EFFECT OF MULCH APPLICATION AND PLANTING DEPTH ON GROWTH, DEVELOPMENT AND PRODUCTIVITY OF UPLAND TARO

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ABSTRACT

Growth, development and harvest attributes of taro were more apparently affected by mulching treatment than by planting depth. Mulched plants exhibited superior height and LAI and markedly higher total and corm dry matter (DM) accumulation than their unmulched counterparts. Most of the harvest characters were significantly greater when taro was mulched than when they were unmulched. The difference between 5 and 10-cm planting depth was negligible for plant height and LAI but was pronounced in the total and corm DM production. Deeper planting significantly favored high DM production at most stages of growth. All harvest characters were significantly increased by planting depth treatments except the main corm volume and total herbage yield.

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KEY WORDS: Taro *(Colocasia esculenta)*. Mulch application. Planting depth. Growth. Development. Productivity.

INTRODUCTION

Taro *(Colocasia esculenta* (L.) Schott) is one of the widely cultivated root crops in the Philippines. It thrives under adverse growing conditions (de la Peña and Plucknett, 1972) but its growth and yield appear to be very variable depending upon the prevailing environment. Villanueva et al. (1983) noted that the growth and yield of upland taro are always depressed when long dry spells occur during the time of its active growth. The leaf area and height of taro decline steeply when the crop experiences moisture stress (Pardales, 1979). Taro also grows best with rainfall of about 2500 mm that is evenly distributed throughout its growing season (Kay, 1973).

Soil temperature also affects taro growth. Pardales et al. (1982) noted that taro root and shoot growth was highly favored by soil temperature ranging from 27 to

29°C and that beyond this temperature, root and shoot growth became restricted. Scarce soil moisture and high soil temperature seem to be the main limiting factors in upland taro production. Hence, it is assumed that any agronomic practice which will conserve soil moisture and maintain soil temperature would favor taro growth and development.

Mulches have been widely proven to be advantageous for some seed crops (Koshi and Fryrear, 1971; Ali and Prasad, 1974) since they prevent rapid soil moisture evaporation (Matthews, 1983), thus making such moisture available to the plants. Adjustment of sowing depth in grain crops is another agronomic practice that has been studied to counteract the detrimental effects of low soil moisture on germination of seeds (Alessi and Power, 1971). With proper planting depth, seeds can come in contact with moist soil layer. These practices, though commonly employed in many grain crops, have not been tried in taro which is particularly noted to be sensitive to fluctuations in soil moisture and temperature. This study was therefore undertaken to determine the effects of mulch application and depth of planting on the growth and development of upland taro.

MATERIALS AND METHODS

The experiment was established at the PRCRTC-Pangasugan field from March to November 1983 using the rhizomatous taro variety, PR-G 066. The soil was sandy clay loam with a bulk density of 1.31 g/cc at planting time.

A split-plot arranged in a randomized complete block design was used. Mulching treatments (with and without mulch) were designated as the main plots and planting depths (5 and 10 cm) as the subplots. Each treatment was replicated three times wherein each replication measured 6 x 6 m.

The whole experimental area was plowed and harrowed prior to planting at a distance of 50 x 75 cm. The plants were applied with 30-30-30 kg N, P_2O_5, K_2O/ha at planting time. Rice straw at the rate of 20 tons/ha was used as mulch. Planting was done by simply slipping the vegetative planting materials, which consisted of about 1.0 cm of the upper section of the corm plus 20 cm of the lower petioles, into prepared holes with predetermined depths.

Five inner row plants were randomly selected from each treatment plot for monthly measurement of plant height and leaf area, which were used here as indices of vegetative growth. Three plants from each plot were also randomly collected every month starting at 1 month after planting (MAP) for dry matter (DM) determination. The sample plants were dried in a forced-draft oven at 80 ± 5°C for over 48 hours. Final harvesting of the remaining plants with complete neighbors in the inner rows was done at 8 MAP.

DM and harvest data were collected and statistically analyzed. Crop growth rate (CGR) was determined using the following formula:

$$CGR = \frac{1}{P} \times \frac{W_2 - W_1}{T_2 - T_1}$$

Where P = ground area, W_1 and W_2 = total plant dry weight, at times T_1 and T_2 (month), respectively.

RESULTS

The weather during the conduct of the experiment was generally dry and hot especially during the first 4 MAP. This is reflected in the data on total monthly rainfall and mean air temperature (Table 1). Also in the same table are the mean soil temperature data from the mulched and unmulched plots.

