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Effect of Trichoderma Isolates on Root Growth of Different Tea (*Camellia Sinensis*) Clones; Nursery Based Study

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Abstract

Most farmers depend on tea as a cash crop and raising it is challenging due to pathogens and other factors which lower the vigour hence production of weak plantlets. Some Trichoderma species promote growth in a wide range of plant species. They establish robust and long lasting colonization of the root surfaces penetrating into the epidermis of plants and promote shoots development; crop productivity and resistance to abiotic stresses. The objectives of this study were to investigate the effect of Trichoderma spp. isolates on development of shoots and shoot biomass of ten selected clones. It was isolated from forest soil (F) and root Rhizosphere of old Tea Plants (TR) using modified Martin's Rose Bengal Agar while standard isolate, T4 was from stock cultures. The isolates were cultured, purified and characterized using morphological, cultural and microscopic characteristic. Pure cultures were multiplied using Potato Dextrose and 1 ml (2.0 × 106 cfu/ml) suspension used for inoculation. Experiments were set up with controls using DAP fertilizers in a randomized complete block design in three replicates. Observations were made after 60 days and 120 days where data was collected in June and August 2019. Data was analyzed using Statistical Analysis Software (2018) and Two-way analysis of variance (ANOVA). Results showed the isolates significantly ($P \leq 0.05$) enhanced development of shoot and shoot biomass in some treated tea clones. It was concluded that Trichoderma spp. Promote growth of shoots and shoot biomass in different tea clones and hence, is recommended for use when raising tea cuttings in the nursery.

Keywords: F-Forest isolate; T4-Standard isolate TR-Tea root Rhizosphere isolate; Clones

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Introduction and Background to the Study

The development of biological control agents of plant pathogens has attracted significant amount of interest in the recent years due to global concerns to conserve the environment and the negative impacts of chemical pollutants on human health worldwide. The research conducted in this field has led to the discovery of many potential fungal biocontrol agents some of which have reached the stage of commercialization [5].The ability of some Trichoderma spp. to parasitize and kill destructive plant pathogens have attracted attention of agricultural scientists, farmers and policy makers worldwide and hence; a large body of information on biological control of plant pathogens have accumulated in the recent past [2].

Recent reports on some beneficial microorganisms from different parts of the world have demonstrated their role in the promotion of plant growth and induction of defence response on host plants in addition to antagonistic action on plant pathogens [4]. Inoculation of tea cuttings with different species of Arbuscular Mycorrhizal Fungi isolated from different tea rhizospheres in Assam (India) significantly improved the survival of the cuttings [1]. Glomus fasciculatum species was found to be the most efficient and had the highest shoot length, root length, dry weight and nutrient uptake in tea cuttings. Field experiments conducted in Assam revealed increased leaf harvest in the Arbuscular

Mycorrhizal Fungi inoculated plants in comparison to controls [1]. In Morocco, the Carob tree (Ceratonia siliqua) is an agro-forest-pastoral species having an enormous socio-economic and ecological interest. Research on the effect of double inoculation with endomycorrhizae species and Trichoderma harzianum species on the growth of Carob plants showed a significant effect on the growth of these plants [4].

In Kenya investigations carried out on Trichoderma spp. have shown their potentials in enhancing the overall growth in tea plants [10]. Research carried out at Tea Research Institute showed antagonistic properties of some Trichoderma species against Armillaria spp. fungi in tea establishment [8] [9] [3]. However, no research has been done on the effects of Trichoderma spp. on any specific tea clone. This research was aimed at carrying out an investigation on the nursery-based screening of ten selected commercial tea clones inoculated with Trichoderma spp. isolates for enhanced growth of roots; the number of roots and biomass to bridge the identified gaps.

Materials and Methods

Experimental design

The research was carried out at Tea Research Institute nursery section for duration of 120 days. The experiments were set up in a Completely Randomized Experimental Block Design (CREBD) in which tea clones were planted in polythene sleeve and randomly place in the experimental blocks in the nursery. The experiments involved 7 isolate treatments namely; Tea Rhizosphere (TR)+DAP; Forest (F)+DAP; Standard (T 4)+DAP; Tea Rhizosphere ONLY ; Forest ONLY; Standard ONLY (T4) and; Control (DAP ONLY).All the experimental set ups were done in three replicates.

