# Impact of mulches on growth and yields of cassava and sweet potato in tropical Asia

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## Abstract

Cassava and sweet potatoes are popular tropical tuber crops, grown under marginal conditions in smallholder systems. Thus potential yields of these crops are not realized due to the suboptimal management practices. Mulching is an easy and useful method inducing benefits to most tropical crops. The impact of three types of plant materials used as mulches (rice straw, grass and leaves of a legume tree Gliricidia) on growth and yields of cassava and sweet potato was determined under field conditions. Mulching increased growth and yields of both species when compared to that of non mulched plants. However legume leaves, which has a lower C: N ratio increased vegetative growth of both species when compared to plants mulched with rice straw or grass**.** The type of mulch did not affect yield components and tuber yield of sweet potato, and tuber yields were increased by 41%. The impact of mulches on cassava was greater (54%) than in non-mulched plants. The rice straw (or grass) mulch, which has a higher C: N ratio enhanced tuber yields by 24% when compared to the legume leaf mulch in this long-term tuber crop. The usefulness of mulches for increasing yields and the benefits of slow decomposing mulches on cassava was observed under rainfed conditions.

## Media summary

Use of mulches enhances yields of cassava and sweet potato. The type of mulch has a greater influence on the long duration crop cassava.

## Key words

Tuber yield, rice straw, *Panicum* sp., *Gliricidia sepium*

## Introduction

Tropical tuber crops are an important source of carbohydrates in the developing nations, especially among the resource poor and rural populations. They are planted by millions of people in the tropics, and are also identified to be the major source of carbohydrates for the populations of the world in the next decades (Scott et al 2000). Their importance lies from the ability to produce harvestable materials in marginal soils and under adverse edaphic and climatic conditions as marginal lands are increasingly being used to grow these crops (Iglesias et *a*l 1996).

Most tropical tubers crops are not managed optimally, thus, resulting in low yields. Amongst the most important factors affecting yield of tropical tubers, soil moisture is considered a vital factor as it affects root development and hence could impose a significant impact on yields (Yamauchi et al 1996). However, in most regions where tropical tubers are cultivated, crops are exposed to moisture stress due to erratic rainfall and the unavailability of irrigation (Turner 2000).

Cassava (*Manihot esculenta*) and sweet potato (*Ipomoea batatas*) are two of the most popular tropical tuber crops (Scott et al 2000). Their wide use in both the tropical and some regions of the temperate countries make them the most widely grown species of tropical tubers, in comparison to species such as yam (*Dioscorea*). However, their growth, development and yields are reduced significantly by soil moisture stress, and this is attributed to changes in root systems of these species due to variations in the available moisture for development (Agili and Pardales 1999).

Mulching is a common practice recommended for tropical smallholder farming systems, due to its ability to conserve soil and moisture and also suppress weeds. Some mulches with low C: N ratios provide

nutrients for crop growth through rapid decomposition (Unger 1994). Furthermore, studies in Latin America and Papua New Guinea (e.g. Ossom et al 2001) report the benefits of applying mulches to cassava and sweet potato to stabilize yields. However, similar reports on the impact of different available mulches on the growth and yields of cassava and sweet potato is not widely reported in the rainfed regions of South Asia, where the crops are grown by smallholder resource poor farmers. Hence field studies were initiated to ascertain the impact of three mulches on the growth and development of cassava and sweet potato under rainfed conditions.

**Materials and Methods**

The experiment was conducted at the experimental station of the University of Peradeniya ($8^oN$, $81^oE$, at 421 meters above mean sea level) in the mid-intermediate zone of the country. The soil of the site is an Ultisol (Rhododhult) (Panabokke, 1996) with a pH (1: 2.5 $H_2O$) of 6.4 $\pm$ 0.26, total N content of 95 mg/g of soil, CEC of 25.61 $\pm$ 2.87 m.eq/100 g of soil. The organic C content in the 0 – 40 cm layer of soil was 0.85%.

