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Field Evaluation of *in vitro* Derived Mutants of different Varieties of Banana on Fruit Quality 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. The different parameters like pulp weight, peel weight, pulp to peel ratio, fruit firmness, flavour acceptance and shelf life were taken for quality parameters. Among 138 *in vitro* derived mutants in plant crop, there was no significant difference noted in pulp weight, pulp to peel ratio and fruit firmness. The maximum pulp weight was recorded in NR45Gy-09 (86.45 g), peel weight, RAJ45Gy-14 (20.00 g) pulp to peel ratio YB35Gy-05 (6.70) flavour acceptance, YB40Gy- 03 (7.82) fruit firmness, YB40Gy-12 (18.82 N) and shelf life YB40Gy-14 (8.10 days)). In ratoon crop, the maximum pulp weight was recorded in NR45Gy-09 (86.45 g), peel weight, RAJ45Gy- 14 (25.00 g) pulp to peel ratio, YB35Gy- 24 (7.36) flavour acceptance, RAJ45Gy -03 (7.48) fruit firmness, YB40Gy-11 (16.50 N) and shelf life YB45Gy- 08 (9.00 days).

Keywords: Banana, *in vitro*, physical mutants, chemical mutants, pulp weight, peel weight, shelf life.

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 cultivated edible bananas are mainly triploids. As triploid varieties are highly sterile, edible plants are typically propagated by asexual methods (Simmonds and Shepherd, 1955).

Yelakki bale (AB) is the choicest diploid cultivar of banana, which is under commercial mono cultivation on a large scale especially in Karnataka and Tamil Nadu. It is popularly known as Puttabale, Mitle bale in Karnataka. It is slender plant bearing bunches of 12-14 kg after 13-14 months. Fruits are small, slender having a prominent beak and arranged around the axis in a way that they bear a wind-blown appearance (Daniells *et al.,* 2001). Fruits are very attractive due to their bright yellow color with ivory white pulp.

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 bunch weigh about 10-15 kg with 8-10 hands and 90-100 fingers. Fruits have attractive yellow colour with thick skin and good blend of sweet and acidity.

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). 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). 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) 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).

Mutation induction using gamma rays had been applied to *Musa* spp. for improving many desirable traits, such as early flowering (Novak and Micke, 1990), tolerance to aluminium (Matsumoto and Yamaguchi, 1990) and *Fusarium* resistance (Chai *et al.,* 2004). 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). 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). Ahmed (2003) showed that irradiated Grand Naine (clone 1 and clone 2) had longer green life than that of untreated Willams. Veena (2017) studied to characterize gamma irradiated *in vitro* regenerated banana cv. Grand Naine under field conditions. Maximum Total Soluble Solids and shelf life were found at 40Gy dose of irradiation.

Mutation induction may uncover a recessive phenotype by mutating, inhibiting or deleting the corresponding dominant allele (Jain and Swennen, 2004). Almost all the edible banana and plantain varieties originate through spontaneous mutations. The best example is the spontaneous banana mutant 'Cavendish' originating from Vietnam, which is resistant to *Fusarium* wilt (race 1) and which replaced 'Gros Michel' in the 1950s and 60s. The discovery of this banana mutant saved the banana industry from collapsing. *In vitro* mutagenesis, therefore, provides the necessary tool for the development of new clones resistant to diseases and also possessing improving characters like Shelf life, Pulp weight, and Flavour acceptance. However, field evaluation of *in vitro* derived mutants is ultimate answer for performance of newly mutated lines of banana under field condition for morpho-agronomic traits and also quality parameters. 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		
Sr. 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

Plate 1. General view of experimental plot at shooting stage of in *vitro* mutants of different varieties of banana.

