CULTURAL MANAGEMENT STUDIES ON UPLAND TARO:

Effects of Cultivation Systems on Growth and Yield of Taro and Incidence of Associated Weeds

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ABSTRACT

Two croppings were conducted to determine the effects of 2 levels of land preparation and different post planting cultivation systems on the performance of upland taro and weed incidence. Plowing and harrowing once or twice with a carabao-drawn plow resulted in the same corm yield. The vegetative growth, biological yield of main plants, weight of rhizomes, number of rhizomes/m^2 and harvest index were also not affected by levels of land preparation. The different postplanting cultivation systems likewise did not significantly affect the above parameters including main corm yield. This effect was attributed largely to the adequate weed control provided by the cultivation systems. Off-barring with carabao-drawn plow at 2 weeks after planting (WAP) + handweeding at 3 WAP + hilling-up at 5 WAP consistently gave high return of investment and required least cost in producing 1 kg of main corms. Handweeding was the most expensive operation. Apparently, one plowing and harrowing is sufficient for upland taro as long as postplanting cultivation is employed with adequate weed control measures.

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KEY WORDS: Land preparation. Postplanting cultivation. Tillage. Cultivation system. Weed control. Return of investment.

INTRODUCTION

Tillage is practically the only cultural management practice that is inseparable from any method of crop production. Although it has some detrimental effects such as increasing water loss through evaporation, soil compaction, erosion and root pruning (Donahue, 1961; Trouse and Humbert, 1961; Russell et al., 1971), cultivation is generally beneficial (Donahue et al., 1977; Thorne, 1979). Tillage is commonly done to improve the condition of the soil. Moreover, its

function as a weed control measure is widely accepted (Pearson, 1967; Zimdahl, 1980). In fact, the weed control aspect of cultivation is well documented in cereals, legumes and other cash crops (Treanor and Andrews, 1965; Cartee and Hanks, 1974).

The definite role of tillage, i.e., land preparation or cultivation in upland taro *(Colocasia esculenta)* still needs to be ascertained. In cassava, the beneficial function of tillage is to loosen the soil to minimize impediment to root enlargement (Villamayor and Reoma, 1983). Soil compaction generally impairs the growth and development of cassava, sweet potato and yam tubers (Lal, 1980; Sajjapongse and Roan, 1982; Ferguson and Gumbs, 1976). Likewise, weed competition reduces the yield of these crops (Bacusmo, 1978; Mariscal, 1978; Onwueme, 1978). In upland taro, weeds need to be controlled especially during the first 8 weeks of growth (Talatala et al., 1983). However, manual and cultural weed control measures entail much time and labor. Thus, soil manipulation through tillage and cultivation involving carabao-drawn implements or its combination with manual weeding may have more beneficial functions, i.e., loosening the soil and controlling weeds, aside from being more economical and practical.

This study was undertaken primarily to evaluate the effects of different levels of land preparation and different postplanting cultivation-management systems on the growth and yield of upland taro, and also to determine the effect of various degrees of soil manipulation through cultivation on weed incidence in taro production.

MATERIALS AND METHODS

Taro variety Kalpao was planted in an experimental area with sandy loam soil having a bulk density of about 1.378 g/cc. Two croppings were established; the first cropping in August 1981 and the second, in June 1982. Crops were harvested 8 months after planting (MAP). A split-plot was used in both croppings arranged in randomized complete block design with 3 replications. The levels of land preparation (1 plowing + 1 harrowing + furrowing, or 2 plowings + 2 harrowings + furrowing) were assigned as main plots. In the first level of land preparation, harrowing was done one week after plowing and then followed immediately by furrowing. Plowing and harrowing were alternately done one week after each operation in the second level. Furrows were made immediately after the second harrowing operation. The direction of the second plowing and harrowing was perpendicular to that of the first plowing and harrowing.

