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A STUDY OF THE EFFECTS OF PLANT SPACING AND IRRIGATION ON SEED PRODUCTION AND SEED DEVELOPMENT IN SIRATRO (*Macroptilium atropurpureum*)

A THESIS PRESENTED IN PARTIAL
FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE
OF DOCTOR OF PHILOSOPHY IN SEED TECHNOLOGY
AT MASSEY UNIVERSITY
PALMERSTON NORTH
NEW ZEALAND

SUNANTA JUNTAKOOL

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ABSTRACT

Since 1980 the Thai government has been interested and active in increasing livestock production by improving the productivity and quality of natural and sown grassland. The introduction of forage legumes, particularly Siratro (*Macroptilium atropurpureum*), is one of the ways in which this can and is being achieved.

The present study was carried out in two parts - the first involving two field trials conducted in Thailand during the wet and the dry season, and the second involving a controlled climate study at Palmerston North (N.Z.). The aim of the field trials was to investigate the effects of plant spacing, and during the dry season the effect of irrigation on Siratro seed production. In the controlled climate study a more detailed investigation was undertaken of the effects of water stress on plant growth and development and subsequent effects on seed yield. Particular attention was also given to relevant aspects of seed development in the latter study.

Irrigation during the dry season produced relatively small but significant increases in plant dry weight and LAI and led to a significant increase in seed yield by the final harvest 40 days after peak flowering. By comparison, plant spacing had a marked effect on plant components and seed yield showing a negative response on a per plant basis but a positive response on a per unit area basis with increasing plant density.

During the longer growing period of the wet season experiment, plant growth was substantial and again showed the same significant responses to increasing plant density stated above. Maximum seed yield per hectare was achieved at very high plant population densities approximately 15 x 15 cm spacings.

The major contributions to seed yield in both trials were inflorescence numbers and especially pod numbers, reflecting their sensitivity

to water stress and plant competition. Numbers of seeds per pod and individual seed weight were relatively insensitive to those environmental factors.

The growth room study clearly showed that early and extended soil moisture stress can cause a severe reduction in plant weight, branch development, leaf number and LAI, leading to a significant reduction in seed yield. However, soil moisture stress imposed at peak flowering resulted in a significant increase in seed yield compared with adequate moisture to final harvest. This beneficial effect was again due mainly to the increase in the number of inflorescences and pods formed on the primary and particularly the secondary branches. Numbers of seeds per pod and individual seed weight were again unaffected by water stress.

The development of Siratro seed followed two obvious phases viz the growth and food reserve accumulation phase and the ripening phase. Water stress reduced the time from anthesis to seed maturity and increased the percentage of hard seed at harvest when imposed early at the mid-vegetative stage.

Plant spacing and irrigation had little or no effect on seed quality characteristics of Siratro, as quality appeared to be more dependent on stage of maturity. High seed quality can be achieved by harvesting Siratro 20 - 30 days after peak flowering.

The possibility of growing Siratro for seed production in Thailand is also discussed.

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SIR ATRO
INFLORESCENCE

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INTRODUCTION

Although about half of the world's grazing animals are found in the tropics, most ruminant production is carried out on natural grasslands rather than on sown pastures. This is one reason why there is such a low animal output per unit area from many tropical pastures (Humphreys, 1978). In these natural grasslands, dominated by a wide range of graminaceous species, both the quantity and quality of the herbage sets a limit to production. The quantity produced is often severely limited by climate and by the low nitrogen availability of the soils, while pasture quality is influenced by both low crude protein content and the characteristic growth pattern of grasses which form the bulk of the diet. As a result, animal production is limited by the low nitrogen content and low digestibility of the feed for a considerable period of the year. Particularly during the dry period, this leads to low dry matter intake and low growth rates in grazing animals.

One reason for the poor nutritive value of many tropical pastures is the low proportion of high producing legumes in the sward. Although legumes may occur in abundance in some tropical grazing lands, edible herbaceous legumes do not usually improve yield or nitrogen status. For example, Humphreys (1978) stated that native legumes such as *Indigofera enneaphylla, Glycine* spp. and *Zornia diphylla* have been shown to contribute only 0.3 - 4.0% of the feed on offer in native grasslands and represent yields which seldom exceed 50 kg/ha.

Certainly the introduction of potentially high yielding legumes into natural grasslands can add nitrogen to the soil as well as providing herbage with an increased protein and nitrogen content (Jones *et al*, 1967), digestibility (Minson and Milford, 1966) and yield (Kretschmer, 1972). Such introductions have resulted in equally dramatic increases in animal production (Norman and Phillips, 1970). Shaw and 't Mannetje (1970) reported that the combination of fertilizers and a suitable tropical legume resulted in almost a doubling of liveweight gain per head and a sixfold increase in animal liveweight per hectare from

improved native grassland. This beneficial effect of the legume in promoting animal liveweight gains has been confirmed by many scientists (Norman and Stewart, 1964; Stobbs, 1965) even at relatively high stocking rates (Norman, 1970).

Perennial pasture legumes give a longer sequence of feed production than annual legumes. They are also often capable of fixing larger amounts of nitrogen than annuals. A number of perennial legumes have been found to produce acceptable amounts of high quality herbage in association with grasses and have shown persistence under grazing pressure. In Thailand generally, and in the North-east Region in particular, a number of perennial legumes have shown promise for pasture improvement. Amongst these, Siratro (*Macroptilium atropurpureum*) has been very successful. Although it is a relatively new pasture legume to Thailand, its use since it was first introduced in 1962 has greatly increased (Wickham, 1976). Since 1962 Siratro has been used in many pasture improvement projects particularly at Khon Kaen University (Annual Report 1976-1980) and in land development at Borabu, Mahasarakham province. Such early work provided important information on the value and potential of forage legumes for increasing animal production from native grasslands in Thailand and justified the associated and subsequent research on forage legume seed production (Wickham, 1976; Wickham *et al*, 1980; Hare and Waranyuwat, 1980).

An important aspect of the more general acceptance and usage of pasture legumes in Thailand is the extent to which reliable supplies of high quality seed can be maintained at reasonable prices. In many tropical countries seed supply has been a major constraint to pasture development. Accompanying this has been the need to develop seed production skills, commercial processing and seed quality controls as the basis of an efficient seed industry. Certainly with the wider use of tropical grasses and legumes by village farmers and government organisation in North-east Thailand, seed production has increased dramatically in importance. Currently seed and pasture production have a special place in nearly all livestock development projects in Thailand (Hare and Waranyuwat, 1980).

The present studies on Siratro seed production were therefore initiated in an attempt to add to the background of knowledge on the growth and development of this species. It was hoped that the results of such a study might be useful as the basis of recommendations and assistance to Thai farmers.

The study was divided into two main sections - a field experiment designed to study the effects of plant spacing on seed production following dry season and wet season plantings, and a controlled environment experiment designed to study Siratro growth and development under differing levels of water stress.

In particular, the objectives of the field study, carried out in Thailand, were:

1. to study the effects of plant spacing on seed production in terms of both seed quantity and quality;

2. to study the effects of irrigation on seed production with particular reference to a dry season planting;

3. to compare the performance of this crop sown at two different times of the year to determine the more suitable sowing time for Siratro seed production in Thailand.

The objectives of the controlled environment study, carried out in New Zealand, were:

1. to examine the role of water stress on plant growth and subsequent seed development and yield;

2. to study the effect of water stress imposed at different stages of growth on reproductive development and the components of seed yield;

3. to follow the sequence of seed development with particular reference to seed yield and quality.

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