RESULTS AND DISCUSSION

There was no significant difference noted in plant crop and ratoon crop of pulp weight among different mutant lines of banana and data is presented in (Table 2). In plant crop, the maximum and minimum pulp weight was found in NR45Gy - 09 (86.45 g), RAJ40Gy - 23 (35.00 g) respectively. In ratoon crop, the maximum and minimum pulp weight was found in RAJ45Gy - 07 (68.00 g), RAJ45Gy - 3 (35.07 g) respectively. Significant difference was noted in plant crop of peel weight among different mutant lines of banana and data is presented in Table 2. The maximum peel weight was found in RAJ45Gy - 14 (20.00 g). The minimum peel weight was found in YB30Gy - 09 (8.47 g). There was significant difference recorded in ratoon crop among different mutant lines of banana (Table 2). The maximum peel weight was found in RAJ45Gy - 14 (25.00 g). The minimum peel weight was found in YB25Gy - 02 (7.21 g).

This might be due to genetic makeup of the plants and also to some extent fruit size which contributes to the more peel weight. There is no report on variations in peel weight in mutant lines in banana. Hence, the results of present study revealed that there is a possibility of variations in peel weight in mutants due to mutations. However, the results of the present study are in line with Sagar *et al.* (2018) who has carried out evaluation of banana genotypes for qualitative traits. These results are in line with Balesh (2020) studied evaluation of elite tissue culture raised banana varieties for growth, yield and quality parameters.

There was no significant difference noted in plant crop and ratoon crop in pulp to peel ratio among different mutant lines of banana and data is presented in Table 2. In plant crop, the maximum pulp to peel ratio was recorded in YB35Gy - 05 (6.70) the minimum pulp to peel ratio was recorded in RAJ45Gy - 14 (2.60).). In ratoon crop, the maximum pulp to peel ratio was recorded in YB35Gy - 24 (7.36) the minimum pulp to peel ratio was recorded in RAJ45Gy - 14 (2.20).

