

POTENTIALS FOR SHADE MANAGEMENT IN AGROFORESTRY SYSTEMS FOR TARO CROPPING

S. ROGERS AND T. IOSEFA¹

Fellow in Agronomy, Institute for Research, Extension and Training
University of the South Pacific, Apia, Western Samoa

Abstract

This paper discusses the potential benefits from shade management in agroforestry systems for taro cropping. Trial work to evaluate weed growth, taro production, and cultivar responses to shade levels are reviewed. It is concluded that weed growth can be reduced in tree-shaded plots without reducing corm production. Higher crop biomass is obtained when taro is grown under fifty percent shade compared to full sunlight. Furthermore, there is a shade/cultivar interaction which indicates the need to select cultivars appropriate to the shade levels found in farmers' fields.

Tree shade in agroforestry plots provides a pleasant environment to carry out heavy tasks such as crop planting and weeding, possibly improving productivity from labor.

Introduction

Most people living in the tropics are well aware of the value of shade in the comfort of their daily lives but perhaps not so aware of the potential benefits in crop production systems.

Throughout the Polynesian Islands, taro is grown as the staple food component in a variety of indigenous agroforestry systems. In Western Samoa, it is the main subsistence food and also a major export crop. In these traditional systems, the crop is grown under a wide range of light levels, from full sunlight to heavy shade, but many farmers consider partial tree shade beneficial at planting to improve crop establishment, particularly during drier months.

Work is currently underway in Western Samoa to investigate agroforestry systems intercropping nitrogen-fixing trees with taro. Various zonal and spatially mixed arrangements are being tested with the major objectives of maintaining soil fertility and sustaining crop yields through the addition of green leaf prunings from the trees. In both the traditional and modern systems, shade levels to the crop can be manipulated through tree density and pruning management. The potential benefits of managing shade levels on weed growth, crop production, and the working environment are discussed in this paper. Also considered

is the selection of cultivars appropriate to the light environment.

Effect of Fifty Percent Shade on Growth and Dry Matter Productivity

Isolating shade effects from interacting factors such as tree root competition can be very difficult in agroforestry experiments. One alternative is to carry out experiments using artificial shade to investigate effects on crop productivity and soil biological activity.

Such an experiment to evaluate the response of taro to shade and mulch without tree root interference, where shade was provided by a canopy of sarlon fifty percent shade cloth and mulch was cut and carried from an adjacent plot, was carried out at Alafua (Rogers et al., in press). Results indicated that plant height and leaf area were higher under shade conditions compared to full sunlight. Total plant biomass (dry weight) was also increased by shade, but the percentage of biomass dry weight in the corm was reduced. Corm yields were not effected by shade or mulching in this trial, however, number and weight of plant suckers was increased by both shade and mulch. Corm percentage dry matter, which reflects corm quality, was highest under shade and no mulch conditions and lowest under no shade mulch conditions (Table 1).

Although in this experiment there were no advantages from shade in corm yields, there were more suckers, which often form a secondary harvest and a valuable source of planting material. Also shade-grown plants produced corms with better cooking and taste quality for the Samoan market.

The fact that total plant biomass was increased by shade indicates greater photosynthetic efficiency under these conditions. However, partitioning of assimilates into corm was not enhanced by shade.

It is considered that the vegetative advantages observed under shade conditions may be translated into improved corm yields if the shade is reduced or removed after one or two months of growth, when a good leaf canopy and root system have developed. The greater foliage biomass

Table 1. Effect of shade and mulch on corm fresh and dry weight yield, corm dry matter content, shoot and sucker dry weight yield, total plant biomass, and sucker number of taro.

Sucker Treatment	Corm yield fresh wt. (kg/ha)	Corm yield dry wt. (kg/ha)	Corm dry matter (%)	Shoot dry wt. (kg/ha)	Sucker dry wt. (kg/ha)	Total plant dry wt. (kg/ha)	(no.)
SM	5,727	1,664	29.1	374	1,539	3,577	122
SNM	5,182	1,614	31.0	404	1,619	3,637	93
NSM	5,148	1,343	26.0	361	964	2,668	99
NSNM	4,977	1,424	28.5	271	987	2,862	69
LSD (P = 0.05)							
Shade	ns	ns	*	ns	492	784	15
Mulch	ns	ns	ns	ns	ns	ns	15
Interaction	ns	ns	3.5	ns	ns	ns	ns

Key: SM - shade mulch; SNM = shade no mulch; NSM = no shade mulch; NSNM = no shade no mulch.

of shaded plants should then result in increased light interception, and full sunlight during crop maturity may improve partitioning of assimilates to the corm. This possibility is currently being explored by investigating length of shade period on crop growth and productivity, with the objectives of developing shade management practices in agroforestry systems involving taro.