The 15 year mean rainfall (1985 – 2000) over the minor season (late April–August, corresponding to the Southwest monsoon) was 421 $\pm$ 34.2 mm while the mean evaporation over the same period was 548 $\pm$ 21.6mm. The rainfall is received in sporadic showers, thus subjecting the crops to soil moisture stress during the season, unless irrigation is available.

With the onset of rains in May, 1999, which corresponds to the minor season, plots of dimensions 8 X 5 m were prepared and cassava (Variety – CARI555) sweet potato (Variety Wariyapola) were planted at spacing of 100 x 80 cm and 50 x 50 cm respectively, using vegetative propagules. At five days after planting, three mulches, namely, rice straw (C: N ratio 51.5), grass (*Panicum maximum*, C: N ratio 36.2) leaves, and legume (*Gliricidia sepium*, C: N ratio 20.6), leaves were applied to the plots at a rate of 4 kg of fresh material per sq. meter. A treatment without a mulch was maintained for comparison. All other management practices were as recommended for Sri Lanka (Department of Agriculture, 1989).

Thus experiment with four treatments per species was replicated four times within a Randomized block design.

At three week intervals for cassava and two week intervals for sweet potato, two plants per plot were carefully removed and dry weights determined until tuber initiation was observed. The leaf area of the species was determined at the time tuber initiation was observed. At harvest, the plants were carefully removed, and numbers of total and marketable tubers (based on visual observations) and fresh tuber weight (the marketable product) were determined along with the dry weights of the shoot. A sub-sample of the tubers was taken for the determination of the harvest index. All dry weights were recorded after desiccation at 80?C for 48 hours.

The data of the two species was subjected to appropriate statistical analysis to determine the significance of observed differences, using a General Linear Model. The crop growth rates were calculated using the shoot dry weights during vegetative phase as described by Hunt (1982).

**Results and Discussion**

Mulches increased leaf area and crop growth rates, and reduced the time for tuber initiation significantly in both cassava and sweet potato, irrespective of the quality (Table 1). This implied the benefits of using some type of plant material as mulch for promoting the vegetative growth and tuber initiation of these tropical crops.

The leaf area indices of cassava and sweet potato were increased by the legume leaf mulch (21% in cassava and 10% in sweet potato) when compared to the non-mulched plants. In contrast, using a grass or straw mulch produced similar leaf areas in both species. The benefits of using a nitrogen rich cover crop, in terms of LAI and CGR, were thus greater in the long-aged cassava plants. The increased leaf

area promoted the crop growth rates of both species significantly, over that of plants grown without a mulch. The legume leaves enhanced dry matter accumulation to a greater extent than the other two mulches (16% in both species) and a significant correlation existed between leaf area indices and crop growth rates for both species ($r^2$ for cassava 0.714 and sweet potato 0.843) (data not shown).

Mulching enhanced mean time for tuber initiation significantly in both species (Cassava by 23 and sweet potato by 18 days). The impact was greater in the long aged cassava. The legume mulch enhanced tuber initiation to a greater extent in both species (30 days in cassava and 18 days in sweet potato), while the grass mulch reduced the time for tuber initiation than rice straw. This impact could be related to leaf area development and growth rates, as greater photosynthetic efficiency and crop growth leads to earlier tuber initiation in tuber crops (Oswald et al 1994). The better growth of the shoots could again be related to the nitrogen supply of the rapidly decaying legume leaves in contrast to the slower decomposition of grass and straw. The benefits of these two mulches could be attributed to retention of soil moisture and lower temperatures in the soil (Ayanaba and Okigbo 1975).

**Table 1. Impact of mulches on vegetative growth of cassava and sweet potato**

| Crop | Mulch | LAI | CGR (g/m$^2$/wk) | Days to Tuber Initiation |
|---|---|---|---|---|
| Cassava | Rice straw | 2.54 | 45.5 | 118 |
| | Grass leaves | 2.31 | 42.8 | 112 |
| | Legume leaves | 2.94 | 51.4 | 105 |
| | None | 1.56 | 26.4 | 135 |
| S E mean (n= 8) | | 0.56 | 14.32 | 6.97 |
| Sweet Potato | Rice straw | 3.81 | 25.6 | 46 |
| | Grass leaves | 3.66 | 22.8 | 43 |
| | Legume leaves | 4.12 | 28.3 | 48 |
| | None | 2.19 | 15.6 | 64 |
| S E mean (n= 8) | | 1.56 | 4.59 | 7.31 |