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

Mutant lines	Pulp weight (g)		Peel weight (g)		Pulp to peel ratio	
	Plant crop	Ratoon crop	Plant crop	Ratoon crop	Plant crop	Ratoon crop
YB25GY 02	54.00	46.50	10.00	7.21	5.40	6.44
YB25GY 03	48.20	49.00	13.22	8.63	3.69	5.67
YB25Gy 04	55.60	51.00	9.50	9.12	5.85	5.59
YB25Gy 05	42.38	47.20	11.00	7.69	3.86	6.13
YB30Gy 01	45.21	56.75	13.84	10.06	3.25	5.64
YB30Gy 02	58.00	44.00	12.26	7.68	4.73	5.72
YB30Gy 03	42.00	40.00	9.50	8.05	4.42	4.96
YB30Gy 04	50.00	52.80	9.82	11.20	5.09	4.71
YB30Gy 06	49.00	61.00	11.20	9.81	4.37	6.21
YB30Gy 07	55.13	57.21	10.67	9.64	5.16	5.93
YB30Gy 08	58.21	53.00	12.54	8.25	4.64	6.42
YB30Gy 09	43.50	48.00	8.47	9.42	5.13	5.09
YB30Gy 10	63.67	43.86	14.25	8.80	4.46	4.98
YB30Gy 11	63.45	54.00	12.00	11.30	5.28	4.77
YB30Gy 15	59.56	46.00	12.82	9.58	4.64	4.80
YB35Gy 01	44.27	39.68	10.56	8.56	4.19	4.63
YB35Gy 02	38.00	45.00	11.03	8.12	3.45	5.54
YB35Gy 03	59.00	42.83	10.17	8.70	5.80	4.92
YB35Gy 04	64.00	51.27	9.62	9.48	6.65	5.40
YB35Gy 05	66.00	60.21	9.85	12.34	6.70	4.87
YB35Gy 06	45.25	56.00	8.96	12.00	5.05	4.66
YB35Gy 07	52.00	49.00	11.02	9.05	4.71	5.41
YB35Gy 09	54.00	57.03	10.06	9.27	5.36	6.15
YB35Gy 10	58.00	61.00	11.20	10.60	5.17	5.75
YB35Gy 11	47.30	56.00	10.65	10.27	4.44	5.45
YB35Gy 12	60.00	53.70	12.00	9.78	5.00	5.48
YB35Gy 14	54.00	49.00	9.85	10.00	3.85	4.90
YB35Gy 15	58.47	46.00	12.00	8.65	4.87	5.31
YB35Gy 18	52.00	49.00	9.50	8.92	5.47	5.49
YB35Gy 20	67.60	64.00	10.41	13.27	6.49	4.82
YB35Gy 23	52.00	61.50	11.00	12.34	4.72	4.98
YB35Gy 24	64.00	58.00	10.04	7.88	6.37	7.36
YB35Gy 25	59.00	66.00	13.00	10.24	4.53	5.07
YB40Gy 01	53.00	48.00	8.50	9.64	6.23	4.97
YB40Gy 02	48.25	51.00	9.65	10.14	5.00	5.03
YB40Gy 03	50.12	63.28	11.02	12.27	4.54	5.15
YB40Gy 04	54.30	49.26	10.52	7.86	5.16	6.26
YB40Gy 05	62.60	51.00	11.67	9.58	5.36	5.32
YB40Gy 06	58.00	53.70	10.00	8.64	5.80	6.48
YB40Gy 07	52.00	47.00	14.00	8.13	3.71	5.78
YB40Gy 08	54.00	49.00	16.00	8.91	3.37	5.49
YB40Gy 10	58.27	61.00	12.04	10.00	4.84	6.10
YB40Gy 11	49.00	46.00	9.50	8.20	5.15	5.61
YB40Gy 12	50.00	58.00	8.64	12.03	5.78	4.82
YB40Gy 13	64.00	56.50	11.33	10.84	5.64	5.72
YB40Gy 14	53.00	46.00	9.20	8.53	5.76	5.39
YB40Gy 15	46.00	44.00	14.00	10.00	4.60	4.40
YB45Gy 02	53.58	58.00	10.69	9.52	5.01	6.09
YB45Gy 03	67.00	64.00	11.85	11.40	5.65	5.61
YB45Gy 04	58.00	62.00	10.40	8.75	5.57	7.08
YB45Gy 05	55.14	59.00	8.76	8.95	6.29	6.59
YB45Gy 06	48.00	55.00	8.95	9.62	5.36	5.71
YB45Gy 07	63.25	57.00	10.00	9.40	6.32	6.06
YB45Gy 08	49.28	54.00	9.85	10.36	5.00	5.21
YB45Gy 09	64.00	52.21	12.00	9.00	5.33	5.80
YB45Gy 11	59.06	65.00	9.42	12.58	6.27	5.16
YB45Gy 12	57.79	63.00	8.65	11.00	6.68	5.72
YB45Gy 13	65.00	59.51	11.00	9.21	5.90	6.46
YB45Gy 15	50.00	55.00	13.00	8.26	3.84	6.65
RAJ25Gy 01	47.51	44.00	10.54	13.61	4.50	3.23
RAJ25Gy 02	48.40	39.05	12.03	10.00	4.02	3.90
RAJ30Gy 02	39.50	42.61	14.00	12.18	2.82	3.49
RAJ30Gy 03	43.18	47.00	12.30	12.56	3.51	3.74
RAJ30Gy 05	44.75	43.54	13.28	14.21	3.37	3.06
RAJ30Gy 07	46.52	38.25	11.31	13.36	4.11	2.86
RAJ30Gy 12	53.00	55.64	16.04	9.30	3.30	5.98
RAJ30Gy 13	64.25	39.22	17.50	10.52	3.67	3.72
RAJ35Gy 01	58.60	46.00	10.04	12.89	5.83	3.56
RAJ35Gy 02	68.59	38.51	18.35	10.00	3.73	3.80
RAJ35Gy 03	56.00	42.00	11.00	9.50	5.09	4.42