Plant Height and Leaf Area Index (LAI)

Monthly plant height and LAI of taro are shown in Figures 1 and 2, respectively. Regardless of planting depth, plants grown with straw mulch consistently exhibited superior vegetative growth over those in the unmulched control. Difference in both plant height and LAI between the mulched and the unmulched plants started to get appre-

Table 1. Monthly rainfall, mean daily temperature of the air and mean daily temperature of the soil during the growing period of taro in the upland (March-November, 1983).

Months After Planting	Total Rainfall (mm)	Mean Air Temperature (°C)	Soil Temperature (°C)	
			Mulched	Unmulched
1	7.9	27.61	25.41	29.81
2	13.9	28.71	27.56	32.78
3	7.8	28.86	28.60	35.20
4	145.3	29.38	28.14	34.45
5	445.8	28.88	27.48	33.56
6	193.9	28.61	28.11	31.67
7	275.5	27.58	26.63	30.32
8	201.3	27.67	27.28	29.54

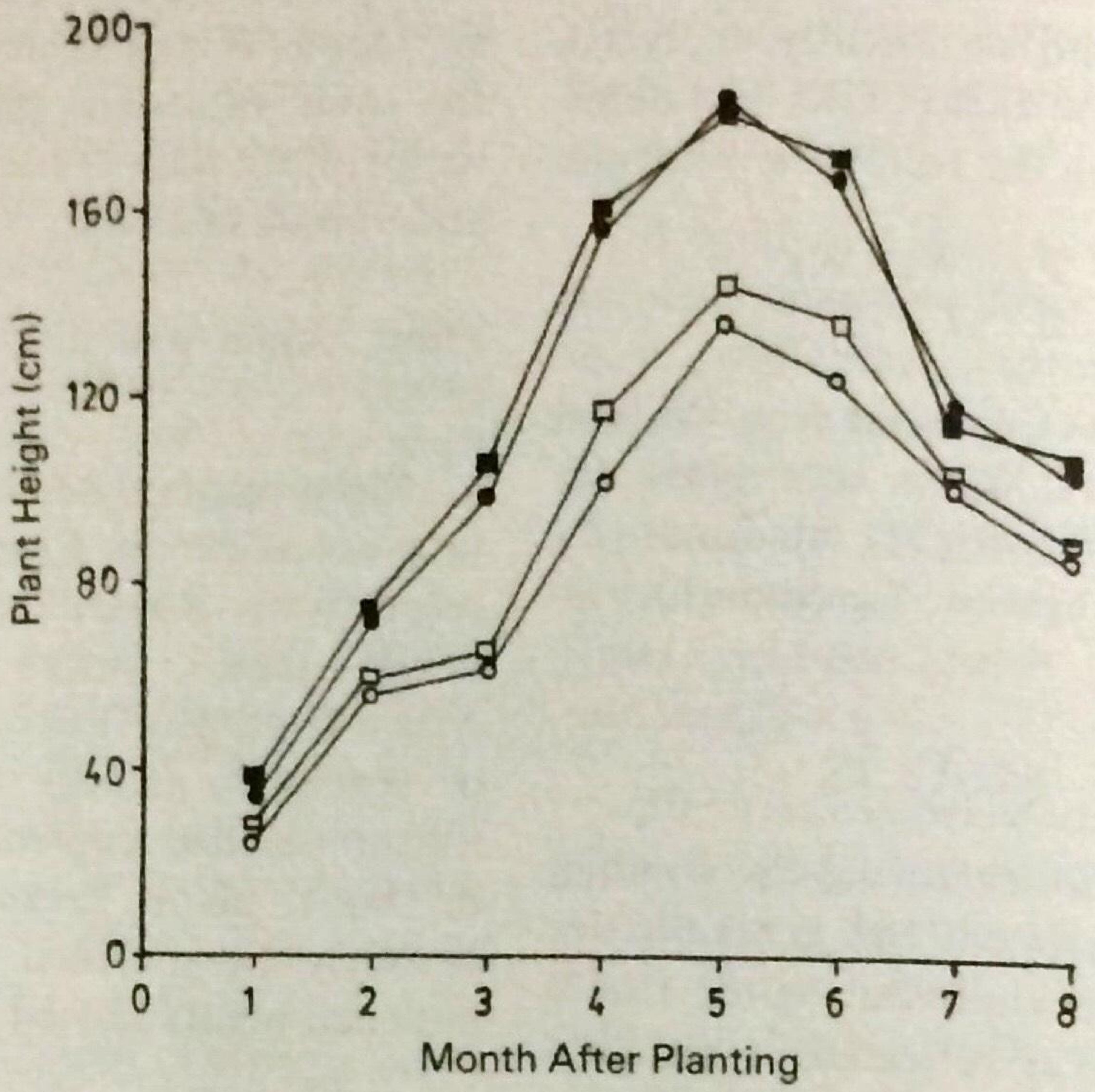

Figure 1. Plant height of taro as influenced by mulching and planting depth. O = 5-cm depth, - mulch; □ = 10-cm depth, -mulch; ● = 5-cm depth, +mulch; ■ = 10-cm depth, +mulch.

