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SEED PRODUCTION STUDIES IN RUZI GRASS

(*Brachiaria ruziziensis* Germain and Everard)

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of the requirement for the

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ABSTRACT

SEED PRODUCTION STUDIES IN RUZI GRASS

(*Brachiaria ruziziensis* Germain and Everard).

The effect of photoperiod on seed production in Ruzi grass (*Brachiaria ruziziensis*) was investigated in order to gain a better understanding of reproductive behaviour. The experiment was conducted in a controlled temperature glasshouse which provided day and night temperatures of $25^{\circ}\text{C} \pm 5$. Plants were raised from seed obtained from Thailand. During the early stage of growth (10 days after germination) Ruzi grass plants were exposed to controlled photoperiods of 14, 13, 12 or 11 hours for a period of 30 days followed by exposure to the decreasing natural daylength occurring in the New Zealand autumn.

The results of this experiment showed there was no "trigger" daylength requirement for reproductive initiation, since Ruzi grass was able to produce flowers in all daylength treatments (14, 13, 12 and 11 h). However, the data did show that the shorter the daylength, the greater the seed yield (i.e. potential seed yield was greatest at 11 h). Accordingly, the results confirm the conclusion of Dirven *et al.*, (1979), that Ruzi grass is a quantitative short-day plant.

The results of this study appear to contradict the reproductive behaviour of Ruzi grass in Thailand, where a critical daylength of approximately $12\frac{1}{2}$ h to trigger reproductive development seems necessary. These results suggest that it is

theoretically possible for Ruzi grass to produce seed over the entire range of daylengths which occur in Thailand, as recorded in this experiment. The fact that this does not occur is possibly due to a juvenility problem, as the plants are only 4-6 weeks old after the onset of the rainy season in late April/early May when the daylength is approximately 13 h, and due to drought conditions which occur in December under the shortest daylength of approximately 11½ h. However, this needs to be confirmed, possibly by conducting trials in Thailand under an 11½ h daylength with irrigation to overcome lack of water.

Daylength strongly affected inflorescence numbers and inflorescence components. As daylength declined the number of racemes/inflorescence arising from basal tillers tended to decrease. This was accompanied by a corresponding increase in aerial tiller numbers. Floret number/raceme was a more important factor influencing seed yield than raceme number/inflorescence.

Basal reproductive and vegetative tiller numbers were not significantly affected by daylength, although aerial reproductive tillers did increase as daylength declined. Total tiller numbers were low, even although they continued to show a steady increase through to harvest, when approximately 30% were reproductive and 70% vegetative. Ruzi grass produced more inflorescences from aerial tillers than from basal tillers.

The morphological changes occurring during the changeover from vegetative to reproductive development were divided into five stages. The time required from

early raceme initiation in the "double ridge" stage to inflorescence exertion was 22 days.

It appears that Ruzi grass does not have a characteristically prolonged anthesis within an individual inflorescence, as all anthers were exerted within 1-2 weeks. Despite this, approximately 80% of florets within an inflorescence completed anthesis in 7 days. Within individual inflorescences, anthesis began in the middle region of the uppermost raceme and subsequently extended to the upper and lower raceme(s). Ruzi grass exhibited a prolonged head emergence period of about 3 months which was highly variable both within and between individual plants.

Seed development studies suggested that although some variation in the extent and timing of seed shedding may occur between plants, harvesting should not be carried out before 20-25 days after anthesis (maximum viability), and should not be delayed longer than 30 days after anthesis (maximum dry weight).

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GENERAL INTRODUCTION

Ruzi grass (*Brachiaria ruziziensis*) is now the dominant pasture grass used in Thailand for beef, and especially for dairy production. The area sown has increased rapidly over the past decade, due to its ease of establishment, its high quality forage and its relatively high seed yield. However, although seed production has increased from 18 tonnes in 1983 to 466 tonnes in 1991 (Phaikaew *et al.*, 1993), demand continues to outstrip supply, and it is therefore important to promote and encourage Thai farmers to produce adequate quantities of high quality seed. Currently, around 2700 farmers are involved in seed production programmes under government schemes with each contracted to grow 0.32 ha of Ruzi grass for seed at a guaranteed price of US\$ 2/kg (Phaikaew *et al.*, 1993). Accordingly, it is essential that growers improve their understanding of this species in terms of development, crop management, environmental response, and factors affecting seed yield, in order to increase and improve the yield and quality of Ruzi seed in the future.

