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Dry Matter Accumulation and Partitioning Of Two Taro (*Colocasia Esculenta (L.) Schott*) Cultivars under Inceptisol Soils in Samoa

Walter Fa'amatuainu and Falaniko Amosa

School of Agriculture and Food Technology, The University of the South Pacific, Alafua Campus, Samoa

Abstract

Taro (Colocasia esculenta) crop is widely grown throughout the humid tropics for its edible leaves, petioles and corms. In this research total dry matter (DM) accumulation and its partitioning between different plant parts were studied to determine their growth pattern over the plants' life cycle (i.e. 35, 70, 105, 140 and 175 days after planting (DAP). An experiment with randomised complete block design (RCBD) having five treatments (DAP) and three replications (blocks) was setup for each of the two improved taro cultivars (Samoa 1 and Samoa 2). After harvest dry matter of each taro plant was estimated for its five parts: leaf blades, petioles, corms, roots and suckers. The data analysis showed that in both the cultivars the DM accumulation and its partitioning to different plant parts (i.e. the leaf blades (LDM), petioles (PDM), roots (RDM), corms (CDM) and suckers (SDM)) varied significantly (p < 0.001) over the five growth stages of plant growth (DAP).

Keywords: *Dry matter, Taro, Accumulation*

1. Introduction

Taro (*Colocasia esculenta*), a member of the Araceae family is an ancient crop widely grown throughout the humid tropics for its edible leaves, petioles and corms (Nath *et al.*, 2013). It is ranked fifth behind potato, cassava, sweet potato and yam in terms of global production (Akwee *et al.*, 2015). Taro is grown in almost all ecological zones in the Pacific because of its wide environmental tolerance; hence, it is a major source of protein, vitamins, and income for many Pacific Islanders. Samoa started exporting taro to New Zealand in 1957, which grew to become the country's largest export earner from 1980 to 1993. However, production of taro was affected in June 1993, due to the outbreak of the taro leaf blight (TLB) which reduced taro export by 99% in the following year *(McGregor et al.*, 2011). Some of the early management practices that were used to control TLB involved the application of fungicides as well as strict quarantine on the movement of infected planting materials. However, these management practices were expensive and ineffective. Fortunately, through plant breeding the new TLB resistant taro varieties were development which provided an alternative method to combat TLB and increase taro production (Iosefa *et al.*, 2012). The two new taro varieties (Samoa 1 and Samoa 2) developed were accepted for export to New Zealand (MAF, 2015). As export commodities, the two new taro cultivars (the Samoa 1 and Samoa 2) needs more research, especially about their physiological characteristics such as growth and development which are essential for understanding ways to increase their yields.

Therefore, this study was undertaken to investigate the dry matter (DM) accumulation and partitioning among different plant parts at different stages of plant growth for these two new taro cultivars in order to determine their productivity as well as providing feedback information for future breeding programmes of taro.

2. Materials and Method

The experiment was conducted at the USP Alafua Campus, Samoa (13 51^{o}S 171 47^{o}W). The soil is a well-drained Inceptisol (very fine, halloysitic, isohyperthermic family of the Fluventic-Oxic Dystropepts), specifically classified as the Alafua soil series. The pre-plant soil nitrogen was 0.38% and the average soil pH was 6.1 at the 0-15 cm soil depth. The mean lowland daily temperature ranged from 27 $^{\circ}$C to 30 $^{\circ}$C while the monthly rainfall ranged from 250 to 700 mm (Iosefa *et al.*, 2012). Suckers of taro cultivar Samoa 1 and Samoa 2 were planted in the field for six months. Plants were harvested for dry matter (DM) analysis at 35, 70, 105, 140 and 175 days after planting (DAP). The experiment was arranged in a randomised complete block design (RCBD) with five harvest dates, DAP, as treatments and three replications (blocks). After harvest each taro plant was divided into its five parts: leaf blades, petioles, corms, roots and suckers. The samples were dried at 65 $^{\circ}$C until constant dry weights were accomplished. DM partitioning was calculated as the ratio of the dry matter of individual plant parts to the total dry matter of the plant. Data obtained were analysed by standard analysis of variance (ANOVA) for RCBD using the GenStat Discovery Edition 4 statistical software. The comparisons between the treatment means were analysed at the 5% probability level (P values <0.05).

3. Results

The estimates of the dry matter content of each part of the taro plant are presented separately for each part of the taro plant. In the last section estimate of total dry matter content of the whole taro plant is provided.