RAJ35Gy 06	64.00	41.00	13.00	10.00	4.92	4.10
RAJ35Gy 07	55.00	59.00	9.50	15.12	5.78	3.70
RAJ35Gy 09	45.00	49.00	10.00	9.00	4.50	5.44
RAJ35Gy 10	57.00	53.06	12.30	11.00	4.63	5.27
RAJ35Gy 12	64.00	47.00	14.00	12.60	4.57	3.73
RAJ40Gy 01	43.24	48.00	14.84	10.00	2.91	4.80
RAJ40Gy 02	40.00	57.00	15.27	12.00	2.62	4.75
RAJ40Gy 03	44.00	61.00	14.00	10.23	3.14	5.96
RAJ40Gy 04	54.50	43.00	17.00	12.00	3.20	3.58
RAJ40Gy 05	49.64	56.00	16.00	13.00	3.10	4.30
RAJ40Gy 08	40.82	49.00	15.25	10.51	2.67	4.66
RAJ40Gy 09	54.20	56.00	14.50	13.00	3.73	4.30
RAJ40Gy 11	45.19	45.00	12.00	10.00	3.76	4.50
RAJ40Gy 15	55.00	59.00	14.94	12.00	3.68	4.91
RAJ40Gy 22	42.64	37.00	9.54	11.50	4.48	3.21
RAJ40Gy 23	35.00	54.00	11.00	10.22	3.18	5.28
RAJ40Gy 25	55.00	49.50	14.63	11.00	3.75	4.50
RAJ45Gy 03	53.18	35.07	12.00	9.02	4.43	3.88
RAJ45Gy 04	57.00	39.00	15.00	10.00	3.80	3.90
RAJ45Gy 07	64.50	68.00	19.00	16.00	3.39	4.25
RAJ45Gy 08	52.00	49.00	16.50	12.10	3.15	4.05
RAJ45Gy 10	51.50	54.00	19.00	11.28	2.71	4.78
RAJ45Gy 13	57.00	53.40	18.00	14.00	3.16	3.81
RAJ45Gy 14	52.00	55.00	20.00	25.00	2.60	2.20
RAJ45Gy 15	58.00	65.00	17.04	22.00	3.40	2.95
RAJ45Gy 19	54.00	61.00	10.58	13.00	5.10	4.69
RAJ45Gy 20	62.00	59.00	9.52	10.00	6.52	5.90
NR30Gy 06	51.00	56.00	12.00	11.00	4.25	5.09
NR30Gy 10	63.00	44.00	15.00	10.55	4.20	4.17
NR35Gy 08	58.00	49.00	10.00	10.00	5.80	4.90
NR35Gy 11	64.00	59.00	16.00	13.00	4.00	4.53
NR35Gy 12	60.07	52.00	14.00	11.14	4.29	4.66
NR35Gy 19	55.00	48.00	11.00	10.00	5.00	4.80
NR40Gy 05	82.00	54.00	15.46	13.60	4.65	3.97
NR40Gy 07	75.21	62.00	12.05	14.00	5.39	4.42
NR40Gy 09	68.00	48.00	13.80	10.38	4.92	4.62
NR40Gy 12	53.50	44.36	14.00	11.00	3.82	4.03
NR40Gy 15	64.00	42.00	12.55	9.00	5.10	4.66
NR45Gy 01	56.00	54.00	16.00	13.00	3.50	4.15
NR45Gy 02	54.00	46.00	13.00	9.00	4.15	5.11
NR45Gy 04	61.00	53.00	12.00	10.21	5.08	5.19
NR45Gy 09	86.45	55.00	17.89	12.50	5.73	4.40
YB EMS 0.6% 1	53.07	43.86	9.56	8.64	5.55	5.07
YB EMS 0.6% 4	56.00	54.00	12.03	11.30	4.65	4.77
YB EMS 0.9% 1	59.24	46.00	10.82	9.58	5.47	4.80
YB EMS 0.9% 2	64.00	51.27	14.00	9.48	4.57	5.40
YB EMS 0.9% 3	54.37	49.60	8.97	9.20	6.33	5.39
YB EMS 0.9% 4	54.12	60.21	11.00	12.34	4.92	4.87
YB SA 0.02% 1	63.02	47.82	12.35	8.80	5.10	5.43
YB SA 0.03% 6	49.45	52.06	9.05	11.30	5.46	4.60
YB BAP15- 1	59.21	46.00	12.82	9.58	4.61	4.80
YB BAP 20-2	55.03	48.25	10.56	8.34	5.21	5.78
RAJ EMS 0.6% 3	56.04	44.12	11.00	9.50	5.09	4.64
RAJ EMS 0.9% 1	64.32	55.02	13.06	10.34	4.92	5.32
RAJ EMS 0.9% 2	80.00	48.05	16.00	10.12	5.83	4.74
RAJ EMS 0.9% 4	63.04	54.00	10.56	9.00	5.97	6.00
RAJ SA 0.02% 1	58.25	51.30	12.00	11.00	4.85	4.66
RAJ SA 0.03% 1	64.03	47.14	14.00	12.60	4.57	3.74
RAJ SA 0.03% 2	53.00	48.05	14.84	10.00	3.56	4.80
RAJ BAP 15- 3	60.00	57.00	12.84	9.86	4.67	5.78
RAJ BAP 20 1	58.06	42.00	11.00	9.50	5.09	4.42
NR EMS 0.6% 3	56.10	53.00	9.54	10.65	6.33	4.41
NR EMS 0.9% 5	62.45	57.12	11.00	9.67	5.63	5.90
NR SA 0.02% 1	56.00	48.30	9.31	10.32	6.01	4.68
NR SA 0.03% 1	49.04	46.33	8.69	9.21	5.64	5.03
NR SA 0.03% 2	58.16	47.02	9.56	11.36	6.08	4.13
NR BAP 15-1	52.14	49.00	10.24	9.86	5.09	4.78
NR BAP20-3	48.05	43.21	9.22	7.62	5.20	5.67
YB	54.14	47.50	10.35	8.48	5.30	5.62
RAJ	59.47	51.78	10.95	9.68	5.44	5.35
NR	54.41	46.76	10.32	9.28	5.32	5.21
S.Em±	9.11	7.35	2.17	0.59	1.12	0.90
CD @ 5%	NS	NS	5.58	1.52	NS	NS

