INVESTIGATIONS ON SEED DORMANCY OF ASPHODELUS TENUIFOLIUS CAVAN

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Investigations on the seed dormancy of *Asphodelus tenuifolius* were taken up as practically no work has hitherto been done on the seed germination behaviour of the plants of the desert regions of West Pakistan. The above mentioned plant belongs to the category of winter annuals and shows a typical periodicity characteristic of its class. Its seeds germinate in November, flowering takes place at the beginning of spring and maturity of seeds and consequent death of plants follow before the end of May.

The seeds of *Asphodelus tenuifolius* were collected from the Montgomery District of West Pakistan on May 5, 1956 and were stored in glass bottles under natural laboratory conditions for use in various experiments. Various measures such as constant and alternating temperatures, mechanical scarification with fine sand paper and light were tried to break the dormancy of the seeds. For the temperature experiments a refrigerator and two thermostats were used. In experiments with alternating temperture, combinations of O°:30°C., 7°:30°C. and 9°:30°C. were tried. The seeds were kept at low temperature for 16 hours from 6 p.m. to 10 a.m. each day, and at high temperature for the remaining 8 hours. In scarification experiments the testa was broken by rubbing the seeds between fine sand-papers.

TABLE I.—GERMINATION AT CONSTANT TEMPERATURES OF 0°C., 7°C., 9°C. AND 30°C. IN SCARIFIED AND NORMAL SEEDS.
(Experiments Started on 18th December 1956.)

No.	Temperature. °C.	Seed condition	Germination percentage		Approximate length of radicle
			After 1 day	After 10 days	
1.	0	Normal	0	0	..
2.	0	Scarified	52	66	0.5 to 1.0 mm No further elongation even when subjected to 30°C.
3.	7	Normal	0	0	..
4.	7	Scarified	76	90	1.0 to 2.0 mm No further elongation even when subjected to 30°C.
5.	9	Normal	0	0	..
6.	9	Scarified	88	98	Unlimited
7.	30	Normal	0	0	..
8.	30	Scarified	88	90	Unlimited

Experimental Results

The results of the experiments, started on Dec. 18, 1956 at constant temperatures with and without scarification, are shown in table I. At constant temperatures of O°C., 7°C., 9°C. and 30°C. there was no germination in unscarified seeds for a period of over one month. After scarification of seeds, however, the radicles made their appearance within a period of 24 hours at all the above mentioned temperatures, but the subsequent behaviour was different. At low temperatures—0°C. and 7°C.—the radicles did not grow beyond the length of 0.5 to 2.0 mm. even if the seeds were later maintained at 30°C. In scarified seeds germinated at 9°C. the radicles elongated to about 2.0 mm in 48 hours, but no further elongation took place for five to six days, after which normal elongation was resumed. At 30°C. the radicles of scarified seeds showed continuous elongation.

The results of experiments by alternating temperatures performed on Dec. 18, 1956 are given in table 2. At alternating temperatures combinations of 0°:30°C. there was no germination. The alternating temperatures of 7°:30°C. and 9°:30°C. gave 10 per cent and 26 per cent germinations respectively after a period of ten days. The scarified seeds showed germination at all the above

TABLE 2.—PERCENTAGE OF GERMINATION AT ALTERNATING TEMPERATURES OF 0°:30°C, 7°:30°C AND 90°:30°C IN SCARIFIED AND NORMAL SEEDS [THE SEEDS WERE KEPT AT LOW TEMPERATURE FOR 16 HOURS EACH DAY FROM 6 P.M. TO 10 A.M. AND AT HIGH TEMPERATURE FOR THE REMAINING 8 HOURS:]

No.	Temperature. °C.	Seeds condition.	Germination percentage. After 1 day.	Germination percentage. After 10 days.	Approximate length of radical.
1.	0:30	Normal.	0	0	..
2.	0:30	Scarified.	96	100	1.0 mm No further elongation even when transferred to 30°C.
3.	7:30	Normal	0	10	Unlimited.
4.	7:30	Scarified.	76	100	Do.
5.	9:30.	Normal.	0	26	Do.
6,	9:30	Scarified.	88	96	Do.

mentioned alternating temperatures within a period of 24 hours. The subsequent behaviour, however, was different at various temperature combinations. At alternating temperatures of 0:30°C. the radicles after an elongation of 0.5 to 1.0 mm. did not grow any further. At alternating temperatures of 7:30° and and 9:30°C,. however, the radicles showed continuous elongation and root hair appeared after four to five days.