Source of Trichoderma spp. isolates

The standard Trichoderma harzianum isolates T4; was obtained from the stock cultures in the TRI laboratory through sub culturing in Potato Dextrose Agar (PDA) while isolates; F and TR were obtained from virgin forest soil and old tea root rhizospheres respectively, through isolating using Martin's Rose Bengal Agar. Identification and characterization were done in the laboratory using microscopic, cultural and morphological characteristics. The isolates were multiplied on PDA and appropriate concentrations were obtained for inoculating all the experimental tea clones in the nursery [9].

Tea varieties

The tea varieties used for the experiments were clones TRFK 6/8; TRFK 7/9; TRFK 31/8; TRFK 56/1; TRFK 301/4; TRFK 303/577; TRFK 7/3; TRFK 306/1; TRFK 597/1 and TRFK 704/. Seedling cuttings were obtained from the Tea Research Institute-Timbilil Estate mother bushes. Each cutting had two buds and a leaf obtained from mother bush 2.5 cm to 4 cm in length. Ten (10) clones out of 59 commercial clones developed by Tea Research Institute were selected for popularity among farmers. Selection of the 10 varieties was based on; Yield potential kg/mt/ha/yr.; Quality index of black tea; Rooting of cuttings; Current utilization status [6]

Trichoderma harzianum species isolates;T4;TR; and F spore harvesting

Spores of Trichoderma species were harvested from mature cultures by scrubbing off using a sterile glass slide. The harvested spores were counted using haemocytometer and the concentration adjusted to 2.0 X 106 CFU/ml with sterile distilled water [9].

Nursery bed establishment

Nursey soil comprising of a mixture of both topsoil and subsoil mixed with DAP fertilizers (600 g of DAP per 1,000,000 cm3 volume of soil) were staffed in Polythene sleeves of 10 cm in diameter and 26 cm deep (Simon, 2014). Cuttings were planted, watered and covered with polythene sheets. There were 10 different clones per plot each with 3 Replicates 1, 2 and 3(R1, R2 and R3) respectively. Each replicate was further replicated 3 times to give a total of ninety (90) plantlets per plot. There were seven (7) plots each with plantlets to give a total of 630 plantlets in the experimental plots in the nursery. Tinder net was used to provide 60% shading in order to reduce the impact of direct sun [8]

Inoculation with Trichoderma spp. isolates

The Trichoderma treatments, T. harzianum T4, TR; and F were applied onto each sleeve using a pipette to enhance colonisation by the inoculum. Two (2) millilitres of spore suspension containing 2.0 X 106 cfu was introduced into each respective sleeve. A control treatment was also set up using (DAP only) for each clone [7]

Data Collection

Growth measurements on root lengths by destructive sampling and getting the length using a ruler &, number of roots and Biomass were taken randomly after 120 days for each tea clones. Biomass (dry weights) was recorded after drying the plant materials and weighing until the weight became consistently constant. Details of the data collected were recorded on a designed table for analysis and drawing of general conclusion

Data analysis

The collected data was subjected to Statistical Analysis Software (SAS version 9.0) for analysis and drawing of general conclusions based on the results obtained

Results and Discussion

The shoot length development, number of leaves and dry weight varied significantly (LSD P≤0.05) in all the treatments after 60 days. Results on the effects of Trichoderma harzianum species isolates on growth of shoot lengths after 60 days showed that treatments; TR+DAP; TR ONLY; and T4 ONLY significantly enhanced growth of shoots and hence demonstrated the highest development of shoots. It therefore justifies the argument that Trichoderma harzianum species is a biofertilizers [10]. Treatments: F+DAP; T4+DAP; CONTROL; and F ONLY also did not exhibit significant variation in their means and showed low development of shoots. Shoot lengths for Clones TRFK 6/8

produced the highest shoot length (Table 1), followed by clone TRFK 306/1; TRFK 31/8; TRFK 301/4 and TRFK 704/2 respectively. Clones TRFK 56/89; TRFK 303/577; and TRFK 7/9 showed moderate shoot development. While clones TRFK 597/1 and 7/3 had the lowest shoot development. Treatments; T4 ONLY showed the highest number of leaves followed by TR+DAP; F ONLY; TR ONLY; and F+DAP respectively. Treatments; Control (DAP) showed the lowest number of leaves. Clones showed varied results with clone TRFK 6/8 producing the highest number of leaves, followed by clones TRFK 31/8; TRFK 306/1; TRFK 56/89; and TRFK 301/4 respectively. Clones TRFK 7/9; TRFK 303/577; and TRFK 704/2 showed moderate number of leaves. Clones TRFK 7/3 and TRFK 597/1 had the lowest number of leaves (Table 2).

