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Some ecological factors controlling the distribution of the closely related species *Cassia senna* L. and *Cassia italica* Mill. around Khartoum area in the Sudan

M. TAG EL-SEED AND A. M. A. ISMAIL*

Department of Botany, Faculty of Science,
University of Khartoum, Khartoum, Sudan

ABSTRACT

The absolute and relative growth rates of *Cassia senna* and *C. italica* were compared. The species responded differently to the various combinations of soil types and water regimes and the association between this and their behaviour under natural field conditions is discussed.

INTRODUCTION

Harper *et al.* (1961) stated some prerequisites for the successful occurrence of closely related species together in the same area: (a) the species must tolerate the hazards which occur in the area in which they live together particularly the length of the growing season and excess or deficit of water supply, (b) the species must differ in at least some aspects so that they do not enter a struggle for existence in which one succeeds at the expense of the other. Both *Cassia senna* and *C. italica* are widespread in the Sudan. The former species is an important medicinal plant as both leaves and pods are used as purgatives (Dalziel 1937) and the latter species has been reported (Watt & Gerdina 1962) as toxic to stock.

It is generally accepted that plant growth and distribution is primarily controlled by climatic factors and secondarily by edaphic factors. A close relationship exists between the plant cover and the type of soil (Smith 1944) and this relationship is related partly to the mechanical composition of soils (Smith 1949; Black 1968).

Cassia senna and *C. italica* may occur in nature together or separated. In the Sudan *C. senna* occurs separately near the banks of the Blue Nile. In the gravel desert and where the floor cover is sand both species are associated. The two species are also associated in the deeper layers of the sand drift ecosystem of the Omdurman desert. This association is also observed in 'khors' (wadis) where the two species are confined to the undergrowth layer of vegetation. It has also been observed (Menniger 1952) that most of the *Cassia* species grow well on relatively poor soil and survive wind storms with little damage. *Cassia senna* is reported by Imam (1957) in the Nubian gravel desert

* Present address: Department of Botany, Faculty of Science, University of Qatar, P.O. Box 2713, Doha, Qatar, Arabian Gulf.

which is an example of an extremely arid desert where several years may pass without rain. Its distribution is probably influenced by the intensity of human interference. Halwagy (1962b) reported that *C. senna* grows well when the vegetation is disturbed, especially if the disturbance is due to grazing to which it is resistant. Within the desert and semi-desert habitats *C. senna* and *C. italica* seem to have their different microhabitats which are largely determined by soil type.

A large amount of literature now exists on the relation between soil water regimes and the growth of many different plant species and it is clear that the availability of water and the plant-soil interactions that affect this availability are major factors in the growth and survival of plants (Veihmeyer & Hendrickson 1950; Stanhill 1957; Troughton & Drew 1980). According to Wellensiek (1957) high soil moisture (plants watered every 2 days) results in a regularly increasing stem length and number of flowers, whilst low soil moisture (plants not watered until after first wilting) causes an irregular increase in stem length. In arid and semi-arid regions where rainfall is scanty, the effect of soil type seems to be highly effective in determining the amount of soil moisture.

A study into the effect of the interaction of soil type and water regime on the growth of the closely related species *C. senna* and *C. italica* inhabiting these areas seems to be highly relevant in understanding the distribution, competitive abilities and habitat preferences (mainly edaphic) of these two species.

MATERIALS AND METHODS

Experiment 1. Investigation of the interaction of soil type and water regime on the growth of *Cassia senna* and *C. italica*.

Cassia senna seeds were collected from Soba area and those of *C. italica* were collected from a nearby site from the Blue Nile Bank. Four soil types—all collected from the area around Khartoum—where either or both species were growing naturally, were used. They included: (1) a heavy clayey soil, (2) a gravel sandy soil, (3) a coarse sandy soil, and (4) a soft sandy soil.

Four watering frequencies were tried: (1) watering daily (water regime I), (2) watering every 2 days (water regime II), (3) watering every 5 days (water regime III), and (4) watering every week (water regime IV).

