

AUTECOLOGY OF *ARISTIDA ADSCENSIONIS* LINN.*

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Aristida adscensionis is a rainy season xerophytic grass which occurs abundantly on old calcareous walls and in overgrazed fields of Varanasi. Its ecological life-history was studied in nature and in culture garden. It has an average reproductive capacity of 1,037 and 667 potential off-spring per plant in ground and wall habitats respectively. Percentage of calcium is higher in plants grown on calcareous soils, however, reproductive capacity shows negative correlation with exchangeable calcium in the soil. Susceptibility to shade and inter-specific competition seem to control its distribution in the area.

Varshney (1964) has worked out the ecology of the wall flora of Varanasi, and reported a wide occurrence of *Aristida adscensionis* on the specialized wall habitats. The investigation reported below concerns the autecology of *A. adscensionis*—a xerophytic rainy season annual—found commonly at Varanasi on old walls and building tops. On ground, however, its distribution in the area is limited to calcareous soils and overgrazed fields. The objectives of the study are twofold: first, to survey its performance on ground and specialized wall habitat, and second, to examine the factors responsible for its peculiar distribution in the area.

ENVIRONMENTAL FACTORS

Climatic.—The climate of Varanasi is characterized by the monsoon which indicates a seasonal rhythm of weather. It is typical of Upper Gangetic Plain as described by Dudgeon (1920) and Misra (1946). All the elements of climate, viz. temperature, rainfall, relative humidity and wind with their characteristic fluctuations, mark three distinct seasons: (1) Rainy season from last week of June to October; (2) Winter season from November to February; (3) Summer season from March to third week of June. *A. adscensionis* occurs only during the rainy season and perennates during the winter and summer seasons by its resistant seeds.

Edaphic.—Soils from wall and ground habitat of *A. adscensionis* were collected and analysed, data of soil analysis are set in Table I.

* Bor, N. L. (1960), page 405.

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TABLE I
Soil analysis data for *A. adscensionis*

Locality	Moisture ¹ content (%)	pH ²	Electrical ³ conductivity in mhos ($\times 0.597$)	Carbonate ⁴ content (%)	Exch. ⁵ cal. (m.e.%)	Organic ⁶ matter (%)
<i>Wall</i>						
Lanka ..	8.28	8.2	3.1×10^{-4}	20.60	24.25	0.495
Rajghat ..	9.31	8.4	3.4×10^{-4}	21.60	20.75	0.645
Nati Imli ..	10.32	8.5	3.1×10^{-4}	27.35	28.75	0.540
<i>Ground</i>						
Near Sivaji Hall	16.31	7.2	3.7×10^{-3}	0.38	7.25	0.720
Arts College ground ..	18.12	7.1	2.9×10^{-3}	0.28	8.80	0.880

¹ Determined by drying soil samples at 105° C.

² Electrometrically with a Beckman photovolt pH meter.

³ Electrical conductivity bridge.

⁴ Collin's calcimeter by the procedure given by Shah and Amin (1951).

⁵ Leaching with barium chloride triethanolamine at pH 8.1, Mehlich (1953).

⁶ Walkley and Black rapid titration method—see Piper (1944).

The plants seem to tolerate a wide range of moisture level. Moisture percentage in the substratum was found to vary from 8.28 to 18.12 per cent in the rainy season. The pH of the soils varies from 7.1 to 8.5. Values for conductivity of the soils were found to range from 3.1×10^{-4} to 3.7×10^{-3} mhos. Carbonate content was found to range from 0.28 to 27.35 per cent in the soils. Exchangeable calcium in the soils was found to vary from 7.25 to 28.75 m.e.

TABLE II
Performance of A. adscensionis in different localities

Locality	Avg. height of plants in cm.	Avg. No. of panicles/plant	Avg. No. of seeds per panicle	Seed output/ plant	Cal. oxide (% dry wt. of plants)
<i>Wall</i>					
Rajghat ..	52.21 \pm 5.81	6.18 \pm 1.94	126.8 \pm 15.17	784	0.4592
Nati Imli ..	43.92 \pm 6.38	6.48 \pm 2.04	125.6 \pm 17.02	814	0.5096
Lanka ..	56.80 \pm 6.80	6.90 \pm 1.59	130.8 \pm 16.43	903	0.5209
<i>Ground</i>					
Sivaji Hall ..	59.76 \pm 5.06	8.85 \pm 1.76	140.56 \pm 13.43	1,244	0.2630
Arts College ground	65.32 \pm 5.09	8.90 \pm 2.02	151.44 \pm 19.33	1,348	0.3080

per cent. Soils are poor in organic matter which varies from 0.88 to 0.49 per cent.