CLONES	TRFK 6/8	TRFK 07(Sep	TRFK 31(Aug)	TRFK 56/8/9	TRFK 301/4	TRFK 303/577	TRFK 07(Mar	TRFK 306/1	TRFK 597/1	TRFK 704/2	mean treatments
TREATMENTS F+DAP	2.7 (1.55)	1.4(1.23)	2.1(1.4)	1.3(1.2)	1.2(1.15)	0(0.69)	0.3(0.83)	6.4(2.13)	0.5(0.9)	2.6(1.52)	1.2 b
TR+DAP	3.3(1.67)	3(1.6)	2.8(1.57)	3.5(1.7)	1.5(1.26)	5.2(1.97)	0.2(0.77)	4(1.79)	1.1(1.14)	3.5(1.7)	1.5 ab
T4+DAP	3.5(1.7)	0.5(0.9)	3.3(1.66)	0.2(0.77)	4.5(1.87)	1.2(1.15)	1.2(1.15)	2.8(1.57)	0.6(0.96)	1.9(1.37)	1.3 b
Control (DAP)	2.9(1.59)	1(1.1)	1.7(1.3)	1.2(1.15)	3(1.61)	3.2(1.64)	0(0.69)	3.8(1.75)	0.3(0.84)	0.7(1)	1.3 b
F ONLY	7.5(2.25)	1.7(1.3)	6.2(2.1)	2.4(1.48)	2(1.38)	0.9(1.06)	0.7(1)	1.7(1.32)	0(0.69)	4.3(1.84)	1.3 b
TR ONLY	7.5(2.25)	0.5(0.92)	6.6(2.15)	2.6(1.52)	2.7(1.55)	0(0.69)	0(0.69)	5.1(1.96)	2.1(1.42)	2.2(1.43)	1.5 ab
T4 ONLY	5.8(2.06)	1.3(1.2)	3.7(1.74)	5.4(2)	5.4(2)	5.4(2)	0(0.69)	8.3(2.33)	0(0.69)	4.8(1.91)	1.7 a
Mean clone	1.9 a	2.1 de	1.7 ab	1.4 bcd	1.5 abc	1.3 cd	0.8 e	1.8 a	1 e	1.5 abc	
C.V (%)	41.41										
LSD (P≤0.05)	5										
Treatments	0.3										
clones	0.36										

The interaction of treatment (T) and Clones (C) showed varied results. Results from the above table show the findings when10 different clones of tea were subjected to 7 different treatments, to test on their length of shoots. In the table above, shoot length development did vary significantly (LSD P≤0.05) in all the treatments.

Table 1: Effects of T.harzianum species on growth of shoot lengths after 60 days.

CLONES	TRFK 6/8	TRK 7/9	TRK 31/8	TRFK 56/89	TRFK 301/4	TRFK 303/577	TRK 7/3	TRFK 306/1	TRK 597/1	TRFK 7041/2	mean treats
Treatments F+DAP	2(1.1)	4(1.8)	7(2.2)	7(2.2)	5(1.9)	3(1.62)	1(1.2)	3(1.6)	2(1.5)	10(2.5)	1.79b
TR+DAP	8(2.3)	3(1.6)	6(2.1)	9(2.4)	12(2.6)	9(2.41)	1(0.9)	4(1.8)	2(1.5)	10(2.5)	2.02a
T4+DAP	7(2.2)	2(1.3)	7(2.3)	5(1.9)	10(2.5)	8(2.28)	1(1.1)	9(2.4)	6(2.1)	4(1.8)	1.99ab
Control(DAP)	6(2.1)	3(1.7)	3(1.6)	8(2.3)	5(1.9)	4(1.73)	1(1.1)	6(2.1)	2(1.5)	7(2.2)	1.83ab
F ONLY	8(2.3)	3(1.6)	5(1.9)	8(2.2)	7(2.2)	6(2.1)	2(1.4)	8(2.3)	4(1.8)	5(1.9)	1.99ab
TR ONLY	5(1.9)	3(1.7)	4(1.8)	10(2.5)	4(1.9)	4(1.75)	2(1.3)	10(2.5)	4(1.9)	5(1.9)	1.91ab
T4 ONLY	7(2.2)	3(1.6)	4(1.8)	10(2.5)	8(2.3)	4(1.86)	1(0.9)	9(2.4)	3 (1.7)	5(1.98)	1.93ab
Mean clone	2.06ab	1.61c	1.96b	2.30a	2.20ab	1.96b	1.14d	2.15ab	1.68c	2.14ab	
C.V (%)	21.42										
LSD (P≤0.05)											
Treatments	0.21										
clones	0.25										

The interaction of treatment (T) and clone (C) showed varied results as shown in table 2 above. Results from the table showed the findings when ten different clones of tea were subjected to seven different treatments, to test on their length of shoots after 120 days. In the table, shoot length development did vary significantly (LSD P≤0.05) in all the treatments.

