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Field Evaluation of *in vitro* derived mutants of different varieties of banana on biochemical parameters

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Abstract
A field experiment was conducted on field evaluation of *in vitro* derived mutants of different varieties of banana during 2018-19 and 2019-20 at the Department of Fruit Science, College of Horticulture, University of Horticultural Sciences, Bagalkot. The 138 *in vitro* derived banana mutants both physical and chemical mutagens treated plants along with check were planted. The experiment was laid out in Augmented block design with 6 blocks and 26 subplots each block having 23 *in vitro* mutant lines and three checks. Among 138 *in vitro* derived mutants in plant crop, the maximum TSS was recorded in YB40Gy- 06 (28.60 ^{0}B) Titratable acidity, YB40Gy- 11 (0.70%) Total Sugars, YB45Gy- 15 (25.58%) Reducing sugars, RAJ35Gy- 12 (22.34%) and Non reducing sugars, RAJ40Gy-02 (8.50%). in ratoon crop, the maximum TSS, was recorded in YB40Gy- 06 (27.51 ^{0}B), Titratable acidity, YB40Gy- 08 (0.52%) Total Sugars, YB40Gy-06 (24.78%) Reducing sugars, YB45Gy-07 (22.70%) and Non reducing sugars YB35Gy-15 (6.15%).

Keywords: Banana, *in vitro*, physical mutants, chemical mutants, TSS, Non reducing sugars, total sugars

Introduction
Banana is a monocotyledonous herbaceous plant belonging to the section *Eumusa* under the family Musaceae. All edible bananas are originated from two species namely *Musa acuminata* and *Musa balbisiana* and most of the cultivated cultivars are their hybrids. The basic chromosome number in banana varies from 7-11 (X= 7, 9, 10, 11). The edible banana has been evolved by two wild progenitors *viz*., *Musa acuminata* and *Musa balbisiana* (Simmonds and Shaphered 1955) [14]. The existing cultivars are distinguished by the number of A and B genomes Ex., AAA predominantly for dessert bananas and ABB for cooking bananas.

Yelakki bale is one of the members of Ney Poovan subgroup assuming commercial monoclonal cultivation on a large scale especially in the state of Karnataka. Among various genomics group of banana, AB group is rare with Ney Poovan and Kunnan subgroup (Bakry *et al*., 2009). Of these Ney Poovan is grown most widely, due to its exceptional flavor (Plotez *et al*., 2007) [11]. Owing to its superior characteristics fruits of these varieties fetch almost double price than that of Cavendish bananas in the local market (Anon., 2001) [1]. Plants of this variety grow slender with medium tall stature typical to diploids (Daniells *et al*., 2001) [4]. Rajapuri bale (AAB) is a popular cultivar of banana grown in northern parts of Karnataka. It is a dwarf variety growing up to 6-8 feet height with a very thick stem and stands up very well to wind. The leaves are wider than those of most bananas growing up to 3 feet wide. It is the best plant to grow in marginal areas or where a grower does not intend to put much care into cultivation of bananas

The Nanjangud Rasabale (*Musa* spp., AAB, silk subgroup) known for its unique taste has a huge demand across the country. But, conditions are not favorable enough for growing the banana and to match the huge demand that it generates (Rangaswamy, 2011) [12]. The cultivar Nanjangud Rasabale has been geographical indication tagged and once leading cultivar of then Mysore province is under threat of extinction due to its susceptibility to panama diseases (pooja *et al*., 2013) [10].

Earlier, the cultivar grown in around 600 acres of land in the district of Mysore, Karnataka, now confined to only 30 acres of land in isolated area (Khan, 2015) [5] due to susceptibility to wilt. Hence, the variety now which is at the danger of extinct has to strictly breed by potential methodology to save and preserve as a germplasm.

Most of the cultivated *Musa* varieties and cultivars are triploids. As triploid varieties are highly sterile, edible plants are typically propagated by asexual methods. Genetic improvement in banana has been extremely complicated due to varied genomic constitutions, heterozygosity, polyploidy, and the sterility in edible cultivars. Creating genetic variability for economically important traits in banana would not be supported application of conventional breeding programs due to the complexity in genome of *Musa* species. In this context, induced mutation has a high potential for bringing genetic improvements of vegetatively propagated crops like banana. The main advantage of induced mutations in vegetatively propagated plants is the ability to change one or a few characters of an outstanding cultivar without altering the remaining genetic background (Kulkarni *et al.*, 2007) [7].