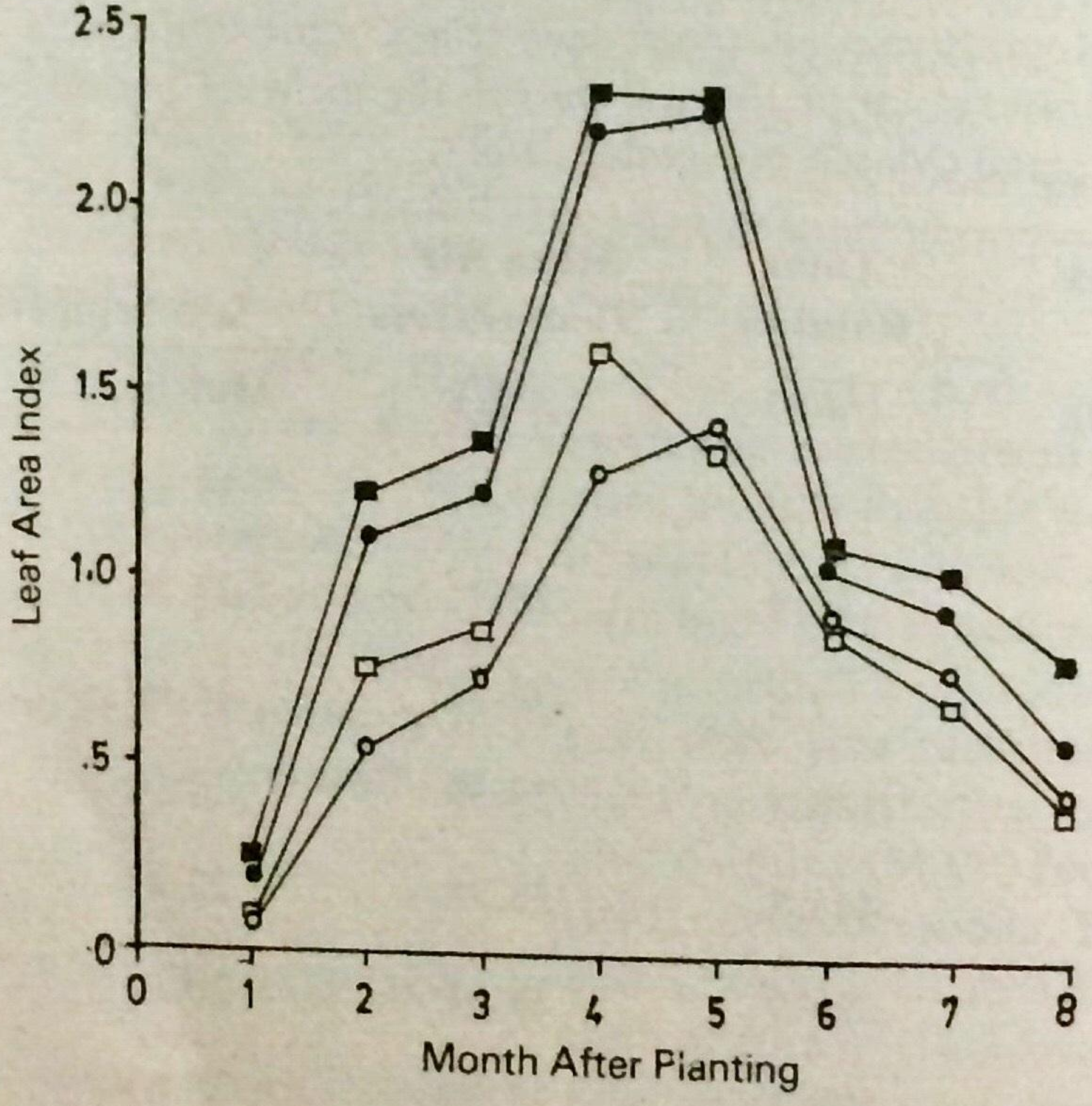

Figure 2. Leaf area index of taro as influenced by mulching and planting depth. O = 5-cm depth, - mulch; □ = 10-cm depth, -mulch; ● = 5-cm depth, +mulch; ■ = 10-cm depth, +mulch.

ciably bigger at 2 MAP until about 5 MAP when the plants were in their active growth. As the plants approached physiological maturity, the difference between the above treatments for both vegetative growth parameters became smaller.