NS- indicates Non significant; YB – Yelakki bale; RAJ- Rajapuri bale; NR- Nanjangud rasabale

There was no significant difference noted in plant crop and ratoon crop of fruit firmness among different mutant lines of banana and data is presented in Table 3. In plant crop, the maximum fruit firmness was recorded in YB40Gy - 12 (18.82 N). the minimum fruit firmness was recorded in YB35Gy - 12 (6.08 N). In ratoon crop, the maximum fruit firmness was recorded in YB40Gy - 11 (16.50 N) the minimum fruit firmness was recorded in RAJ EMS 0.9%- 4 (8.31 N). There was significant difference noted in plant crop in flavour acceptance among different mutant lines of banana (Table 3). The maximum flavour acceptance was recorded in YB40Gy 03 (7.82), which was on par with YB45Gy - 08 (7.72), YB35Gy - 23 (7.76), YB40Gy - 13 (7.60), RAJ40Gy - 23 (7.58), YB45Gy - 03 (7.58), YB45Gy - 07 (7.48).This might be due to genetic characters, environmental conditions prevailed during the crop production, presence of more total soluble solids, superior in taste. There is no report on variations in flavour acceptance in mutant lines in banana. Hence, the results of present study revealed that there is a possibility of variations in flavour acceptance in mutants due to mutations. However, the results of the present study are in line with Sagar *et al.* (2018) who has carried out evaluation of banana genotypes for qualitative traits. These results are in line with Balesh (2020) studied evaluation of elite tissue culture raised banana varieties for growth, yield and quality parameters.

Table 3: Quality parameters of plant and ratoon crop of banana mutant lines.

