The 5-striped squirrel, *F. pennanti,* shows a diploid number of 54[2,3]. *F. p. bellaricus* shows the same diploid number. However, it has 2 biarmed chromosomes less and 2 acrocentric chromosomes more than *F. pennanti.* X chromosomes of both are large biarmed chromosomes but the Y chromosome of *bellaricus* is a large subacrocentric unlike the small acrocentric Y chromosome of *F. pennanti.*

Assuming the modal number for the genus *Funambulus* to be 2n=46, *F. tristriatus* would appear to have arisen first and the other 4 species subsequently in the following order: *pennanti, palmarum, sublineatus* and *lyardi*[4]. Rao et al.[4] further state that the karyotype of *F. pennanti* seems to have arisen from that of *F. tristriatus* through the mechanism of centric fission. In the present case, however, it is difficult to ascertain the presumed Robertsonian changes with any precision.

Chromosomes are utilized in rodent taxonomy as characters for diagnosis and as a means for establishing phylogenetic relationships[9]. For instance, chromosomes are diagnostic in tree and flying squirrels of the genera *Sciurus, Tamiasciurus* and *Glaucomys*[10]. At times, even subspecies may be differentiated by their chromosomes as in the case of the ground squirrel, *Spermophilus richardsonii*[11] and in the present report. Thus, concerning the phylogenetic relationships in the genus *Funambulus,* chromosomes can possibly be used as indicators at specific and infraspecific levels.

1 We thank Prof. G.T. Tonapi for providing the laboratory facilities and the Zoological Survey of India, Western Regional Station, Pune for identifying the specimens.
2 V.L. Chopra and R.A. Pai, Nature, Lond. *207,* 1110 (1965).
3 V.K. Sharma, S.R.V. Rao and V.C. Shah, Indian J. exp. Biol. *8,* 249 (1970).
4 S.R.V. Rao, S.C. Lakhotia and S.C. Jhanwar, Proc. natl Acad. Sci. B *38,* 8 (1973).
5 K.L. Satya Prakash and N.V. Aswathanarayana, Curr. Sci. *42,* 284 (1973).
6 J.R. Ellerman, in: The fauna of India, 2 edn, vol. 3, p. 219. Ed. M.L. Roonwal. Zoological Survey of India, Calcutta 1961.
7 Some of the specimens are deposited at the ZSI, WRS, Pune.
8 M. Raymond Lee, Stain Technol. *44,* 155 (1969).
9 C.F. Nadler, in: Comparative mammalian cytogenetics, p. 277. Ed. K. Benirschke. Springer, New York 1969.
10 C.F. Nadler and D.A. Sutton, Experientia *23,* 249 (1967).
11 C.F. Nadler, Chromosoma *15,* 289 (1964).

Inhibition of germination in *Striga* by means of urea

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Summary. In vitro seed germination percentages and radicle lengths of *Striga hermonthica* markedly decreased in the presence of urea at concentrations which could be expected in the field after standard application rates. Relatively high concentrations of ammonium sulphate brought about a similar effect while sodium nitrate was ineffective.

Striga species are very troublesome parasitic weeds which, especially in the Sahel area, cause great losses in the yields of the staple crops sorghum, millet and maize. Control is very difficult as considerable damage has been done to a host plant before the parasite emerges above the soil. Therefore handweeding, or chemical control, for example with 2,4-D, are not very effective. Moreover, the seeds remain viable for many years and only germinate in the presence of a germination stimulant(s), which occurs in the root exudate of host plants and certain non-host plants. *Striga* is particularly a pest of low fertility soils and usually the infestation decreases if nitrogenous fertilizers are applied[2-8]. However, it is unknown which stage(s) in the life cycle of the parasite is affected.

We have found that urea, at concentrations which may be expected to occur in the field after standard application rates, markedly inhibits in vitro seed germination of *S. hermonthica.* This is not only seen in the germination percentage, but also from the length of the radicles. In the presence of ammonium sulphate, at concentrations which were relatively high from an economic point of view, there was also a marked inhibition of the radicle length, while sodium nitrate was ineffective at the concentrations tested.

The seeds of *S. hermonthica* (Del.) Benth. which were used in the present study, had been collected in 1978 in Wad Medani in the Sudan and were received in February 1980 from Dr S.O. El Hiweris of the University of Khartoum. They were stored in our laboratory in the dark at a temperature of 5 °C and a relative humidity of approximately 70%. A synthetic germination stimulant, GR-24, was obtained from Dr A.W. Johnson of the University of Sussex, Brighton, UK.

