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Effects of Tree Leaf Litter and Shading on Growth and Yield of Paddy Rice in Northeast Thailand

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ABSTRACT

Earlier results have shown that a tree standing on rice paddy bund enhance soil fertility close to tree base as a result of leaf litter produced, but the higher soil fertility did not translate into higher rice yield relative to the rice grown away from the tree. Shading was deduced to be the cause of low rice yield. The objectives of this study were to determine the effects of quantities of leaf litter and levels of shading on rice growth and yield. A field experiment was conducted with 3 levels of shading, (0-no shading, 20% shading and 50% shading), and 4 levels of leaf litter from *Dipterocarpus obtusifolius* (i.e. 0, 3.75, 7.50, and 11.25 tons ha^{-1}). The experiment was arranged in split plot design with shading as the main plot and litter quantity as the subplots. There were 4 replications. Each experimental unit was 2x2 m^2 of bunded plot. RD-6 rice was grown. Shading resulted in decreased rice yield due to the decrease in various yield components and the increase in unfilled grains. However, plant height was increased under shade. Leaf litter brougth about higher rice yield than that without leaf litter. However, the yield increases due to leaf litter were only significant under reduced light condition. It was suggested that trees to be planted on paddy bund should be selected with their canopy characteristics in mind, as shading was proved to be an important factor negatively affecting rice yield.

Key words : leaf litter, shading, rice growth, Northeast Thailand

INTRODUCTION

Trees in paddy fields is a unique agroecosystem of Northeast Thailand. Tree stands are found both on paddy floors and on paddy bunds. The co-existence of trees and rice is acceptable by farmers due to the many uses of the trees in their subsistence way of life such as food, medicine, animal fodder, construction materials and shade (Grandstaff *et al.*, 1986). These trees are mainly the remnants of the once-existing forest and their seedlings naturally regenerated, and some are domesticated trees naturally regenerated or planted by farmers.

Trees have been shown to provide many beneficial effects to agricultural crops grown in association with it as well as to the sustainability of agroecosystem as a whole through soil fertility enhancement, moisture conservation, and erosion control. Leaf litter fall is a mechanism whereby recycle of ecosystem nutrients occurs. Therefore, it is a mechanism which enhance soil fertility. In the rice paddy fields of Northeast Thailand, it has been shown that paddy soil was more fertile in the plot with higher tree density which produced higher quantity of litter fall relative to that with lower tree density (vityakon et al., 1988). However, the effects of trees on reducing agricultural crop productivity through shading and nutrient and moisture competition are seen as an obstacle for agroforestry promotion. An earlier study on effects of trees on paddy bunds on soil fertility and rice growth (Sae-Lee et al., 1992) has shown that trees, especially leguminous tree, increase soil fertility and the effects are more pronounced at positions closer to the tree trunk. however, the growth and yield of rice at positions closer to the trunk were reduced. The reduction effects were more clearly demonstrated in rice grown in association with trees with relatively more spreading and denser canopies. This prompted

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the deduction that shading may be the main effect responsible for rice growth and yield reduction. It is well-grasped that shading is a major negative effects of trees on crop growth which constitute a major obstacle for farmer's adoption of agroforestry (Young, 1989). To confirm effect of shading on rice growth and gaining more knowledge in this respect, further investigation should be conducted.

The present study is a continuation of that of Sae Lee et al. (1992) in which 2 tree factors have been identified as producing opposite effects on rice. The enhancement of soil fertility was to be beneficial to rice growth but it was deduced that the growth was hampered by tree shading. The objectives of this study were to determine the effects of various quantities of leaf litter and various levels of shading on rice growth and yield under controlled treatments of field experiment condition.

MATERIALS AND METHODS

A field experiment was conducted in Khon Kaen Rice Experimental Station in Northeast Thailand. The soil was of Roi Et series (Aeric Paleaquults) which is the most extensive paddy soil of the region.

Table 1 **Chemical properties of Roi Et soil used in the experiment.**

Soil chemical properties	Values
pH (1:1 soil:water)[1]	5.7
Organic matter (g kg^{-1})[2]	3.0
Total N (g kg^{-1})[3]	0.2
Extractable P (mg kg^{-1})[4]	14.4
Exchangeable K (cmol (+)kg^{-1})[5]	0.3
Exchangeable Ca (cmol (+)kg^{-1})[5]	3.0
Exchangeable Mg (cmol (+)kg^{-1})[5]	0.3
Cation exchange (cmol (+)kg^{-1})[6] capacity (CEC)	1.6

1 pH meter.
2 Walkley and Black method (Nelson and Sommers, 1982).
3 Micro-Kjeldahl method (bremner and Mulvaney, 1982)..ls1
4 P was extracted by Bray II solution and determined by molybdenum blue method (Olsen and Sommers, 1982).
5 1 *N* NH_4 OAc pH 7 extraction and elemental determination was by flame photometry for K, and atomic spectrophotometer for Ca and Mg.
6 Cation displacement by NH_4 using 1 *N* NH_4 OAc pH7.

Some properties of the soil are shown in Table 1.

Treatments consisted of 3 levels of shading, (i.e. 0 - no shading, 20% shading - 80% light was allowed, and 50% shading), and 4 levels of leaf litter of *Dipterocarpus obtusifolius* applied, (i.e. o, 3.75, 7.50, and 11.25 ton ha^{-1}). The 20% shade was created using commercial black plastic shade cloth, while the 50% shade was obtained through the use of blue 1x1 mm mesh net shade cloth. Light intensity measuring device was used to quantify the amount of shading resulted from the use of the shade cloths. Chemical compositions of leaf litter are shown in Table 2. The levels of leaf litter were based on the information on quantity of litter fall in high and low density of *Dipterocarpus obtusifolius* stands in paddy fields during the 5-month leaf shedding period of dry season (Vityakon et al., 1988). the experiment was arranged in split plot design with shading as the main plot and litter quantity as the subplots. There were 4 replications.