Mutant lines	Fruit firmness (N)		Flavour acceptance		Shelf life (number of days)	
	Plant crop	Ratoon crop	Plant crop	Ratoon crop	Plant crop	Ratoon crop
YB25GY 02	13.54	11.26	6.78	6.20	4.82	6.00
YB25GY 03	12.16	10.57	6.55	5.86	6.25	5.04
YB25Gy 04	16.18	13.50	5.68	6.24	4.75	5.39
YB25Gy 05	9.61	11.78	6.25	4.26	6.00	4.10
YB30Gy 01	14.90	9.15	7.01	5.41	5.43	4.00
YB30Gy 02	18.53	15.62	6.79	6.30	6.00	5.20
YB30Gy 03	11.57	14.33	6.63	6.29	5.33	4.90
YB30Gy 04	7.06	10.96	6.58	6.42	6.50	5.00
YB30Gy 06	13.72	12.24	6.49	5.86	7.00	5.34
YB30Gy 07	13.53	14.40	6.15	5.48	5.72	4.86
YB30Gy 08	17.65	11.56	5.40	4.67	5.11	6.00
YB30Gy 09	10.10	12.39	6.02	6.42	6.00	5.00
YB30Gy 10	16.47	15.64	7.22	6.50	7.00	5.40
YB30Gy 11	9.12	13.06	5.21	5.67	5.22	6.10
YB30Gy 15	12.94	15.80	5.34	4.86	5.56	4.00
YB35Gy 01	9.41	13.32	6.20	6.63	7.00	4.82
YB35Gy 02	13.63	16.40	5.10	5.27	5.60	6.00
YB35Gy 03	15.59	13.56	6.52	5.36	7.20	6.90
YB35Gy 04	12.16	15.70	6.00	6.57	5.50	6.20
YB35Gy 05	10.29	14.51	6.68	5.66	5.00	4.10
YB35Gy 06	9.90	12.45	5.61	4.52	6.50	5.01
YB35Gy 07	6.57	10.38	6.70	4.80	7.20	6.20
YB35Gy 09	13.14	11.50	5.83	5.00	6.24	7.38
YB35Gy 10	10.57	13.62	7.38	6.70	4.80	5.64
YB35Gy 11	7.94	11.80	6.05	5.63	5.43	6.00
YB35Gy 12	6.08	13.02	7.04	6.75	5.56	4.00
YB35Gy 14	11.27	14.00	5.03	5.33	7.08	5.50
YB35Gy 15	9.31	10.58	5.27	4.38	6.00	7.22
YB35Gy 18	17.06	12.04	5.69	5.21	7.22	5.00
YB35Gy 20	13.14	9.86	6.45	6.02	4.00	6.25
YB35Gy 23	10.00	14.55	7.76	6.62	7.50	6.30
YB35Gy 24	14.90	16.27	7.21	6.97	7.04	5.00
YB35Gy 25	13.20	12.34	6.63	6.30	7.00	6.74
YB40Gy 01	17.55	15.01	6.25	5.74	5.00	7.00
YB40Gy 02	16.47	13.89	6.84	6.31	6.00	5.32
YB40Gy 03	12.45	15.46	7.82	7.34	7.50	6.00
YB40Gy 04	14.41	10.04	6.73	6.56	6.28	5.00
YB40Gy 05	10.59	12.68	6.30	6.00	6.00	7.50
YB40Gy 06	12.74	14.79	7.00	6.58	6.50	8.00
YB40Gy 07	13.53	10.63	7.40	7.29	7.62	6.00
YB40Gy 08	15.88	10.55	6.38	6.41	6.00	5.00
YB40Gy 10	15.00	12.30	6.44	5.39	4.50	6.72
YB40Gy 11	14.51	16.50	6.96	4.62	6.20	6.00
YB40Gy 12	18.82	13.24	7.10	5.28	5.00	6.00
YB40Gy 13	16.18	14.78	7.60	6.29	6.41	5.00
YB40Gy 14	10.98	11.21	7.30	5.62	8.10	6.39

