ผลกระทบของการปลูกยูคาลิปตัสบนคันนาต่อพืชไร่ที่ปลูกในนา [1]

Effects of Paddy – Bund – Planted Eucalyptus Trees on Performance of Field Crops.

ABSTRACT

Many fast growing trees of the genus ***Eucalyptus*** are already grown throughout Northeast Thailand in forest areas, public lands, private plantations and farmers' fields and planting is continuing at a rapid rate. The mature wood is used for fuel, production of charcoal, paper-pulp and construction purposes. In order to satisfy farmer demand for fuelwood, and construction, NERAD has been producing seedlings of a number of tree species the past 5 years for distribution to villagers for planting on their own land. The dominant species used was ***Eucalyptus camaldulensis*** which found favor with the farmers for planting on their paddy bunds due to its hardy nature, drought and waterlogging tolerance and erect canopy structure which reduced shading of the paddy crops. Eucalypt planting on the bunds began in 1982 and is still continuing and the current age-structure of the tress varies from seedlings right through to 5 year old trees, 30 metgers tall with trunk-girths of up to 25 centimeters in diameter. Utilization to date has been restricted to limited use of branches for crop-staking, fuelwood and charcoal. In 1987, poor growth was reported by farmers and field assistants in the pre-rice kenaf and peanut trials in the vicinity of mature ***Eucalyptus*** trees. Data on crop performance were collected throughout the plant growth period for both early season crops and the wet season rice crop. Pre-rice, kenaf crop-growth was markedly reduced in the vicinity of the trees, and the effect extended for a distance for a distance of up to 20 meters into the crop. Plants close to the eucalypts were stunted and failed to thrive. Plants close to the eucalypts were stunted and failed to thrive. The addition of higher rates of fertilizer did not compensate for reduced growth caused by the eucalypts, and cutting the trees did not solve the problem, at least in the short-term. In the case of peanuts, growth was retarded, maturity delayed and germination was reduced up to 15 meters from the trees. Both kenaf and peanut plants further away from the trees appared normal. The yields of both crops were markedly reduced with increasing proximity to the trees. Yields of the following rice crops were also reduced by the presence of eucalypts but in a less consistent manner. The available evidence tends to indicate that soil moisture relationships are at least party responsible for the effects observed. This does not rule out other factors however, as the soil moisture effect may be interacting with other components such as nutrient availability, allelopathy, etc. Further research designed specifically to identify the key processes involved is required and economic studies to quantify the costs and the benefits of the eucalypts are also needed.

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บทคัดย่อ

ยูคาลิปตัส เป็นต้นไม้โตเร็วที่กำลังนิยมปลูกกันทั่วไปในภาคตะวันออกเฉียงเหนือของประเทศไทย ไม่ว่าจะเป็นพื้นที่ป่า (สงวน) ที่สาธารณะ, ที่ดินส่วนบุคคล ตลอดจนตามไร่-นาของเกษตรกร การปลูกยูคาลิปตัสนับวันแต่จะเพิ่มจำนวนขึ้นเรื่อย ๆ ยูคาลิปตัสที่โตได้ที่แล้วจะนำไปใช้เป็นเชื้อเพลิง, เผาเอาถ่าน และทำเยื่อกระดาษ ตลอดจนนำไปก่อสร้าง

