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Yield and quality performances of four tea test clones

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Abstract

An experiment was carried out during 1994–2007 to investigate the yield and quality performances of four vegetatively propagated test clones of tea viz. SH/D/11/13, SH/D/11/333, B/HB/2/3 and B/HB/6/4. Two clones, BT1 and TV23, were used as check for quality and yield, respectively. Cuttings of the test clones were collected from the selected bushes of Shumshernugger Tea Estate and hybrid lines of Bangladesh Tea Research Institute (BTRI) and were raised at BTRI nursery. Then the saplings were managed for long term yield and quality trial following randomized complete block design with 5 replications. The green leaf was harvested at weekly interval during the plucking season starting from mid March to mid December throughout the experimental period. The overall cup quality of the test clones was assessed by conventional organoleptic test. At the immature stage (2^{nd}–5^{th} year after plantation), all test clones showed similar yield trend as that of check BT1. At the mature stage (6^{th}–13^{th} year), the test clones SH/D/11/333 and B/HB/6/4 gave the significantly higher average yield (3095 and 3342 kg ha^{-1} made tea, respectively) compared to the check BT1 (3042 kg ha^{-1} made tea). The cup quality of all the test clones and BT1 was found to be "Above Average" while the cup quality of TV23 was "Average". Considering the overall performances, the test clones SH/D/11/333 and B/HB/6/4 have been released as BT13 and BT14, respectively for commercial plantation in the tea estates.

Keywords: Yield Performance, Cup Quality, Test Clones, Bangladesh Tea Research Institute

Introduction

Tea, one of the most important cash crops in Bangladesh, is an important beverage commodity of international trade. Tea export income is accounting for ca. 0.35% of the total export income of Bangladesh (BBS, 2011). In 2010, Bangladesh produced only 60.6 million kg made tea when the world production was 4,162 million kg (ITC, 2011). The annual tea production of Bangladesh remains static for last 10 years, but the domestic tea consumption has been increasing very fast. Taking the current rate of domestic consumption into consideration, the country will need to import ca. 20 million kg of tea to meet internal demand after five to six years (Islam, 2009). The yield of Bangladesh tea is quite low compared to other tea growing countries of the world. Some of the major causes for lower yield are very old seedling population, inferior planting materials with lower yield potential, low plant population density, bad soil management practices, etc. The increasing cost of production as well as the adverse climatic conditions has also led to marginal economic return to the tea industry. In these circumstances, the industry needs to replant and extend new tea areas with improved planting materials of higher yield potential and good quality.

Due to the heterogenous nature of tea seedlings, the seed available except biclonal stocks, could not guarantee the production of improved planting material (Njuguna, 1990). Emphasis should be given on selection and plantation of vegetatively propagated material i.e., high yielding quality clones for better yield and quality of tea (Dutta and Alam, 2001). Clonal selection is the most popular practice in tea for evolving better cultivars. As tea plant is an allogamous species, a large variation of characters occurs from bush to bush in existing seedling tea population and cross pollinated progenies. Such variation is exploited through selection programs to develop new tea cultivars with enhanced traits (Ranatunga *et al*., 2009). Procedure of clonal selection is more or less same in all the tea growing countries (Tubbs, 1946; Visser and Kehl, 1958; Wight, 1961; Barua, 1964; Waheed *et al*., 2001).

With an objective of evolving planting materials with high yield and quality potential Bangladesh Tea Research Institute (BTRI) has put its priorities on clonal selection and hybridization programme since its inception. As an outcome of these works, the institute so far released eighteen vegetative clones in the BT (Bangladesh Tea)-series to the industry (Hossain and Dutta, 2010). In this pathway, the present experiment was carried out to study the long term yield and quality performances of four vegetatively propagated test clones; SH/D/11/13, SH/D/11/333, B/HB/2/3 and B/HB/6/4, compared with two check clones; BT1 and TV23.

