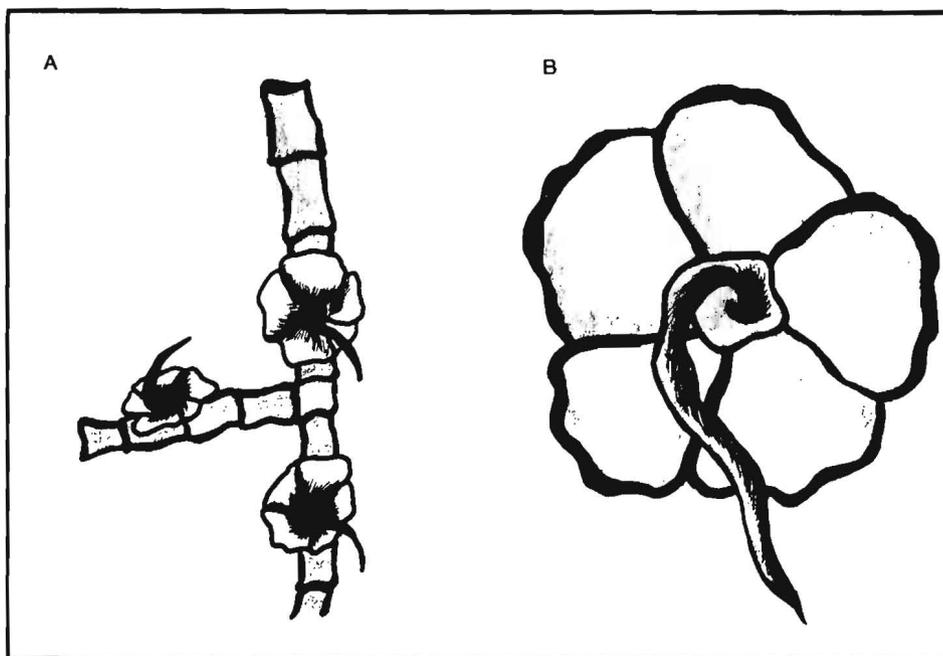


Fig. 2. Diagrammatic representation of seed germination while the fruit is still attached to the twig. A, fruits attached to the twig; B, fruit removed, while the germinating seed is still attached to the fruit.

Table 1. Effect of hydration and dehydration of 10-months old seeds on germination and seedling development. Type I, seeds stored in refrigerator, Type II, seeds stored at room temperature

Imbibition time (hydration) hours	Germination %		Seedling Length (mm)	
	I	II	I	II
0.0	97	60	35	16
0.5	92	12	31	12
1.0	98	22	32	12
2.0	95	34	32	13
3.0	95	42	33	15
4.0	94	30	32	14
8.0	95	31	32	14

moisture supply. Thus it might happen that the seeds absorb water at certain times but dry out before having chance to germinate. To investigate such an effect of hydration and drying out on subsequent germination and seedling development, two samples of 100 seeds each were placed in Petri dishes containing 5 ml of distilled water. The seeds were about 10-months old, one group had been kept under room temperature conditions, while the other had been kept in a refrigerator. After 0.5, 1.0, 2.0, 4.0 and 8.0 hours of imbibition, the seeds were taken out and placed on dry filter paper in Petri dishes and were left on the laboratory bench. After one week of drying the seeds were tested for germination and seedling development. The results are shown in (Table 1). We have emphasized earlier that the seeds of *H. salicornicum* exhibit full germination capacity when fresh and newly collected, but as time passes their germinability is lost gradually (Clor *et al.* 1974). Thus it is seen that the seeds that had been kept under laboratory conditions showed 60% germination and produced poor seedlings, while hydration and dehydration lowered further their germination capacity and the subsequent growth of their seedlings. Such hydration and drying of older seeds probably causes some kind of damage to the embryo which may already be deprived of most of its oxidizable food materials. It is possible that due to the low level of stored materials in the older embryos, the products of the digesting enzymes, that are activated by hydration, are also low as compared to those in the highly viable embryos. Thus upon hydration and drying out, such products might be denatured or destroyed more profoundly in the older seeds thus causing relatively more damage to the embryos. On this basis it becomes understandable why the seeds that were kept in the refrigerator maintained their full germination capacity when hydrated and dehydrated (Table 1), and produced normal and vigorous seedlings.