Parallel experiments are also being conducted in alley cropping and tree intercropping trials, where tree pruning practice is being manipulated to manage shade levels to the intercropped taro.

Effects of Tree Shade on Weed Growth

Another potential benefit of shade, which is being developed in the agroforestry systems under investigation in Western Samoa, is in weed control. Results from two alley cropping experiments have shown significantly lower weed populations and growth in alley plots which are subjected to dense tree shade during an annual short three- to four-month fallow (Table 2 and Fig. 1).

A similar reduction in weed growth has been observed in plots where *Erythrina subumbrans* is intercropped with taro. In this on-farm trial, the well established *Erythrina* trees were only lightly pruned at taro planting time, leaving an approximate reduction in photosynthetically active radiation of sixty percent to the young crop. This shade level was maintained during the first six weeks of crop establishment by periodic light pruning of the trees. Weed growth in the shaded plots was noticeably less than in control plots with no tree shade. Indeed, control plots required an extra weeding at this time, resulting in additional inputs of both chemicals and labor.

The beneficial effects of canopy shade in reducing weed growth have been observed within 12 months of planting trees in taro plots. It is thought that there will be a cumulative effect on weed populations over years, resulting in reductions of both weed vigor and the density of noxious perennial grass weeds. Experimental plots are currently being monitored to test this hypothesis.

Table 2. Relative weed biomass in the control and tree plots in Moamoa alley farming trial at the end of the first four-month fallow period.

Treatment	Weed fresh weight (kg/ha)	Weed dry weight (kg/ha)
Control	2.9	0.40
S. <i>Calliandra</i>	2.0	0.23
D. <i>Calliandra</i>	2.0	0.23
S. <i>Paraserianthes</i>	1.3	0.15
D. <i>Paraserianthes</i>	1.7	0.20
LSD (0.01)	0.61	0.17

S. and D. refer to single and double hedgerows, respectively. All alleys are 6-m wide.

Cultivar Responses to Shade

Traditionally, farmers plant a range of cultivars on their farm plots. This diversity is probably maintained for several reasons--to satisfy different cooking and taste requirements, to produce harvestable corms over an extended period (cultivars having different maturity times), and to some extent to match cultivar to specific ecological niches.