Materials and Methods

The experiment was carried out in the main farm of BTRI with four test clones viz. SH/D/11/13 and SH/D/11/333 selected from Shumshernugger Tea Estate (T.E.) and B/HB/2/3 and B/HB/6/4 from BTRI hybrid lines, and two check (control) clones viz. BT1 and TV23 during the period from April 1994 to December 2007. The local standard clone BT1 and a popular Indian yield clone TV23 were used as check for quality and yield comparison, respectively (Table 1). General characteristics of four test clones and two check clones are given in Table 2. Cuttings were collected from the selected bushes of Shumshernugger T.E. and BTRI hybrid lines during 1994, which were raised at BTRI nursery. After rooting trial in the nursery, the selected test clones viz. SH/D/11/13, SH/D/11/333, B/HB/2/3 and B/HB/6/4 were put to long term yield and quality trial during 1996 at BTRI Farm. The experiment was laid out in a randomized complete block design with 5 replications at the standard (105cm x 60cm) spacing (Dutta and Alam, 2001). The experiment is conducted in rainfed condition. Fertilizer was applied at young and mature tea as per BTRI recommendations (Kibria and Rashid, 1994; Kibria and Uddin, 1998). Young and mature tea pruning were followed as per BTRI recommendations (Rashid, 1986; Shahiduzzaman *et al*., 2002). Yield data was collected during the cropping seasons throughout the experimental period. The green leaf was harvested at weekly interval during the plucking season starting from mid March to mid December throughout the experimental period. Yield data were recorded and analyzed statistically in MSTAT programme. The mean values were adjudged by Duncan's new multiple range test (DMRT). The yield was expressed as mean yield of green leaf (g plant^{-1}) and has presented separately for immature (2^{nd}–5^{th} year) and mature (6^{th}–13^{th} year) stages. The made tea (kg ha^{-1}) was also calculated on the basis of 23% recovery from green leaf with the population density 15,875 plants ha^{-1} (at 105cm x 60cm spacing). The quality performances of all the test and check clones, manufactured by crush, tear and curl (CTC) method in the BTRI mini tea factory, were assessed weekly by conventional organoleptic test and scored numerically.

Table 1. Category of tea clones

Category of clones	Yield clone	Standard clone	Quality clone
Yield	>4000 kg ha^{-1}	3000–4000 kg ha^{-1}	2500–3000 kg ha^{-1}
Cup Quality*	AA or A	AA	E

*Quality score: E = Excellent (34 to >34 out of 50), AA = Above Average (32 to <34 out of 50), A = Average (30–32 out of 50) and BA = Below Average (<30 out of 50)

Table 2. Characteristic of four test clones, BT1 and TV23

Clone	Bush characters	Leaf type	Pruning recovery	Nursery rooting	Cup quality	Manu. pref.*
SH/D/11/13	Assam hybrid, medium bush, good branching, semi-orthotropic, good girth, fairly compact	Large and broad, semi-dark green with prominent pointed apex, semi-erect	Good	Good	Above average	CTC
SH/D/11/333	Assam hybrid, vigorous, semi-orthotropic, grower with good branching fairly compact plucking table	Large, broad, light green, pointed apex and uniformly serrated margin, semi-erect	Good	Good	Above average	CTC
B/HB/2/3	Medium bush, heavy girth, good grower with good spread, plagio-orthotropic, thick shoots	Medium, light green, erect, prominent leaf apex	Good	Good	Above average	CTC
B/HB/6/4	Manipuri hybrid, medium bush, vigorous semi-orthotropic grower, Plucking table is fairly compact with a good spread	Medium, semi-dark green, semi-erect, uniformly serrated margin	Good	Good	Above average	CTC
BT1 (Quality standard)	Bush size medium, plagiotropic, thickly branched and compact, fairly dense and evenly distributed plucking points with short internodes	Leaves semi-dark green, medium sized, horizontal pose. Prominent long apex, leaf margin deeply serrated, leaf blade wavy	Good	Good	Above average	CTC
TV23 (Yield standard)	Assam hybrid, large bush, vigorous, Ortho-plagiotropic, grower with good spread, quite compact plucking table	Large, light green with prominent pointed apex, semi erect	Good	Good	Average	CTC