เพื่อเป็นการตอบสนองของเกษตรกรในการหาไม้มาทำเป็นเชื้อเพลิง และสร้างที่อยู่อาศัยนั้น โครงการพัฒนาการเกษตรอาศัยน้ำฝนภาคตะวันออกเฉียงเหนือ (NERAD) จึงได้เพาะชำต้นกล้าไม้โตเร็วสายพันธุ์ต่าง ๆ แจกจ่ายให้ชาวบ้านไปปลูกในที่ดินของตนเองเป็นเวลากว่า 5 ปีมาแล้ว สายพันธุ์ที่แจกมากที่สุด ได้แก่ ต้น ***Eucalyptus camaldulensis*** ซึ่งต่อมาพบว่าเกษตรกรชอบนำไปปลูกไว้ตามคันนา เนื่องจากเป็นพันธุ์ที่แข็งแรงทนแล้งทนน้ำท่วมขังได้ และโครงสร้างของลำต้นก็โปร่งบางเป็นที่กำบังแดดให้แก่ข้าวกล้าได้น้อย การปลูกยูคาลิปตัสไว้ตามคันนานั้นได้เริ่มมาตั้งแต่ ปี พ.ศ. 2525 จนกระทั่งถึงปัจจุบันนี้ นับเป็นเวลาได้ 5 ปีแล้ว จนยูคาลิปตัสที่ปลูกไว้มีลำต้นสูงถึง 30 เมตร วัดรอบลำต้นจะได้เส้นผ่าศูนย์กลาง 25 ซม. ส่วนการที่จะนำต้นยูคาลิปตัสมาใช้ประโยชน์นั้น ก็มีขอบเขตกำจัด เช่น นำมาใช้เป็นเสาเข็ม ทำเป็นเชื้อเพลิง และเผาถ่าน

เมื่อปี พ.ศ. 2531 ได้รับรายงานจากเกษตรกรและเจ้าหน้าที่ประจำภาคสนามเกี่ยวกับพืชก่อนข้าวคือ ปอแก้ว และถั่วลิสง ที่ทดสอบปลูกในบริเวณใกล้เคียงกับต้นยูคาลิปตัสที่โตเต็มที่แล้ว ปรากฏว่าการเจริญเติบโตของพืชดังกล่าวช้ากว่าปกติ เพราะฉะนั้นจึงได้จัดเก็บข้อมูลในพืชก่อนข้าวและข้าวที่ปลูกตามมา ปรากฏว่าปอแก้วที่ปลูกก่อนข้าวเจริญเติบโตช้าลงอย่างเห็นได้ชัด มีผลกระทบเป็นระยะทางถึง 20 เมตร จากต้นยูคาลิปตัสต้นพืชที่ได้รับผลกระทบจะมีอาการแคระแกรน และชะงักการเจริญเติบโตไปด้วย แม้ว่าอัตราการใส่ปุ๋ยจะเพิ่มปริมาณมากกว่าเดิมก็ตาม ก็ไม่ทำให้ต้นพืชที่ได้รับผลกระทบจากต้นยูคาลิปตัสเจริญเติบโตขึ้นเลย และการตัดต้นยูคาลิปตัสทิ้งก็ไม่ได้แก้ปัญหาในช่วงสั้น ๆ ได้อีกเหมือนกัน ในกรณีถั่วลิสงก็เหมือนกันคือ โตช้า, ฝักแก่ช้า และความงอกลดลง ในช่วงที่ห่างจากต้นยูคาลิปตัสระยะ 15 เมตร ตรงกันข้ามปอแก้วและถั่วลิสงที่ปลูกในระยะห่างออกไปจากระยะที่กำหนดดังกล่าวจะงอกงามและเจริญเติบโตเป็นปกติ ผลผลิตของพืชทั้งสองก็เหมือนกันยิ่งปลูกใกล้ต้นยูคาลิปตัสมากก็ยิ่งลดลงมาก ส่วนผลผลิตข้าวที่เป็นพืชปลูกตามมาก็จะลดลงเหมือนกัน เฉพาะบริเวณใกล้ต้นยูคาลิปตัสแต่ปริมาณการลดลงจะน้อยกว่า

จากข้อมูลที่ได้มาชี้ให้เห็นว่าการแย่งความชื้นในดินของต้นยูคาลิปตัส เป็นสาเหตุส่วนใหญ่ที่ทำให้เกิดผลกระทบ อย่างไรก็ตามเรื่องนี้ควรจะพิจารณาปัจจัยอื่น ๆ ประกอบด้วยเพราะว่าผลกระทบเกี่ยวกับความชื้นในดินมีความสัมพันธ์กับความมีประโยชน์ของธาตุอาหาร และสารพิษ (ALLELOPATHY) เป็นต้น การวิจัยคงจะต้องมีต่อไปอีก โดยเฉพาะอย่างยิ่งเพื่อค้นหา กระบวนการที่สำคัญ ๆ เกี่ยวกับผลกระทบดังกล่าว และการศึกษาในเชิงเศรษฐศาสตร์ เพื่อคำนวณหาค่าใช้จ่ายและผลประโยชน์ที่จะได้รับจากต้นยูคาลิปตัส น่าจะถือว่าเป็นเรื่องจำเป็นเหมือนกัน