The experiments were carried out in 9 cm diameter Petri dishes in an environmental chamber at 25±2 °C in the dark. During the conditioning period (14 days) as well as during the germination test (2 days) the seeds were exposed to various concentrations (pure laboratory chemicals were used) of urea, $(NH_4)_2SO_4$ and $NaNO_3$ (as well as NaCl in order to check any effect of salts). The pH was adjusted to 6 respectively 7.5 with 0.001 M KH_2PO_4/NaOH buffer. This

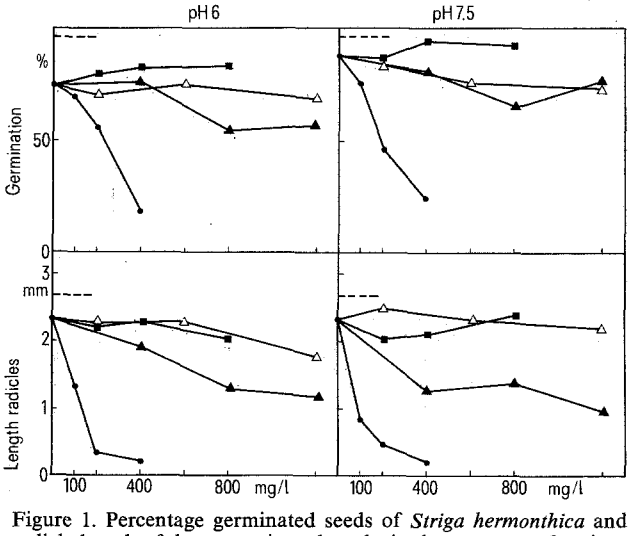

Figure 1. Percentage germinated seeds of *Striga hermonthica* and radicle length of these germinated seeds, in the presence of various concentrations of ● Urea ▲ $(NH_4)_2SO_4$, ■ $NaNO_3$ and △ NaCl added to a 0.001 M KH_2PO_4/NaOH buffer solution.
---- Germination percentage and radicle length when seeds were exposed to demineralized water only.

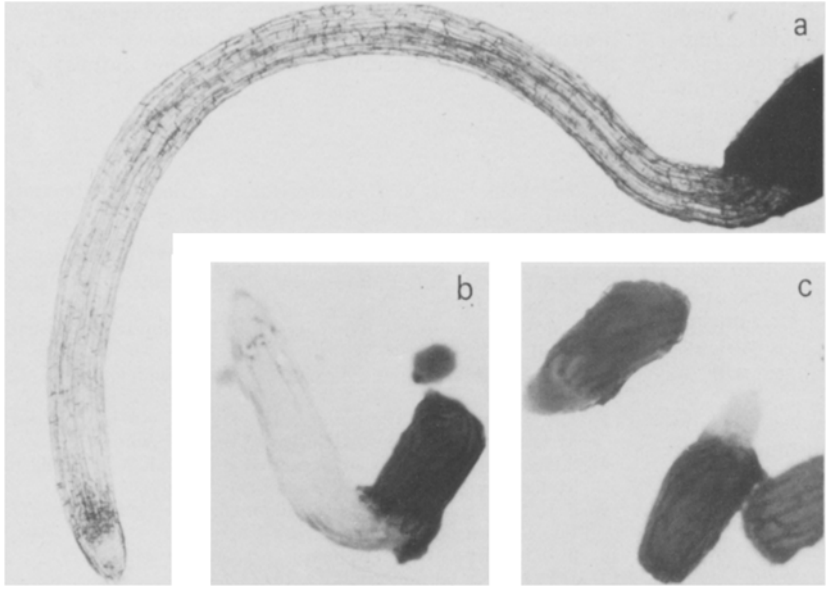

Figure 2. Germinated *Striga hermonthica* seeds in the absence of urea (a), in the presence of 200 mg/l urea (b) and in the presence of 400 mg/l urea (c). Note the differences in the length of the radicles. × 75.

was the lowest concentration with a sufficient buffering capacity to keep the pH during the experiments constant i.e. slightly acid or slightly alkaline.

The methods which were used for conditioning and germination of the seeds were similar to those described earlier[9,10]. The seeds were placed on moist 8 mm discs of glass fiber filter paper (about 25 seeds per disc) and subsequently these discs were arranged on 2 layers of Whatman No. 1 filter paper wetted with 8 ml of test solution (5 discs per Petri dish). The discs with conditioned seeds were transferred to wetted (with 40 µl water) 0.5–1 cm wide rings of filter paper cut from 9 cm diameter Whatman No. 1 papers (5 discs per Petri dish). Subsequently each disc was moistened with 20 µl of test solution supplemented with 1 mg/l of GR-24. Germination and radicle length (radicle length of 5 germinated seeds per disc, if available, taken at random) were assessed with the help of a low power binoculair microscope.

