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Effect of Mulching, Potassium Fertilizer and Clones in Minimizing Drought Effects in Young Tea

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ABSTRACT. The effectiveness of mulching, potassium fertilizer application and selection of clones in minimizing drought effects on young tea was investigated. The results confirmed the adequacy of the recommended mulching rate (37.5 t/ha) for enhanced growth and moisture conservation. However, mulching appeared to result in shallow rooting. Increased potassium fertilizer application and selection of drought resistant clones were shown to minimize the drought effects and reduce casualty rate in young plants.

INTRODUCTION

Over 66% of the total tea extent of Sri Lanka is under seedling tea, and is generally low yielding. Therefore, programmes of replanting old seedling tea with high yielding vegetatively propagated (VP) tea commenced three decades ago. The rate of replanting was envisaged at a rate of 2% annually (Nathaniels, 1985). However, actual rate of replanting is well below the envisaged target. The slow rate of replanting is attributed to various factors, among which failure in plant establishment due to drought is considered as the primary factor in the Mid Country.

Measures to minimize drought effects during plant establishment, plays an important role in the management of plantations and small holdings. Mulching is widely practised for moisture conservation in new

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clearings (Manipura, 1971) and drought resistant clones are advocated for drought prone areas (TRI, 1976). Furthermore, Potassium is reported to reduce transpiration rate and economizes water use by plants (Achitov, 1961). Therefore, this study was undertaken to evaluate the feasibility of minimizing drought effects through proper integration of mulching, increased potassium fertilizer application and selection of suitable clones.

MATERIALS AND METHODS

The experiment was conducted at the Tea Research Institute, Advisory and Extension Centre, Hantane, Kandy (7° 26'N, 80° 38'E and 762 m amsl), over a period of two years (1986 and 1987). The experimental plots were 6.4 m x 12.8 m in dimension. The treatments tested were: 3 levels of mulching and 3 levels of potassium fertilizer on three clones with different drought response characteristics. The details of the treatments are given below;

Treatments

Mulching:

M0 - No Mulching

M1 - Mulching @ 37.5 t/ha

M2 - Mulching @ 75.0 t/ha

Potassium:

	1st Yr	2nd Yr (Kg K2O/ha/Yr)
K0 - 7.5% K2O	90	123
K1 - 11.25% K2O	135	185
K2 - 15.0% K2O	180	246

Clones:

C0 - TRI 2023 (Drought susceptible)

C1 - TRI 2025 (Moderately drought tolerant)

C2 - DG 7 (Drought resistant)

The selected clones were planted in June 1985 using 10 month old plants, at the spacing of 0.6 m x 1.2 m. The mulching materials (fresh *Mana* grass, *Cymbopogon confertiflorous*) was spread in-between tea rows, soon after planting. The mulch cover was maintained by replenishing the mulch every 4 months as this material decomposes in 12-16 months (Krishnapillai, 1990).

The young tea fertilizer mixture T.200 (10.3% N, 6.9% P2O5 7.5% K2O and 3.0% MgO) was applied at 60 day intervals, at the rate of 15 g and 20 g per plant during the 1st and 2nd years respectively. Additional potassium in K1 and K2 treatments was incorporated into the T.200 mixture with Muriate of Potash (KCl, 60% K2O). Cultural practices and aftercare operations were carried out according to the TRI recommendations (Sandanam,1986).

Soil moisture measurements were monitored during the dry period with the help of the Neutron Moisture Probe (Troxler, Model 1255). Soil moisture contents at depths of 0-15 cm was estimated by sampling with a post hole auger and determining the gravimetric moisture content. The Neutron moisture meter was used to determine the soil moisture content at depths of 22.5, 37.5, 52.5, 67.5 and 82.5 cm.

Three assessments were made of growth in tea. The first two non-destructive assessments were made on 6 and 12 month old plants, while the destructive sampling was done on 24 month old plants. The training operation for bush formation was done by cutting the plants at 30 cm and 40 cm when plants were 12 and 16 months respectively. The weight of the plant parts were also recorded.

