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COMPARISON OF GROWTH PERFORMANCE AND GERMINATION BEHAVIOUR OF SEEDS OF *CASSIA TORA* L. AND *C. OBTUSIFOLIA* L.

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INTRODUCTION

The simultaneous publication of *Cassia tora* L. and *Cassia obtusifolia* L. by Linnaeus in 1753 as two distinct species was followed by the reduction of *C. obtusifolia* to a synonym of *C. tora* by Bentham (1871). Since then these two species have received confused treatment by taxonomists being regarded by some as synonyms (Hooker 1879, Bamber 1916, Jackson 1895), while by others as two different species (Roxburgh 1832, Prain 1897, De Witt 1955, and Brenan 1958). Mall (1957) has studied autecology of the two species and suggested that they are distinct species.

My field observations have revealed that both the species usually grow in association with each other. It was considered fit, therefore to investigate whether, their growth performance and environmental relations warrant us to separate the two taxa. In the present communication the growth performance of the two species in field and under uniform culture conditions along with the germination behaviour of their seeds have been compared.

For identification of the plants, characters given by Brenan (1958) have been followed.

MATERIALS AND METHODS

(a) Growth performance in field:

Plants of both the species were sampled at random from mixed populations growing at Chakia (48 km. from Varanasi) and Latifshaw (59 km. from Varanasi) in the month of November 1964. Height of plants, diameter at the base, and number of branches were recorded for ten plants of both species at the two sites, separately.

(b) Cultivation under uniform conditions:

Seeds of both the species were obtained from three different localities, viz., Ahmedabad (23.20 N. Lat. 72.38 E. Long.), Ujjain (23.25 N. Lat., 75.80 E.

Long.) and Sagar 23.50 N. Lat., 78.50 E. Long.) during January of 1965. Plants were raised from these seeds in weed garden during September-October, 1965 in different plots. 50 plants for each species from each locality were maintained. When the plants were 30 days old, their height, root penetration, dry weight of shoot and dry weight of root were recorded. Five plants drawn at random were sampled for each population. When fruits were mature, thirty pods from each population were collected at random, measured for length and, number of seeds contained therein were counted.

(c) Germination:

Seeds were kept between two moist filter papers in Petri dishes at 30°C for germination test. 3 to 4 replicates, each having 100 seeds were used for each experiment. Mechanical scarification was done by rubbing the seeds on a carborundum block and chemical scarification with sulphuric acid. Different storage temperatures were obtained in deep freeze, refrigerators and incubators.

RESULTS

(a) Growth performance in field:

The range and average values for height, number of branches and the diameter of stem at the base for both the species are given in the table 1.

TABLE 1. *Growth performance of* C. tora *and* C. obtusifolia *in two localities*

Characters.		C. tora	C. obtusifolia
1. Latifshaw			
Height (cm) :			
Range	...	27·1—70·0	80·0—128·5
Average	...	47·94	96·75
Number of branches :			
Range	..	1—10	1—14
Average	..	5·3	3·8
Diameter at the base (cm) :			
Range	...	0·2—0·7	0·45—1.5
Average	..	0·39	0·96
2. Chakia			
Height (cm) :			
Range	..	12·6—50·5	56·0—82·0
Average	..	22·03	67·8
Number of branches :			
Range	..	1—7	1—8
Average	..	3·7	3·3
Diameter at the base (cm) :			
Range	..	0·15—0·4	0·35—1·2
Average	...	0·25	0·82

The height and the diameter of stem in case of plants belonging to *C. obtusifolia*, at both the study sites, register higher values (2-3 times) as compared to corresponding *C. tora* plants. Thus the plants of *C. tora* are shorter by 48.81 cm. at Latifshaw and 45.77 cm. at Chakia than those of C. *obtusifolia*. The stem diameter in *C. tora* is less by 0.57 cm. at Latifshaw and 0.60 cm. at Chakia. Although mean values show less branching in case of *C. obtusifolia*, the range in the two cases is much overlapping.

(b) Cultivation under uniform conditions:

Mean values for characters selected to represent growth performance of plants of both the species raised from three different seed origins are tabulated in table 2. Summary of analysis of variance for these characters is given in table 3.

