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Adventitious Root Characteristics of Some Assamica Tea Clones (*Camellia sinensis* L. Kuntz)

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ABSTRACT

Tea is multiplied either through generative or vegetative propagation systems. Vegetative propagation is limited by several factors such as poor survival rate at nursery due to poor root formation of some clones and seasonal dependent rooting ability of cutting, however root system plays an important role in regulating of water uptake and absorb nutrient from the soil. Root formation was believed under genetically control, therefore the objective of this research is to characterize genetically the adventitious root of some tea clones. Seven clones were explored to study the adventitious root formation through the improvement of rooting media. The result showed that (1) improvement of root quality of tea through adding rooting media with plant growth regulators seemed difficult to be implemented, (2). Rooting of tea cutting is under genetic control, (3) effort to improve root quality of tea through breeding approach looked visible in the future.

Keyword : *assamica tea, root, characters*

INTRODUCTION

Tea (*Camellia sinensis* L.) is one of the most popular beverages in the world (Su *et al*., 2007). Tea plays a significant role in the foreign exchange earnings of a number of developing countries (Aye *et al.*, 2008). Wright (1959) classified tea on the basis of morphological characteristics such as leaf size, leaf shape, length of pistill and flower size. There are two main varieties of tea i.e. sinensis and assamica (Ming, 2000). The bush with small leaves, resistant to cold is characterized as china type sinensis, while assamica type is normally tall, large leaves (Sealy, 1958). However, from breeding point of view, both are highly cross pollinated and inter-crossable without any barriers (Roy and Cakraborty, 2009).

Tea is propagated either through seeds or cuttings (Mondal *et al*., 2004). Seed grown plants show a high degree of variability; therefore the alternative choice is through vegetative propagation of the elite cultivar where

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in single leaf inter-node cuttings are planted and followed by the transferred of rooted cutting to the field. Vegetative propagation is limited by several factors such as poor survival rate at nursery due to poor root formation of some cultivars and seasonal dependent rooting ability of cutting, However root system plays an important role in regulating of water uptake (Chaitra *et al*., 2006) and absorb nutrient from the soil (Mephec, 2005). Root growth is an important component of plant growth, and improvement of root architecture and production are likely to improve crop production when they are especially grown on marginal land and suffer from increased disease pressure and poor fertility (Mephec, 2005).

Drought tolerance has been associated to root characteristics (Sanders & Markhart, 1992). Among root morphological traits, maximum root length and root diameter were found to be associated with drought tolerance (Toorchi *et al*., 2007). Deep root helps to explore different level of soil moisture and root thickness may be important in water uptake and translocation (Abdallah, 2009). Vegetative propagation products are generally suspected to be more prone to drought (Nathaniel, 1992), however root regeneration is highly heritable (Han *et al*., 1994). Root formation is under fairly strong genetic control and therefore responsive to clonal selection (Zalesny *et al*., 2005). Vigorous root systems are as essential as vigorous shoot for growth and development of healthy plants (Nicole, 1998). Vigorous root system is stable in the face of varying environmental conditions (Zalesny *et al*., 2005). Breeding for enhanced root ability has been a key component of clonal development, therefore in this experiment, the root characteristics of some clones of tea at the polyclonal field will be studied in order to develop new clone of tea with strong rooting ability.

MATERIALS AND METHODS

Some of tea accessions grown at polyclonal collection of Pagilaran plantation were used for the study (Table 1). Stock clone plants before cutting preparation were hard pruned, so that the clone could develop healthy shoots. Single leaf bud cuttings were prepared from the middle portion of produced shoots. These cuttings were planting on different rooting bed media *i.e*. top soil, topsoil treated with 1 mg/l rootone-F, and topsoil treated with 1 mg/l IBA (Indole butyric acid) and kept under mist-propagation system.

Table 1. Clones grown at the polyclonal collection of Pagilaran plantation

No.	Clone's name	Clone's symbol
1.	Tea research Institute-2025	TRI-2025
2.	Suka Ati-40	SA-40
3.	Malabar-2	Mal-2
4.	Pasir sarongge-1	PS-1
5.	Kiara-8	Kia-8
6.	Cinyiruan-143	Cin-143
7.	Sukamaju-118	Skm-118

Twenty cuttings were used as an experimental unit and arranged randomly with 3 replicates, and placed under 2 meter leaf shading. After 2 months incubation times, root characteristic data such as root length (cm), root number, root volume (ml), and total root dry weight (g) were collected. Broad sense heritability and genotypic coefficient variation were estimated using analyses of variance of 7 x 3 factorial treatment design (Singh and Chaudary, 1979). If there is significant different among clones and/or rooting media, interaction and main effects were evaluated using Duncan Multiple Range Test with 5% significant level (Gomez and Gomez, 1984).

RESULT S AND DISCUSSIONS

Most successful method of vegetative propagation of tea was the use of single node cuttings kept under very high humid environment planted in an appropriate rooting media (Banerjee, 1993). Rooting of hardwood cutting is under genetic control, although genotypic-environmental interaction affected selection of promising genotypes (Zalesny *et al*., 2005). The structure of root system was shaped by an endogenous genetic program and external factors perceived from the biotic and abiotic environments (Hochholdinger *et al*., 2004). Rapid rooting with good root characteristics was critical for economic and biological viabilities of cutting, because rapid rooting of cuttings reduced establishment cost by permitting the use of un-rooted cutting as commercial propagules. Good rooting could be used as an indicator of good shoot growth in the field (Muchtar *et al*., 1990). Enough root number determined the cutting success, because root number related to nutrient and water absorption capacities (Mephec, 2005).