Transpiration rate and stomatal diffusive resistance were measured using a Steady State Porometer (Model LI-1600). The measurements were taken during June 1986.

Visual assessments on drought tolerance or susceptibility were carried out twice during March 1987. Wilting, scorching, defoliation and die back of shoots were assessed visually in the visual assessments. The more severe effects of the drought were ascertained by a casualty count carried out in April 1987.

RESULTS AND DISCUSSION

Growth assessments

Both mulching and potassium fertilizer application did not have a significant effect on growth at the early stages (Table 1). However, there was a significant increase in plant height and stem girth as a result of mulching in 12 month old plants. Further benefits were not observed by doubling of the mulching rate from 37.5 to 75.0 t/ha. Increased potassium fertilizer application resulted in stem thickening of 12 month old plants. The clone TRI 2023 indicated superior growth attributes over TRI 2025 and DG 7 at all stages of growth, confirming vigorous growth habit of this clone (Richards, 1967 and Wadasinghe, 1988).

Dry matter production

There were significantly higher shoot weights from both first and second cuts in mulched plots. However, the increase was not significant with doubling of the mulching rate. Clone TRI 2023 was superior to the other two clones (Table 2).

Mulched plants did not show a significant increase in dry weight of plants components, *i.e.* stem, leaf and roots or whole plant of 24 month old plants. The root weights in mulched plants was lower than in un-mulched plants, however, the differences were not significant (Table 2). The decrease in root growth in mulched plots may be due to better soil moisture regimes (Ekanayake, 1992).

Clones followed a similar pattern as above. Where as TRI 2023 produced significantly higher stem dry weights and leaves than DG 7 and 2025, the root dry weights of TRI 2023 was lower than that of DG 7. Potassium did not have any significant effect on the dry matter production of the plants. This may be due to lack of proportionate increase in other nutrients coupled with the increase of potassium as Ranganathan and Natesan (1985).

Table 1. Effect of mulching and potassium on plant height and stem girth of three clones.

Treatments	Plant height(cm/pl) 6m	12m	24m	Stem girth(mm/pl) 6m	12m
No Mulch	57.1	82.0	115.9	2.97	10.80
37.5 t/ha	62.1	92.6	120.3	3.22	12.30
75.0 t/ha	62.4	97.1	125.1	3.27	11.90
LSD (P=0.05)	NS	11.0	9.2	NS	0.80
TRI 2023	77.9	106.2	124.4	3.90	13.40
TRI 2025	48.6	82.3	112.1	2.74	11.30
DG 7	55.1	83.1	124.8	2.82	10.30
LSD (P=0.05)	11.4	11.0	9.3	0.40	0.80
K0	55.1	85.3	117.9	3.00	9.80
K1	62.8	90.9	123.9	3.20	12.40
K2	63.3	94.8	120.9	3.26	12.50
LSD (P=0.05)	NS	NS	NS	NS	0.80
Interactions	NS	NS	NS	NS	NS

Table 2. Effect of mulching and potassium on dry matter production of three clones.

Treatments	Dry weight in gm per plant					
	Stems	Leaves	Roots	Total	1st cut	2nd cut
No Mulch	65.4	61.5	46.1	173.0	29.4	33.8
37.5 t/ha	70.7	65.4	45.2	181.3	42.3	40.3
75.0 t/ha	70.9	71.8	43.1	185.8	51.2	44.8
LSD (P=0.05)	NS	NS	NS	NS	12.3	6.4
TRI 2023	73.3	76.4	43.6	193.3	63.2	42.6
TRI 2025	77.4	64.2	44.2	185.8	27.7	33.4
DG 7	56.2	58.2	46.6	161.0	31.8	45.8
LSD (P=0.05)	16.5	11.8	NS	31.0	12.3	6.4
K0	59.6	58.8	42.4	160.8	35.2	37.4
K1	72.6	69.9	46.1	188.6	40.8	42.6
K2	74.7	70.2	45.9	190.8	46.8	41.8
LSD (P=0.05)	NS	NS	NS	NS	NS	NS
Interaction	NS	NS	NS	NS	NS	NS

