SOME EFFECTS OF MULCHING ON THE GROWTH OF YOUNG TEA

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With the large-scale replanting now adopted on estates, until a good cover of tea is obtained with the replanted tea, the land is largely exposed. During this period there could be considerable soil erosion, loss of soil moisture due to evaporation and dense weed growth. Results of an experiment carried out to compare the effects of mulching with Guatemala grass, once and twice a year, with no mulching showed that mulching resulted in increased growth of plants, as determined by the dry weight components of tipped shoots. The moisture content of mulched plots was higher than that of unmulched plots during the dry season. Available phosphorus, exchangeable potassium and organic carbon in the top three inches of the soil were greater in mulched plots than in the unmulched plots at the end of two years. The potassium content of mature leaf increased with mulching, but the calcium content decreased slightly. Further, weed growth was reduced markedly, in the second year in the mulched plots.

The practice of mulching with crop residues, grass, straw or other material is well known in agriculture. The effect of mulching on plant growth and soil properties has been widely investigated in a number of crops. Jacks, Brind and Smith (1955) in a wide survey of the literature on the effects of mulching in temperate and tropical crops observed that the beneficial effects of mulching could be due to various factors such as suppression of weed growth, conservation of moisture by reducing evaporation and runoff, protection from erosion, increased infiltration of water, changes in soil temperature, enhanced nutrient availability, enhanced nitrification, additional nutrients and organic matter derived from decomposing mulch and other improvements in physical and chemical properties of soil. It is clear that mulching brings about many changes in soil properties and the beneficial effects on the growth of crops could be due to one or more factors that are important under particular soil and climatic conditions and on the type of crop.

Many tea estates are now adopting large-scale replanting. Until a good cover of tea is obtained with the replanted tea, much of the land is exposed and there could be considerable loss of fertility due to soil erosion. In addition, there is often dense weed growth during the early stages of growth of the replanted tea and loss of soil moisture due to surface evaporation could also be high. Recently, Hasselo and Sikurajapathy (1965) drew attention to the hazards that could result from erosion during the replanting period. The methods that have been suggested for maintaining an effective soil cover during the replanting period are mulching with loppings of Guatemala grass (*Tripsacum laxum*) or Mana grass (*Cymbopogon confertiflorus*) or growing suitable cover crops between tea rows. Mulching at present is carried out either by growing Guatemala or Mana grass *in situ* prior to replanting and leaving the grass residues on the soil surface or by mulching after replanting with grass grown elsewhere.

Mulching has been recommended as a desirable estate practice in East Africa (Tea Research Institute of East Africa 1966), and in Malawi (Shaxson and Hall 1966). Although mulching of young tea is a standard practice in most estates in Ceylon, few experiments have been carried out to study the effects of mulching on the growth of tea. The object of the experiment reported in this paper was to study the effects of mulching with Guatemala grass, in comparison with no mulching, during the first two years after replanting.

Experimental

An experiment was carried out at St Coombs on a clearing of clone TC9 which had been rehabilitated with Guatemala grass for two years prior to replanting. Three treatments were compared in this experiment, *viz* (a) mulched once a year at the rate of 15 tons fresh Guatemala grass per acre in May/June (b) mulched twice a year, in May/June and December/January, at the rate of 15 tons Guatemala grass per acre each time, and (c) untreated control. The plots were 15 ft x 8 ft in extent and tea was planted at a spacing of 3 ft x 1 ft, and there were 40 plants per plot. The experiment was laid out in a randomized block design and each treatment had six replicates. The first application of mulch was given immediately after planting in 1967. Fertilizer applications were carried out according to the recommendations given by Tolhurst (1961).

Soil moisture was determined gravimetrically at two depths, 0-6 in. and 6-12 in. Four soil samples were taken at each depth in each plot and these were bulked, mixed thoroughly and then sub-sampled before drying in the oven at 100°C for 24 hours. Loss in moisture was expressed as a percentage of oven dry soil.

Soil samples for chemical analysis were taken at a depth of 0-3 in., after removing the undecomposed mulch in the mulched plots. Six auger samples were taken in each plot and these were mixed thoroughly before sub-sampling for chemical analysis. Available phosphorus was determined using borax and sulphuric acid extractant (pH 1.5), and exchangeable potassium after extracting with neutral normal ammonium acetate. Organic carbon was determined by the method of Tinsley (1960) and total nitrogen by Kjeldhal's method.

Fully matured leaf samples were analysed for nitrogen by Kjeldhal's method ; potassium and calcium were determined by flame photometry, and magnesium by the 'Titan Yellow Method' (Chenery 1964), after dry ashing of the leaf samples and digestion with hydrochloric acid.

Assessments of weed growth were carried out by removing all weeds by hand and determining the fresh weight for each plot.

Plants were cut at the end of one year at 9 in. and at the end of two years at 12 in. At each sampling the dry weight of the leaves and stems of the tipped shoots was determined.

Results

Growth

The effect of mulching on leaf, stem and total dry weight per plant of tipped shoots taken at the end of one and two years is shown in Table 1.