Table 2: The effects on growth of shoot lengths after 120 days.

Treatments:

TR+DAP; and TR+DAP showed the highest dry weight followed by F+DAP; F ONLY; TR ONLY; and T4+DAP respectively. Treatments; T4 ONLY showed moderate mean dry weight. Treatments; Control (DAP ONLY) showed the lowest dry weight.

The clones showed varied results with clone TRFK 306/1 and TRFK301/4 producing the highest mean dry weight followed by clones TRFK 31/8; TRFK 597/1;and TRFK 6/8 respectively. Clone TRFK 56/89; TRFK 704/2 and TRFK7/9 showed moderate mean dry weight. Clone TRFK 7/3 recorded lowest mean dry weight.

The shoot length development, number of leaves and dry weight varied significantly (LSD P≤0.05) in all the treatments after 120 days. Treatments TR+DAP; TR ONLY; and T4 ONLY did not vary significantly in their means and showed the highest shoot length. Treatments F+DAP; T4+DAP; CONTROL; and F ONLY did not show significant variation in their means (1.96 b). Shoot length for Clones: TRFK 6/8; TRFK 56/89; TRFK 306/1; TRFK 31/8; TRFK 301/4 and TRFK 704/2 produced the highest shoot length, Clones TRFK 303/577; and TRFK 7/9 showed moderate shoot length and clones TRFK 597/1 and TRFK7/3 had the lowest shoot length (Table 3).

CLONES	TRK 06/08/2021	TRFK 07/09/2021	TRFK 31/08/2021	TRFK 56/89 301/4	TRFK	TRFK 303/577	TRFK 07/03/2021	TRFK 306/1	TRFK 597/1	TRFK 704/2	Mean treatment
Treatments F+DAP	4.3(1.8)	3.0 (1.6)	2.9 (1.58)	1.8(1.33)	1.8(1.33)	1(1.1)	1.3(1.2)	4.3 (1.84)	0.6(0.96)	1.3(1.2)	1.4 bc
TR+DAP	2.6(1.5)	4.0 (1.7)	3.0 (1.61)	3(1.61)	1.6(1.27)	4.6(1.89)	1.3(1.2)	3(1.6)	1.9(1.37)	2.2(1.44)	1.5 b
T4+DAP	4.7(1.9)	1.6 (1.2)	2.6 (1.53)	1(1.1)	3(1.61)	1.6(1.27)	1.8(1.3)	2.6 (1.53)	1.6(1.27)	2.7(1.55)	1.4 bc
Control (DAP)	3.3(1.6)	1.8 (1.3)	1.8 (1.34)	2.2(1.44)	2.5(1.5)	1.8(1.33)	1(1.1)	3.0 (1.61)	1(1.1)	1.6(1.27)	1.4 c
F ONLY	5(1.9)	2.7 (1.5)	4.3 (1.84)	2.5(1.5)	2.3(1.46)	1.8(1.33)	1.1(1.1)	1.8 (1.33)	1.3(1.2)	2.7(1.54)	1.5 bc
TR ONLY	5.4(2)	1.7 (1.3)	3.9 (1.78)	3(1.61)	2.8(1.56)	1(1.1)	1(1.1)	3.0 (1.61)	2.8(1.56)	1.9(1.37)	1.5 bc
T4 ONLY	4.7 (1.9)	2.5 (1.5)	4.7(1.9)	4.3(1.84)	4.3(1.84)	4.3(1.84)	1.3(1.2)	5.7 (2.04)	2.1(1.4)	2.3(1.46)	1.7 a
Mean clone 1.6a	1.8 a	1.5 cd	1.7 ab	1.5 bcd	1.5 bcd	1.4 de	1.2 f	1.7 abc	1.3 ef	1.4 de	
C.V (%)	19.63										
LSD (P≤0.05)											
Treatments	0.15										
clones	0.18										
The interaction of Treatment (T) and Clones (C) showed varied results. Results from the above table show the findings when; 10 different clones of tea were subjected to 7 different treatments, to test on their number of leaves. In the table above, number of leaves did vary significantly (LSD P≤0.05) in all the treatments.											