Root depth

The clones DG 7 and TRI 2025, which are relatively drought resistant clones had deeper root systems than TRI 2023 (Table 3) which is a drought susceptible clone. Mulching did not have a significant effect on rooting depth, although there was a trend to indicate a decrease in root depth with increased mulching rate. This is supported by the lower root weight of mulched plants (Table 2). The higher moisture availability in the shallow layers in mulched plots may have resulted in shallow rooting as reported by Othieno and Ahn (1986).

Transpiration rate

Research in tea and other crops (Nagaraja, 1979; Krishnapillai *et. al.*, 1988; Mengel and Kirkby, 1987) report that potassium influences leaf diffusion resistance of stomata and hence affects transpiration. This was confirmed in this study where the highest potassium levels K2 significantly reduced the transpiration rate of leaves when compared with the control, K0 tested (Table 4). The clone DG 7 had a significantly lower transpiration rate than TRI 2023. Clone TRI 2025 had a lower transpiration rate than TRI 2023 and a higher transpiration rate than DG 7. The drought response characteristics of these clones are partly explained by the difference in their transpiration rates. Mulching did not have a significant effect on the transpiration rate.

Stomatal diffusive resistance

The diffusive resistance is related to the transpiration rate. Therefore, a lower transpiration rate is in effect due to higher stomatal diffusive resistance. The clone DG 7 had significantly higher stomatal diffusive resistance and hence a lower transpiration rate than the other two clones. The plants supplied with higher levels of potassium fertilizer had a higher stomatal diffusive resistance (Table 4). This resulted in lower transpiration rate increasing the water use economy of the tea plant as reported by Krishnapillai *et. al.*, (1988).

Table 3. Effect of mulching and potassium on root depth of three clones.

Treatment	Root depth(cm/pl)
No Mulch	38.7
37.5 t/ha	37.1
75.0 t/ha	35.1
LSD (P=0.05)	NS
TRI 2023	34.0
TRI 2025	35.5
DG 7	40.4
LSD (P=0.05)	3.4
K0	36.2
K1	36.1
K2	38.6
LSD (P=0.05)	NS
Interaction	NS

Table 4. **Effect of mulching and potassium on transpiration rate and stomatal diffusive resistance of three clones.**

Treatments	Transpiration rate (ug/cm_2/s)	Stomatal diffusive resistance(s.cm/s)
No Mulch	2.46	8.98
37.5 t/ha	2.68	8.88
75.0 t/ha	2.64	8.82
LSD (P=0.05)	NS	NS
TRI 2023	2.92	7.46
TRI 2025	2.68	9.19
DG 7	2.39	10.03
LSD (P=0.05)	0.43	2.50
K0	2.95	6.94
K1	2.69	8.82
K2	2.39	10.88
LSD (P=0.05)	0.43	2.50
Interaction	NS	NS

Visual assessments on drought susceptibility/tolerance of plants

Plants in mulched plots were least affected by drought. Plants mulched with 37.5 t/ha of grass had significantly lower visual score (less affected by drought) than plants in un-mulched plots (Table 5). Doubling of the mulching application did not have a significant reduction in the visual score on drought effects. This confirms the adequacy of presently recommended mulching rate of 37.5 t/ha (Sandanam, 1986). The lower visual score in mulched plots could be attributed to higher soil moisture availability, thus plants are not subjected to stress (Russel, 1973; Manipura, 1969; Othieno, 1980 and Anandacoomaraswamy *et. al.*, 1988). A lower transpiration rate due to higher stomatal diffusive resistance results in less water use by plants. . The clone DG 7 in addition to these attributes also had a deeper root system than the other two clones. As a result clone DG 7 had the lowest visual score compared to the other two clones. Plots supplied with potassium fertilizer level (K2) had a lower score than K0 plots. Therefore, as reported by Krishnapillai *et. al.*, (1988), increased potassium fertilizer application had effectively minimized drought effects in this study.