Mutation induction using gamma rays had been applied to *Musa* spp. for improving many desirable traits, such as early flowering (Novak and Micke, 1990) [9], tolerance to aluminium (Matsumoto and Yamaguchi, 1990) [8] and *Fusarium* resistance (Chai *et al.*, 2004) [3]. A number of chemicals are able to induce mutations in banana plants such as sodium azide, 2,4-D (2,4-dichlorophenoxy acetic acid) and 6-Benzylaminopurine (6-BA) (Bhagwat and Duncan, 1998) [2]. Further, induction of mutation through chemical mutagens such as EMS and Sodium azide has generated several mutants of banana cv. Nanjangud rasabale under *in vitro* conditions (Kishor *et al.*, 2017) [6]. In this regard, the study has been planned in which the mutated (using physical and chemical mutagens) *in vitro* regenerated lines of the popular cultivars of Karnataka, *viz.*, Rajapuri bale, Yelakki bale and Nanjangud Rasabale are field evaluated for morpho-agronomic and quality parameters.

Material and Methods

The present investigation entitled "Field evaluation of *in vitro* derived mutants of different varieties of banana (*Musa* spp.)" was carried out during two years 2018-19 and 2019-20 at the Department of Fruit Science, College of Horticulture, University of Horticultural Sciences, Bagalkot. The 138 *in vitro* derived banana mutants (both physical and chemical mutagens treated plants) along with check were planted following Augmented Block Design at Fruit Orchard University of Horticultural Sciences, Bagalkot. The experimental site was divided into 6 blocks and 26 sub plots. The uniform pits of 60 cm^3 were dug out according to the plan of layout and recommended spacing (1.5m×1.5m). Each pit was filled with 20 kg well decomposed farmyard manure. The banana mutants were subjected quality parameters after harvesting.

Table 1: *In vitro* mutants of three cultivars of Banana

	Origin of *in vitro* mutant line		
Sl. No	**a) Yelakki Bale**	**b) Rajapuri Bale**	**c) Nanjangud Rasabale**
1	Control (06 plants)	Control (06 plants)	Control (06 plants)
2	25Gy (04 plants)	25Gy (02 plants)	25Gy (0 plants)
3	30Gy (11 plants)	30Gy (06 plants)	30Gy (02 plants)
4	35Gy (18 plants)	35Gy (08 plants)	35Gy (04 plants)
5	40Gy (14 plants)	40Gy (12 plants)	40Gy (05 plants)
6	45Gy (12 plants)	45Gy (10 plants)	45Gy (04 plants)
7	EMS- 0.60% (2 plants)	EMS- 0.60% (1 plants)	EMS- 0.60% (1 plants)
8	EMS -0.90% (4 plants)	EMS -0.90% (3 plants)	EMS -0.90% (1 plants)
9	SA- 0.02% (1 plants)	SA- 0.02% (1 plants)	SA- 0.02% (1 plants)
10	SA- 0.03% (1 plants)	SA- 0.03% (2 plants)	SA- 0.03% (2 plants)
11	BAP-15 mg/l (1 plants)	BAP-15 mg/l (1 plants)	BAP-15 mg/l (1 plants)
12	BAP -20 mg/ 1 (1 plants)	BAP -20 mg/ 1 (1 plants)	BAP -20 mg/ 1 (1 plants)
	75	53	28
Total lines used			156

Note: EMS - Ethyl Methyl Sulphonate; SA - Sodium Azide; BAP - Benzyl Amino Purine Gy-Gamma irradiation

Results and Discussion

The data pertaining to TSS was found to be significant difference in plant crop among different mutant lines of banana (Table 1). The maximum TSS was recorded in YB40Gy - 06 (28.60 ^{0}B), which was on par with YB35Gy - 24 (27.90 ^{0}B), YB40Gy - 03 (27.40 ^{0}B), YB45Gy - 15 (27.00^0 B), YB40Gy - 10 (26.80 ^{0}B), RAJ40Gy - 02 (26.70 ^{0}B), YB EMS 0.6% -4 (26.30 ^{0}B), NR35Gy - 08 (26.20 ^{0}B), YB45Gy - 07 (26.20 ^{0}B), NR40Gy - 05 (26.10 ^{0}B), RAJ45Gy - 19 (26.00 ^{0}B), NR45Gy - 09 (26.00 ^{0}B). The minimum TSS was recorded in YB35Gy - 05 (17.34 ^{0}B). The increase of TSS is an important trait of hydrolysis of starch into soluble sugars such as glucose, sucrose and fructose during ripening. The higher TSS may also because of soil, climate, seasonal variation and varietal characters.

There was no significant difference in ratoon crop among different treatments in mutant lines of banana and data is presented in (Table 1). In plant crop, the maximum Titratable acidity was recorded in YB40Gy - 11 (0.70 %). the minimum titratable acidity were recorded in, RAJ45Gy - 08 (0.15%). In ratoon crop, the maximum titratable acidity were recorded in YB40Gy- 08 (0.52 %) the minimum titratable acidity were recorded in RAJ35Gy- 12 (0.16%). Sarswathi *et al.* (2012) has reported that chemically induced mutants of Rasthali recorded maximum Titratable acidity (0.25%), there was no variation compared to control (0.22%).