3.1. Leaf-Blades Dry Matter (LDM)

As shown in Figure 1, there is a significant difference ($p < 0.001$) in LDM among five harvest dates of taro. This supported the fact that LDM received large portion of the total dry matter early in the growth stages but started to decrease as the taro plants grew towards maturity. The above results is similar to those by Sivan (1976) who showed that for the three cultivars he studied, their LDM increased from planting until 140 DAP even though the magnitude of leaf blades dry matter differed among cultivars. Another study reported that the number of leaves and leaf area indices of Samoa 1 and Samoa 2 cultivars of taro were significantly different ($p < 0.001$) from each other after six months of growth (Faamatuainu and Amosa, 2016)

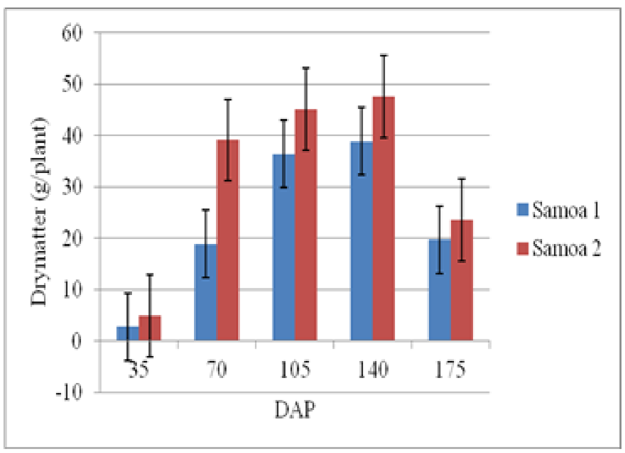

Figure 1. The effect of five harvest dates (days after planting, DAP) on the leaf dry matter (LDM) of Samoa 1 and Samoa 2 cultivars of taro (lsd =10.3).

3.2. Petioles Dry Matter (PDM)

As shown in Figure 2, there is a significant difference in the two cultivars PDM accumulation at the five harvest dates ($p < 0.001$). The PDM of Samoa 1 accumulated over time from 4.8 to 94.95 g/plant during the 35 to 140 DAP time period while the petioles dry matter for Samoa 2 also increased from 6.8 to 119.9 g/plant at 35 to 140 DAP. The above results are similar to the results of PDM by other researchers whereby the PDM increased from planting until at least 100 DAP and then declining afterwards (Amosa, 1993; Goenaga, 1995; Sivan, 1976).

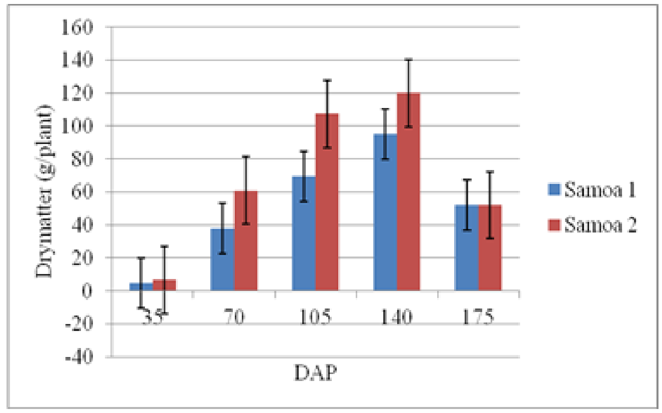

Figure 2. The effect of five harvest dates (days after planting, DAP) on the petioles dry matter (PDM) of Samoa 1 and Samoa 2 cultivars of taro (lsd =20.8).

3.3. Corm Dry Matter (CDM)

The difference shown in Figure 3 between the CDM of Samoa 1 and Samoa 2 between harvest dates is highly significant ($p < 0.001$). Corm dry matters (CDM) of both Samoa 1 and Samoa 2 increased over time from 35 DAP (5.8 and 4.6g/plant) to 175 DAP (138.5 and 202.1 g/plant) respectively. The CDM of Samoa 2 cultivar was higher than Samoa 1 at 70,105,140 and 175 DAP. The above results are supported by Sivan (1976) where the CDM for the Hawaii cultivar increased from 5g/plant at 35 DAP to 155 g/plant at 290 DAP. Amosa (1993) also reported that the CDM accumulation for the Lehua Maoli cultivar increased from 40 to 235DAP.