Casualty rate

Overall casualty rate was low due to favourable weather conditions that prevailed during the experimental period. Even with the low casualty rate, mulching at 37.5 t/ha had significantly reduced the death of young tea plants due to drought. There was no further reduction in the casualty rate with the doubling of the mulching rate (Table 5). The clone DG 7 had a significantly lower casualty rate than TRI 202 and TRI 2025. Clone TRI 2025 had a lower casualty rate than TRI 2023 which is a drought susceptible clone. This confirms the drought response characteristics of the three clones tested. Increased potassium fertilizer application effectively reduced the drought effects and hence the casualty rate. This suggests that by judicious application of potassium it is possible to reduce drought effects and casualty rate of young tea plants during dry weather.

Table 5. Effect of mulching and potassium on drought susceptibility/resistant and casualty rates of three clones.

Treatments	Visual Score	Casualty rate (%)
No Mulch	3.38	11.3
37.5 t/ha	2.59	8.1
75.0 t/ha	2.51	7.8
LSD (P=0.05)	0.77	3.2
TRI 2023	3.53	11.2
TRI 2025	2.95	9.2
DG 7	2.00	6.8
LSD (P=0.05)	0.77	3.2
K0	3.48	10.4
K1	2.80	9.6
K2	2.20	7.2
LSD (P=0.05)	0.77	3.2
Interaction	NS	NS

Soil moisture extraction pattern

The moisture depletion curves (Figure 1) indicate that in mulched plots the moisture extraction was up to a depth of about 40 cm. In un-mulched plots,plant extracted moisture from deeper layers. This may be attributed to shallow rooting of plants in mulched plots (Table 3). The clone TRI 2023 and TRI 2025 extracted moisture up to a depth of 50 cm (Figure 2). The clone DG 7 on the other hand extracted moisture up to a depth of 70 cm, corresponding to the extent of rooting of these clones. The moisture extraction pattern by tea plants under three potassium fertilizer levels did not differ (Figure 3). This also corresponds to the root depth of plants under three potassium levels, where significant differences between treatments were not observed.

CONCLUSIONS

The results suggest that mulching with *Mana* grass at the rate of 37.5 t/ha, which is the current recommendation can reduce the drought effects on tea plants as a result of increased moisture retention. This also enhanced plant growth.

Doubling of the mulching rate did not show any significant increase in moisture retention or plant growth. However, there was significant reduction in drought effects.

Mulching results in shallow rooting of tea plants. The tendency increases with the increased rates of mulching. Therefore, over-mulching should be strongly discouraged in new clearings of tea.

The clone DG 7 had the ability to withstand drought and had the lowest casualty rate. Therefore, this clone could be recommended for replanting in drought prone areas.

The study also revealed the effectiveness of increased potassium fertilizer application in minimizing drought effects in young tea.