Table 1: Biochemical parameters of plant and ratoon crop of banana mutant lines

Mutant lines	TSS (^{0}Brix)		Titratable acidity (%)	
	Plant crop	Ratoon crop	Plant crop	Ratoon crop
YB25Gy 02	21.90	23.30	0.53	0.39
YB25Gy 03	18.00	18.60	0.47	0.36
YB25Gy 04	19.21	21.48	0.43	0.35
YB25Gy 05	20.47	22.85	0.36	0.40
YB30Gy 01	23.20	25.00	0.45	0.49
YB30Gy 02	18.51	17.14	0.37	0.32
YB30Gy 03	23.50	23.10	0.31	0.38
YB30Gy 04	22.90	25.89	0.28	0.26
YB30Gy 06	21.90	20.14	0.60	0.47
YB30Gy 07	24.70	24.67	0.30	0.34
YB30Gy 08	18.91	21.27	0.51	0.21
YB30Gy 09	21.90	18.68	0.53	0.42
YB30Gy 10	20.30	23.64	0.48	0.30
YB30Gy 11	18.52	23.42	0.60	0.33
YB30Gy 15	24.00	26.54	0.33	0.27
YB35Gy 01	20.98	18.20	0.60	0.46
YB35Gy 02	24.70	23.10	0.30	0.27
YB35Gy 03	19.37	20.32	0.43	0.38
YB35Gy 04	22.00	24.52	0.31	0.29
YB35Gy 05	17.31	19.50	0.45	0.34
YB35Gy 06	25.00	25.66	0.29	0.26
YB35Gy 07	21.82	20.00	0.41	0.29
YB35Gy 09	24.38	24.10	0.37	0.33
YB35Gy 10	25.56	27.21	0.32	0.35
YB35Gy 11	18.24	21.16	0.16	0.28
YB35Gy 12	22.48	24.00	0.28	0.26
YB35Gy 14	23.56	21.04	0.46	0.39
YB35Gy 15	19.64	23.81	0.51	0.48

Contd…..

Mutant lines	TSS (^{0}Brix)		Titratable acidity (%)	
	Plant crop	Ratoon crop	Plant crop	Ratoon crop
YB35Gy 18	24.30	25.62	0.50	0.41
YB35Gy 20	23.18	19.76	0.42	0.46
YB35Gy 23	24.15	23.68	0.37	0.39
YB35Gy 24	27.90	24.61	0.25	0.31
YB35Gy 25	23.03	20.08	0.29	0.33
YB40Gy 01	18.80	19.24	0.48	0.42
YB40Gy 02	22.50	25.70	0.37	0.30
YB40Gy 03	27.40	26.38	0.20	0.28
YB40Gy 04	23.30	21.69	0.35	0.23
YB40Gy 05	25.00	25.36	0.28	0.24
YB40Gy 06	28.60	27.51	0.20	0.26
YB40Gy 07	23.37	24.4	0.37	0.36
YB40Gy 08	20.58	22.72	0.60	0.52
YB40Gy 10	26.80	25.16	0.39	0.41
YB40Gy 11	19.46	21.38	0.70	0.44
YB40Gy 12	24.35	26.00	0.48	0.36
YB40Gy 13	25.30	24.10	0.36	0.39
YB40Gy 14	21.52	23.58	0.44	0.31
YB40Gy 15	23.81	26.00	0.47	0.41
YB45Gy 02	18.69	22.31	0.60	0.46
YB45Gy 03	24.70	25.00	0.27	0.33
YB45Gy 04	21.80	23.34	0.51	0.43
YB45Gy 05	18.14	20.00	0.42	0.35
YB45Gy 06	22.36	19.54	0.38	0.30
YB45Gy 07	26.20	26.18	0.26	0.28
YB45Gy 08	22.59	24.37	0.34	0.37
YB45Gy 09	24.48	25.60	0.29	0.41
YB45Gy 11	19.70	24.00	0.36	0.39
YB45Gy 12	21.00	19.00	0.27	0.28
YB45Gy 13	25.60	24.79	0.23	0.36

Contd…..