Cassia italica seeds were soaked in absolute alcohol for 6 hr and then thoroughly washed, while *Cassia senna* seeds were immersed in running water for 1 hr, to break their dormancy. Twenty seeds of each species were sown in 9-in clay pots and the pots were watered daily (500 ml of water per pot). After emergence and establishment (15 days from sowing) the seedlings were thinned to five per pot and the water regimes then commenced. Seeds were sown on 11 October, 1978 and the first harvest was taken on 3 January, 1979. The experiment included three replicates in a randomised block design, i.e. 96 pots were used. The experiment was conducted in a 'rakuba', a partially shaded, artificially lit greenhouse, to prevent dust but allow the prevailing atmospheric conditions.

Experiment 2. Investigation of the growth rates of *Cassia senna* and *C. italica*.

Seeds from the same lot used for the previous experiment were used in this investigation. To obtain a good homogeneous emergence the seeds were treated with absolute alcohol and water as explained in the previous experiment. Fifteen seeds of

each of the two species were sown in 7-in clay pots filled with a soil mixture of equal portions of sand, clay and humus. After emergence, these were subsequently thinned to five plants per pot. The experiment included three replicates and five sequential harvests (after 1, 2, 4, 6 and 8 weeks) and was conducted in a 'rakuba' as before.

RESULTS

Experiment 1. Results are shown in Fig. 1 which presents the dry weight yields of the plant species in response to the interaction of the various soil types and watering frequencies.

(a) The responses of the different species.

(i) *Cassia senna.* It appears that this species gave the best yield when watered daily (water regime I) in the 4 soil types. This was followed by the yield of water regime II, then water regime III and the lowest yield was recorded when watering was carried out weekly. The only aberrant yield was that of the clay

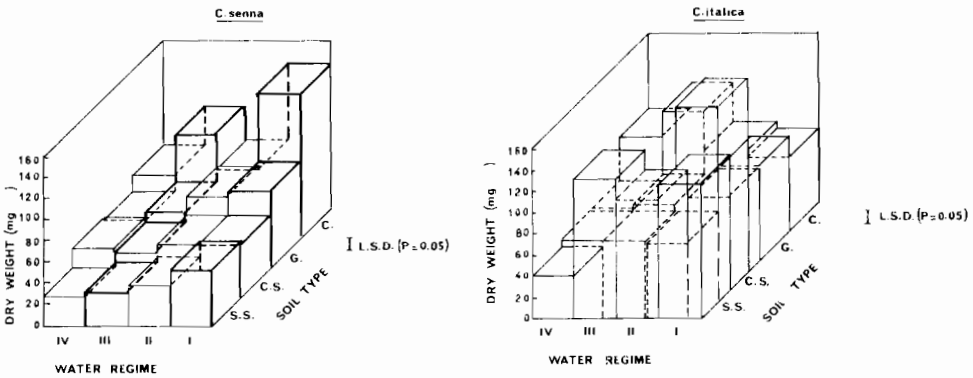

Fig. 1. The response of *Cassia senna* and *C. italica* to the different types of soil and frequencies of irrigation.

soil under water regime III. As for the effect of the soil type is seems to vary with the water regime. For water regime I the order of dry matter production was clay > gravel > soft sand = coarse sand. For water regime II the order was gravel = clay > coarse sand > soft sand. For water regime III the order of yield was clay > gravel > coarse sand > soft sand. For water regime IV the order of yield was clay > coarse sand = gravel > soft sand.

(ii) *Cassia italica.* For this species the effects of the water regime and soil type seem to be highly interdependent. The yield seems to be a function of the interaction of soil type and water regime more than a function of each factor alone. The order of dry matter production for the different water regimes could be summarised as follows:

Water regime I: soft sand > coarse sand = gravel > clay, water regime II: gravel > soft sand > clay > coarse sand, water regime III: soft sand > clay > gravel > coarse sand, water regime IV: clay > coarse sand > soft sand = gravel. The order of yield for the soil type is as follows:

Gravel	water regime	II > I > III > IV
Clay	water regime	III > IV > II > I
Soft sand	water regime	III > I > II > IV
Coarse sand	water regime	I > II > III > IV

Table 1 a & b shows the effect of these individual factors on each of the two species.