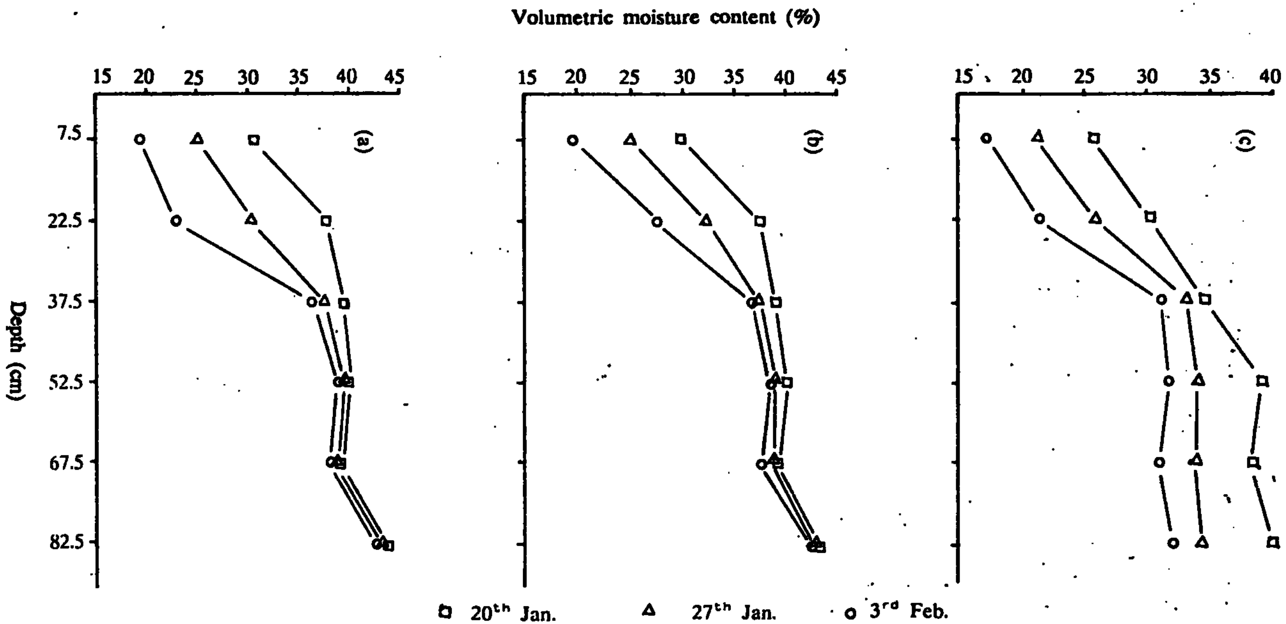

Figure 1. Soil moisture extraction pattern during 1986
(a) Mulching * 75.0 t/ha
(b) Mulching * 37.5 t/ha AND
(c) No mulching

