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Vegetative growth performance of three tea cultivars in the foothills of Arunachal Pradesh, India

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In India, the state of Arunachal Pradesh is the 2nd largest tea producing state in the North-Eastern region next to Assam. Arunachal Pradesh annually produces approximately 11 to 13 million kg of made tea. Assam contributes (618.3 million kg) approximately 50 per cent of total tea production (1255.60 million kg) in the country from an area of 3.04 lakh hectares (Source: Tea Board, India). East Siang district of Arunachal Pradesh, which lies adjoining to Assam, comes under the tea plantation belt producing good quality tea. However, different tea cultivars are grown in the state's foothills, but thorough screening is required to identify the suitable varieties for this region. Therefore, the present investigation was carried out to evaluate the performance of three popular cultivars, *viz.*, TS-463, Tinali-17, and N-436, for the foothills of Arunachal Pradesh. This would help the prospective tea planters and small tea growers (STGs) of the state make appropriate decisions on selecting suitable cultivars for new plantations and the expansion of the existing garden.

Table 1. Particulars on attributes of the three tea cultivars at the Estate

Parameters	TS-463	Tinali-17	N-436
a. Origin	TRA:(TV-1 X TV-19)	Tinali T.E, Naharkatia, Dibrugarh, Assam	Norkhoroy T.E Tinsukia, Assam
b. Introduction to the estate	2000s	1990s	1990s
c. Practiced spacing (cm):	110 x 75 x 65		
d. App. plant population per ha	12,000-13,000		
e. Yield [made tea per ha (kg)]	2500	3000	2000
f. Preference of shade trees	*Acacia lenticulars*, *Albizia odoritissima* (*Albizia* sp.), *Derris robusta*		
g. Conversion ratio in the estate (Green leaf: made tea) (or Made tea: green tea leaf::23%)	4.35		
h. Cup quality (amongst the three cultivars)	Good	Better	Best
i. Suitability for specialized tea	CTC/ Orthodox	CTC/ Orthodox/ White tea	Orthodox/ White tea

(Courtesy: M/s Donyi Polo Tea Estate, Oyan, Arunachal Pradesh, India)

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Tea polyphenols (catechins) and caffeine are the major chemical constituents in tea leaves. Other constituents include amino acids, vitamins (E and K), inorganic elements (Al, Fl and Mn), carbohydrates (cellulose and lignin) and lipids, chlorophylls (a and b) and carotenoids. Oxidation of polyphenols by polyphenol oxidases (PPOs) during the rolling and oxidation stage of processing results in the production of *thearubigin* and *theaflavins*. The content of these two bio-organic compounds and caffeine in tea leaves are responsible for the unique taste, flavour and briskness of tea (Balentine *et al.,* 1997). In a very innovative approach, Karikalan and Mandal (2015) had, for the first time, explored the bio-reduction of gold (*Aurum*) metals into nanoparticles (NPs) using plant extracts of *Camellia sinensis.* Gold nanoparticles (Au-NPs) have been acknowledged to possess tremendous potential in diagnostic and therapeutic applications.

The accumulation rate of chemical constituents in leaves is higher during and after the resting period of the tea bush. Thus, in Assam, the tea manufactured from the first flush during spring (February-March-early April) fetches a higher price in auction every year than other periods of the year. On the other hand, the slower growth rate in Darjeeling and Nilgiri Hill teas enhances the accumulation of the chemical constituents in the leaves, providing uniqueness in terms of their liquor quality (Deka *et al*., 2006).

Potom and Nimasow (2016) undertook an extensive survey and reported an increase in plantation area by around 20 per cent and production by 25 per cent each year in the Lohit district of Arunachal Pradesh. They also highlighted the practical constraints such as labour problem, transportation, soil degradation, climatic constraints, and plant pest and diseases as encountered by the tea growers. Therefore, it is felt that the identification of hardy tea cultivars holds significance for the prospective tea growers in the state.

Vegetatively propagated planting materials of the two cultivars of tea, namely Tinali-17, N-436 and one biclonal seedstock TS-463, were sourced from M/s Donyi Polo Tea Estate, East Siang District, Arunachal Pradesh, India. In these cultivars, N refers to Nakhoi or Norkhoroy (Upper Assam) and TS refers to Tocklai Biclonal Stock (TV-1 X TV-19). These are amongst the chosen cultivars in the estate and planted in different blocks of varied acreages. The plantation was taken up in the experimental plot (28.08 East Latitude and 95.326 North Longitude) of the Department of Fruit Science, College of Horticulture and Forestry, CAU (Imphal), Pasighat, East Siang District, Arunachal Pradesh, India. Thirty plants per treatment per replication were planted in 2018 to observe their establishment and growth pattern and survival under normal rainfed conditions. Each treatment was replicated seven times.