YB40Gy 15	13.04	10.07	6.83	6.29	8.00	6.30
YB45Gy 02	12.55	9.63	6.66	5.14	5.00	7.00
YB45Gy 03	15.69	11.30	7.58	5.30	6.92	6.10
YB45Gy 04	9.51	12.64	6.25	6.01	6.58	6.00
YB45Gy 05	14.31	13.27	6.51	6.22	7.00	5.00
YB45Gy 06	9.31	15.40	6.90	5.75	6.21	7.00
YB45Gy 07	10.39	11.00	7.48	6.38	7.17	6.50
YB45Gy 08	12.74	14.38	7.72	6.42	6.08	9.00
YB45Gy 09	14.61	15.69	7.12	6.31	6.52	7.00
YB45Gy 11	11.76	15.07	6.27	5.87	7.00	5.00
YB45Gy 12	13.43	14.02	6.62	5.93	6.27	6.82
YB45Gy 13	15.29	13.66	6.79	6.65	6.84	5.00
YB45Gy 15	12.55	12.04	6.42	6.30	6.92	6.00
RAJ25Gy 01	9.31	8.75	6.23	5.27	5.92	6.00
RAJ25Gy 02	11.20	9.28	6.67	6.30	6.21	7.00
RAJ30Gy 02	15.88	10.52	5.50	5.51	4.00	6.00
RAJ30Gy 03	7.06	9.96	5.01	4.86	5.33	4.82
RAJ30Gy 05	10.57	11.58	6.04	6.23	6.20	5.00
RAJ30Gy 07	11.37	10.62	6.71	5.40	5.00	6.24
RAJ30Gy 12	9.12	11.40	6.82	5.10	6.21	5.00
RAJ30Gy 13	10.39	8.94	6.30	4.43	6.67	4.00
RAJ35Gy 01	12.35	10.31	6.42	4.82	5.00	5.34
RAJ35Gy 02	8.72	10.42	7.01	5.30	6.35	6.00
RAJ35Gy 03	9.21	13.62	5.40	5.52	5.60	4.10
RAJ35Gy 06	11.24	9.71	6.30	6.00	6.05	7.00
RAJ35Gy 07	14.21	12.69	6.42	6.27	6.60	5.00
RAJ35Gy 09	8.92	11.55	6.91	6.12	5.80	6.24
RAJ35Gy 10	10.52	10.27	5.26	4.30	5.00	7.00
RAJ35Gy 12	7.45	9.83	7.07	7.45	6.00	5.03
RAJ40Gy 01	9.61	10.21	5.58	6.39	7.05	7.00
RAJ40Gy 02	9.12	8.96	6.21	5.92	7.00	6.00
RAJ40Gy 03	11.76	10.55	7.30	7.28	5.50	5.20
RAJ40Gy 04	10.98	10.82	6.38	5.22	6.00	4.50
RAJ40Gy 05	8.43	13.67	6.92	6.01	6.70	5.50
RAJ40Gy 08	9.82	11.40	6.87	5.37	5.50	4.00
RAJ40Gy 09	8.90	10.02	6.44	5.06	4.00	6.00
RAJ40Gy 11	10.68	13.50	7.11	5.00	5.10	5.00
RAJ40Gy 15	13.04	10.00	6.70	6.26	4.30	6.50
RAJ40Gy 22	11.78	12.80	7.36	7.24	4.00	5.31
RAJ40Gy 23	11.57	14.60	7.58	7.31	5.90	6.00
RAJ40Gy 25	12.45	11.72	6.27	6.80	6.00	8.00
RAJ45Gy 03	10.39	8.63	6.66	7.36	5.20	6.00
RAJ45Gy 04	16.18	11.08	6.12	7.21	5.38	7.00
RAJ45Gy 07	9.81	10.37	6.98	7.48	5.24	5.00
RAJ45Gy 08	11.04	11.25	5.31	5.53	6.50	7.00
RAJ45Gy 10	12.60	9.50	5.20	5.49	3.05	5.30
RAJ45Gy 13	10.46	8.76	6.42	5.36	6.50	6.00
RAJ45Gy 14	12.05	9.74	6.04	7.42	5.80	6.00
RAJ45Gy 15	10.34	11.50	6.25	7.00	5.00	6.72
RAJ45Gy 19	11.57	14.30	5.42	6.32	7.00	5.00
RAJ45Gy 20	13.33	12.86	5.38	5.20	5.68	6.00
NR30Gy 06	9.12	10.38	4.96	5.03	6.00	7.54
NR30Gy 10	12.75	11.72	5.25	5.12	7.25	6.00
NR35Gy 08	13.57	9.68	6.10	4.50	7.50	6.04
NR35Gy 11	12.50	14.69	5.00	4.89	7.92	7.00
NR35Gy 12	10.57	11.36	5.41	5.65	6.45	4.05
NR35Gy 19	10.03	10.28	5.32	6.31	6.92	5.00
NR40Gy 05	12.16	12.87	6.84	6.27	7.00	6.30
NR40Gy 07	9.81	10.52	7.16	6.90	7.33	5.34
NR40Gy 09	11.05	11.56	7.03	5.46	8.00	6.00
NR40Gy 12	10.98	12.70	6.20	4.86	6.50	7.00
NR40Gy 15	11.76	12.62	5.60	5.27	6.45	6.00
NR45Gy 01	12.56	14.50	5.12	4.29	7.20	5.00
NR45Gy 02	10.39	11.00	6.00	5.37	5.35	7.20
NR45Gy 04	9.51	12.04	6.50	5.33	6.28	5.62
NR45Gy 09	10.27	12.35	5.05	6.20	7.12	4.89
YB EMS 0.6% 1	13.72	10.26	7.28	6.80	7.58	6.00
YB EMS 0.6% 4	12.95	16.04	7.04	6.57	6.21	5.34
YB EMS 0.9% 1	10.29	13.38	7.12	6.33	5.00	8.00