*Manu. pref. Manufacturing preference

Results and Discussion

Yield performance

The mean yield of green leaf (g plant^{-1}) over the experimental years for immature stage (2nd–5th year) and mature stage (6th–13th year) are presented in Table 3 and Table 4, respectively. Green leaf yield was converted as made tea (kg ha^{-1}) over the experimental period. The converted made tea yield (kg ha^{-1}) for immature and mature stages is presented in Table 5 and Table 6, respectively. At the initial stage of growth all the test clones showed similar yield trend as the check BT1 (Table 3). When the data were analyzed year-wise, their yield differences were significant. Also the test clones varied significantly when data were analyzed over the years. At immature stage (2nd–5th year), the test clone B/HB/6/4 exhibited significantly higher yield in average (1683 kg ha^{-1}) over check BT1 (1527 kg ha^{-1}), the yield of the test clone SH/D/11/333 (1502 kg ha^{-1}) was also comparable with the check BT1 (Fig. 1). The other test clones SH/D/11/13 and B/HB/2/3 gave lower (average) yield than the check. The standard clone TV23 yielded highest (1857 kg ha^{-1}) among the clones at immature stage. The production of larger number of medium sized, thick leaf was one of the causes of higher yield in B/HB/6/4 (Table 2). The higher yield of B/HB/6/4 might be controlled by the genetic make-up of the clone (Alam *et al*., 1997). However, it was noteworthy that the yield of TV23 drastically reduced in 1999 (Table 3), when Bangladesh faced prolonged and severe drought condition in tea growing regions (Dutta and Alam, 2000). On the other hand, all the Bangladeshi clones (both the test and the check) performed better in the same year (Table 3). This may indicate that the Bangladeshi clones are more tolerant to drought condition compared to TV23.

Table 3. Mean yield of green leaf (g plant^{-1}) at immature stage (2nd–5th year)

Year / Clone	2nd Year Prune 1996	3rd Year Skiff 1997	4th Year Prune 1998	5th Year Skiff 1999	Average
SH/D/11/13	157.33c	285.18c	402.00c	490.29c	333.70d
SH/D/11/333	200.40b	371.83b	535.78b	537.87bc	411.40bc
B/HB/2/3	154.19c	341.27b	513.00bc	497.84c	376.60cd
B/HB/6/4	225.00a	459.07a	572.73b	586.62b	460.90ab
BT1	222.00a	433.68a	437.19c	580.13b	418.30bc
TV23	251.25a	468.06a	695.88a	618.37a	508.40a
LSD at 0.05	51.85	79.04	69.40	76.20	63.28

Within a column values followed by different letter(s) are significantly different by DMRT (p≤ 0.05)

Table 4. Mean yield of green leaf (g plant^{-1}) at mature stage (6th–13th year)

Year / Clone	6th Year LP 2000	7th Year DSK 2001	8th Year MSK 2002	9th Year LSK 2003	10th Year LP 2004	11th Year DSK 2005	12th Year MSK 2006	13th Year LSK 2007	Average
SH/D/11/13	635.66b	690.60d	779.74d	971.90bc	440.17cd	753.68cd	907.70bc	921.63bc	762.60cd
SH/D/11/333	590.89c	843.36bc	1015.10b	1059.94b	524.26c	777.50cd	979.32b	991.25b	847.70bc
B/HB/2/3	576.70c	731.04c	904.43bc	1020.77b	397.81d	600.66d	675.80d	865.04c	721.50d
B/HB/6/4	660.31b	925.82b	1109.700b	1083.25b	593.82c	923.27b	1017.20b	1010.59b	915.50b
BT1	612.34b	786.66c	882.00c	1005.83bc	715.82b	868.17c	875.00c	921.25bc	833.20c
TV23	741.87a	1243.74a	1461.24a	1521.87a	919.62a	1203.00a	1530.61a	1553.13a	1272.00a
LSD at 0.05	93.08	167.18	179.04	323.97	169.24	127.71	163.03	84.30	91.55

Within a column values followed by different letter(s) are significantly different by DMRT (p≤ 0.05)

LP Light prune, DSK Deep skiff, MSK Medium skiff, LSK Light skiff

Table 5. Estimated made tea (kg ha^{-1}) at immature stage (2nd–5th year)