Yields of tuber crops are increased by early tuber initiation (Walworth and Carling 2002). The yield components and yields of both species were enhanced by various mulches (Table 2). The mean increases in tuber numbers of cassava and sweet potato due to mulching were 67% and 33% respectively, highlighting the greater impact in cassava, the long aged crop. The impact of the legume mulch was also greater in cassava (22%) than in sweet potato (6%). Mulches increased the marketable tubers compared to no mulches but the type of mulch had no significant effect on the percentage marketable tubers. This suggested that the carbohydrate distribution in the tubers is not affected by mulches, while mulches increase the process of development of all tubers.

**Table 2. Yield components and yields of cassava and sweet potato as affected by mulches**

| Crop | Mulch | No tubers/ plant | % Marketable tubers/plant | Fresh tuber yield (t/ha) | Harvest index |
|---|---|---|---|---|---|
| Cassava | Rice straw | 9.5 | 81.4 | 39.4 | 0.72 |
| | Grass leaves | 9.1 | 80.5 | 37.6 | 0.75 |
| | Legume leaves | 7.6 | 80.6 | 31.4 | 0.71 |
| | None | 5.2 | 66.9 | 22.4 | 0.66 |
| S E mean (n= 8) | | 1.95 | 5.86 | 5.64 | 0.03 |
| Sweet Potato | Rice straw | 6.1 | 83.4 | 25.6 | 0.65 |
| | Grass leaves | 6.4 | 76.9 | 24.9 | 0.63 |
| | Legume leaves | 5.9 | 80.4 | 24.1 | 0.63 |
| | None | 4.6 | 56.6 | 17.8 | 0.52 |
| S E mean (n= 8) | | 0.89 | 9.44 | 7..06 | 0.08 |

Farmers cultivating tropical tubers expect high yields and mulching helped enhance productivity (Table 2). Application of a mulch increased mean tuber yields of cassava and sweet potato by 62% and 41%, respectively. This implied the greater benefits of the mulch on the long aged cassava which could be subjected to changes in the environment for a longer period of time than the short aged sweet potato. However, while the different mulches had no impact on sweet potato yield, the grass or a straw mulch increased tuber yields of cassava by 23%. This was somewhat unexpected result, as legume leaves can provide nitrogen, which could affect yields. However, the benefits of the rice straw or grass mulch could accrue to its slower breakdown, thus providing better soil moisture conservation for a longer period of time, and also by reducing soil temperatures, affecting tuber bulking in tropical tuber crops (Ossom *et a*l 2001). Due to greater yields obtained by mulching harvest indices of both species were increased. In contrast, the harvest indices were not significantly affected by the three mulches used.

Mulching is considered essential in rainfed smallholder farming due to the many benefits they impact to the rhizosphere. However, most farmers do not adopt this practice. In tuber crops, mulches could play a significant role, as they also lower soil temperatures in addition to conserving soil moisture retention. Thus farmers need to be advised on the different types of mulches for different tuber crops, especially if they do apply some fertilizers to the crop. The mulch should be capable of retaining soil moisture, which is a scarce resource in rainfed farming and also lower soil temperatures for a longer period of time to

provide a more conducive rhizosphere for tuber development in tropical tuber crops, especially species such as cassava, which grown for over 7–8 months.

## Conclusions

The study clearly presented the benefits of mulching for tuber crops under rainfed field conditions of the tropics. A legume mulch promotes vegetative growth due to faster decomposition and release of nutrients to the crop. As tuber crops are grown for their harvestable tubers, mulches need to be evaluated in terms of decomposition and retention of soil moisture, especially for long-term species such as cassava. The study clearly shows the benefits of mulches such as rice straw having a slower decomposition rate than legume leaves in increasing yields to a greater extent in the long-aged cassava. However, in sweet potato, which is harvested in about 4 months, in contrast to 8-9 months in cassava, mulching, irrespective of the type provides a beneficial impact

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