INTRODUCTION

There is an increasing body of evidence within NERAD that indicates the presence of a potential problem with the paddy-bund-planting of *Eucalyptus*. The problem is developing in the NERAD site in Utumpornpisai district of Sri Saket and involves a negative effect of *Eucalyptus* trees on rice and field crops planted in nearby fields.

There is currently much debate in both the popular press and in the scientific community as to the *pros* and *cons* of *Eucalyptus* production in Thailand. Unfortunately, there is very little quantitative information available on the costs and benefits of *Eucalyptus* planting in different agro-ecological environments in Thailand. It is not the purpose of this report to take on side or the other in the current debate, but rather to document the information available within NERAD concerning the problem, and to provide quantitative data to the agencies best equipped to consider its implications and to conduct the detailed research that will be necessary if the problem proves to be serious.

The findings reported here are based solely on observations and monitoring from NERAD's cropping system trials. The research was not specifically designed to study the effect of the *Eucalyptus*. on field crops and the data obtained have not been subjected to rigorous statistical analysis. As a result, the findings cannot be considered conclusive but they do indicate the presence of a potentially serious problem that warrants futher study.

BACKGROUND AND IMPORTANCE

Farmers in Northeast Thailand traditionally grow and maintain trees on their paddy bunds. Many different species are cultivated, and they perform a variety of functions useful to the farm system. These paddy-tree systems vary from area to area but four distinct stages of paddy-tree system development have been identified by Grandstaff, **et al.** (1986)

The first stage represents the conversion of forested or partially forested areas to paddy fields. This stage is characterized by felled stumps and a few remaining trees on the paddy floor with many trees still left on the bunds and on termite mounds. as tree clearing proceeds in stage two, fewer trees are left and they are nearly all located on the bunds. During. this stage, tree regeneration is still usually controlled by the farmer. In the next stage, as surrounding forested areas are cleared and paddy tree thinning continues, timber and fuelwood become scarce and the trees remaining are actively preserved and new ones are allowed to regenerate. The final stage is similar in appearance to stage 3 but most of the trees have been planted puposefully, mainly on the bunds, and these include many shrub-type species.

Trees in the rice fields are used by local farmers for a number of purposes including timber for construction, shade for humans and livestock, food, medicine, livestock fodder, fuelwood, charcoal production, poles for fencing and crop-staking and soil fertility conservation (Grandstaff **et al.**, 1986). The property of multiple-use is reflected in the diversity of tree species found in the tree-paddy systems which comprise many native species and also introduced species, especially in those systems in the later stages of development.

DEFINITION OF THE PROBLEM

All the NERAD project sites have trees in the paddy land, but the tree-paddy system in Tambons Tae and Taket, Amphur Utumpornpisai, Changwat Sri Saket are the longest developed and represent the final stage, as previously described in the first section of this report. In this area of Sri Saket, no forest or significant tracts of common land remain and timber and tree products are in short supply. Agriculture in general is relatively well developed and commercially oriented with significant areas of pre and post rice crops grown for sale in the nearby market centers. Consequently, wood and tree products are in high demand for the staking of yard-long beans and cucumbers, for fuel, construction-purposes and for fencing off-season crops.

In order to address this wood-shortage problem, NERAD has been producing seedlings of a variety of tree species for distribution to villagers for planting on their own land because, unlike other project sites, there are no significant areas of public land for the communal raising of trees. The dominant tree species used were of the genus *Eucalyptus* which found favour with the farmers for planting on the paddy bunds because of their hardy nature, drought and water-logging tolerance and erect canopy structure which reduced shading of the paddy crops. Eucalypt planting on the bunds began in 1982 and is still continuing. The current agestructure of the trees varies from seedlings right through to 5 year old trees which are 30 meters tall, with trunk diameters of up to 25 centimeters. Utilization to date has been restricted to limited use of the

branches for crop staking and fuelwood.