Year / Clone	2nd Year Prune 1996	3rd Year Skiff 1997	4th Year Prune 1998	5th Year Skiff 1999
SH/D/11/13	574.38	1041.13	1467.62	1789.95
SH/D/11/333	731.62	1357.48	1956.03	1963.66
B/HB/2/3	562.92	1245.90	1872.76	1817.51
B/HB/6/4	821.43	1675.97	2090.92	2141.63
BT1	810.48	1583.28	1596.09	2117.94
TV23	917.26	1708.79	2540.52	2257.55

At the standard productivity level (from 6th to 13th year), yield variations were significant among the clones (Table 6). The average yield of those 8 years also showed significant differences between the clones. Average yield data showed that the test clones B/HB/6/4 and SH/D/11/333 gave significantly higher yield (3342 and 3095 kg ha^{-1}, respectively) over the check BT1 (3042 kg ha^{-1}), but the yield of other test clones SH/D/11/13 (2784 kg ha^{-1}) and B/HB/2/3 (2634 kg ha^{-1}) were lower than the check BT1 (Fig. 2). Indian clone TV23 that was used as a standard clone for yield in this study, maintained its superiority in yield over other clones throughout the experimental period, although, it has susceptibility to drought condition (Table 5). The recommended pruning cycle, in mature tea, was as follows: Light prune-Deep skiff-Medium skiff-Light skiff (Rashid, 1986). Therefore, the 10th year yield becomes less compared to that of 9th year due to the plant undergoes lower cut (light prune) in the 10th year. Similar trend was also observed in this experiment (Table 4 and 6).

Table 6. Estimated made tea (kg ha^{-1}) at mature stage (6th–13th year)

Year / Clone	6th Year LP 2000	7th Year DSK 2001	8th Year MSK 2002	9th Year LSK 2003	10th Year LP 2004	11th Year DSK 2005	12th Year MSK 2006	13th Year LSK 2007
SH/D/11/13	2320.67	2521.24	2846.67	3548.21	1606.97	2751.53	3313.83	3364.68
SH/D/11/333	2157.22	3078.57	3705.93	3869.63	1913.97	2838.50	3575.30	3618.85
B/HB/2/3	2105.42	2668.88	3301.89	3726.63	1452.32	2192.89	2467.21	3158.09
B/HB/6/4	2410.66	3379.98	4051.29	3954.73	2167.92	3370.67	3713.59	3689.46
BT1	2235.53	2871.94	3220.00	3672.08	2613.32	3169.51	3194.45	3363.29
TV23	2708.42	4540.65	5334.69	5556.04	3357.35	4391.91	5587.95	5670.17

LP Light prune, DSK Deep skiff, MSK Medium skiff, LSK Light skiff

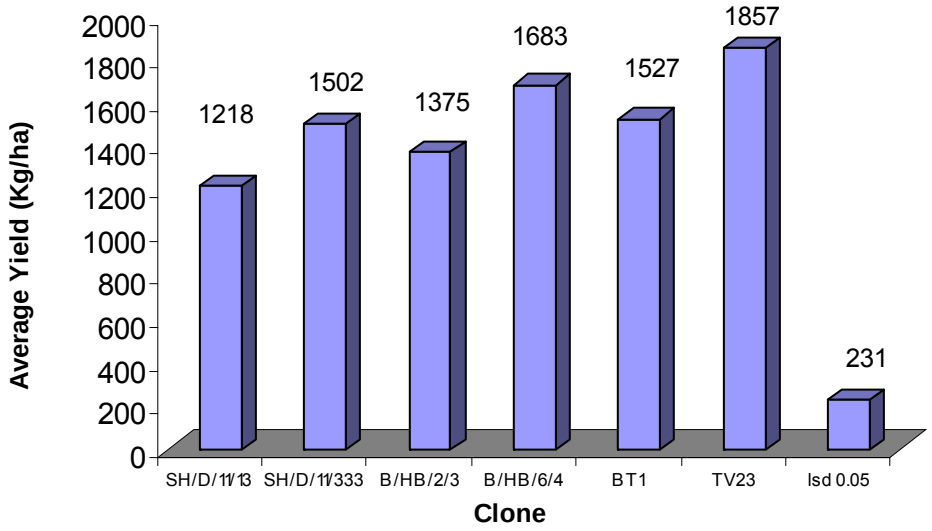

Fig. 1 Estimated made tea yield at immature stage (2nd to 5th yr)