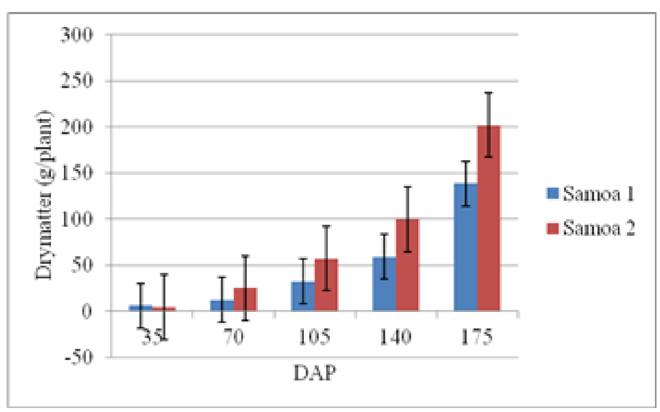

Figure 3. The effect of five harvest dates (days after planting, DAP) on the corm dry matter (CDM) of Samoa 1 and Samoa 2 cultivars of taro (lsd =23.3).

3.4. Roots Dry Matter (RDM)

The difference shown in Figure 4 between the RDM of the two cultivars at each of the five harvest dates is highly significant ($p < 0.001$). The interaction between the cultivars and the five harvest dates is also highly significant ($p < 0.001$). The roots dry matter (RDM) for Samoa 1 increased from 35 (0.56 g/plant) to 140 DAP (9.46 g/plant) before declining at 175 DAP (3.14). There are large drops in the RDM of Samoa 1 and Samoa 2 at 175 DAP. The reductions in RDM are in accordance with other growth stages of taro reported by other researchers (Amosa, 1993; Goenaga, 1995; Lebot 2009; Pardales Jr., 1986; Sivan, 1976,).

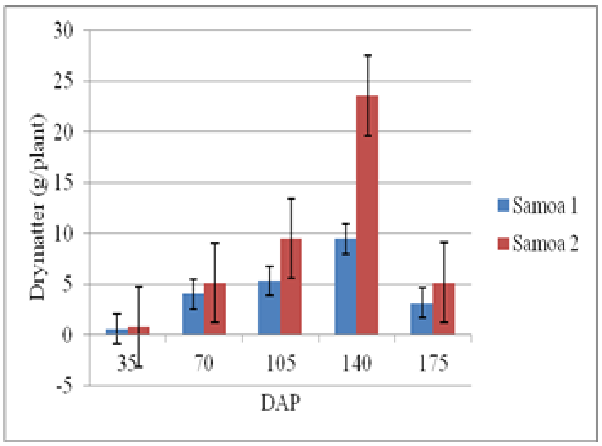

Figure 4. The effect five harvest dates (days after planting, DAP) on the roots dry matter (RDM) of Samoa 1 and Samoa 2 cultivars of taro (lsd = 2.7).

3.5. Suckers Dry Matter (SDM)

The difference between the SDM of Samoa 1 and Samoa 2 between different harvest dates is highly significant ($p < 0.001$).

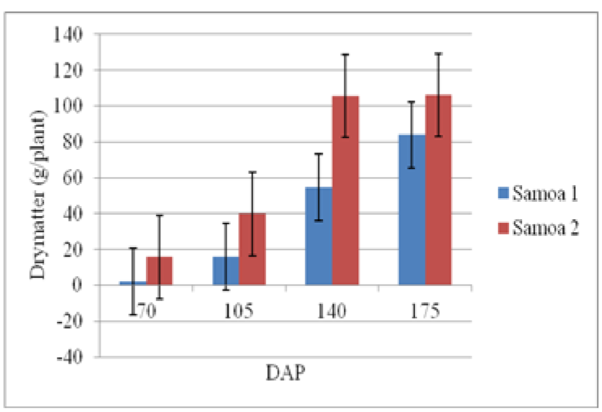

Figure 5. The effect of five harvest dates (days after planting, DAP) on the suckers dry matter (SDM) of Samoa 1 and Samoa 2 cultivars of taro (lsd = 27.8).

As shown in Figure 5, sucker production for both Samoa 1 and Samoa 2 cultivars started from 70 DAP and increased up to 175 DAP. The above results are supported by Sivan (1976) who reported a similar trend for the three taro cultivars he studied in Hawaii. The results from his study suggested that SDM increased from planting until the harvest time.