From table 2 it is apparent that values recorded for all the five characters in the case of *C. obtusifolia* are higher than the corresponding values for *C. tora*. The two exceptions to this are the values for root penetration and number of seeds per pod which exhibit opposite relation in case of plants of Ujjain and Ahmedabad origins, respectively. But the difference between the values in these two cases is not significant statistically as the critical difference is larger in each case. (c.d. for root penetration=4.31 and for number of seeds per pod =1.68).

TABLE 2. *Growth performance of* C. tora *and* C. obtusifolia *plants of three different seed origins under uniform culture conditions*

(Mean values)

Characters	C. tora			C. obtusifolia		
	Ahmedabad	Sagar	Ujjain	Ahmedabad	Sagar	Ujjain
1. Height (cm)	11.20	11.12	14.10	20.48	20.74	20.38
2. Root penetration (cm)	14.54	17.60	20.30	18.68	20.74	16.90
3. Dry weight of shoot (g)	1.980	0.542	2.462	3.596	2.130	3.52
4. Dry weight of root (g)	0.096	0.092	0.078	0.148	0.154	0.166
5. Length of pod (cm)	10.10	11.20	9.60	10.60	14.10	13.40
6. Number of seeds per pod	15.73	17.80	14.30	15.70	21.03	22.20

Analysis of variance for all these characters (table 3) shows significant differences between the two species, except in the case of root penetration where only interaction between localities and species is significantly different. Place of origin has significant effect on three characters, viz., dry weight of shoot, pod length, and the number of seeds per pod.

TABLE 3. *Analysis of variance for growth performance data of* C. tora *and* C. obtusifolia *of three different seed origins grown under uniform culture conditions.*

(Mean sum of squares)

Source of Variation	Height.	Root penetration.	Dry Wt. shoot.	Dry Wt. root.	Pod length.	Number of seeds per pod.
1. Species	244.90***	13.40	15.20**	0.0341***	260.88***	604.10***
2. Localities	16.18	18.30	8.40*	0.00008	80.84***	164.90***
3. Species x localities	140.54**	41.00*	0.115	0.001865	45.35*	292.00***
4. Error	15.80	10.96	1.23	0.00176	10.62	11.03

*** Significant at 0.1%.
** Significant at 1%.
* Significant at 5%.

The response to uniform culture of plants of the two species from the same place of origin is not similar. Thus, *C. obtusifolia* plants originating from Sagar seeds show maximum height, root penetration and pod length among the populations of this species. But in *C. tora* populations, plants of Ujjain origin exhibit maximum height, root penetration and dry weight of shoot. Plants of this species originating from Sagar seeds show maximum pod length only while values for height and dry weight of shoot are minimum, and that of root penetration intermediate.

Thus it follows that plants of *C. obtusifolia* originating from the three different localities are more robust than those of *C. tora* of corresponding seed origins and that the differences between the two species are statistically significant.

(c) Germination behaviour of seeds:

Freshly collected seeds of *C. tora* have been found to possess very low germinability on account of the seed-coat impermeability. Mechanical and

chemical scarification results in cent per cent germination (Singh 1965). A similar germination test for *C. obtusifolia* in November 1965 revealed the favourable effect of scarification on seed germination (Table 4).

TABLE 4. *Percentage germination of scarified seeds of* C. obtusifolia *at* 30°C

(15-11-1965—19-11-1965)

Dates	Mechanical Scarification.	Chemical Scarification.	Control. (unscarified).
16.11.65	80	75	0
17.11.65	12	15	4
18.11.65	6	7	0
19.11.65	0	2	1
Total	98	99	5

The seeds which were stored for 5 months (December 1964 to April 1965) at room temperature (20° to 30°C) and then stored at different temperatures from May 1965 to April 1966 gave the following result when subjected to germination test at 30°C (table 5).