Table 3: The effects of *T. harzianum* on growth of the number leaves 60 days.

Treatments TR+DAP; F ONLY; TR ONLY; showed the highest number of leaves whileTreatmentsT4 ONLY and Control (DAP) gave moderate number of leaves and treatment F+DAP showed the lowest number of leaves. Clones showed varied results with clone 56/89 producing the highest number of leaves, followed by clones TRFK 306/1; TRFK 6/8 and TRFK 7/9, Clones TRFK 597/1; TRFK 31/8; TRFK 303/577 and TRFK 704/2 showed moderate number of leaves. Clones TRFK 7/3 and TRFK 597/1 had the lowest number of leaves (Table 4).

CLONES	TRFK6/8	TRFK7/9	TRFK 31/8	TRFK 56/89	TRFK 301/4	TRFK 303/577	TRFK 7/3	TRFK 306/1	TRFK597/1	TRFK704/2	mean treats
TreatmentsF+DAP	2 (1.)	5 (1.)	4 (1.84)	4 (1.78)	3 (1.66)	3 (1.61)	3 (1.6)	3 (1.67)	5 (1.89)	4 (1.79)	1.72b
TR+DAP	6 (2.0)	5 (1.9)	4 (1.84)	6 (2.14)	5 (1.95)	5(1.9)	2 (1.3)	3 (1.56)	4 (1.71)	4 (1.84)	1.84a
T4+DAP	6 (2.0)	4 (1.7)	5 (1.99)	5 (1.92)	4 (1.84)	5 (1.94)	3 (1.2)	5 (1.99)	4 (1.84)	3 (1.56)	1.82ab
Control(DAP	5 (1.9)	3 (1.6)	2 (1.44)	5 (1.99)	3 (1.56)	4 (1.84)	3 (1.6)	6 (2.02)	3 (1.61)	4 (1.79)	1.74ab
F ONLY	5 (1.9)	3 (1.6)	4 (1.79)	7 (2.16)	4 (1.77)	5 (1.94)	3 (1.6)	6 (2.02)	4 (1.79)	3 (1.59)	1.84a
TR ONLY	5 (1.8)	6 (2.0)	3 (1.67)	7 (2.2)	3 (1.67)	3 (1.61)	3 (1.5)	6 (2.12)	4 (1.84)	4 (1.79)	1.84a
T4 ONLY	5 (1.9)	4 (1.7)	4 (1.73)	6 (2.11)	4 (1.79)	4 (1.71)	1 (1.1)	7 (2.16)	4 (1.71)	4 (1.72)	1.78ab
Mean clone 1.6a	1.91abc	1.81bcd	1.76d	2.04a	1.75d	1.79cd	1.46e	1.94ab	1.77cd	1.73d	
C.V (%)	12.74										
LSD (P≤0.05)											
Treatments	0.12										
clones	0.14										
The interaction of treatment (T) and clone (C) showed varied results as shown table 4. Results from the table showed the findings when ten different clones of tea were subjected to seven different treatments of T. harzianum spp., to test on their number of leaves. From the table below, the number of leaves did vary significantly (LSD P≤0.05) in all the treatments.											

Table 4: Effects on growth of the number leaves after 120 days.

Treatments TR+DAP; and T4+DAP;F+DAP showed the highest dry weight followed by F ONLY; T4 ONLY; and T4+DAP respectively, Treatments TR showed moderate mean dry weight and Control (DAP ONLY) showed the lowest dry weight. The clones showed varied results with clone TRFK 301/4 and TRFK 704/2 producing the highest mean dry weight followed by clones TRFK 56/89; TRFK 306/1; TRFK 31/8; TRFK597/1; and TRFK 6/8 respectively. Clones TRFK 6/8; TRFK 303/577 and TRFK 7/9 showed moderate mean dry weight and Clone TRFK 7/3 recorded lowest mean dry weight

The interaction of treatments (T) and clone (C) showed varied results as shown in (Table 5 and 6). Results from the table below showed the findings when ten different clones of tea were subjected to seven different treatments, to test on their dry weights. From the table below, dry weight did vary significantly (LSD P≤0.05) in all the treatment.