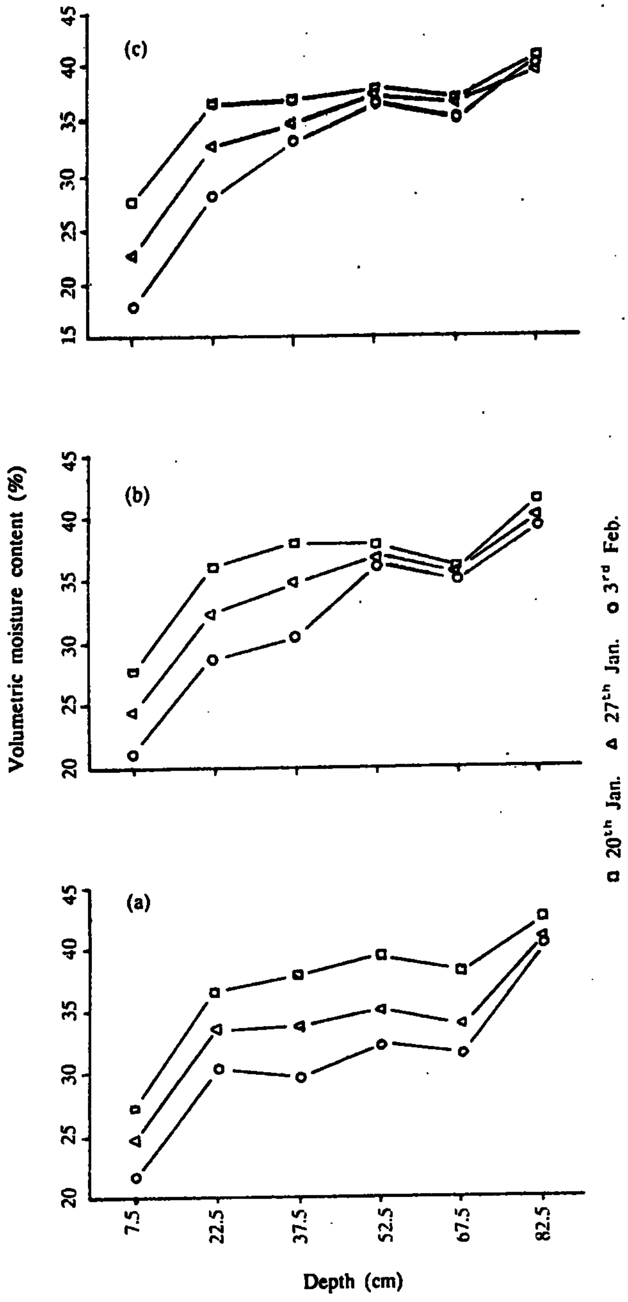

Figure 2. Soil moisture extraction pattern during 1986 (a) Clone DC7 (b) Clone TRI 2025 and (C) Clone TRI 2023

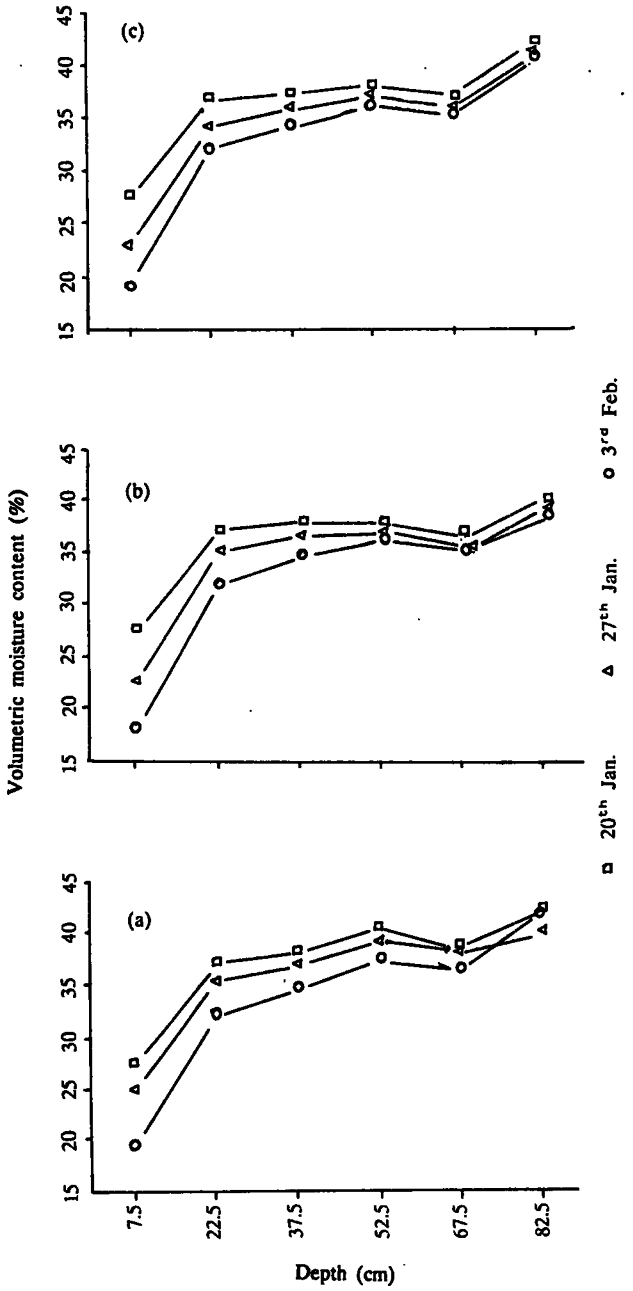

Figure 3. Soil moisture extraction pattern during 1986 (a) 180 Kg K_2O (b) 135 Kg K_2O and 90 Kg K_2O

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