TABLE 5. *Percentage germination of seeds of* C. tora *and* C. obtusifolia *at 30°C after one year storage at different temperatures*

(May-June 1966)

Temperature of storage.	C. obtusifolia	C. tora
—15°C (for 3 months, later changed to 0°C)	7.5	60
0°C	8.5	54
10°C	10.5	57
20°C	19.5	63
30°C	39.5	68

It is apparent from the above table that germinability of *C. tora* seeds is much less than that of *C. obtusifolia* in all the storage conditions. Further, low temperature storage of seeds results in decreased germinability in *C. tora* while in case of *C. obtusifolia*, apparently the germinability is indifferent to storage temperature (in range of −15° to 30°C).

DISCUSSION

According to Roxburgh (1832) *C. obtusifolia* grows nearly erect, to the height of six or more feet whereas *C. tora* growing in the same soil is diffuse, rarely more than one or two feet high. On the other hand Mall (1957) found no marked difference in size or branching wherever the two species were growing side by side at Sagar. The growth performance of the two species in mixed populations at Chakia and Latifshaw is quite different as evidenced by the data collected for the present study (Table 1). The plants of *C. obtusifolia* are definitely taller and thicker than those of *C. tora*. However, the size of plants in both the cases is much variable as the same differs to a great extent between the two localities.

The cultivation of these two species under uniform culture conditions clearly illustrates the differences in their growth performance (Tables 2 and 3). The plants of *C. obtusifolia* originating from the three different seed sources are decidedly taller and have more dry matter in their shoots and roots than those of *C. tora* of corresponding seed origins. Pods of *C. obtusifolia* are longer and contain more seeds. This experiment demonstrates differential behaviour to uniform culture thus indicating genetic difference.

Irwin and Turner (1960) have described the result of an experiment in which uniglandular and biglandular forms were cultivated under uniform culture conditions. According to them this experiment verified the differences in the two forms, i.e., the uniglandular form maintained its erect habit and produced few to several ascending branches, while the biglandular form became much diffuse. The two forms had different haploid chromosome numbers (uniglandular: 14; biglandular: 13). On the basis of this study they (Irwin and Turner 1960) suggest the existence of two forms in *C. obtusifolia*. In the present case however, except one plant of Ujjain origin and two of Sagar which developed two glands in two lower leaves, all the other plants of *C. obtusifolia* had uniglandular leaves. Plants of both the species were erect but those of *C. tora* exhibited a tendency to diffused habit.

Regarding the distribution and native home of these two species Brenan (1958) opines that *C. tora* is strictly confined to the Old World, from India eastwards to Polynesia, while *C. obtusifolia* is distributed throughout the tropical regions of the World. The native home of *C. tora* might be in Asia or Pacific Islands and that of *C. obtusifolia* is uncertain though possibility of its

being in Old World should be taken into account. Duthie (1961) considers *C. obtusifolia* to be tropical American. Irwin and Turner (1960) consider the section Prososperma, to which the two species under consideration belong, to be American. According to these authors ".... the very flexible and adaptable *C. obtusifolia* gained wide distribution, probably quite recently .... the biglandular form of *C. obtusifolia* of northern south America, other deviates such as the *"C. tora"* with n-13 of Datta (1933), and in all probability *C. tora* itself, have arisen from *C. obtusifolia."* In light of this remark the data on germination studies (Table 4, 5) are of significance. Although seeds of *C. obtusifolia* have seed-coat impermeability similar to *C. tora* (Table 4), their response to storage temperature on subsequent germination is considerably different. While on the one hand, storage at low temperature is associated with decreased percentage germination in *C. tora,* the seeds of *C. obtusifolia,* on the other hand, are apparently indifferent to storage temperature (in the range of —15°C to 30°C). This demonstrates the flexibility of *C. obtusifolia.* The retention of seed-coat impermeability to a greater extent at low temperature in case of *C. tora* indicates its favour for warmer habitats and a narrowing of optimal conditions. This supports to some extent, at least, the opinion of Irwin and Turner (1960) about the origin of *C. tora.*

SUMMARY

Plants of *C. tora* and *C. obtusifolia* exhibit differential growth performance in nature as well as in cultivation under uniform conditions. Seeds of both the species possess seed-coat impermeability and scarification favours germination. Germinability of seeds of the two species is influenced by storage temperature in different way. While it is decreased by storage at low temperature in *C. tora,* it remains indifferent in the case of *C. obtusifolia.* The study indicates genetic difference in the two species and throws some light on their native home.

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