CLONES	TRFK 06/08/2021	TRFK 7/9	TRFK 31/8	TRFK 56/89	TRFK 301/4	TRFK 303/577	TRFK 7/3	TRFK 306/1	TRFK 597/1	TRFK 704/2	Mean treatment
Treatments F ONLY	0.8	0.59	0.94	0.77	0.81	0.81	0.51	0.85	1.03	0.89	0.80abc
TR ONLY	0.91	0.72	0.86	0.67	1.48	0.75	0.33	1.07	0.84	0.65	0.83ab
T4 ONLY	1.16	0.46	0.8	0.61	0.86	0.72	0.29	1.37	0.71	0.63	0.76bc
F+DAP	0.7	0.71	1.07	0.64	1.36	0.98	0.43	1.14	0.77	0.76	0.86ab
TR+DAP	0.81	0.7	0.88	0.63	1.52	0.94	0.46	0.97	0.96	0.87	0.88a
T4+DAP	0.61	0.7	0.79	0.57	1.01	0.72	0.42	1.25	0.93	0.71	0.77abc
Control (DAP)	0.62	0.56	0.75	0.88	0.95	0.86	0.26	0.87	0.58	0.63	0.70c
Mean clone	0.8 bcd	0.64 e	0.87 b	0.69 de	1.14 a	0.83 bc	0.38f	1.07 a	0.83 bc	0.74 cde	
C.V (%)	27.32										
LSD (P≤0.05)											
Treatments	0.112										
clones	0.133										
The interaction of Treatment (T) and Clones (C) showed varied results in trial I. Results from the above table show the findings when; 10 different clones of tea were subjected to 7 different treatments, to test on their dry weights in the table above, dry weight did vary significantly (LSD P≤0.05) in all the treatmen											

Table 5: The effects of T. harzianum on growth of dry weight after 60 days.

CLONS	TRFK 6/8	TRFK 7/9	TRFK 31/8	TRFK 56/89	TRFK 301/4	TRFK 303/577	TRFK 7/3	TRFK 306/1	TRFK 597/1	TRFK704/2	mean treats
Treatment FONLY	1.17	1.49	0.79	1.81	2.37	1.18	1.16	1.71	1.51	1.14	1.4ab
TRONLY	0.97	0.69	1.7	1.78	1.4	1.09	0.74	1.79	1.48	1.3	1.3bcd
T4 ONLY	0.96	1.44	1.68	1.63	1.82	1.31	0.8	1.2	1.43	1.29	1.4abc
F+DAP	0.84	1.46	1.65	1.67	1.43	0.69	0.61	1.63	1.63	3.49	1.5a
TR+DAP	0.86	0.75	2.54	1.72	1.84	2.16	0.56	1.22	1.49	1.86	1.5a
T4+DAP	0.91	0.9	1.81	0.94	1.95	1.28	0.49	1.34	1.85	1.25	1.3cd
Control(DAP)	0.8	0.7	0.789	1.24	1.65	0.97	0.54	1.64	1.22	1.43	1.1d
Mean clone	0.9d	1.1c	1.6b	1.5b	1.8a	1.2c	0.7e	1.5b	1.5b	1.7ab	
C.V (%)	21.7										
LSD (P≤0.05)											
Treatment	0.15										
Clones	0.18										
Interaction											
The interaction of treatments (T) and clone (C) showed varied results as shown in table 4.10. Results from the table below showed the findings when ten different clones of tea were subjected to seven different treatments, to test on their dry weights. From the table below, dry weight did vary significantly (LSD P≤0.05) in all the treatments											

Table 6: Effects on dry weight after 120 days.

Conclusion and Recommendations

If treatment s TR+DAP; TR ONLY; are applied singly or in combination with DAP fertilizers growth of shoots will be greatly enhanced. Treatment T4 ONLY when applied singly will have the same effects.

Shoot lengths for Clones TRFK 6/8; TRFK 306/1; TRFK 31/8; TRFK 301/4 and TRFK 704/2 respectively could be enhance by application of the Trichoderma harzianum species treatments.

Trichoderma harzianum species should be incorporated in the soil when growing tea cuttings in the nursery to enhance their establishment.

Further research be carried out on clone TRFK 7/3 whose overall growth was least enhanced by all the treatment compared to the other clones.

Further research to be carried out on the effects of the other Trichoderma spp. isolates on growth of tea cuttings and other tea clones not covered by the research.

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