The present study on Ruzi grass was divided into four sections, as follows:

1. The effect of photoperiod on seed production
2. Morphological changes from the vegetative to the reproductive stage
3. Flowering pattern, floret fertility and seed shedding
4. Seed development

GENERAL DESCRIPTION OF THE SPECIES

Brachiaria ruzizensis Germain and Everard is synonymous with *Brachiaria eminii* Mez (Skerman and Riveros, 1990) and has been renamed *Brachiaria decumbens* var. *ruzizensis* comb. nov. by Ndabaneze (1989). However, *Brachiaria ruzizensis* is still the most widely used botanical name.

The species is known under various common names depending on the countries in which it is grown. These include: Kennedy ruzi grass (Australia), Congo Signal grass (Africa), prostrate Signal grass (Kenya), and Ruzi grass (Thailand). The names 'Ruzi grass' and *Brachiaria ruzizensis* are used in this study.

Ruzi grass originated from the Lake Edward and Lake Kivu districts of Rwanda, Burundi and the Ruzizi plains in Zaire but is now widely distributed throughout the tropics (Skerman and Riveros, 1990). It is regarded as a pioneer species of cleared rain forests in Africa, providing an important grazing species in the wetter tropics (Skerman and Riveros, 1990).

Descriptions of the morphological features of Ruzi grass have been made by Bogdan (1977), Whiteman (1980) and Skerman and Riveros (1990). It is a spreading perennial with short rhizomes, similar in habit to Para grass (*Brachiaria mutica* (Fork.) Stapf). The inflorescence consists of dense and spike-like racemes. The spikelets are all sessile and close together, the rachis of the racemes winged, broad and over 3 mm wide. The lower glume is under half the length of the spikelet

which is hairy (Harker and Napper, 1960). It has softer leaves than *Brachiaria brizantha* and is leafier than *Setaria sphacelata* (Schum) Stapf and Hubbard (Deinum and Dirven, 1976).

Many characteristics of Ruzi grass are similar to *B. decumbens* (Humphreys and Riveros, 1986). However, one of the obvious differences between the two species is the mode of reproduction, *B. decumbens* being tetraploid and an obligate apomictic (Humphreys and Riveros, 1986) while *B. ruzizensis* is a diploid with 18 chromosomes and cross-fertilization occurs at a very high frequency under conditions of natural open pollination (Ferguson and Crowder, 1974). Seed-set averages 21 and 0.4% for open-pollination and self-pollination respectively, suggesting the operation of a self-incompatibility mechanism. Similarly, CIAT (1972) reports that *B. ruzizensis* clones when cross-pollinated, averaged 30% of spikelets with a caryopsis, but only 0.5% when selfed. Skerman and Riveros (1990) and Bogdan (1959a, 1965a), state that Ruzi appears to be apomictic.

Being a tropical species, its season of growth is during the rainy season in the so-called summer or warmer period of the year, with an optimum temperature of 33°C day and 28°C night (Deinum and Dirven, 1972). Plant growth is stimulated by increasing temperature which leads to lower protein content and lower digestibility of organic matter in leaves and stems. Temperature also has a direct negative effect on stem digestibility, apart from its effect on stem development (Deinum and Dirven, 1976). Low temperatures, as found by Ludlow (1976), adversely affect the growth rate of this species.

Rattray (1973) reported that Ruzi grew successfully in an altitude range of 1000 - 2000 m above sea level in Kenya and up to 1200 m in Panama. It is most productive under an average annual rainfall of about 1000 mm and can endure hot dry spells (Skerman and Riveros, 1990), and hence is described as drought resistant. It will not, however, withstand flooding or frost.

To achieve high dry matter production Ruzi grass requires a soil of relatively high fertility and good drainage, but performs well on a wide range of soil types. It will tolerate acid soils and also responds well to nitrogen, either from fertiliser or legumes, but has a higher requirement than Guinea grass (Mellor *et al.*, 1973b). Yonken *et al.*, (1986) showed that application of phosphorus did not lead to improved yield of Ruzi grass on feratic soils but suggested that about 50 units of P_2O_5 /ha would seem necessary to maintain production on non-feratic soils. On the Adamawa plateau of the Cameroons, Pamo and Pieper (1989) showed that nitrogen fertilization in combination with phosphorus and potassium increased the productivity of Ruzi grass and recommended that a fertilizer rate of between 60 and 90 units of nitrogen/ha be applied after each cutting, with a single application of 100 units of triple superphosphate and potassium sulphate/ha at the beginning of each rainy season. This response was obtained under a 30 day cutting frequency.