NERAD has also been developing cropping system technologies by conducting on-farm research and extension trials in farmers' fields. In a number of cases, these trial-plots coincide with fields that have also been border planted with eucalypts. For the first three years of tree growth no effect on crop production was discernible, however, starting in the 1986 rice crop, farmers noticed a detrimental effect on rice plants in the vicinity of trees of four or more years in age. A similar but larger detrimental effect was observed in the pre-rice-season field crops in 1987 by both farmers and Department of Agriculture researchers. Some farmers were sufficiently convinced of the severity of the problem to begin cutting down the eucalypts; others were aware of the detrimental effects but waited for guidance from NERAD Project officials before making a decision on whether to fell the trees.

The fields where the problem has been observed represent a very small proportion of the area actually planted to eucalypts and occur only where trees have reached four to five years of age. However, if the poor crop performance observed proves to be related to the presence of *Eucalyptus*. on the paddy bunds, then its impact can be expected to increase significantly as the large number of younger trees already planted begin to mature. Depending on the local specificity of the agroecological factors that combine to produce the effect, the problem could have an impact over the whole of the Northeast where significant paddy-bund-planting of eucalypts has already occurred.

PROBLEM ANALYSIS

The crops first observed to be affected by the presence of *Eucalyptus* were kenaf (Plate 1), peanuts and rice, but the effect has now also been observed in rice, cassava, corn, vegetable and fruit tree crops. The first effects were observed on two plots each of kenaf and peanuts in June 1987 where mature eucalypts were growing on the bunds of cropping system research plots. Similar effects were not noticeable on nearby plots of the same trial, where only immature or no trees were present. Crop performance in these fields was satisfactory suggesting that the effect was not due to adverse climatic conditions or pest damage.

Plate 1 Showing the effect of *Eucalyptus*. on crop growht of Kenaf.

Although detailed pest sampling was not conducted, no noticeable differences were observed in pest incidence in plants adjacent to the trees and those far away, and most plots received similar rainfall during the growing period. Affected kenaf plants appeared stunted and maturity was delayed. In the case of peanuts, seed germination also appeared to be significantly reduced in areas adjacent to the *Eucalyptus* (Plate 2). Plants further away from the trees appeared normal and healthy although leaf yellowing was observed in patches which was attributed to nutrient stress, however, this was not correlated to the distance from the eucalypts.

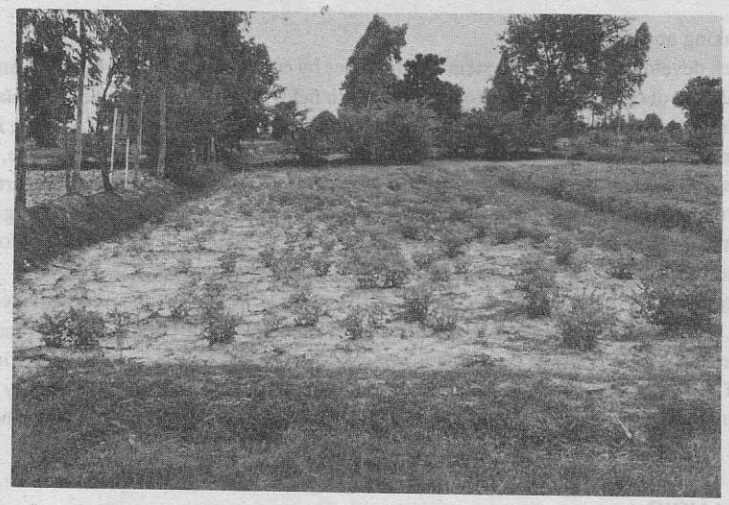

Plate 2 Showing the effect of ***Eucalyptus*** on peanut crop growth.

Data on crop performance of peanut and kenaf at various distances from the trees was collected on the 2nd July, 1987 when the kenaf was approximately 90 days old and the peanut was at the podfilling stage. Plant height measurements were taken at regular intervals along randomly selected transects at right angles to the tree line, and visual observations were made of the entire plot and crop performance was recorded in relation to position of the ***Eucalyptus*** and other trees on the surrounding bunds. The data for plant height of 3 kenaf crop-transects at right angles to the tree-line and a control transect taken parallel to the tree-line are compared in Figure 1.