Mutant lines	TSS (^{0}Brix)		Titratable acidity (%)	
	Plant crop	Ratoon crop	Plant crop	Ratoon crop
YB45Gy 15	27.00	24.14	0.35	0.31
RAJ25Gy 01	22.17	24.52	0.34	0.27
RAJ25Gy 02	24.00	23.57	0.31	0.36
RAJ30Gy 02	21.26	20.45	0.33	0.38
RAJ30Gy 03	24.10	21.36	0.27	0.41
RAJ30Gy 05	20.63	22.14	0.38	0.29
RAJ30Gy 07	24.80	22.63	0.29	0.32
RAJ30Gy 12	23.20	21.13	0.25	0.36
RAJ30Gy 13	20.17	20.24	0.31	0.34
RAJ35Gy 01	20.51	18.93	0.34	0.39
RAJ35Gy 02	25.10	20.57	0.36	0.38
RAJ35Gy 03	23.00	24.62	0.27	0.19
RAJ35Gy 06	20.45	24.07	0.43	0.33
RAJ35Gy 07	23.12	20.68	0.26	0.29
RAJ35Gy 09	18.93	21.13	0.39	0.28
RAJ35Gy 10	24.00	23.68	0.37	0.24
RAJ35Gy 12	19.91	24.72	0.61	0.16
RAJ40Gy 01	18.50	19.76	0.42	0.29
RAJ40Gy 02	26.70	23.42	0.29	0.18
RAJ40Gy 03	20.45	22.30	0.36	0.20
RAJ40Gy 04	24.37	22.16	0.31	0.28
RAJ40Gy 05	22.82	21.84	0.28	0.17
RAJ40Gy 08	20.15	23.61	0.25	0.34
RAJ40Gy 09	23.64	24.45	0.38	0.29
RAJ40Gy 11	19.52	20.96	0.35	0.31
RAJ40Gy 15	23.57	22.89	0.26	0.29
RAJ40Gy 22	22.54	24.73	0.26	0.19
RAJ40Gy 23	25.21	23.65	0.27	0.22
RAJ40Gy 25	20.45	24.51	0.20	0.26
RAJ45Gy 03	22.50	26.67	0.24	0.31

Contd…..

Mutant lines	TSS (^{0}Brix)		Titratable acidity (%)	
	Plant crop	Ratoon crop	Plant crop	Ratoon crop
RAJ45Gy 04	24.00	25.58	0.20	0.23
RAJ45Gy 07	23.89	22.15	0.32	0.28
RAJ45Gy 08	24.84	24.36	0.20	0.22
RAJ45Gy 10	25.19	21.28	0.26	0.30
RAJ45Gy 13	24.30	24.45	0.34	0.36
RAJ45Gy 14	22.18	24.80	0.17	0.28
RAJ45Gy 15	23.12	22.44	0.20	0.30
RAJ45Gy 19	26.00	25.39	0.28	0.35
RAJ45Gy 20	19.50	22.76	0.31	0.33
NR30Gy 06	22.28	25.51	0.50	0.44
NR30Gy 10	23.72	25.96	0.43	0.32
NR35Gy 08	26.20	24.35	0.41	0.38
NR35Gy 11	23.28	24.20	0.31	0.33
NR35Gy 12	24.36	24.59	0.36	0.27
NR35Gy 19	24.23	24.61	0.30	0.35
NR40Gy 05	26.10	25.80	0.39	0.36
NR40Gy 07	24.38	21.68	0.26	0.35
NR40Gy 09	22.15	25.61	0.34	0.27
NR40Gy 12	25.00	22.40	0.32	0.38
NR40Gy 15	23.58	25.14	0.46	0.41
NR45Gy 01	25.50	25.2	0.35	0.31
NR45Gy 02	22.60	23.19	0.28	0.34
NR45Gy 04	23.69	21.50	0.36	0.28
NR45Gy 09	26.00	24.58	0.34	0.30
YB EMS 0.6% 1	24.15	23.68	0.37	0.39
YB EMS 0.6% 4	26.30	24.61	0.25	0.31
YB EMS 0.9% 1	23.03	20.08	0.29	0.33
YB EMS 0.9% 2	21.95	18.62	0.53	0.42
YB EMS 0.9% 3	23.38	24.45	0.36	0.29
YB EMS 0.9% 4	22.31	23.64	0.48	0.3

Contd…..

Mutant lines	TSS (^{0}Brix)		Titratable acidity (%)	
	Plant crop	Ratoon crop	Plant crop	Ratoon crop
YB SA 0.02% 1	18.35	22.45	0.60	0.33
YB SA 0.03% 6	24.00	26.54	0.33	0.27
YB BAP15- 1	20.97	18.20	0.60	0.46
YB BAP 20-2	24.02	23.10	0.30	0.27
RAJ EMS 0.6 3	19.54	22.06	0.39	0.34
RAJ EMS 0.9% 1	23.50	23.68	0.37	0.28
RAJ EMS 0.9% 2	19.31	24.05	0.60	0.30
RAJ EMS 0.9% 4	21.05	19.76	0.42	0.35
RAJ SA 0.02% 1	24.71	26.42	0.29	0.18
RAJ SA 0.03% 1	21.40	22.30	0.36	0.26
RAJ SA 0.03% 2	24.37	22.16	0.31	0.28
RAJ BAP 15- 3	22.80	21.84	0.33	0.29
RAJ BAP 20 1	20.15	22.61	0.25	0.34
NR EMS 0.6% 3	25.40	21.63	0.26	0.35
NR EMS 0.9% 5	22.15	25.61	0.34	0.27
NR SA 0.02% 1	25.00	22.47	0.32	0.38
NR SA 0.03% 1	23.59	25.31	0.46	0.41
NR SA 0.03% 2	25.40	25.02	0.35	0.31
NR BAP 15-1	22.60	23.19	0.28	0.34
NR BAP 20-3	23.01	21.50	0.36	0.28
YB	23.56	24.19	0.38	0.34
RAJ	22.30	23.19	0.46	0.37
NR	24.90	24.37	0.34	0.32
S.Em±	1.07	2.51	0.11	0.10
CD @ 5%	2.77	NS	NS	NS