Table II shows that the plants exhibit better performance on the ground. A direct correlation can be established with moisture content. However, the performance of the plants as indexed by seed output shows a negative correlation with carbonate content and exchangeable calcium in the soil. Calcium content of the plants from the corresponding localities shows that it is low in the ground plants but high in the plants of calcareous wall habitats. A comparison of the seed output data (Table II) and plant calcium shows that the two behave independently.

Biotic factors :

Biotic factors, particularly excessive grazing, bring about the invasion of *A. adscensionis* in the grasslands of Varanasi. The grass suffers adversely in the mildly grazed areas, or eliminated by the perennial grasses like *Dichanthium annulatum*, *Bothriochloa pertusa*, etc., from protected areas.

The following fungal parasites have been reported on this grass from India* :

- (1) *Puccinia aristidae*,
- (2) *Puccinia graminis*,
- (3) *Sorosporium consanguineum* var. *bullatum*.

At Varanasi *S. consanguineum* var. *bullatum* was found to infect a few ovaries in each panicle.

Associates of *A. adscensionis* are given in Table III.

Seed character :

The grain is enclosed in the fertile glume. The length of the grain varies from 5.355 to 4.712 mm and the breadth from 0.310 to 0.263 mm. The shape index as indicated by the length/breadth ratio varies from 17.2 to 17.9. The average weight of the seed is 0.45 mg.

Germination of Seeds :

Seeds collected in October 1962 were put for germination after different periods of dry storage, between moist filter papers, in Petri dishes. The data are given in Table IV.

Table IV shows that an after-ripening period of about four months is required for germination to take place. The germination percentage constantly increases from February to June, when 76 per cent germination is obtained.

* The information was kindly supplied by the Head of the Division of Mycology and Plant Pathology, IARI, New Delhi.

TABLE III
Associates of A. adscensionis on walls (W) and on ground (G)

va = very abundant o = occasional
 a = abundant r = rare
 f = frequent vr = very rare

Species	Localities				
	1(W)	2(W)	3(W)	4(G)	5(G)
<i>Achyranthes aspera</i>	—	vr	—	vr	—
<i>Alysicarpus longifolius</i>	vr	—	—	—	—
<i>Aristida funiculata</i>	o	f	r	—	—
<i>Arthraxon lancifolius</i>	o	f	—	—	—
<i>Bidens biternata</i>	r	o	—	—	—
<i>Boerhavia diffusa</i>	—	—	vr	r	r
<i>Bothriochloa pertusa</i>	—	—	—	f	o
<i>Brachiria reptans</i>	vr	f	o	—	—
<i>Corchorus aestuans</i>	—	f	o	f	f
<i>Crotalaria medicaginea</i>	o	—	f	o	f
<i>Cynodon dactylon</i>	—	—	—	f	o
<i>Dichanthium annulatum</i>	—	—	—	o	f
<i>Eragrostis tenella</i>	—	—	—	o	r
<i>E. viscosa</i>	—	—	—	—	o
<i>Ficus religiosa</i>	—	r	r	—	—
<i>Justicia diffusa</i>	—	r	—	—	—
<i>Leucas aspera</i>	r	—	vr	r	—
<i>Lindenbergia polyantha</i>	o	—	o	—	—
<i>Phyllanthus niruri</i>	o	—	r	vr	—
<i>Polygala chinensis</i>	—	—	vr	r	—
<i>Setaria glauca</i>	r	o	r	—	o
<i>Tridax procumbens</i>	r	r	—	—	—
<i>Triumfetta rhomboidea</i>	r	—	—	r	r
<i>Zornia diphylla</i>	—	—	—	f	o

1. Rajghat
2. Nati Imli
3. Lanka
4. Sivaji Hall
5. Arts College ground

TABLE IV
Germination of A. adscensionis seeds after different periods of dry storage

Date	No. of seeds germinated out of 50	Percentage germination
1-11-62	—	—
13-12-62	—	—
14-1-63	—	—
3-2-63	7	14
18-3-63	21	42
6-4-63	35	70
13-6-63	38	76

In order to break the dormancy, the seeds were subjected to different treatments before putting for germination. Data obtained are recorded in Table V.