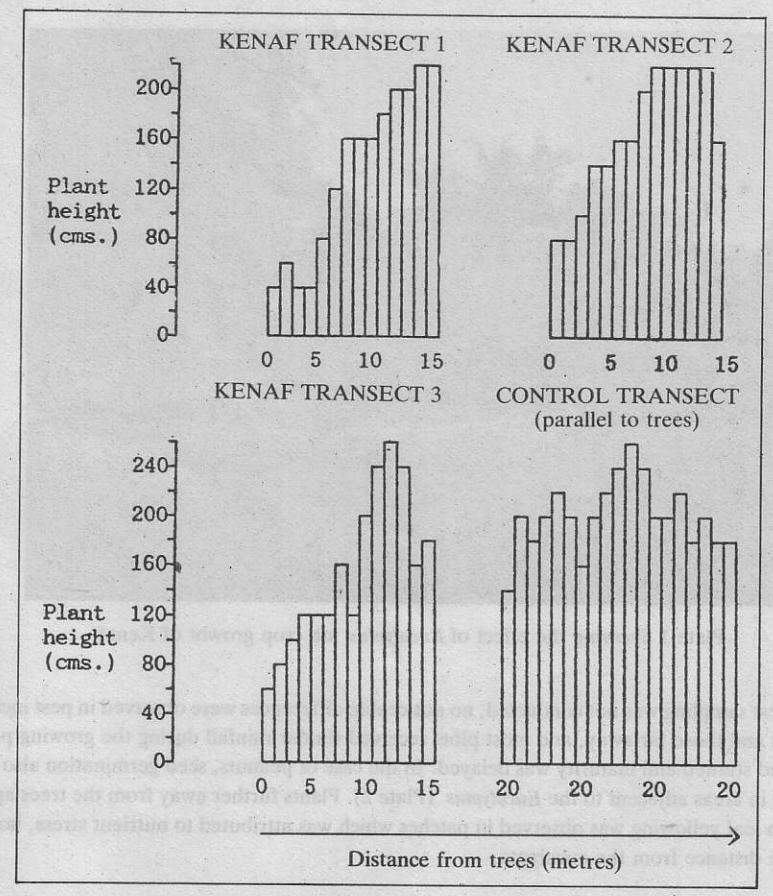

Figure 1. Effect of Eucalyptus on kenaf plant height at 90 days.

As can be seen, plant height decreases with increasing proximity to the eucalypts and the effect of the trees extends for up to 15 metres. One row of *Eucalyptus* trees also contained a mature mango tree. Interestingly, crop performance did not appear to be affected by the mango tree even though, due to its canopy architecture, it exerted a much larger shading effect on the nearby kenaf plants (Plate 3). Kenaf germination appeared uniform throughout the plot, with no discernible effects from the eucalypts.

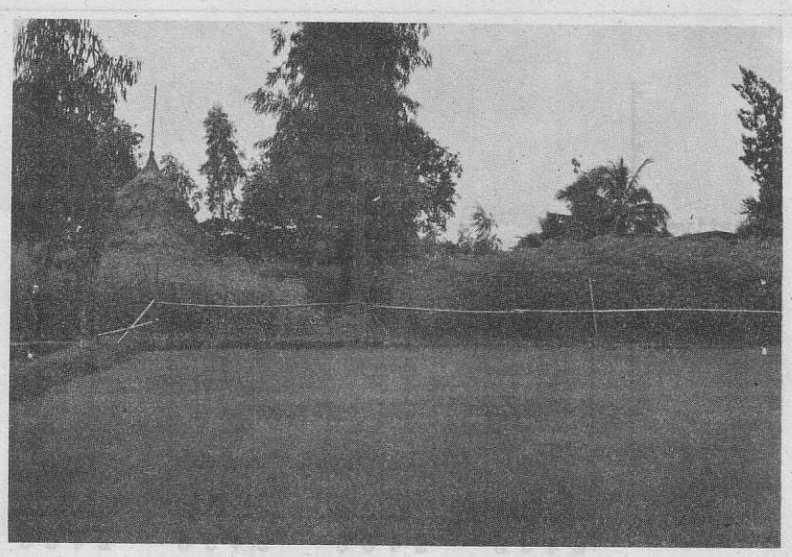

Plate 3 Showing the comparative effect of *Eucalyptus* and Mango trees on crop growth of Kenaf.