NS- indicates Non significant

Table 2: Biochemical parameters of plant and ratoon crop of banana mutant lines

Mutant lines	Total sugars (%)		Reducing sugars (%)		Non-reducing sugars (%)	
	Plant crop	Ratoon crop	Plant crop	Ratoon crop	Plant crop	Ratoon crop
YB25GY 02	19.28	21.05	15.57	18.27	3.71	2.78
YB25GY 03	15.67	16.41	14.20	14.28	1.47	2.13
YB25Gy 04	16.23	17.10	13.83	15.20	2.39	1.90
YB25Gy 05	17.50	20.00	14.42	18.14	3.08	1.86
YB30Gy 01	21.50	23.16	19.27	20.00	2.23	3.16
YB30Gy 02	16.47	16.58	14.40	14.37	2.07	2.21
YB30Gy 03	16.64	22.37	18.45	19.50	1.81	2.87
YB30Gy 04	17.40	24.21	19.18	18.34	1.78	5.86
YB30Gy 06	19.00	18.50	21.30	16.36	2.30	2.15
YB30Gy 07	18.42	23.89	15.64	20.71	2.78	3.18
YB30Gy 08	15.74	19.38	13.50	17.41	2.24	1.97
YB30Gy 09	17.47	17.26	14.72	16.92	2.75	0.34
YB30Gy 10	16.41	21.94	13.75	19.36	2.66	2.58
YB30Gy 11	15.89	19.00	13.42	16.61	2.40	2.39
YB30Gy 15	18.43	24.35	15.02	21.10	2.81	3.25
YB35Gy 01	19.38	16.39	17.40	14.21	1.98	2.18
YB35Gy 02	17.02	21.67	19.30	19.20	2.28	2.47
YB35Gy 03	16.77	17.00	14.51	15.80	2.26	1.20
YB35Gy 04	17.63	21.45	15.64	17.06	1.99	4.39
YB35Gy 05	16.20	16.40	14.48	13.41	1.72	2.79
YB35Gy 06	19.54	23.16	16.97	20.00	2.56	3.16
YB35Gy 07	16.88	17.28	14.25	15.37	2.63	1.91
YB35Gy 09	23.07	21.00	19.58	18.96	3.49	2.04
YB35Gy 10	19.48	24.53	16.36	20.00	3.12	4.10
YB35Gy 11	16.32	19.81	14.68	16.07	1.64	3.74
YB35Gy 12	20.47	21.00	18.78	18.56	1.69	2.44
YB35Gy 14	20.08	20.08	19.51	17.31	0.57	2.77
YB35Gy 15	18.27	21.43	15.28	18.26	2.99	6.15

Contd…..

Mutant lines	Total sugars (%)		Reducing sugars (%)		Non-reducing sugars (%)	
	Plant crop	Ratoon crop	Plant crop	Ratoon crop	Plant crop	Ratoon crop
YB35Gy 18	21.70	21.30	18.26	18.91	3.44	3.04
YB35Gy 20	18.14	18.00	16.30	15.04	1.83	2.96
YB35Gy 23	21.28	20.03	19.68	19.00	1.60	1.03
YB35Gy 24	20.23	22.00	17.71	18.50	2.52	3.50
YB35Gy 25	19.28	17.64	17.43	14.62	1.85	3.02
YB40Gy 01	17.12	18.00	15.31	15.30	1.81	2.70
YB40Gy 02	20.61	23.00	16.92	21.74	3.69	1.26
YB40Gy 03	19.82	24.00	17.37	22.30	2.45	1.70
YB40Gy 04	20.16	18.55	17.24	15.67	2.92	2.88
YB40Gy 05	23.37	21.44	20.13	18.22	3.24	3.22
YB40Gy 06	20.35	24.78	18.72	21.00	1.63	3.78
YB40Gy 07	19.34	20.96	17.20	17.45	2.14	3.51
YB40Gy 08	18.42	20.37	16.14	17.00	2.28	3.37
YB40Gy 10	24.16	22.84	20.89	20.61	3.27	2.23
YB40Gy 11	17.27	19.00	15.56	16.21	1.71	2.79
YB40Gy 12	23.40	23.91	20.46	20.15	2.94	3.76
YB40Gy 13	22.36	22.18	19.40	19.04	2.96	3.14
YB40Gy 14	18.72	20.00	16.58	18.61	2.14	1.39
YB40Gy 15	20.48	22.47	18.41	19.10	2.07	3.37
YB45Gy 02	15.71	20.65	14.27	18.16	1.44	2.49
YB45Gy 03	22.45	23.00	20.14	19.76	2.31	3.24
YB45Gy 04	19.61	21.45	17.00	18.24	2.60	2.61
YB45Gy 05	16.50	19.15	15.27	17.83	1.23	1.32
YB45Gy 06	19.53	16.25	16.22	14.21	3.31	2.04
YB45Gy 07	23.87	24.50	20.41	22.70	3.46	1.80
YB45Gy 08	20.42	22.96	17.61	19.52	2.81	3.44
YB45Gy 09	22.00	24.73	18.38	20.38	3.61	4.35
YB45Gy 11	17.27	23.64	15.52	20.41	1.75	3.23
YB45Gy 12	19.21	17.81	16.57	15.31	2.64	2.50