The following postplanting cultivation systems were designated as subplots:

1. Handweeding (HW) 4 times whenever necessary
2. Hilling-up (HU) 2 and 5 weeks

after planting (WAP) + HW between hills at 5 WAP
3. Off-barring (OB) 2 WAP + HW 2 WAP + HU 4 and 6 WAP
4. OB 2 WAP + HW 3 WAP + HU 5 WAP
5. OB 2 WAP + HU 4 WAP + OB 6 WAP + HU 8 WAP

Based on the results of the first cropping, the above post-planting cultivation treatments were reduced to 3 in the second planting. Only those cultivation systems that were either economical or those which gave good yield of main corms were selected. These were as follows:

1. HU 2 and 5 WAP + HW between hills at 5 WAP
2. OB 2 WAP + HW 2 WAP + HU 4 and 6 WAP
3. OB 2 WAP + HW 3 WAP + HU 5 WAP

The 2 levels of land preparations were still maintained as main plots in the second cropping.

The subplot size used in the first planting was 18.4 $m.^2$ which gave 25 harvestable plants after elimination of those in the guard rows. In the second cropping, the subplot area was increased to 37.5 $m.^2$ with 64 sample plants. Planting distance was set at 75 cm x 50 cm. Fertilizer at the rate of 30-30-30 kg NPK/ha was applied in split manner, i.e., one-half at planting and the remaining half 2 months after planting.

Planting materials or setts used consisted of about 2 cm of the upper portion of the corm or cormel containing the growing point and 20-25 cm of the lower part of the petioles. Setts of uniform size were selected for planting.

RESULTS AND DISCUSSION

Crop Growth and Development

The survival rate of the setts at 15 and 25 days after planting (DAP) in the 2 croppings was not significantly affected by levels of land preparation (Table 1). The notable decrease in the rate of plant survival at 25 DAP during the first planting was due to rotting of the planting materials caused by *Sclerotium rolfsii* Sac. The fungus infected the base of newly planted setts especially when the soil was damp.

When averaged across post-planting cultivation techniques, the levels of land preparation did not significantly affect monthly height and leaf area index (LAI) of the plants in both croppings. Similarly, both plant height and LAI were not significantly influenced by the different cultivation systems regardless of the level of land preparation.

The general effect of the different pre- and postplanting tillage systems employed on the growth of taro suggests that varying degree of soil manipulation did not affect the pattern of development of its above-ground parts. Since all the pre- and postplanting tillage systems did not significantly affect both monthly plant height and LAI, then it may be assumed that these cultivation techniques were beneficial to the plants.

Table 1. Survival rate of taro planting materials at 15 and 25 days after planting (DAP) during the 2 croppings as influenced by 2 levels of land preparation.

Level of land preparation	Survival rate (%)	
	15 DAP	25 DAP
First Cropping		
1 plowing + 1 harrowing	98.30	92.76
2 plowings + 2 harrowings	98.70	94.26
C.V. (%)	0.75	3.35
Second Cropping		
1 plowing + 1 harrowing	98.55	98.44
2 plowings + 2 harrowings	98.00	98.22
C.V. (%)	0.14	0.14

Weed control during the early part of crop establishment eliminated crop-weed competition. It follows then that as long as it provides consistent weed control, any degree of postplanting cultivation favors vegetative growth and development in upland taro.

Yield and Yield Components.

When data were averaged across postplanting cultivation systems, there was no significant difference in main corm yield between levels of land preparation in the 2 croppings (Table 2). Moreover, the biological yield of main plants, weight of rhizomes, number of rhizomes per square meter at harvest and harvest index (HI) were not significantly affected by land preparation levels (Table 3).

Regardless of the level of land preparation, the different systems of postplanting cultivation used did not significantly affect main corm yield of the crop in the two plantings (Table 2). This non-significance may be partially due to early weed control as a result of the combination of handweeding and soil disturbance by hilling-up and off-barring operations. The different postplanting cultivation systems employed during the early crop growth prevented the vigorous development of weeds especially during the time when taro was most susceptible to weed competition. The first 8 weeks after planting is considered to be the most critical period for weed competition in upland taro (Talatala, et al., 1983). Weed competition in taro during its early stage of development generally results in reduced corm yield (Plucknett et al., 1971).