Regardless of the mulching treatment, the effect of planting depth on vegetative growth appeared negligible although closer inspection of Figures 1 and 2 would reveal that 10-cm planting depth gave better results than the 5-cm depth. At deeper planting, the plants grew taller and attained comparatively higher LAI than at shallower planting depth. This trend, however, was very apparent in the unmulched than in the mulched condition especially during the period before maximum vegetative growth was reached, i.e., at about 5 MAP.

Dry Matter (DM) Production

Total DM production of taro main plants generally increased with age and attained a peak at about 6 MAP (Table 2). However, it gradually declined towards physiological maturity due to gradual cessation of vegetative development. Despite this, the effects of mulching and planting depth treatments on DM production were statistically pronounced at most stages of growth. Except at 1 and 2 MAP, mulched plants accumulated significantly more DM than their unmulched counterparts. Significantly higher total DM was consistently observed at the 10-cm planting depth than at the 5-cm depth from 2 MAP until the final harvest.

The effect of mulching and planting depth treatments on DM accumulation of corms strictly followed that of the total DM production (Table 3). Application of straw mulch significantly stimulated DM accumulation of taro corms. This trend was observed from 3 MAP until 8 MAP. Deep planting at 10 cm also caused appreciably higher corm DM production than shallow planting at 5 cm at all stages of development.

In terms of crop growth rate (CGR), mulched plants achieved better average CGR than the unmulched ones. Likewise, crops planted at 10-cm depth showed higher CGR than those planted at 5-cm depth (Table 4).

Harvest Characters

The differences between mulching treatments were pronounced in all harvest characters considered except main corm yield (Table 5). Plants with mulch gave significantly higher cormel, biological and total herbage yields including corm volume and number of rhizomes than plants without mulch. Meanwhile, the effect of planting depth treatments was significant on the main corm, cormel, and biological yields as well as on the number of rhizomes but not on the herbage yield and main corm volume. Deeper planting brought about significantly greater main corm and biological yields. Although corm volume and herbage yield were only marginally affected by planting

Table 2. Total dry matter production of taro main plants at different stages of development as influenced by mulching and planting depth treatments.

Treatment	Total Dry Matter Production (g/m^2)							
	Months After Planting							
	1	2	3	4	5	6	7	8
Mulching[a]								
+Mulch	7.92	24.97	108.16	183.42	191.22	247.00	194.40	184.77
—Mulch	6.25	23.65	74.77	124.27	146.77	158.32	149.10	124.82
F-test	ns	ns	**	**	*	**	*	*
Planting Depth[b]								
5 cm	6.57	21.05	83.34	143.20	162.32	188.94	146.00	131.85
10 cm	7.60	27.57	99.59	164.48	175.67	216.38	197.50	177.85
F-test	ns	*	*	**	ns	**	**	**

[a] Averaged across planting depth treatments.
[b] Averaged across mulching treatments.

ns- not significant
* - significant at 5% level.
** - significant at 1% level.

Table 3. Dry matter production of taro main corms at different stages of development as influenced by different mulching and planting depth treatments.

Treatment	Dry Matter Production (g/m^2) Months After Planting 3	4	5	6	7	8
Mulching[a]						
+Mulch	21.40	31.32	53.28	112.83	138.33	155.42
—Mulch	14.18	16.42	37.72	74.87	93.67	98.97
F-test	*	*	*	**	**	*
Planting Depth[b]						
5 cm	12.45	20.32	42.05	79.94	93.34	109.95
10 cm	23.13	27.42	48.95	107.77	138.67	144.44
F-test	**	**	*	**	**	**

[a] Averaged across planting depth treatments.

[b] Averaged across mulching treatments.

* - significant at 5% level.

** - significant at 1% level.

Table 4. Crop growth rates of taro under different treatments.

Time Interval (month)	Crop Growth Rate ($g/m^2/day$)			
	Mulching		Planting Depth	
	+ Mulch	—Mulch	5 cm	10 cm
0—1	+0.75	+0.60	+0.63	+0.72
1—2	+1.62	+1.66	+1.38	+1.90
2—3	+7.92	+4.87	+5.93	+6.86
3—4	+5.74	+4.71	+4.70	+5.75
4—5	+0.74	+2.14	+1.82	+1.07
5—6	+5.31	+1.10	+2.46	+3.87
6—7	-5.05	-0.88	-4.01	-1.80
7—8	-0.87	-2.31	-1.35	-1.87
Average	+2.20	+1.49	+1.57	+2.12

depth, higher values were obtained at the 10-cm planting depth. In contrast, significantly more rhizomes, hence more cormel yield, were obtained at the 5-cm than at the 10-cm planting depth.