c) *Survival of the Young Seedlings*: Preliminary observations indicated that very young seedlings, usually at the hypocotyl-radicle extended stage (Fig. 1b), could withstand complete drying for a week or so and resume their normal growth again when moisture became available. To confirm such an observation, 10-months old seeds that had been kept in a refrigerator were germinated regularly. Young seedlings, 4, 8, 24, and 48 hours old (from the time of radicle emergence) were placed in Petri dishes lined with dry filter paper and kept on a laboratory bench for one week. Such seedlings ranged from 5-to about 30 mm in length. The dried seedlings were then transferred back to Petri dishes lined with two layers of filter paper and moistened with 5 ml of distilled water (A total of 60 seedlings were divided into 4 dishes). All the seedlings that were less than about 15 mm in length were reactivated upon hydration and resumed normal growth. Such seedlings represented the early hypocotyl-radicle extended stage. All the other seedlings showed no recovery, for the root tips were invariably damaged. Such response is understandable because the extension of the seedlings at the hypocotyl-radicle stage is mostly by cell elongation, and such young seedlings are still relatively tough and well protected by a heavy cuticle. Once, however, the primary root is initiated (Fig. 1c) the root tips are damaged by drying. This unusual capacity of the very young seedlings for drought resistance is of an extreme ecological significance as an adaptive feature.

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بعض خصائص الانبات وتكيفات البذور والبادرات في نبات الرمث

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مركز البحوث الزراعية والموارد المائية - مجلس البحث العلمي - ص . ب ٢٤٤١
الجلادرية - بغداد - العراق

الرمث شجيرة هامة واسعة الانتشار في المناطق الجافة من العراق، يكتمل نمو ثمارها في نهاية الصيف وتكون بذورها جاهزة للانتشار والانبات في أواخر الخريف. البذرة على شكل مخروط ناقص يتكون من محور جنيني لولبي الشكل ومحاط بغلاف رقيق. وعند التشرّب السريع بالماء تتسع الخلايا وينتفخ الشكل اللولبي، ويصل طول القطب الجذيري إلى حوالي ١٠ ملم خلال اليوم الأول، ويبلغ طوله ١٥ - ٢٠ ملم خلال اليوم الثاني. وتمتاز البادرة الصغيرة في هذه المرحلة بعدم استقامتها، فقد تكون منحنية أو ملتوية بأشكال مختلفة.

تتميز البذور حديثة النضج بخاصية «النمو المستمر»، إذ تمتاز بحيويتها العالية وقدرتها على الانبات المباشر، كما يمكن مشاهدة بذور نابته وهي مازالت متصلة بالأغصان بعد سقوط أمطار شديدة نسبياً حيث يشاهد الجذير متدلياً من الثمرة. وتفقد البذور قدرتها الانباتية تدريجياً عند الخزن تحت الظروف الاعتيادية، لكنها تحتفظ بحيويتها لفترة سنتين أو أكثر إذا ما خزنت بدرجة حرارة ٥°م.

وقد وجد أيضاً بأن ترطيب البذور ذات الحيوية العالية بالماء لعدة ساعات ثم تجفيفها لمدة أسبوع لا يفقدها القدرة الانباتية العالية. كما وجد أيضاً بأن البادات الصغيرة (في مرحلة تمدد المحور الجنيني) يمكن أن تجفف لمدة أسبوع وتستعيد نموها الطبيعي إذا ماتوفر لها الماء ثانية. وهذه الخاصية ذات أهمية ايكولوجية بالغة، فالبذور أو البادات الفتية قد تتعرض لمثل هذه الحالات تحت الظروف الطبيعية للمناطق الجافة.