TABLE V
Germination of *A. adscensionis* under various dormancy breaking treatments
Date of starting germination: 3rd February, 1963

Treatment	No. of seeds germinated out of 50	Percentage germination
Pre-heated at 60° C for 24 hr. then kept at room temp.	nil	nil
Kept at 20° C	5	10
Kept at 20° C and 40° C alternately for 12 hr.	21	42
Mechanical scarification	19	38
Acid scarification (treated with conc. H ₂ SO ₄ for 5 min.)	28	56
Control	7	14

It is evident from Table V that seeds treated with conc. sulphuric acid for five minutes prior to germination give the highest germination. Alternating temperatures of 20° C and 40° C for 12 hours and mechanical scarification were found effective in breaking the dormancy.

The results of germination tests to study the effect of light on germination of *A. adscensionis* are given in Table VI.

Table VI shows that 80 per cent germination was recorded in continuous light while in total darkness the germination percentage dropped to 48 per cent.

Seedling morphology:

A few days after the seeds are put for germination the radicle protrudes out near the callus. When the radicle is only 1 to 2 mm long the plumule arises as a protuberance from the opposite end. The mesocotyl elongates and gives rise to the first leaf.

Reproductive capacity:

The average reproductive capacity of *A. adscensionis* comes to 1,037 and 667 potential offspring in ground and wall habitats respectively.

Culture experiments:

EXPERIMENT No. 1—To test the field observations regarding the response of *A. adscensionis* to exchangeable calcium in soil, plants were grown in soils with three different levels of exchangeable calcium. When the plants were mature they were harvested and their seed output and plant calcium were determined. The data obtained are set in Table VII.

TABLE VI
Germination of *A. adscensionis* under different
light conditions

Date	No. of seeds germinated out of 50		
	In dif- fused daylight	In total darkness	In conti- nuous light
14-6-63	—	—	—
15-6-63	—	—	—
16-6-63	—	—	—
17-6-63	—	—	—
18-6-63	4	—	2
19-6-63	2	—	3
20-6-63	4	—	5
21-6-63	3	—	4
22-6-63	4	4	3
23-6-63	2	2	3
24-6-63	2	—	3
25-6-63	5	—	4
26-6-63	3	1	2
27-6-63	4	2	3
28-6-63	2	1	—
29-6-63	—	2	2
30-6-63	2	4	1
1-7-63	1	2	3
2-7-63	—	—	—
3-7-63	—	—	1
4-7-63	—	3	—
5-7-63	—	2	—
6-7-63	—	—	1
7-7-63	—	1	—
8-7-63	—	—	—
Percentage	76	48	80

Table VII shows that the general performance as evidenced by seed output decreased, while plant calcium was high with the increase of exchangeable calcium in the soil. This confirms the field observations.

EXPERIMENT NO. 2—To study the effect of shade on the performance of *A. adscensionis*, two sets of pots were filled with garden soil. One set was kept in the open sun while the other set was kept under the shade of a mango tree. Observations are recorded in Table VIII.

It is seen from Table VIII that the performance of the plants in shade is extremely poor. In shade plants either failed to flower or exhibited very poor flowering. The average height (which includes panicles also) remains

TABLE VII

Performance of A. adscensionis in soils with different levels of calcium

Starting date : 25-6-63 Closing date : 6-10-63

Observation	Culture sets*		
	1	2	3
Average height of the plant (cm) ..	53.6 ± 1.83	55.2 ± 1.88	59.5 ± 1.19
Average number of panicles/plant ..	7.7 ± 1.20	8.1 ± 0.80	9.0 ± 1.06
Average number of seeds/panicle ..	135.3 ± 6.29	143.0 ± 6.84	146.8 ± 6.91
Average seed output ..	1,042	1,159	1,321
Calcium oxide (% dry weight of plants)	0.526	0.481	0.459

*(1) Wall material: Exch. cal. 28.37 m.e. %; (2) Garden soil + calcium carbonate: Exch. cal. 17.25 m.e. %; (3) Garden soil: Exch. cal. 6.12 m.e. %.