TABLE 1 — *Effect of mulching on the dry weight components of tipped shoots*

	g/plant					
	First year			Second year		
	Leaf	Stem	Total	Leaf	Stem	Total
Control	35.6	20.4	56.0	49.4	22.0	71.4
Mulched once a year	43.6	27.4	70.8	57.0	29.2	86.2
Mulched twice a year	42.3	24.9	67.1	62.9	29.0	91.8
LSD ($P = 0.05$)	6.3	4.3	10.5	8.9	5.4	13.0

Mulching once a year increased the weight of leaf, stem and total dry weight of tipped shoots, compared with no mulching, but mulching twice a year did not result in any further increase in these components. These trends were evident in both years and the increase in total dry weight of shoots by mulching once a year compared with no mulching was approximately 26% and 21% for the first and second year respectively.

Soil moisture

In Table 2 are presented the summarized results of soil moisture determinations carried out at two depths, *viz* 0-6 in. and 6-12 in., on four occasions during the dry season. There was evidence of increase in soil moisture content with mulching, though mostly, significant differences were obtained only between the control and 'twice-mulched' treatment. Significant differences in soil moisture content were observed at both depths.

TABLE 2 — *Effect of mulching on soil moisture content*

	Per cent oven dry soil							
Date of sampling	3 March 1968		26 March 1968		28 Feb. 1969		14 March 1969	
Depth (in.)	0–6	6–12	0–6	6–12	0–6	6–12	0–6	6–12
Control	25.9	27.8	26.2	31.7	23.4	23.6	16.9	15.6
Mulched once a year	27.6	29.4	31.3	33.7	24.8	26.6	19.9	20.6
Mulched twice a year	29.9	31.7	33.0	33.9	27.7	29.0	21.6	22.9
LSD ($P = 0.05$)	2.4	2.3	2.1	NS	3.0	3.7	3.0	2.4

Where plots were mulched once a year, mulching was carried out at the beginning of the south west monsoon rains and most of this mulch had decomposed before the onset of the dry season. The plots mulched twice a year, however, received a second application of mulch at the beginning of the dry season and this treatment was therefore more effective in reducing soil moisture loss.

Weed growth

Visual observations showed that mulching was effective in controlling the growth of weeds for 2-3 months after the application of mulch. Weed assessments were done on four occasions. The summarized results of the fresh weight of weeds per plot are shown in Table 3.

TABLE 3 — *Effect of mulching on weed growth*

	Fresh weight (lb) of weeds per plot			
Date of sampling	20 June 1968	30 December 1968	5 May 1969	4 October 1969
Control	5.30	18.28	14.45	5.28
Mulched once a year	3.32	12.82	6.14	0.67
Mulched twice a year	1.98	13.95	3.67	0.80
LSD ($P = 0.05$)	NS	NS	1.83	3.53

At the first and second sampling in 1968, though there was a reduction in the amount of weeds in the mulched plots compared with the control plots, this effect was not significant. However, at the 3rd and 4th sampling, there was a significant reduction in weed growth in the mulched plots, compared with the control plots. Repeated application of mulch is thus likely to bring down the weed growth considerably, as evident from the very low weight of weeds obtained from the mulched plots at the last sampling.

Soil nutrients

In Table 4 are shown the results of total nitrogen, available phosphorus, exchangeable potassium, organic carbon and pH of soil samples taken at 0.3 in. depth at the end of the second year. The total nitrogen content of soil increased slightly with mulching, though the effect was not significant. Available phosphorus and organic carbon increased significantly by mulching once a year compared with the control plots, but there was no further increase in these nutrients by mulching twice a year. There was a marked increase in the potassium content due to mulching and mulching twice a year was significantly superior to mulching once a year. Soil pH was not affected by any of the mulching treatments.

TABLE 4 — *Effect of mulching on soil nutrients in the second year*

	Total N (%)	Available P (ppm)	Exchangeable K (m eq %)	Organic carbon (%)	pH
Control	0.216	45.0	0.25	2.69	4.89
Mulched once a year	0.228	64.4	0.58	3.16	4.79
Mulched twice a year	0.246	59.6	0.74	3.30	4.86
LSD ($P = 0.05$)	NS	13.2	0.11	0.26	NS

Leaf composition

Nitrogen, phosphorus, potassium, magnesium and calcium content of mature leaves in the second year are presented in Table 5. There was a small increase in the potassium content of leaf with mulching once a year compared with no mulching, but there was no further increase with mulching twice a year. Calcium content in the mulched treatments was slightly lower than in the control. The concentration of nitrogen, phosphorus, and magnesium was not affected by mulching treatments.