The layout of the component technology treatments in one trial plot enabled some conclusions to be drawn on the interaction of applied fertilizer with the effect of the eucalypts (Figure 2).

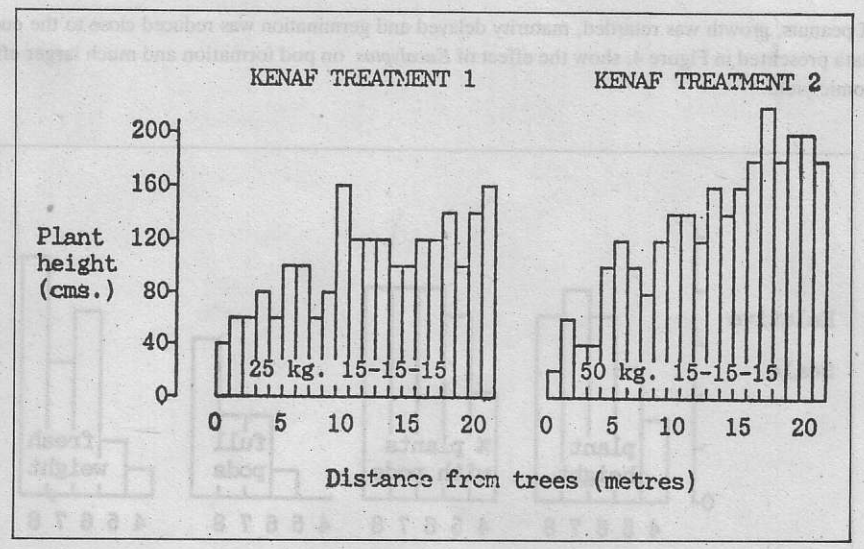

Figure 2. Effect of fertilizer on kenaf yield-reduction from *Eucalyptus*

As can be seen from the Figure, the addition of higher rates of fertilizer does not appear to compensate for reduced growth close to the eucalypts. If anything, the effect is more pronounced at the higher fertilizer rate. In this plot a number of the eucalyptus trees had been cut by the farmer approximately 6 months previously, and although they had begun to regenerate, total leaf area and above-ground biomass was still very small. There was, however, no apparent reduction in the effect of

these felled trees on Kenaf growth, thus indicating that cutting the trees does not solve the problem, at least in the short-term. Yield component data taken at harvest time (Figure 3), show that the effect of *Eucalyptus* on plant height of kenaf is maintained throughout the entire period of crop growth. Total crop-biomass (fresh weight) is also reduced with increasing proximity to the trees and this is even more marked for economic yield (dry fibre). The trees did not appear to have an effect on plant stand which was close to 100 percent throughout the plot.