The results of the periodic germination tests on scarified seeds at constant temperatures of 30°C 9°C and 7°C and alternating temperatures of 0°:30°C., 7°:30C. and 9°:30C. are shown in Figs. 1 to 3. In all the above cases with the exception of alternating temperatures of 0°:30°C. with opposite trend in the annual course of germination, curves of the same type were obtained. The germination did not go beyond 12 per cent with the various above mentioned treatments upto September but from then onward the tendency to germinate increased gradually till December, when the highest germination, approaching 100 per cent in some treatments, was obtained.

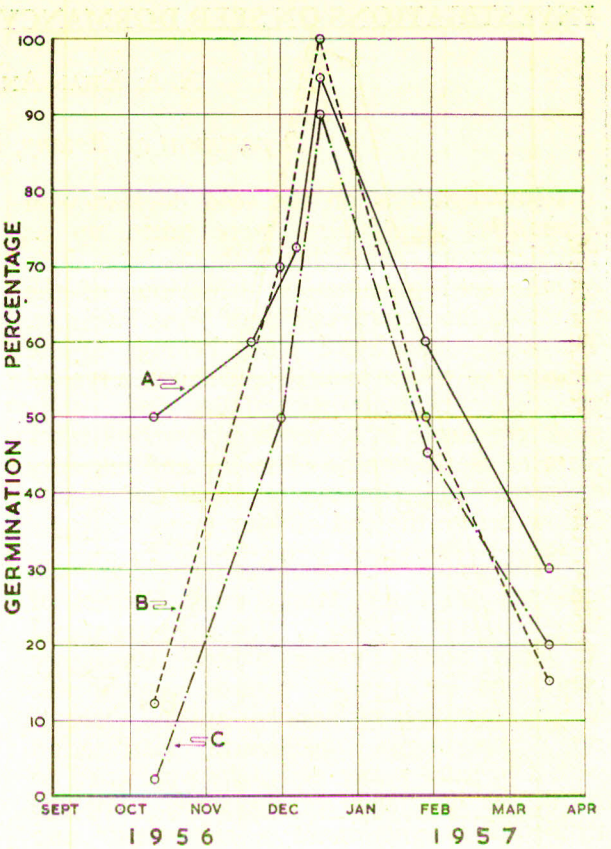

FIG. 1.—Periodic germination behaviour in scarified seeds at constant temperatures of 30°C (A), 9°C (B) and 7°C (C). Germination period 10 days.

Thereafter, the seeds again started to show increasing signs of dormancy. It was also found that the number of days required to reach the peak germination varied at different parts of the year, following an opposite course to that of germination as shown in Fig. 4 in the case of alternating temperatures of 9°:30°C.

Discussion

The germination behaviour of *Asphodelus tenuifolius* shows some interesting feature. At constant temperatures there was no germination throughout the period of investigation in normal seeds. In the scarified seeds short radicles made their appearance within a few hours of starting the experiment at all the temperatures tested. Further elongation of

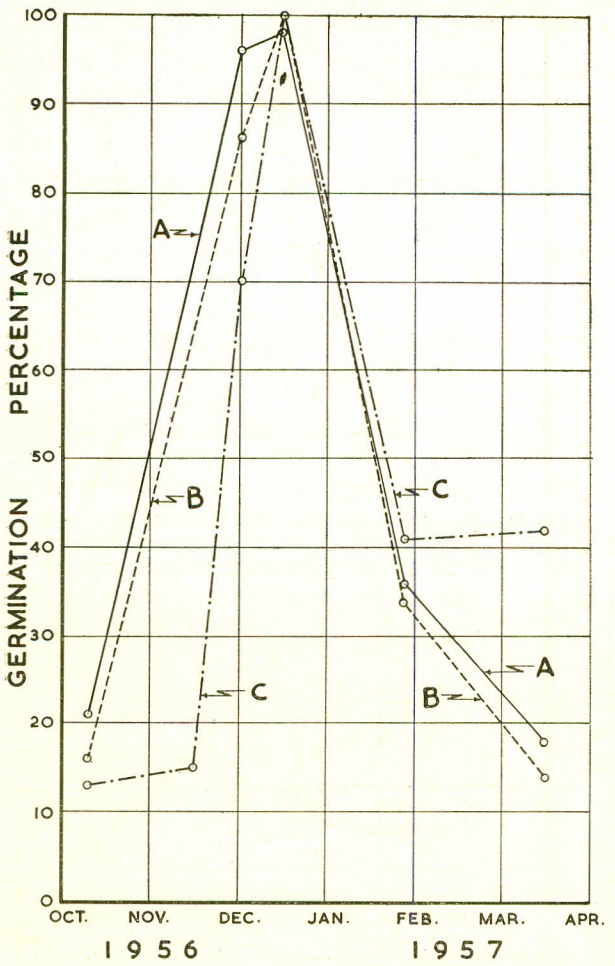

FIG. 2.—Periodic germination behaviour in scarified seeds at alternating temperatures of 9°:30°C. (A), 7°:30°C (B) and 0°:30°C. (C) Germination period 10 days.