TABLE 5 — *Effect of mulching on leaf nutrients in the second year*

	Leaf nutrient content %				
	N	P	K	Mg	Ca
Control	3.49	0.16	1.01	0.22	0.72
Mulched once a year	3.50	0.16	1.09	0.22	0.69
Mulched twice a year	3.54	0.18	1.10	0.21	0.68
LSD ($P = 0.05$)	NS	NS	0.04	NS	0.02

Soil structure and erosion

Though no estimates of soil erosion and surface runoff were made in this experiment, observations in other experiments have shown that mulching resulted in a marked reduction in runoff and soil losses compared with land left bare or clean weeded. In an unreplicated trial at St Coombs, it was found that during the month of April 1969, when a considerable number of storms of high rainfall intensity occurred, soil loss in the bare clean weeded plot was approximately 18 tons per acre compared with only 0.03 tons per acre in the mulched plot. Mulching also resulted in a marked reduction in the surface runoff.

Whereas the soil in mulched plots was maintained in a good structural condition, in bare plots the surface soil had formed a crust which probably impeded infiltration and accelerated runoff and erosion.

Discussion

Investigations on the effects of mulching on young tea in Central Africa (Shaxson 1965) have shown that mulching resulted in higher yields than no mulching and mulching also gave greater plant survival during the dry seasons. Shyu and Wu (1968) have reported increased growth resulting from mulching with paddy straw in young tea. In the present experiment, mulching once a year increased leaf, stem and total dry weight of tipped shoots, compared with no mulching. These effects were evident both in the first and second years after planting, the increase in total dry weight being in the order of 20-25 % over the unmulched treatment. In respect of growth, however, mulching twice a year did not differ significantly from mulching once a year. But, to maintain a good soil cover throughout the year, two applications of mulch per year would be necessary at the rates of application carried out in the present experiment, and for reducing soil erosion and for conserving soil moisture, it may be necessary to maintain an effective ground cover throughout the year.

The effect of mulches on soil moisture losses is well known. Considerable increases of soil mositure content due to mulching in coffee soils in East Africa have been reported by Gilbert (1945), and in tea soils in China by Shyu and Wu (1968). In the present experiment, mulching increased soil moisture up to a depth of 12 in. compared with the unmulched treatment, during the dry season. Further, mulching twice a year was found to be superior to mulching once a year. Twice-a-year mulching treatment received an application of mulch at the beginning of the dry season in addition to the mulch given at the beginning of the south west monsoon rains, which was partially decomposed before the onset of the dry season. In Uva and other parts of Ceylon where a prolonged dry season is experienced, conservation of soil moisture may be of much importance in the survival of young tea and mulching could help to reduce soil moisture evaporation considerably in such areas.

Mulching has been shown to reduce surface runoff and soil erosion and increase the rate of infiltration (Adams 1966 ; Smith 1968). In the present investigation, there was good evidence that mulching reduced soil erosion and surface runoff to negligible amounts during a period of intense storms. It is thus clear that during the first two years of the growth of tea when most of the land is exposed, soil erosion could be serious unless a suitable ground cover could be provided. Maintaining a surface mulch of Guatemala grass or other suitable material during the rainy season would therefore be of great importance in this respect.

The decomposing mulch adds considerable amounts of nutrients to the soil. With an average content of 1.00 % N, 0.13 % P and 0.68 % K of dry matter in Guatemala grass (unpublished data), an application of grass at the rate of four tons dry matter per acre would amount to the addition of 88 lb N, 11 lb P and 60 lb K per

acre and some of these nutrients may be available to the plant. In addition the presence of a mulch may enhance the availability of nutrients already present in the soil due to improvements in soil structure and favourable soil moisture conditions.

Analysis of soil at 0-3 in. depth in the second year showed that mulching resulted in a slight increase in the total nitrogen content compared with no mulching. Further, the content of organic carbon, exchangeable potassium and available phosphorus were also significantly higher in the mulched treatments than in the control. Similar increases in soil nutrient content due to mulching have also been reported by Robinson and Hosegood (1965) in coffee and Ashrif and Thornton (1965) in ground nuts, marked effects being in the content of exchangeable potassium.

Improvements in the soil nutrient status would ultimately be reflected in increased growth and higher nutrient content of the plant. In the present experiment there was an increase in the potassium content of the leaf and a slight decrease in the calcium content. But, the concentrations of nitrogen, phosphorus and magnesium were unaffected by the mulching treatments. An increase in potassium content in the leaf due to mulching has also been reported by Robinson and Hosegood (1965) for coffee and by White and Holloway (1967) for apples. These effects are probably due to the release of readily available potassium from decomposing mulch, though Robinson and Hosegood (1965) have suggested that mulching may also reduce fixation of potassium in certain soils. It is interesting to note that though there was a marked increase in the phosphorus content of the soil at 0-3 in. depth with mulching, the content of phosphorus in the leaf was not affected. The slight lowering of the calcium content of leaf with mulching is in agreement with the work of Robinson and Hosegood (1965).

A reduction in weed growth due to mulching in coffee has been reported by Gilbert (1945). In the present work, observations showed Guatemala grass mulch reduced weed growth for only 2-3 months after application, but as the mulch decomposed this effect was negligible. However, during the second year weed growth was markedly reduced in the mulched plots. Though mulching may not eliminate the weeds completely, 2-3 applications may help to reduce the weed population considerably and limit manual weeding to a minimum, thereby reducing root damage, soil disturbance and erosion.

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