DISCUSSION

The consistently inferior growth and development exhibited by unmulched taro could be attributed largely to moisture insufficiency and warm temperature in the soil during the establishment and active growing phase of the crop. The usual physical and agronomic manifestations of stressed taro plants are impaired vegetative growth and development, and depressed corm yield (Pardales, 1979; Pardales et al., 1982; Pardales, 1984). On the other hand, the stimulated growth of the mulched taro plants could be ascribed to the adequate moisture content and suitable temperature of the soil afforded by the insulating action of the straw mulch against soil moisture and temperature fluctuations. Ali and Prasad (1974) and Black (1970) attributed the better stand performance of their respective mulched crops to the adequacy of soil water and its availability for a longer period in the soil immediately below the surface mulch. Lal (1974)

Table 5. Harvest characters of taro at final harvest as influenced by different mulching and planting depth treatments.

Harvest Character	Mulching[a]		F	Planting Depth[b]		F
	+ Mulch	— Mulch	test	5 cm	10 cm	test
Main corm yield (tons/ha)	10.98	8.83	ns	8.98	10.22	**
Cormel yield (tons/ha)	3.32	1.50	*	2.72	2.11	*
Main plant biological yield (tons/ha)	13.77	8.71	*	10.00	11.88	*
Total herbage yield (tons/ha)[c]	17.63	8.96	**	13.50	14.09	ns
Main corm volume (cc)	714.00	448.83	**	583.22	594.62	ns
Number of rhizomes/m^2	14.22	7.69	**	11.28	10.63	*

[a]Averaged across planting depth treatments.
[b]Averaged across mulching treatments.
[c]Main plant plus daughter plants arising from rhizomes.
ns - not significant.
* - significant at 5% level.
** - significant at 1% level.

indicated that the beneficial effect of mulches lies in their ability to improve soil temperature for root and shoot growth.

Results of this experiment suggest that straw mulch application would be a sound agronomic practice for the production of upland taro during times of scant rainfall. Moreover, the fact that herbage yield of taro was enhanced by the application of mulch, may indicate that this practice might have a great impact on the production of taro silage as what is being practiced in Hawaii (de la Peña, personal communication). Weed control cost is also considerably reduced by mulching.

Deep planting of taro at 10 cm seemed more advantageous than shallow planting at 5 cm especially when the crop is not mulched. This might be due to the availability of more moisture in the deeper soil layer to sustain growth and development. Seeds of grain crops like corn and pigeon pea are occasionally planted deeper during dry months to allow the seeds to avail of the soil moisture that is more readily present in deeper layers than near the surface (Alessi and Power, 1971; Tayo, 1983). Although very deep placement has some unfavorable effects on the germination of grain crops (Banks and Gilmore, 1979; Johnson and Schneiter, 1982), these effects were not observed in taro because only a part of the planting material is covered with soil at planting. Moreover, since taro resembles rice in that it can transport O_2 which is vital to normal root growth and functioning, from the leaves to the roots (de la Peña and Plucknett, 1972), this root crop can withstand deeper establishment. However, planting taro deeper than 10 cm may have some undesirable effects on the corm yield due to greater soil mechanical impedance to corm enlargement. When mulch was applied, planting depths did not cause marked variation in taro growth and development mainly because the straw conserved ample water and suppressed temperature rise in the soil, thus favoring plant growth regardless of soil depth.

The strong positive relationship between some vegetative growth and harvest characters of taro as reflected in Table 6 affirms that application of mulch and deeper planting of unmulched plants increased total DM production mainly through their enhancement effect on vegetative growth that permitted efficient utilization of solar energy. However, there are several possible mechanisms by which soil temperature and moisture can affect the growth of plants. Depending on the conditions of the atmosphere, the rate at which roots can absorb water and nutrients from the soil increases with availability of moisture and suitability of soil temperature.

Table 6. Relationship between some growth and harvest characters of taro.

Related Characters	r value
Maximum plant height and main corm yield	0.87*
Maximum leaf area index and main corm yield	0.83*
Total leaf area and total plant dry weight	0.91**
Plant height and main corm dry weight	0.93**
Leaf area index and main corm dry weight	0.88**

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