radicles, however, took place only in the case of the seeds maintained at temperatures of 9°C. and 30°C. (Table I). The appearance of short radicles in scarified seeds at low temperatures of —0°C. and 7°C—thus seems to be false germination. The radicles appear to be pushed out a little due to the pressure exerted by the water absorped by it. The seed coating being hard seems to hinder the entry of water and exchange of gases. While preparing the seeds for microtome sections it was observed that the intact seed coating did not allow even xylol or paraffin to enter the seed. The scarified seeds grown at low tem-

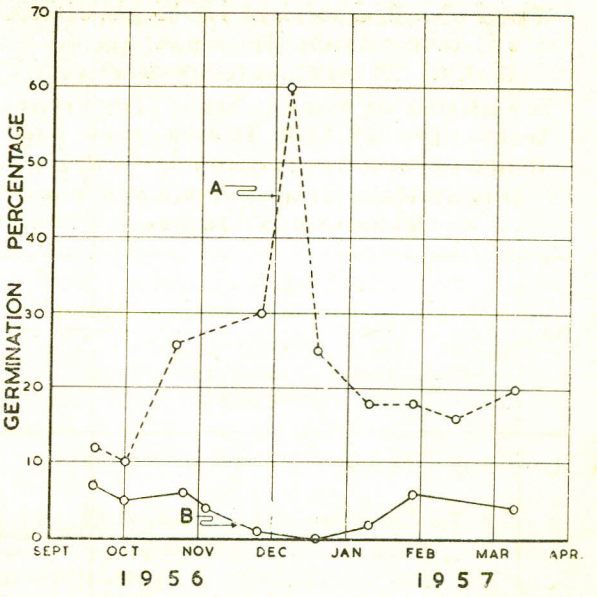

FIG. 3.—Periodic germination behaviour at alternating temperatures of 9°:30°C. (A) and 0°:30°C. (B) at the end of ten days.

peratures of 0°C. and 7°C. did not grow beyond 0.5 to 2.0 mm. even if their temperature was later raised to 30°C. These low-temperature treatments seem to induce a secondary dormancy in the embryo.

At alternating temperatures of 0°:30°C. the percentage of germination ranged from 0 to 8 during various parts of the year but the radicles failed to grow beyond 2.0mm. even if such seeds were later put at 30°C. At 7°:30°C. and 9°:30°C. on the other hand, normal continuous elongation of the radicle was observed. After scarification of seeds, maximum germination was obtained within 48 hours. At all the above-mentioned alternating temperatures of 7°:30°C. and 9°:30°C however, normal elongation continued although the root hair was formed after four to five days. These results show that the low temperature of 0°C has an unfavourable effect on germination and elongation of the radicles. The effect of alternating temperatures seems to be mainly on the seed coating in this particular case. In the case of scarified seeds the alternating temperatures of 0:30°C, 7:30°C. and 9:30°C. have almost the same effects on the seeds as the constant tempera-

tures of 0°C., 7°C., 9°C. and 30°C. At 0°:30°C. there is false germination similar to the germination at the constant temperature of 0°C.

The periodic germination tests under different treatments (Figs. 1-3) showed that germination in *Asphodelus tenuifolius* followed an annual endogenous rhythm which had been earlier discovered in seed germination of plants by Buenning.[1] In this plant the inner tendency of the seeds to germinate starts to rise gradually in October till the maximum is reached in January when it again starts declining. This internal tendency of the seeds to germinate coincides exactly with the active phase of the plant.