Associations with legumes such as *Centrosema pubescens* (Mellor *et al.*, 1973a), *Stylosanthes humilis* (Falvey, 1976), *C. pubescens* and *Macroptilium atropurpureum* (Nitis *et al.*, 1976) have all proved successful. However, Ruzi was grouped into the least shade-tolerant species along with *Setaria sphacelata*

cv.Kazungula, *B. decumbens* cv.Transvala. These compare with *P. maximum* cv.Common, *P. maximum* cv.Tanganyika, *Digitaria setivalva* and *B. decumbens* which are regarded as more shade-tolerant grasses (Wong *et al.*, 1985).

Seed dormancy is generally high in freshly harvested seed, because of an impermeable seed coat (Davidson, 1966; McLean and Grof, 1968). The period of seed dormancy is normally 4 to 6 months, but can extend to 18 months if the seed is stored at low temperature (Devahuti and Sirisomparn, 1985). Seed dormancy can be broken by treating the seed with concentrated sulphuric acid for 15 minutes (Barnard, 1969) which can increase germination from 17 to 40% (McLean and Grof, 1968), or by mechanical scarification (Jones, 1973).

Ruzi grass is the most widely used grass species grown in Thailand because of its ease of establishment and its relatively good forage quality (Phaikaew and Pholsen, 1993) and is normally sown at 15-25 kg/ha. Bogdan (1964) recommended that the seed be sown at a depth of 2 cm and in rows 60 cm apart, but it can be broadcast over the land after scarification of the soil with a disc harrow or brushcutter, without burning the native pastures (Risopoulos, 1966). However a well prepared seed bed is highly recommended for best results (Skerman and Riveros, 1990).

Ruzi grass is suitable not only as a green forage but also as hay and silage, and is very palatable to stock. In Thailand, Ruzi grass is commonly used for both forage and seed production, with the success of seed production being dependent on

the cessation of grazing and closing of the pasture for seed production at the correct time, normally towards the end of August (Phaikaew, *et al.*, 1985).

Dry matter production of Ruzi grass can vary considerably, depending on rainfall, fertility conditions and management. In Tanzania, dry matter yields of 21,159 kg/ha have been recorded (Naveh and Anderson, 1967), and at South Johnstone, (North Queensland) Grof and Harding (1970) recorded dry matter yields of 19,500 kg/ha under a six week cutting interval and an input of 220 kgN/ha/annum. In Sri Lanka dry matter yields of 16,807, 22,031 and 25,585 kg/ha/year were obtained with nitrogen applications of 112, 224 and 366 kg N/ha (Appadurai, 1975).

For seed production, farmer yields of 400 kg/ha are commonly achieved in Thailand where repeated hand harvesting is practised (Phaikaew, *et al.*, 1993), compared with a yield of 125 kg/ha in Queensland and 200 kg/ha in Zaire (Risopoulos, 1966) where harvesting is a single machine operation. Like other tropical grasses, Ruzi exhibits a prolonged flowering period with uneven ripening of seed on individual inflorescences and quick shedding of seed when ripe (Boonman, 1971a; Hare and Waranyuwat, 1980; Phaikaew and Pholsen, 1993).

In Thailand, Devahuti *et al.*, (1986) showed that the flowering period of Ruzi grass occurred from October to November, with peak flowering near the end of October. At 10 days after flowering, about 5% of seed was shed and this had increased to 60% when the seed reached physiological maturity, approximately 3

weeks after flowering.

As shown in work on harvesting times by Phaikaew *et al.*, (1986), 15-20 days after 50% of seedheads had emerged was the best compromise to achieve both high seed yield and good quality. Seed can be harvested either by hand shaking for small scale production or cutting of seedheads for large scale production (Phaikaew, 1989). In Queensland, a tractor-mounted buffel type seed harvester is often used but yields are lower than by hand harvesting (Davidson, 1966).

Phaikaew *et al.*, (1987) found that a single cut of seedheads followed by 2-3 days "sweating" produced lower quality seed, compared with the daily shaking of seedheads.

In Queensland, Australia 15% germinable seed and 40% purity are required for commercial sale (Skerman and Riveros, 1990).

Ruzi grass is relatively free of disease and pest problems (Skerman and Riveros, 1990).