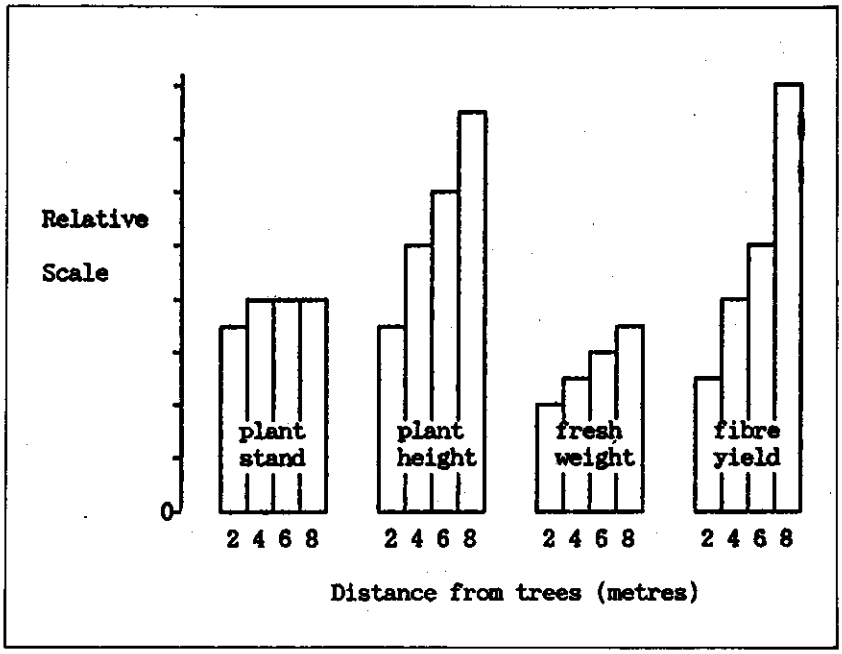

Figure 3. Effect of Eucalyptus on the yield components of kenaf.

In the case of peanuts, growth was retarded, maturity delayed and germination was reduced close to the eucalypts. Yield component data presented in Figure 4, show the effect of *Eucalyptus* on pod formation and much larger effects on seed-set and economic yield.

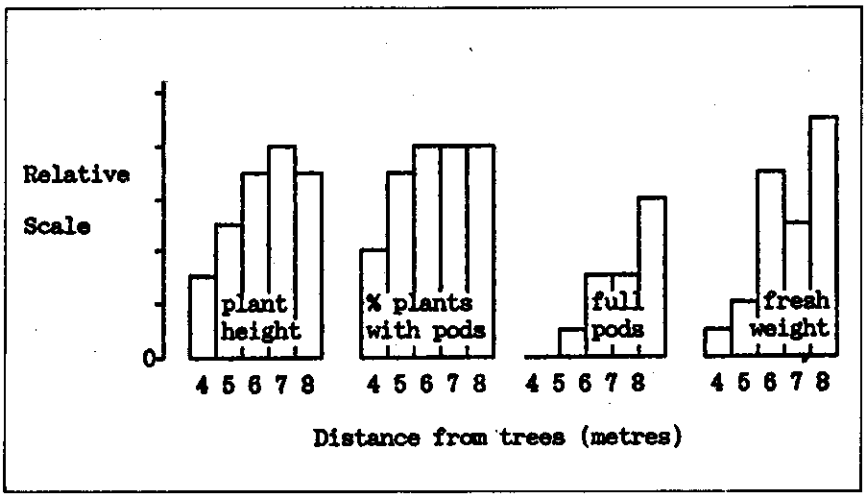

Figure 4. Effect of Eucalyptus on the yield components of peanut.

As was the case for kenaf, the addition of fertilizer did not appear to compensate for the effect of *Eucalyptus* on peanut growth, but there is evidence to suggest that soil moisture availability is involved in the effect of the trees on peanut. One affected peanut plot showed compensatory crop growth after a heavy rain shower which replenished soil moisture to field capacity. Other plots did not receive any rain and the effect of the *Eucalyptus.* remained pronounced in these fields. This tends to indicate that maintaining available soil-moisture can help to overcome the effect.

Crop performance data for the rainy-season rice crop were also collected from the kenaf and peanut plots at harvest time. Total rice biomass, plant height and grain yield were measured at two-metre intervals from the trees along three, randomly-selected, metre-wide transects from each of four affected fields. The individual results obtained were somewhat variable, and less consistent than for the upland crops, but the mean data demonstrate an overall trend of decreasing yield with increasing proximity to the eucalypts (Figure 5).

Various hypotheses on the detrimental effect of *Eucalyptus* to the crop growth environment can be found in the scientific literature and the popular press. These hypotheses include an increase in water run-off and soil erosion, reduction in available plant nutrients, competitive shading, reduction in available soil moisture and lowering of the water table, soil acidification and production of plant toxins and allelopathic effects on seed germination and plant growth (Davidson, 1985; Rice, 1974; Moral **et al.**, 1969 and 1970; Poore **et al.**, 1985).