Table 2. Analysis of variance of several root characteristics

Source of variation	Degrees of freedom	Mean square of several root characteristics			
		Root length	Root number	Root volume	Root dry weight
Clone	6	35.633*	243.100*	0.871*	0.718*
Rooting media	2	18.749 ns	8.464 ns	0.487 ns	0.064 ns
Interaction	12	5.635 ns	17.085 ns	0.212 ns	0.196 ns
Error	42	6.467	24.409	0.231	0.167
Coefficient of variation		21.533	27.714	30.670	56.154

*). Significant at 5% significant level

Table 2 showed that there is no interaction between clones and rooting media used to propagate tea. Significant effect was only observed in genotypes factor. Try to improve rooting media by adding root inducing plant regulators such as auxin was failed. Tanimoto *et al*. (2009) for instance successfully improved tea root quality by using gibberelic acid, a shoot-growth promoting hormone. Different rooting capacities were observed among clones. Root formation was genetically control (Adams, 1959; Camargo and Fitho, 2005).

Further analyses showed that TRI-2025 produce significantly the longest adventitious root than other clones. Deeply observation found that the development of adventitious root is directly correlated with the appearance of root initials which was observed 2-3 weeks after planting. Similar result has been reported by Konyucu and Balta (2004). Both added that adventitious root primordial arose from near the vascular cambium and secondary phloem parenchymatous tissue. High heritability was observed for root length (table 3). Similar result was reported by Gerildiyal *et al*. (2009) and root length genotypic variability was also observed in this experiment was similar in Pinus roxburgii. Due to the presence of enough genetic variation and high heritability, selection for more extensive root system to have better morphological performance especially in answering the less severe drought stress has been recommended. Selection of strong root growth which was shown by root length would be effective (Carmargo and Fitho, 2005).

Although there were limited publications including root number and volume for the characterization of root formation, root number and root volume determined root architecture (Lynch, 1995; Vieira *et al*., 2008). Root number would be altered by osmotic potential of the soils (Deak and Malany, 2005). In this experiment, there were two distinct groups of clones related to the root formation ability. SA-40, Kia-8 and SKM-118 were three best clones of root formation ability. More genotypic variability and better heritability were observed in root number compared to root length. It means that selection based on root number would be also very effective.

There was different observable root volume among clones. TRI-2025 showed the best root volume. It seemed that root volume in cutting tea was influenced by root length not by root number. Root volume exhibited moderate heritability (0.48). If there was large additive effect, selection based root volume would also be effective (Saleh and Griffon, 1988). Root length and its distribution in the soil which was in this experiment shown as root volume together with the uptake rate per unit root length determined the uptake of water and nutrient (Bengough *et al*., 2004).

Root biomass was the easiest way to describe root growth. Root growth was an important component of plant growth (Mephec, 2005). Root dry weight was parameter of root system which could be useful as screening criteria for drought tolerance (Matsui and Singh, 2003). Root biomass exhibited moderate to high heritability (saleh and Griffon, 1988). This experiment found similar observation in tea. Root biomass of tea showed very high genotypic variation. Similar result was reported by Gerildiyal et al. (2009). Relatively high broad-sense heritability was observed in other dicotyledonous (Ali-khan and Snoad, 1977), and monocotyledonous plants (Ekanayake *et al*., 1985). With moderately heritability but very high genotypic variability, selection based root biomass would also be effective. This strategy was also proposed by Ennos (1995) and highlighted by Annichiarico and Piano (2004).

Vigorous root system was essential for growth and development of healthy plants. Early root growth and development even for vegetative propagated crops determined the optimum root system throughout the entire life of plants, potentially leading to optimize yield (Leskovar and Sloffela, 1995).

Table 3. Root length (cm), root numbers, root volume (ml) and dry root weight (g) of different clones of assamica tea planted at different rooting media

Treatments and genetic parameters	Root characteristics			
	Root length (cm)	Root number	Root volume (ml)	Dry root weight (g)
Clones				
TRI-2025	14.144 a	14.167 b	2.067 a	1.280 a
SA-40	11.228 bcd	21.000 a	1.461 bc	0.643 b
Mal-2	13.239 ab	11.111 b	1.394 bc	0.404 b
PS-1	13.561 ab	12.222 b	1.800 ab	0.768 b
Kia-8	8.983 d	22.444 a	1.378 bc	0.547 b
Cin-148	9.606 cd	10.278 b	1.150 c	0.601 b
SKM-118	11.906 abc	20.611 a	1.728 ab	0.840 b
Genetic parameter				
GCV	26.407	61.090	25.502	97.332
Heritability (H)	0.601	0.748	0.479	0.525

Means in column followed by similar letters showed no statistical different by DMRT at 5 % significant level. GCV = Genotypic coefficient of variation

CONCLUSSION

With such simple experiment, it could be concluded that (1) improvement of root quality of tea through adding rooting media with plant growth regulators seemed difficult to be implemented, (2). Rooting of tea cutting is under genetic control, (3) effort to improve root quality of tea through breeding approach looked visible in the future.

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