Contd…..

Mutant lines	Total sugars (%)		Reducing sugars (%)		Non-reducing sugars (%)	
	Plant crop	Ratoon crop	Plant crop	Ratoon crop	Plant crop	Ratoon crop
YB45Gy 13	22.40	20.31	19.78	17.68	2.62	2.63
YB45Gy 15	25.58	23.40	21.64	20.15	3.94	3.25
RAJ25Gy 01	20.24	23.00	17.58	20.61	2.66	3.61
RAJ25Gy 02	19.51	20.56	13.57	16.53	5.94	4.03
RAJ30Gy 02	18.91	18.34	12.60	15.41	6.30	2.93
RAJ30Gy 03	20.58	17.62	17.65	14.38	2.93	3.24
RAJ30Gy 05	18.84	19.61	12.97	16.34	6.52	3.27
RAJ30Gy 07	22.16	18.54	19.54	15.60	2.62	2.94
RAJ30Gy 12	20.57	18.69	17.68	16.44	2.89	2.25
RAJ30Gy 13	19.68	17.63	15.55	15.38	4.13	2.25
RAJ35Gy 01	17.29	16.48	14.56	14.25	2.73	2.23
RAJ35Gy 02	21.59	17.79	19.30	13.68	2.29	4.11
RAJ35Gy 03	20.36	21.05	17.61	19.72	2.75	1.33
RAJ35Gy 06	17.46	22.62	15.67	20.31	1.79	2.31
RAJ35Gy 07	20.89	18.43	18.26	16.27	2.63	2.16
RAJ35Gy 09	17.62	19.62	15.25	16.50	2.37	3.12
RAJ35Gy 10	22.00	20.54	19.69	17.83	2.31	2.71
RAJ35Gy 12	25.46	21.78	22.34	18.54	3.12	3.24
RAJ40Gy 01	19.05	17.49	13.92	14.66	5.10	2.83
RAJ40Gy 02	24.50	19.36	16.00	15.62	8.50	3.74
RAJ40Gy 03	18.35	20.15	14.34	17.60	4.01	2.55
RAJ40Gy 04	22.10	19.46	16.84	16.32	5.26	3.14
RAJ40Gy 05	20.91	18.21	17.48	15.62	3.43	2.59
RAJ40Gy 08	22.15	20.43	18.30	17.61	3.85	2.82
RAJ40Gy 09	18.84	21.38	14.97	18.00	3.87	3.38
RAJ40Gy 11	18.22	17.61	12.71	15.03	5.51	2.58
RAJ40Gy 15	24.19	19.44	18.20	16.68	5.99	2.76
RAJ40Gy 22	17.54	20.62	12.92	18.89	4.63	1.73
RAJ40Gy 23	24.42	24.63	17.84	22.16	6.58	2.47

Contd…..