In the periodic germination tests which were conducted at low temperatures of 0°C. and 7°C. and alternating temperatures of 0°:30°C. the radicles failed to elongate and false germination resulted in each case. This abnormal behaviour is due to the pressure exerted by the absorption of water. The above periodic tests further showed that the capacity to exert pressure was variable in different parts of the year. As this pressure is exerted by the absorption of water it means that the capacity of the living cells to absorb water differs in different parts of the year. The maximum capacity of the seed to absorb water coincides with the period of active phase of the plant and maximum tendency of the seed to germinate. In the same manner the number of days required to reach the peak germination (Fig. 4) as well as the total germination in peak days (Fig. 5) at alternating temperature of 9°:30°C. showed corresponding variations with annual endogenous rhythm. These variations result due to the differences in the capacity of the living cells to take up water.

The periodic tests at alternating temperatures of 0°:30°C. (Fig. 3) revealed that adverse effects of low temperatures were the greatest during the maximum germination period of the year. Buenning and Bauer [2] have also found that the resistance to high temperatures decreases during the period when the seeds show minimum dormancy.

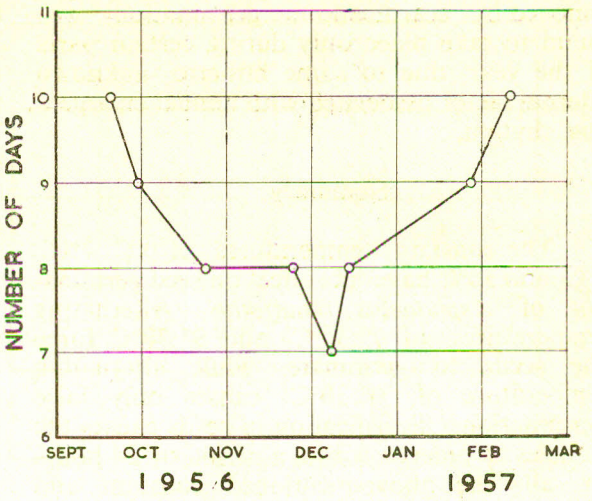

FIG. 4.—Number of days required to reach daily peak germination at alternating temperatures of 9°:30°C. during the course of investigation.

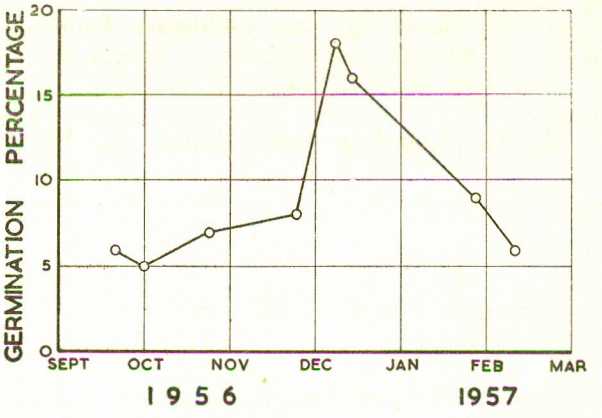

FIG. 5.—Germination in peak days at alternating temperatures of 9°:30°C. during the course of investigation.

Conclusion

The two main causes of dormancy in seeds of *Asphodelus tenuifolius* are thus the hard coating of seed and annual endogenous rhythm. The seed coating appears to affect germination by preventing the entrance of water and exchange of gases. The suitable alternating temperatures and scarifications of seeds were found to overcome this factor. Even when the seed coating was

removed by scarification, germination was found to take place only during certain parts of the year, due to some hitherto unknown internal factor associated with annual endogenous rhythm.

Summary

The constant temperatures of 0°C. 7°C., 9°C and 30°C have no effect on seed germination of *Asphodelus tenuifolius*. Alternating temperatures of 7°:30°C. and 9°:30°C. force the seeds to germinate, while alternating temperature of 0°:30°C. causes only false germination. Scarification of seeds causes the radicles to emerge within a period of 24 hours at all the above-mentioned constant and alternating temperatures. In scarified seeds both at constant temperatures of 0°C, and 7°C. and alternating temperatures of 0°:30°C. there is only short emergence of radicles due to the pressure exerted by absorption of water, but normal elongation of radicles is only obtained at constant temperatures of 9°C. and 30°C and at alternating temperatures of of 7°;30°C and 9°:30°C.

The periodic tests show that seeds follow an annual endogenous rhythm in germination. Associated with this is the capacity of the seeds to absorb water and the resistance to low temperatures. This internal capacity of the seeds to germinate coincides with the active phase of the plant.

References

1. E. Buenning, Die Endogene Ruheperiode der Samen, Planta **35**. 352-359(1947).

2. E. Buenning, and Bauer, E. W. Ueber die Ursachen endogener Keimfaehig keitschwankungen in Samen. Zeitschr. f. Bot. **40**. 67-76 (1952).