TABLE VIII

Performance of A. adscensionis under sun and shade

Date of starting the experiment : 25-6-63 Closing date : 8-10-63

	Avg. height of plant (cm)	Avg. length of leaf (4th node) (cm)	Avg. length of 4th internode (cm)	Avg. No. of panicles/ plant	Avg. No. of seeds/ panicle	Seed output/ plant
Sun ..	58.6 ± 3.26	8.44 ± 0.98	5.4 ± 0.88	10.2 ± 0.94	146.2 ± 6.22	1,491
Shade ..	45.5 ± 4.77	12.80 ± 1.70	6.0 ± 0.61	3.6 ± 0.78	48.2 ± 4.64	147

less than those of sun plants in spite of their longer leaves and internodes. It appears that because of its poor performance this grass remains absent from the shaded walls.

EXPERIMENT NO. 3—To study the effect of inter-specific competition on *A. adscensionis* plants in set one were kept free from invading weeds while in set two, invading weeds were allowed to grow and compete with *A. adscensionis* plants. Observations are recorded in Table IX.

It is clear from Table IX that performance of the species suffers seriously in competition.

Phenology :

It is an annual xerophytic grass of the monsoon period, though, Bor (1941) and Achariar (1921) have reported it to behave as perennial under favourable conditions. In nature seeds germinate in early July after first few

TABLE IX

Performance of A. adscensionis in inter-specific competition

Starting date : 25-6-63 Closing date : 12-10-63

Observation	Culture sets	
	Control	In competition
Avg. height of plant (cm) ..	59.6±2.40	32.2±3.40
Avg. No. of panicles/plant ..	9.6±1.07	3.4±0.78
Avg. No. of seeds/panicle ..	145.0±6.02	78.0±6.18
Seed output	1,392	265
Avg. fresh weight of shoot (g) ..	4.143	0.811
Avg. fresh weight of root (g) ..	0.764	0.171
Avg. dry weight of shoot (g) ..	1.848	0.318
Avg. dry weight of root (g) ..	0.381	0.082
Root/shoot ratio (fresh weight basis)	0.184	0.210
Root/shoot ratio (dry weight basis)	0.206	0.257

heavy showers. Flowering starts two months after the appearance of seedlings. Plants die with the end of the rainy season in October, leaving behind a crop of seeds to tide over unfavourable period of the year.

Dispersal :

The seed of *A. adscensionis* is enclosed in a glume which terminates into a tripartite awn. Seeds are very light in weight and are possibly carried by wind for fairly long distances and to considerable heights. Its occurrence on walls and building tops is indicative of its dispersal through the agency of wind. According to Hitchcock (*quoted by* Ridley 1930), in North America, the three awns of *A. adscensionis* (*A. fasciculata*) spread widely and are caught by the wind which carries the spikelets with the bearded callus. The seed may be caught in the fleece of an animal. Ridley (1930) mentions that because of the bearded callus and tripartite awn it can readily get attached to the fleece of sheep or to the hair of goats and regards the distribution of this grass due to adhesion of the spikelets. He further expects its absence from wet tropical regions, but wherever the country is suitable and goats or sheep have travelled, this plant seems to have accompanied them.

DISCUSSION

Salisbury (1942) pointed out that a species may not exhibit its best performance in the community in which it occurs generally. He showed that the reproductive capacity of *Ranunculus bulbosus*, which normally occurs in closed meadow community, was considerably low in comparison to the plants

which were maintained in bare or semi-bare conditions. He also emphasized that occurrence of a species in a specialized habitat may be viewed with caution as to the requirement of the species. In case of *Aristida adscensionis*, field observations and results of culture experiments suggest that high carbonate content and exchangeable calcium in the soil are not the underlying factors in its distribution on wall habitats.

Dudgeon (1920) and Bor (1941) characterized it as a species of over-grazed areas. However, Misra (1946) found its high incidence on alkaline soils, old mortar joints and sloping lands subjected to erosion.

The distribution behaviour as recorded by the above workers can be explained in light of the present investigation. It is seen from culture experiments that competition and shade greatly suppress the performance of the grass; moreover high levels of exchangeable calcium in the soil are not important for its growth though it can withstand highly calcareous conditions. It appears that its restricted distribution on such habitats as old walls, eroded soils and in over-grazed fields is because they provide an open habitat and ensure freedom from shade and competition.

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