Table 1a. The effect of soil type (order of performance on different soil types)

Cassia senna	*Cassia italica*
clay[a]*	soft sand[a]*
gravel[b]	clay[b]
coarse sand[c]	gravel[c]
soft sand[c]	coarse sand[c]

* Values in a column sharing a common letter do not differ at $P=0{\cdot}05$.

Table 1b. The effect of watering frequency

Species	Order of water regime preference
Cassia senna	I, II, III, IV
Cassia italica	II, I, III, IV

Experiment 2. Results for the absolute and relative growth rates are given in Table 2. The relative growth rate (RGR) was calculated from the formula

$$\text{RGR} = (\log_e W_2 - \log_e W_1)/(t_2 - t_1)$$

where W_2 is the dry weight at time t_2 and W_1 is the dry weight at time t_1.

Table 2. The relative growth rate (mg/mg/day) for *Cassia senna* and *C. italica*

	Species	
Harvest period	*Cassia senna*	*Cassia italica*
1st–2nd	0·050	0·061
2nd–3rd	0·066	0·660
3rd–4th	0·118	0·103
4th–5th	0·042	0·065

DISCUSSION

The ecological factors affecting the distribution of vegetation round Khartoum have been previously studied (Halwagy 1961, 1962a, 1962b; Greig-Smith & Chadwick 1965; Mahmoud & Obeid 1971; Obeid & Mahmoud 1971); our present investigation is an extension of their work.

The absolute growth rate of the two *Cassia* species was the same until the sixth week after emergence. At the final harvest *Cassia italica* recorded a higher dry weight than *C. senna* and this was attributed to the earlier flowering and pod setting of *C. italica*. The results of the second experiment conform well with the habitat preference of the two species under investigation. *C. senna*, widely distributed in the clay soils near the Blue Nile bank, gave its maximum yield on the clay soil under daily watering. The observation of Imam (1957) that this species is dominant in the Nubian gravel desert is also reflected on its performance on the gravel soil (highest response after clay, Table 1a) under all water regimes. The species could also establish itself in a sandy soil under different moisture conditions. This seems to explain its distribution and association with *Panicum turgidum* Forsk. (a moncot) in favoured spots of the sand drift ecosystem of the Omdurman desert which receive greater sand accumulations.

The association of *Cassia italica* with *C. senna* in the sandy soil round Omdurman is well reflected in its highest performance on soft sand (Table 1a). The association of *C. italica* with *C. senna* in most of its habitats especially the relatively drier ones can be seen in its response to the clayey and sandy types of soil and the first and second regimes of watering (Table 1b), yet this species seems to be more adapted to drier conditions than *C. senna*.

Overall the results are consistent with the geographical distribution of these two species in the arid and semiarid zones of the tropics and subtropics where these species are found. The vegetation in these areas is scarce and the plants are endowed with certain characteristics which enable them to live in these habitats with their various hazards including scarcity and inconsistency of rainfall. The results are consistent with those of Harper *et al.* (1961) and Diver (1936) who indicated that groups of closely related species frequently live together in similar, if not identical, ecological conditions.

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دراسة العوامل البيئية التى تؤثر في توزيع نوعين من جنس كاسيا (كاسيا سنا وكاسيا اتاليكا) حول منطقة الخرطوم بالسودان

ميرغني تاج السيد و أحمد محمد على اسماعيل *
قسم النبات بكلية العلوم ، جامعة الخرطوم
الخرطوم ، السودان

خلاصة

تمت دراسة بيئية مقارنة لنوعين من جنس كاسيا (كاسيا سنا وكاسيا اتاليكا) ، وتم احضار أنواع التربة المختلفة التى ينمو عليها النوعان ـ احدهما أو كلاهما ـ من البيئة الطبيعية الى صوبة زراعية (راكوبا) ، وأجريت على النوعين تجارب لقياس معدل النماء في انواع التربة المختلفة وتحت أربعة نظم للري .

لوحظ في النهاية ان النوعين يمكن ان يعيشا معا في نفس البيئة وان يستفيدا من العناصر البيئية المتاحة طالما انهما لا يتناحران بشكل يؤدى الى نجاح نوع منهما على حساب الاخر وذلك لاختلاف معدلات نمو النوعين .

* العنوان الحالي : قسم النبات بكلية العلوم ، جامعة قطر ، الدوحة ، قطر .