General tea estate management practices (TEMP) were adopted during the 18 months of the establishment to screen suitable hardy cultivars for the foothills of Arunachal Pradesh. The management practices included stacking, weeding, earthing up and FYM application. The crops were allowed to establish under rainfed conditions. In the present experiment, no separate irrigation was provided.

Observations were recorded after 18 months of planting, *i.e.,* during June 2019 for the parameters like plant height, stem girth, canopy spread, stem height at the first branch, number of primary branches, length of the longest primary branch and survival percentage.

$$\text{Survival percentage} = \frac{\text{Number of plants survived}}{\text{Number of plants transplanted}} \times 100$$

Statistical analysis was carried out using the online statistical tool, Web Agri Stat Package 1.0 (WASP 1.0) software (Anon, 2019).

The results of the experiment presented in Table 2 revealed that Tinali-17 recorded maximum plant height (108.1 cm) and the least height (69.3 cm) was observed for TS-463 which was statistically at par with that of N-436 (75.3 cm). The stem girth at 10 cm height was significantly higher (13.7 cm) in Tinali-17, minimum in TS-463 (7.7 cm) which was at par with that of N-436 (8.9 cm). The canopy spread North-South (50.4 cm) and East-West (46.4 cm) was observed maximum for the cultivar Tinali-17. The height of the stem where the first branch emerged was low in TS-463 and N-436. However, statistically, these data are at par with that of Tinali-17 (13.7 cm). The number of primary branches was maximum in

Table 2. Growth parameters and survival percentage of tea cultivars under foothills condition of Arunachal Pradesh

Tea cultivars	Height of plant (cm)	Girth at 10 cm height (mm)	Canopy spread (cm)		Height of first branching (cm)	No. of primary branches	Length of longest branch (cm)	Survival percentage (%)
			N-S	E-W				
TS-463	69.3 b	7.7 b	33.7 b	36.3 b	7.0	8.9	41.7 b	46.4 b
Tinali-17	108.1 a	13.7 a	50.4 a	46.4 a	13.7	12.4	63.1 a	82.2 a
N-436	75.3 b	8.9 b	45.4 a	45.7 a	9.8	9.2	45.6 b	67.9 a
CV	15.05	20.45	20.40	15.20	44.88	26.36	19.94	27.21
CD (5%)	14.76	2.43	10.24	7.58	NS	NS	11.64	20.75

Tinal-17 (12.4) as compared to TS-463 (8.9) and N-436 (9.2). The length of the longest branch was maximum in Tinali-17 (63.1 cm), which was statistically significant as compared to TS-463 (41.7 cm) and N-436 (45.6 cm). The survival percentage was significantly higher for Tinali-17 (82.2%), followed by N-436 (67.9%) and TS-463 (46.4%).

Misra *et al.* (2016) had reported that Tinali-17 is a popular tea cultivar amongst the popularly cultivated tea clones and *jats* (TV-1, TV-20, TV26, TV-29, TV-30, Tingamara, Dangari Manipuri and Sundaram (B/5/63), Takda-7, 8 *etc.*) in tea growing belts of North Bengal, *i.e*., Terai, Dooars and Hill region. Tanti *et al.* (2016) considered TV-1, Clone 663 and Tinali 17 as standard clones in their investigation for analyzing the phylloplane microbiological parameters at Tocklai Tea Research Institute (TTRI), Tea Research Association (TRA), Jorhat (Assam). Tinali-17 is regarded as one of the most popular Assam Types of tea cultivars (Sabhapondit *et al.,* 2012). They had reported that the catechin content was highest in Assam variety, followed by Cambod and China varieties.

In the present experiment, Tinali-17, an Assam Type cultivar, was found to establish better than the other two cultivars under the foothills of Arunachal Pradesh. The maximum number of primary branches, thereby more foliages, would result in higher photosynthetic activity and more biosynthesis of phytohormones, including auxins. This, in turn, would induce the formation of better rooting and its three-dimensional growth. The height of the stem where the first branch emerged in Tinali-17 was more than the other two cultivars. Even though the recorded height is acceptable in tea crop, thump pruning/ debudding needs to be adopted to induce branching at the lower position to achieve frame formation at the appropriate age of the bush. The survival percentage was higher in Tinali-17 (82.2%).

In their study, Radhakrishnan *et al*. (2013) showed that the cultivar TRF-1, an Assam type hybrid, exhibited the potential to yield consistently throughout the year under the Nilgiris condition. They had also observed highly satisfactory survival of TRF-1 clones in the field. The selection of drought-tolerant tea cultivar is advocated as the most significant parameter and need of the hour in the climate change scenario that is affecting the tea-growing belt in the world (Wijeratne *et al.,* 2018). Therefore, identification of hardy and suitable tea cultivars as preferred by existing tea estates in the state would be appropriate. True to type, clonal planting materials of such identified tea cultivars like Tinali-17 can be targeted to propagate in larger quantity to meet the emerging demand in coming years.

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