Mutant lines	Total sugars (%)		Reducing sugars (%)		Non-reducing sugars (%)	
	Plant crop	Ratoon crop	Plant crop	Ratoon crop	Plant crop	Ratoon crop
RAJ40Gy 25	20.80	19.85	16.44	17.52	4.35	2.33
RAJ45Gy 03	19.30	23.76	15.82	20.17	3.48	3.59
RAJ45Gy 04	19.35	22.60	15.40	19.04	3.95	3.56
RAJ45Gy 07	20.40	19.65	16.27	15.06	4.14	4.59
RAJ45Gy 08	21.00	21.58	15.52	19.33	5.48	2.25
RAJ45Gy 10	15.40	19.67	11.82	16.00	4.38	3.67
RAJ45Gy 13	19.00	20.33	19.14	18.64	3.97	1.69
RAJ45Gy 14	17.91	21.00	20.00	18.50	3.90	2.50
RAJ45Gy 15	20.04	19.45	16.71	16.53	3.33	2.92
RAJ45Gy 19	22.51	21.82	18.00	17.62	4.51	4.20
RAJ45Gy 20	18.26	19.26	15.64	16.14	2.62	3.12
NR30Gy 06	19.50	22.38	17.00	18.56	2.50	3.82
NR30Gy 10	18.74	22.16	16.68	18.05	2.06	4.11
NR35Gy 08	20.41	20.64	17.36	16.08	3.05	4.56
NR35Gy 11	22.81	21.10	19.96	17.03	2.85	4.07
NR35Gy 12	23.00	19.86	18.62	16.21	4.38	3.65
NR35Gy 19	20.08	21.30	17.88	19.88	2.20	1.42
NR40Gy 05	18.92	21.16	16.54	18.53	2.38	2.63
NR40Gy 07	22.10	20.38	18.50	16.03	3.60	4.35
NR40Gy 09	21.57	20.56	17.62	15.04	3.95	5.52
NR40Gy 12	24.51	19.08	20.32	16.00	4.19	3.08
NR40Gy 15	22.65	22.30	18.27	19.06	4.38	3.24
NR45Gy 01	21.34	21.45	17.45	18.40	3.89	3.05
NR45Gy 02	17.61	20.66	14.64	17.31	2.97	3.35
NR45Gy 04	19.86	18.47	16.27	16.04	3.59	2.43
NR45Gy 09	24.15	22.00	19.68	19.22	4.47	2.78
YB EMS 0.6% 1	21.00	20.03	18.68	19.00	2.32	1.03
YB EMS 0.6% 4	25.04	22.34	22.15	19.50	2.89	2.84
YB EMS 0.9% 1	19.28	17.64	17.43	14.62	1.85	3.02

Contd…..

Mutant lines	Total sugars (%)		Reducing sugars (%)		Non-reducing sugars (%)	
	Plant crop	Ratoon crop	Plant crop	Ratoon crop	Plant crop	Ratoon crop
YB EMS 0.9% 2	19.47	18.26	15.72	16.92	3.75	1.34
YB EMS 0.9% 3	20.12	18.59	17.22	17.48	2.90	1.10
YB EMS 0.9% 4	18.41	21.94	15.06	19.36	3.35	2.58
YB SA 0.02% 1	16.89	19.00	13.42	16.61	3.47	2.39
YB SA 0.03% 6	18.43	24.35	15.02	21.10	2.81	3.25
YB BAP15- 1	19.38	16.39	17.40	14.21	1.98	2.18
YB BAP 20-2	20.51	21.67	19.30	19.20	1.21	2.47
RAJ EMS 0.6% 3	17.62	19.62	15.25	16.50	2.37	3.12
RAJ EMS 0.9% 1	22.00	20.54	19.69	17.83	2.31	2.71
RAJ EMS 0.9% 2	17.46	21.78	22.34	15.54	1.92	3.24
RAJ EMS 0.9% 4	19.05	17.49	15.92	14.66	3.13	2.83
RAJ SA 0.02% 1	24.50	19.36	16.00	15.62	8.50	3.74
RAJ SA 0.03% 1	18.35	20.15	14.34	17.60	4.01	2.55
RAJ SA 0.03% 2	22.10	19.46	16.84	16.32	5.26	3.14
RAJ BAP 15- 3	20.91	19.02	18.06	17.21	2.85	1.81
RAJ BAP 20 1	22.15	20.43	18.30	17.61	3.85	2.82
NR EMS 0.6% 3	22.10	20.38	18.50	16.03	3.60	4.35
NR EMS 0.9% 5	21.57	20.56	17.62	15.62	3.95	4.94
NR SA 0.02% 1	24.51	19.08	20.32	16.04	4.19	3.03
NR SA 0.03% 1	22.65	22.30	18.27	19.06	4.38	3.24
NR SA 0.03% 2	21.34	21.45	17.45	18.40	3.89	3.05
NR BAP 15-1	17.61	20.66	14.64	17.31	2.97	3.35
NR BAP20-3	20.81	19.47	18.27	17.04	2.54	2.43
YB	20.55	21.56	17.71	18.66	2.83	2.90
RAJ	20.46	20.19	17.74	17.15	2.72	2.71
NR	21.72	20.20	18.99	17.50	2.72	2.53
S.Em±	2.84	2.93	2.61	2.70	1.00	0.66
CD @ 5%	NS	NS	NS	NS	2.58	1.72

NS- indicates Non significant

In plant crop, the maximum total sugars was recorded in YB45Gy - 15 (25.58 %) the minimum total sugars was recorded in RAJ45Gy - 10 (15.40 %). In ratoon crop, the maximum total sugars was recorded in YB40Gy - 06 (24.78

%) the minimum total sugars was recorded in YB45Gy - 06 (16.25 %).

There was no significant difference recorded in plant crop and ratoon crop among different mutant lines of banana (Table 2). In plant crop, the maximum reducing sugars was recorded in RAJ35Gy - 12 (22.34%), RAJ EMS 0.9% - 2 (22.34%), the minimum reducing sugars was recorded in RAJ30Gy - 02 (12.60%). In ratoon crop, the maximum reducing sugars was recorded in YB45Gy - 07 (22.70%), the minimum reducing sugars was recorded in RAJ35Gy - 02 (13.68%).