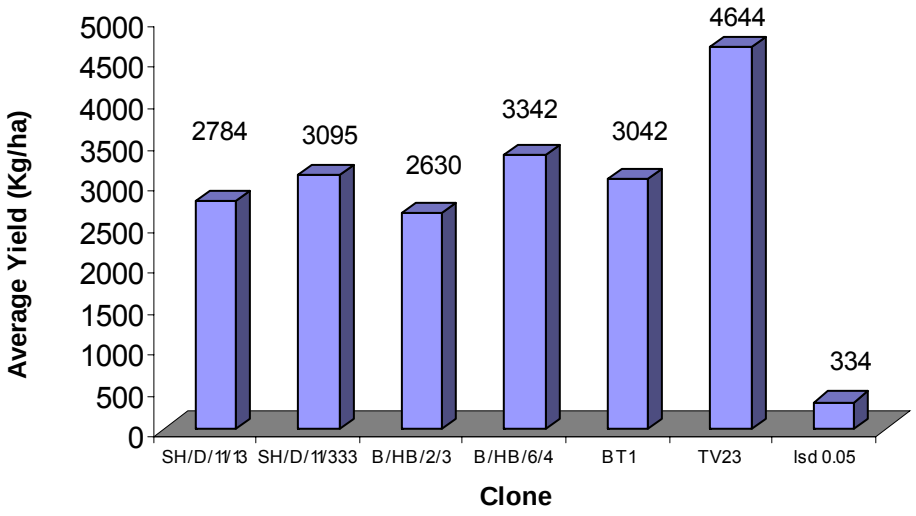

Fig. 2 Estimated made tea yield at mature stage (6th to 13th year)

Quality performance

Cup quality is an inherent character and one of the most important considerations in selecting potential commercial cultivars. The overall quality performances of the test and the check clones assessed by conventional organoleptic test are shown in Table 7. It was observed that the cup characteristics of all the test clones and the BT1 were categorized as “Above Average” while only the TV23 as “Average”. They have bright infusion, coloury liquour with useful strength and briskness (Table 7).

Table 7. Cup quality of different test clones (Average score of 10 years, from 1998 to 2007)

Test Clone	Infusion (10)	Liquour Colour (10)	Briskness (10)	Strength (10)	Creaming down (10)	Total (50)	Over all Quality
SH/D/11/13	7.52a	7.57	7.51a	7.46ab	3.27a	32.78a	AA
SH/D/11/333	7.39ab	7.50	7.57a	7.54a	3.07a	33.27a	AA
B/HB/2/3	7.29ab	7.66	7.33ab	7.43ab	3.20a	32.93a	AA
B/HB/6/4	7.32ab	7.50	7.67a	7.50ab	3.30a	33.32a	AA
BT1	7.42ab	7.59	7.62a	7.51ab	3.04a	33.23a	AA
TV23	7.20b	7.41	7.14b	7.16b	2.76b	31.47b	A
LSD at 0.05	0.2208	NS	0.3177	0.3364	0.2433	1.094	-

Within a column values followed by different letter(s) are significantly different by DMRT ($p \leq 0.05$)

AA = Above Average, A = Average

The test clones SH/D/11/333 and B/HB/6/4 also appeared quite potential in respect of nursery rooting, drought tolerance and other field performances during its selection and field trial periods (Dutta and Alam, 2000, 2002). Considering the overall performances throughout the study period compared to the check BT1, the test clones SH/D/11/333 and B/HB/6/4 appeared superior and confirmed their earlier provisional released as standard clones. After the severe drought condition of 1999, there was a growing demand of drought tolerant clones from the tea industry. Moreover, these test clones, SH/D/11/333 and B/HB/6/4, appeared so promising that they have immediately provisionally released as standard clones in BT series for commercial use in the tea industry before completion of the long term field trial. The test clones SH/D/11/333 and B/HB/6/4 were renamed and provisionally released as BT13 (Dutta and Alam, 2000) and BT14 (Dutta and Alam, 2002), respectively.

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