The results suggest that any postplanting cultivation could be beneficial to upland taro as long as it could check weed growth during early crop growth. Moreover, it appears that the minimum level of

Table 2. Main corm yield of upland gabi during the 2 croppings as influenced by 2 levels of land preparation and different postplanting cultivation techniques.

Postplanting cultivation technique	Yield (t/ha)		
	1 plowing + 1 harrowing	2 plowings + 2 harrowings	Mean
First Cropping			
Handweeding (HW) 4 times	10.03	10.06	10.04
Hilling up (HU) 2, 5 weeks after planting (WAP) + HW 5 WAP	9.03	10.95	9.99
Off-barring (OB) 2 WAP + HW 2 WAP + HU 4 and 6 WAP	10.10	10.17	10.13
OB 2 WAP + HW 3 WAP + HU 5 WAP	8.93	9.40	9.27
OB 2 WAP + HU 4 WAP + OB 6 WAP + HU 8 WAP	10.81	11.13	10.97
Mean	9.78	10.38	10.08
Second Cropping			
HU 2 and 5 WAP + HW 5 WAP	11.72	11.94	11.83
OB 2 WAP + HW 2 WAP + HU 4 and 6 WAP	12.35	13.07	12.71
OB 2 WAP + HW 3 WAP + HU 5 WAP	12.67	12.33	12.50
Mean	12.24	12.45	12.35
First cropping: C.V. (land preparation) = 24.47% C.V. (cultivation) = 19.07%		Second cropping: C.V. (land preparation) = 20.93% C.V. (cultivation) = 20.61%	

land preparation, i.e., 1 plowing + 1 harrowing, is adequate to obtain optimum corm yield as long as the postplanting cultivation applied can adequately control weeds.

Weed weights taken at 2 MAP were very low compared to those at 5 MAP (Table 4). Although weed incidence at 2 MAP was slightly high in the first cropping, the weeds apparently did not compete with the crop because there was no noticeable difference in the corm yield at harvest. Weed density increased in the fifth MAP but this was already beyond the established critical weed control period for the crop (Talatala et al., 1983).

The different postplanting tillage systems did not significantly affect the biological yield of main plants, weight of rhizomes, number of

Table 3. Yield components of upland taro during 2 croppings as influenced by 2 levels of land preparation and averaged across postplanting cultivation techniques.

Level of Land Preparation	Biological yield of main plants (t/ha)	Weight of rhizomes (t/ha)	Number of rhizomes per m^2	Harvest Index
First Cropping				
1 plowing + 1 harrowing	16.92	11.98	12.76	0.58
2 plowings + 2 harrowings	17.06	12.31	12.89	0.61
C.V. (%)	23.68	25.92	17.99	8.97
Second Cropping				
1 plowing + 1 harrowing	15.4€	8.10	13.28	0.80
2 plowings + 2 harrowings	16.19	8.36	12.70	0.78
C.V. (%)	21.93	27.53	32.95	4.20

rhizomes/m^2 and HI (Table 5). These results tend to show that the different combinations of off-barring/hilling-up/harvesting at various periods, i.e., 2 WAP until the 6th week did not adversely affect the development of the main plant as well as the rhizomes. The period from planting until 8 WAP is probably the best time to cultivate upland taro.

The overall result of the 2 croppings indicates that since different systems of postplanting cultivation involving a combination of hilling-up and off-barring using carabao-drawn plow resulted in corm yields comparable to that obtained from handweeding, it follows that there was only little effect of cultivation systems on upland taro aside from weed control. This is possible because the development of taro corms is towards the soil surface unlike in cassava where normal tuber development is sideways beneath the ground. Hence for the latter crop, Villamayor and Reoma (1983) found that loosening the soil through cultivation significantly affected the number of marketable roots per square meter, weight of marketable roots, total root weight and biological yield.

Cost and Benefit Estimates.