There was significant difference found in plant crop among different mutant lines of banana (Table 2). The maximum non reducing sugars was recorded in RAJ40Gy - 02 (8.50%), which was on par with RAJ SA 0.02% -1 (8.50%), RAJ30Gy - 05 (6.52%), RAJ30Gy - 02 (6.30%), RAJ25Gy - 02 (5.94%), RAJ40Gy - 23 (6.58%), RAJ40Gy - 15 (5.99%) and RAJ40Gy - 15 (5.99%). the minimum non reducing sugars was noticed in YB35Gy - 14 (0.57%).

Significant difference was recorded in ratoon crop among different mutant lines of banana (Table 2) the maximum non reducing sugars was recorded in YB35Gy - 15 (6.15%), which was on par with YB30Gy - 04 (5.86%), NR40Gy - 09 (5.52%), RAJ45Gy - 07 (4.59%), NR EMS 0.9%-5 (4.94%) and NR35Gy - 08 (4.56%). In plant crop, in Yelakki bale mutant lines the maximum non reducing sugars compared to check (2.83) was recorded in YB45Gy - 15 (3.94%). In Rajapuri bale mutant lines the maximum non reducing sugars compared to check (2.72%) was recorded in RAJ40Gy - 02(8.50%), In Nanjangud Rasabale the maximum non reducing sugars compared to check (2.72%) was recorded in NR45Gy - 09 (4.47%).

Conclusion

Mutation induction can lead to enhance heritable variation this might be useful for functional genomics or breeding application. This can be exploited for suppressing vegetative character like plant height and improve fruit quality parameters like Total Soluble Solids, acidity reducing sugars and total sugars. This can be due to mutation induction can lead to enhance heritable variation. The application of gamma radiation and chemical mutagen is a promising technique to obtain maximum Total Soluble Solids and other biochemical parameters.

Future line of work

1) Continuation of evaluation of identified mutant lines for consistency in performance
2) Multi-locational trails for performance and suitability of identified multiple trait putative mutants

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References

1. Anonymus. Handbook of Horticulture Indian council of Agricultural sciences. New Delhi. 2001.
2. Bhagwat B, Duncan EJ. Mutation breeding in banana cv. Highgate (*Musa* spp., AAA Group) for tolerance to *Fusarium oxysporum* f. sp. *cubense* using chemical mutagens. Sci. Horti. 1998;73:11-22.
3. Chai M, Ho YW, Asif JM. Biotechnology and *in vitro* mutagenesis for banana improvement. African J Biotech. 2004;9(19):273-277.
4. Daniells JJD Dwarf: A superior Cavendish cultivar. Infomusa. 2001;11(2):18-19.
5. Khan AL. Only 30 acres for exotic Nanjangud Rasabale. The Hindu. Daily newspaper dated. 2015, January 30.
6. Kishor H, Prabhuling G, Prakash DP, Babu AG, Manjunatha N, Abhijith YC. Phenotypic Characterization of EMS and NaN_3 Induced Banana Mutants. Res J. Chem. Environ. Sci., 2017;6(1):99-103.
7. Kulkarni VM, Ganapathi TR, Suprasanna P, Bapat VA., *In vitro* mutagenesis in banana (*Musa* spp.) using gamma irradiation., 543–559. In: Protocols for micropropagation of woody trees and fruits. 2007, p, 543-559.
8. Matsumoto K, Yamaguchi H. Selection of aluminum-tolerant variants from irradiated protocorm-like bodies in banana. Tropi. l Agric. 1990;67:229–232.
9. Novak FJ, Micke A. Advancement of *in vitro* mutation breeding technology for bananas and plantain. 56–65: *In vitro* mutation breeding of banana and plantain Report of the FAO/IAEA CRP on mutation breeding of bananas and plantain. IAEA, Vienna, Austria. 1990.
10. Pooja B, Ajit AW, Umesha K. Preliminary assessment of intra-clonal variations in Indian banana varieties for sucker production. Indian. J Natul prodc. resour. 2013;4(4):387-391.
11. Plotez RC, Kepler AK, Daniells J, Nelson SC. Banana and Plantain- an overview with emphasis on pacific island Agroforestry. Permanent Agriculture Resources (PAR). Holualoa, Hawai (www. traditional tree. Org). 2007.
12. Rangaswamy R. Nanjangud banana on slippery ground. *Deccan Herald Daily Newspaper*, Dated. 2011 July 11.
13. Saraswathi MS, Thangavelu R, Mustaffa MM. Field evaluation of Rasthali mutants for desirable agronomic traits. Annual report: NRC Banana, 2012, 27-28.
14. Simmonds NW, Shepherd K. The taxonomy and origins of the cultivated bananas. J Linnean Soc. London. 1955;55:302–312.