The results are presented in figure 1. It is evident that both under acid and alkaline conditions, urea markedly inhibits germination as well as the length of the radicles at concentrations of 200 mg/l and higher. At 500 mg/l the percentage of germinated seed was as low as 18% in slightly acid conditions and 23% under slightly alkaline conditions. In the absence of urea these values were 73% and 88% respectively. The length of the radicles was only 0.2 mm in the presence of 400 mg/l urea (both pH 6 and 7.5) whereas in the absence of urea the length was 2.3 mm. As a consequence, if the seeds germinate in the presence of 200 mg/l and higher concentrations of urea, the potential of the radicles to reach a host plant root is considerably reduced.

In figure 2 germinated seeds are shown which had been exposed to 0.001 M buffer solution (radicles normally developed), 0.001 M buffer solution supplemented with 200 mg/l urea (development of radicles markedly inhibited) and 0.001 M buffer solution supplemented with 400 mg/l urea (development of radicles almost completely inhibited) respectively. In the presence of relatively high concentrations of $(NH_4)_2\ SO_4$ on radicle length was more pronounced, both under acid and alkaline conditions, but to a markedly lower degree than with urea.

$NaNO_3$ and NaCl had no significant effect at the concentrations tested. Germination percentage and radicle length in buffer solution were slightly lower than in demineralized water; however, these differences were not significant. Concentrated buffer solutions (0.05 M and higher) had an inhibiting effect on germination but in the field such extremely high phosphate values are not feasible.

The results suggest that relatively low concentrations of urea, which could certainly be expected to occur in the soil after a standard application rate of about 100–200 kg/ha of urea, might be used to decrease *Striga* infestation. As a consequence it could be of great economic interest to use urea instead of other nitrogenous fertilizers in areas where *Striga* is a problem. In this context it should be noted that in the Sahel countries urea is less expensive than most other nitrogenous fertilizers, as transport costs play an important role (N content of urea, being 45%, is relatively high).

It is not clear by which mechanism urea brings about its effect. It is not merely a decrease in the growth rate of the radicles as after an extended period of time (up to 10 days) the length of the radicles did not increase in the presence of 200 and 400 mg/l urea. Thus far a similar phenomenon has not been described in other plants. If ammonium groups are involved, the difference between the effects of urea and $(NH_4)_2SO_4$ is remarkable. In addition, it remains to be investigated whether in the field the beneficial effect of nitrogen manuring could be exclusively attributed to an inhibition of seed germination of *Striga*. Experiments concerning this aspect are currently being carried out in the greenhouse.

1 Address for reprint request: A.H. Pieterse, Royal Tropical Institute, Department of Agricultural Research, Mauritskade 63, NL-1092 AD Amsterdam (The Netherlands).

2 G.H. Egly, Weed Sci. *19*, 528 (1971).
3 F.T. Last, Ann. appl. Biol. *40*, 207 (1960).
4 C. Parker, Proc. Acad. nat. Sci. *11*, 99 (1965).
5 K. Wilson Jones, Nature *172*, 128 (1953).
6 S.A.J. Tarr, Ann. appl. Biol. *49*, 347 (1961).
7 N.T. Yaduraju, M.M. Hosmani and T.K. Prabhakara Setty, in: Proc. 2nd Int. Symp. Parasitic Weeds, Raleigh, USA, p.285. Eds L.J. Musselman, A.D. Worsham and R.E. Eplee. North Carolina State University, Raleigh 1979.
8 A.E. Younis and K.A. Agabawi, Acta biol. hung. *15*, 361 (1965).
9 C. Parker, A.M. Hitchcock and K.V. Ramaiah, in: Proc. 6th Asian Pacific Weed Sci. Soc. Conf., Jakarta, p.67. Eds M. Soerjani, D.E. Barnes and T.O. Robson. The Asian-Pacific Weed Science Society, Bogor 1977.
10 D.C. Reid and C. Parker, in: Proc. 2nd Int. Symp. Parasitic Weeds, Raleigh, USA, p.202. Eds L.J. Musselman, A.D. Worsham and R.E. Eplee. North Carolina State University, Raleigh 1979.