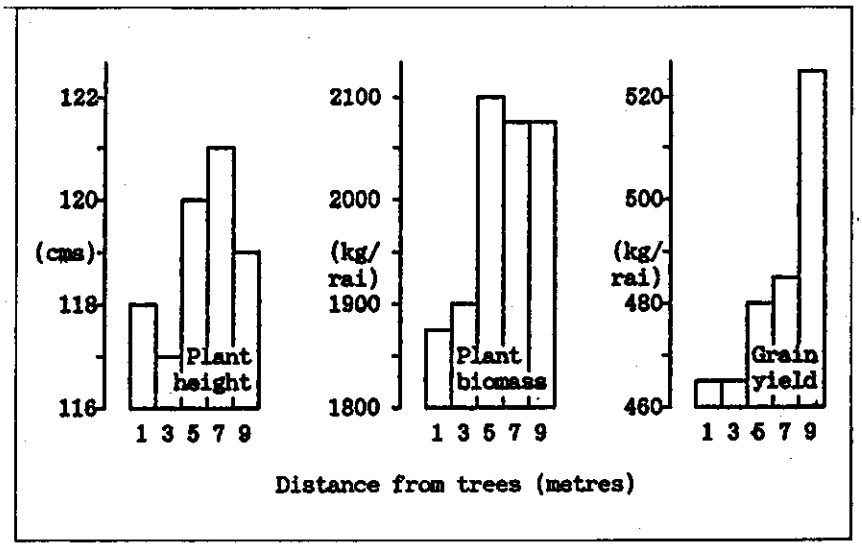

Figure 5. Effect of Eucalyptus on some yield components of rice.

Compensatory growth by an affected peanut crop after a localized rain-shower and the fact that there was a less consistent effect of the eucalypts on the wet season rice crop in which good water control was maintained throughout most of the growing season, tends to indicate that soil moisture relationships are at least partly responsible for the effects observed. This does not rule out other factors however, as the soil moisture effect could be related to problems such as nutrient-stress, allelopathy, etc.

FURTHER RESEARCH REQUIRED

The potential problem described in this document will continue to be monitored and studied within the NERAD Project. In addition, the suitability of alternative species for paddy-bund-planting will be explored. Further work is also needed ot quantify both the costs and benefits (economic, environmental and social) of the paddy-bund-planting of eucalypts in order to assess whether the cost in terms of lost crop production reported here does in fact out-weigh the benefits from the wood produced.

The potential for developing systems of eucalypt production that avoid or reduce the problem also needs to be explored. In this respect, there is a need for research on systems of rotational ratooning of eucalypts before the problem develops and research on the use of alternative species of *Eucalyptus* However, adaptive research of thsi nature on ways of overcoming the problem, will only be possible after the source of the problem has been clearly identified. The NERAD project does

not have the expertise nor the resources necessary for the detailed research needed to identify the source of the problem. This will require detailed, interdisciplinary research by foresters, agronomists, soil scientists, crop micro- climatologists, hydrologists, micro-biologists, and social scientists from all relevant agencies in the Thai Ministry of Agriculture.

CONCLUSIONS

The production of wood using the genus ***Eucalyptus*** is a potentially valuable technology for Northeast Thailand if properly planned and implemented in those conditions for which it is ecologically and economically suited. However, the evidence presented here tends indicate that one of the current systemes of ***Eucalyptus*** planting, namely on the paddy bunds, is detrimental to the current agricultural production systems of some Northeastern agroecosystems. Because of the already widespread and continuing promotion of this practice throughout the Northeast, there is an urgent need for further research to assess the situation and produce guidelines for defining those conditions for which ***Eucalyptus*** planting is both an ecologically and economically sound practice for meeting the needs of the local population.

The situation where this problem has been observed represents only a very small proportion of the total area already planted to ***Eucalyptus*** in the region and tends to occur where the trees have reached four to five years of age. However, if the poor crop performance observed proves to be due to the presence of ***Eucalyptus*** on the paddy bunds, then its impact can be expected to increase significantly as the large number of younger trees planted extensively throughout the Northeast begin to mature.

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