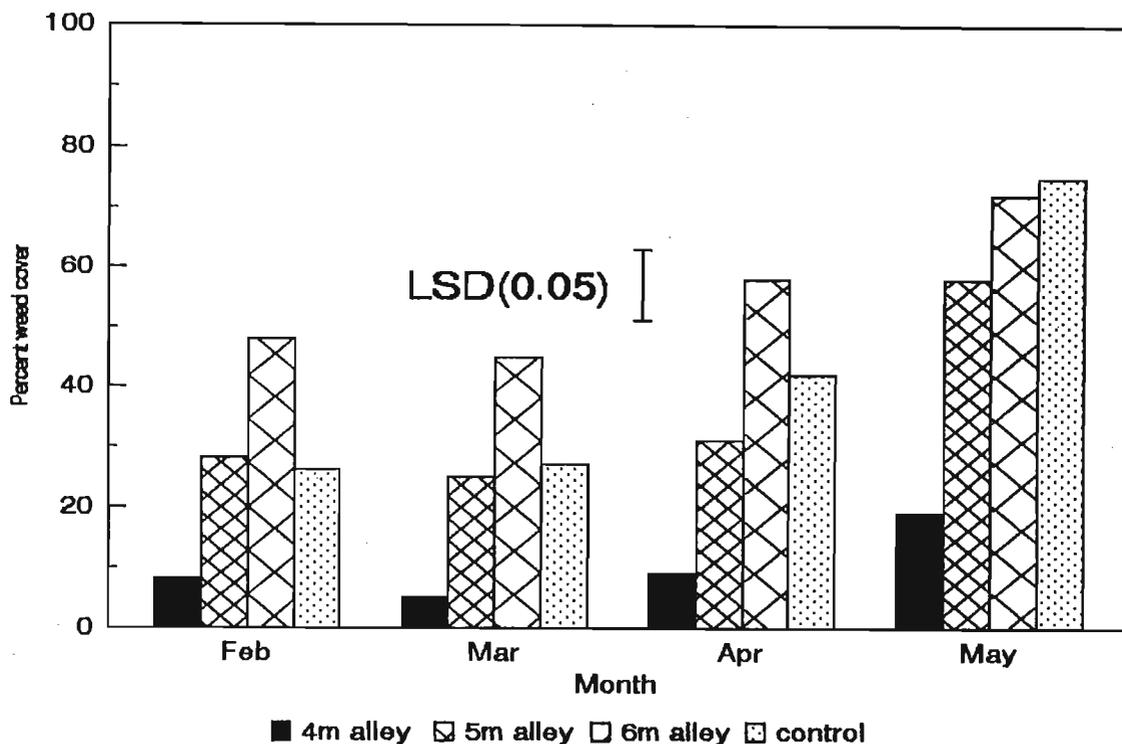


Fig. 1. Percent weed cover in control and tree plots in Alafua alley trial for first four months of fallow period.

Also, planting a mixture of cultivars may reduce risk of total crop loss as a result of pest damage or weather extremes. Cultivar diversity was noted as a major characteristic in the traditional agroforestry systems in Pohnpei, which provided benefits in terms of improved supply, risk avoidance, and variety (Raynor and Fownes 1991).

It is considered that this diversity should be maintained when developing agroforestry practices for sustainable cropping.

However, to date most improved cultivars have been selected and evaluated under full sun conditions. Results from a factorial experiment to compare two 'improved' cultivars from the Alafua breeding program with three traditional ones in their responses to growing in full sunlight and fifty percent shade indicated a significant interaction between cultivar and shade (Fig. 2). Although the two improved cultivars, 'Alafua Sunrise' and 'Samoa Hybrid', out yielded the traditional ones under both full sunlight and shade, their relative positions changed. Whereas 'Alafua Sunrise' yield is reduced by shade, the yield of 'Samoa Hybrid' is not. The traditional cultivar 'Manua' out yielded 'Taro Paepae' in the no-shade but not in shade plots.

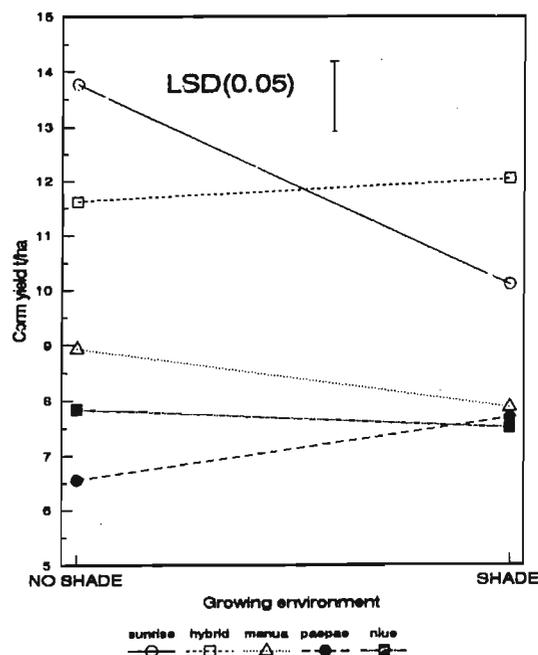


Fig. 2. Corm yield of five cultivars grown in full sunlight or fifty percent shade.

These preliminary results suggest a potential for selecting cultivars for particular shade levels in field plots and the need to include this parameter in the breeding programs.

Social Benefits of Shade

The final potential shade benefit brings us back to the opening remarks on the comfort value and how this relates to the work environment and the productivity of labor in agroforestry plots. Clearly, tree shade provides a cooler, more pleasant environment than full sun, conditions which are better suited to carrying out heavy work tasks such as crop planting and hand weeding. Under the cooler conditions, it should be expected that productivity of labor would be higher, although this may be difficult to quantify.

Conclusions

Management of shade levels in agroforestry systems for taro cropping through timely pruning of trees and density of planting, could improve productivity and corm quality while reducing weed competition. Furthermore, information on cultivar responses to growing in different light environments should aid selection of appropriate cultivars for particular farm niches.

With increased interest in developing agroforestry systems for sustainable production of food crops, it is suggested that shade is an important parameter to be considered both in breeding programs and agronomy trials.

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¹ Research Assistant, Institute for Research, Extension and Training, University of the South Pacific, Apia, Western Samoa.

The Editor

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