As expected, plowing and harrowing the field twice was more expensive than plowing and harrowing once. Double plowing and harrowing requires more human/animal labor, hence, higher capital investment for initial cultivation. Since there was no difference in corm yield of taro between the 2 levels of land preparation, it may be assumed that 1 plowing + 1 harrowing is an economically sound preplanting cultivation technique.

Table 4. Dry weight of weeds per $m.^2$ taken at 2 and 5 months after planting (MAP) during the 2 croppings of taro as affected by different postplanting cultivation techniques.

Postplanting cultivation technique	Dry weed weight (g/m^2)	
	2 MAP	5 MAP
First Cropping		
Handweeding (HW) 4 times	18.05 ab	25.57 c
Hilling up (HU) 2 and 5 weeks after planting (WAP) + HW 5 WAP	7.13 c	54.50 b
Off-barring (OB) 2 WAP + HW 2 WAP + HU 4 and 6 WAP	17.15 b	83.58 a
OB 2 WAP + HW 3 WAP + HU 5 WAP	22.17 a	84.48 a
OB 2 WAP + HU 4 WAP + OB 6 WAP + HU 8 WAP	10.07 c	17.60 c
C.V. (%)	22.99	35.86
Second Cropping		
HU 2 and 5 WAP + HW 5 WAP	1.55	33.40
OB 2 WAP + HW 2 WAP + HU 4 and 6 WAP	2.03	25.10
OB 2 WAP + HW 3 WAP + HU 5 WAP	3.02	24.27
C.V (%)	48.11	30.02

Within a column in the first cropping, means followed by the same letter are not significantly different at 5% based on DMRT.

Handweeding as a postplanting tillage system was the most expensive operation followed closely by off-barring at 2 WAP + hilling up at 4 WAP + off-barring at 6 WAP + hilling up at 8 WAP. These 2 systems required relatively higher capital input thus, these apparently gave the least return of investment and required the highest cost in producing 1 kilogram of corms.

In the 2 croppings made, off-barring at 2 WAP + handweeding at 3 WAP + hilling up at 5 WAP consistently gave high return to every peso invested on tillage. This was followed by off-barring at 2 WAP + handweeding at 5 WAP. Evidently, the same systems required lesser cost in producing a kilogram of corms.

The above observations indicate the possibility of reducing production cost in upland taro through adoption of suitable pre- and postplanting tillage systems. Although handweeding was incorporated in the cultivation using mechanical means in this particular study, the labor and time required in this operation was reduced since soil disturbance due to off-barring and hilling-up brought about initial control of weeds. In general, this study

Table 5. Yield components of upland taro during the 2 croppings, as influenced by different techniques of postplanting cultivation and averaged across levels of land preparation.

Postplanting cultivation technique	Biological yield of main plants (t/ha)	Weight of rhizomes (t/ha)	Number of rhizomes per m^2	Harvest Index
First Cropping				
Handweeding (HW) 4 times	16.59	9.39	12.20	0.61
Hilling up (HU)2 and 5 weeks after planting (WAP) + HW 5 WAP	16.93	13.80	12.53	0.59
Off-barring (OB) 2 WAP + HW 2 WAP + HU 4 and 6 WAP	17.44	13.00	12.68	0.60
OB 2 WAP + HW 3 WAP + HU 5 WAP	15.50	10.83	11.15	0.60
OB 2 WAP + HU 4 WAP + OB 6 WAP + HU 8 WAP	18.51	13.74	15.59	0.59
C.V. (%)	13.75	34.35	32.80	7.64
Second Cropping				
HU 2 and 5 WAP + HW 5 WAP	14.71	7.31	13.05	0.81
OB 2 WAP + HW 2 WAP + HU 4 and 6 WAP	16.39	9.87	13.83	0.79
OB 2 WAP + HW 3 WAP + HU 5 WAP	16.38	7.51	12.09	0.77
C.V. (%)	20.61	31.40	17.07	10.96

indicates that inter-row cultivation in taro is very practical to reduce both time and labor cost especially in controlling weeds.

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