Each experimental plot (2×2 m^2 in size) was bunded to retain water for paddy. Coarsely ground leaf litter was applied to the plots according to the predetermined rate one day before rice transplanting. They were ploughed into the topsoil layer. Twenty-nine-day-old rice (cv RD-6) seedlings were transplanted into the experimental plot at 20x20 cm spacing. Each plot had 15-cm in height of water. This level of water was maintained for most of the experimental duration except when there were heavy rains and some overflows occurred. The water were drained from the plots at ripening stage. Basal fertilizer at the

Table 2 **Chemical compositions of *Dipterocarpus obtusifolius* leaf litter.**

Chemical compositions (g kg^{-1})	Values
Total N[1]	6.4
Total P[2]	3.2
Total K[3]	1.3
Total Ca[3]	12.5
Total Mg[3]	0.8

1 Micro-Kjeldahl method.
2 Dry ashing and vanado-molybdate method (Cottenie, 1980).
3 Dry ashing and K was determined by flame photometry, while Ca and Mg was determined by atomic absorption spectrophotometry.

rate of 62.5 kg N P K ha^{-1} was applied one week after transplanting.

Twenty-four days after transplanting, shade cloth was installed at predesignated plot at the height of 1.5 meter above ground to provide different levels of predetermined shading.

Rice harvesting was done at 143 days after seedling emergence. The following growth and yield components were measured employing methods of Gomez (1972): plant height, tiller number per hill, % unfilled grain, and grain yield (at 14% w/w moisture content).

RESULTS AND DISCUSSION

The height of rice plant was significantly greater under shading relatively to that under full sunlight condition (Table 3). It has been documented that many agricultural crops responded to reduced light by stem elongation such as Earley et al. (1966) in corn, and Eriksen and Whitney (1981) in Signal grass. The increase in height in response to the reduced light underneath a tree canopy is considered undesirable by farmers of Northeast Thailand, because it can lead to lodging. Lodging besides brings about difficulties in harvesting, if occur when grain filling process is not yet complete, can lead to yield reduction due to increasing number of unfilled grain.

The reduction in various yield components, (i.e. number of tillers and panicle per hill, number of grains per panicle), and the increase in % unfilled grain led to the overall reduction in grain yield under shade (Table 3).

Increasing level of leaf litter applied resulted in significant increase in grain yield over that of the control. In addition, the height of rice plants significantly decreased with increasing level of leaf litter (Table 4). The yield increase was likely to result from improved soil nutrient status brought about by the leaf litter applied.

At high level of shading (50%), increasing levels of leaf litter applied significantly increased grain yield as compared with that without leaf litter. However, at low level of shading (20%) and without shading, leaf litter did not exert significant effect on grain yield (Figure 1). It appears that shading is a more dominant factor controlling growth than leaf litter in this case. This may be because soil fertility

Table 4 Effects of levels of leaf litter applied on growth and yield components of RD-6 rice.

Leaf litter level (ton ha^{-1})	Rice growth and yield[1]	
	Height (cm)	Grain yield (kg ha^{-1})
0	154.9 a	1534 b
3.75	152.1 ab	1825 a
7.50	151.5 ab	1870 a
11.25	150.1 b	1685 ab
LSD (0.05)	4.8	290

1 Means in the same column followed by the same letter are not significantly different at 5% level of probability (Least significant difference - LSD).

Table 3 Effects of shading on growth and yield components of RD-6 rice.

Level of shading (%)	Rice growth and yield component[1]					
	Height (cm)	Tiller/hill	Panicle/hill	Grain/panicle	Unfilled grain (%)	Grain yield (kg ha^{-1})
0 (full light)	147.2 b	4.5 ab	4.4 ab	325.8 a	8.4 a	1884 a
20	154.4 ab	4.6 a	4.6 a	326.9 a	8.2 a	1712 a
50	154.8 a	4.2 b	4.1 b	307.7 b	9.6 a	1589 a
LSD (0.05)	7.6	0.3	0.4	15.8	2.0	341

1 Means in a column followed by the same letter are not significantly different at 5% level of probability (Least significant difference -LSD).

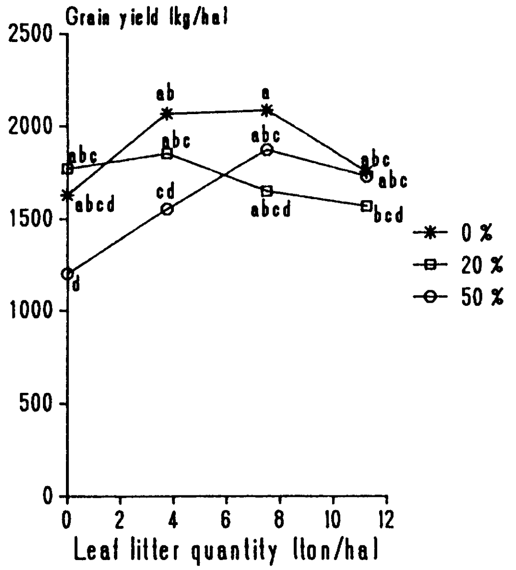

Figure 1 **Effects of levels of shading and quantities of leaf litter on rice grain yield.**

was not a limiting factor in this case.

CONCLUSIONS

The results of this study have confirmed the speculation made by Sae-Lee et al. (1992) on the possible negative effect of shading of tree on paddy bund on rice yield close to the tree base, despite the higher soil fertility at the same position. These results tend to suggest that careful selection of tree types to be planted on paddy bund is necessary. The selection criteria should include canopy characteristics of the trees on top of other ecological and socio-economic criteria.

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