3.6. Total Dry Matter (TDM)

The difference in TDM between harvest dates is highly significant ($p < 0.001$) (Figure 6) for both the cultivars. The total dry matter of Samoa 1 and Samoa 2 cultivars kept increasing from 35 to 175 days after planning. The petioles and leaf blades dry matter had the largest contribution to the overall increase in the total dry matter accumulation during the early stages of plant growth while the accumulation of dry matter in corm and suckers dominated the later stages of plant growth. Samoa 2 had a higher TDM than Samoa 1 in most of the harvest dates. Sivan (1976) also reported that in three taro cultivars (i.e. Hawaii, Tausala ni Samoa, and Qawe ni Urau) total dry matters increased during the first 168 days after planting.

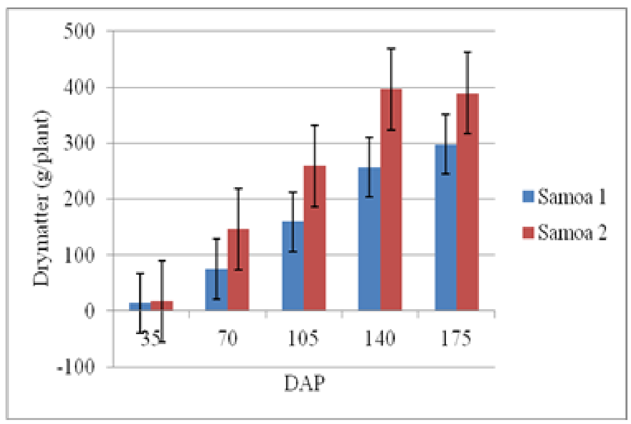

Figure 6. The effect of five harvest dates (days after planting, DAP) on the total dry matter (TDM) of Samoa 1 and Samoa 2 cultivars of taro (lsd = 56.1).

4. Discussion

Sivan (1976) proposed three growth phases for taro after he studied the DM accumulation and partitioning of three taro cultivars (Hawaii, Tausala ni Samoa and Qawe ni Urau) in Fiji. The first phase occurred very early during growth whereby the taro plants lost DM in the first two weeks before slowly recovering DM in the following six weeks. The second phase ("grand growth period") comprised of the rapid accumulation of leaf blades and petiole DM whereby both reached peak values at 168 DAP, while the corm continued to accumulate DM until harvest at 336 DAP. The final phase was recognised as the stage in which the total DM started to decline mainly because of the leaf blades and petioles losing dry matters.

According to Goenaga (1995), the growth of the two taro cultivars (Blanca and Lila) in Puerto Rico were characterized by three distinct stages. Stage 1 was dominated by the low rates of total dry matter accumulation during the first 48 DAP, followed by the rapid growth of total dry matter until 159 DAP whereby all plant parts experience improved dry matter accumulations. The third and final stage involved continuous rise in the TDM of the two cultivars which was mainly due to the DM accumulations of the corm and suckers.

In the present study also a similar pattern of dry matter accumulation (TDM) was observed. The total dry matter accumulations of Samoa 1 and Samoa 2 cultivars of taro crop had similar growth patterns from 35 to 175 days after planting (DAP). For the first 35 DAP there was a slow rate of TDM accumulation. Afterwards, the TDM accumulated very rapidly until 160 DAP. Finally, the TDM which is dominated by the corm and suckers dry matter gradually accumulated until the final harvest at 175 DAP. Therefore, the TDM accumulation of Samoa 1 and Samoa 2 cultivars of taro is in accordance with the other studies on taro conducted elsewhere (Goenaga, 1995; Sivan, 1976).

In the case of DM partitioning, a previous study (Goenaga, 1995) revealed that in the early growth season (82 DAP) of taro, plants allocated a greater percentage of the total dry matter to the leaf blades and petioles which accounted for at least 40% of the total dry matter.

Afterwards (from 100 to 350 DAP) the corm and suckers accumulated greater portions of the total dry matter while the shares of the leaf blades and petioles dry matter in the total dry matter decreased significantly. Hence, the partitioning of DM in Samoa 1 and Samoa 2 cultivars is in conformity with previous studies (Goenaga, 1995).

4. Conclusion

It was noted from the results that the growth of aboveground (i.e. leaf blades and petioles) biomass was very rapid during the first three months, thus had higher dry matters in the above ground parts of taro than the other parts of plant. On the other hand, the accumulation of dry matter in corm and suckers dominated the last three months of plant growth.

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Correspondence to: F. Amosa
Email: falaniko.amosa@samoa.usp.ac.fj