YB EMS 0.9% 2	10.56	11.50	7.34	6.92	7.25	5.76
YB EMS 0.9% 3	11.80	12.62	6.58	5.62	6.89	6.74
YB EMS 0.9% 4	13.05	12.42	6.96	5.60	6.00	5.27
YB SA 0.02% 1	13.57	14.50	5.76	5.21	5.24	4.81
YB SA 0.03% 6	15.60	13.70	7.23	4.80	6.85	5.00
YB BAP15- 1	12.53	10.68	6.39	4.36	5.00	4.27
YB BAP 20-2	10.29	14.32	6.96	6.00	6.67	6.20
RAJ EMS 0.6% 3	8.76	9.56	7.02	6.28	6.00	4.00
RAJ EMS 0.9% 1	10.40	13.66	6.52	6.39	5.64	5.00
RAJ EMS 0.9% 2	10.55	9.84	7.40	6.44	7.00	5.34
RAJ EMS 0.9% 4	11.34	8.31	6.70	7.02	6.00	5.00
RAJ SA 0.02% 1	12.46	10.04	5.22	4.50	5.46	4.73
RAJ SA 0.03% 1	9.28	9.63	4.56	4.62	6.00	5.00
RAJ SA 0.03% 2	9.69	10.00	6.72	6.24	5.62	6.00
RAJ BAP 15- 3	10.38	10.42	5.07	6.78	7.00	5.04
RAJ BAP 20 1	8.94	9.20	6.12	5.60	5.00	7.20
NR EMS 0.6% 3	12.40	11.88	7.00	5.82	6.00	5.30
NR EMS 0.9% 5	11.79	12.60	6.53	6.21	7.00	6.00
NR SA 0.02% 1	13.06	10.53	4.62	5.06	8.00	6.55
NR SA 0.03% 1	12.27	8.61	4.76	5.00	8.00	7.00
NR SA 0.03% 2	10.82	14.57	6.45	6.30	6.34	5.40
NR BAP 15-1	11.51	13.60	6.29	4.52	7.02	6.02
NR BAP20-3	10.91	12.00	6.80	5.21	6.50	7.00
YB	12.72	12.01	6.45	6.07	6.57	6.21
RAJ	12.64	12.77	6.45	6.55	6.21	6.26
NR	11.80	12.00	6.29	5.96	6.45	5.87
S.Em±	2.24	2.10	0.61	0.59	0.87	0.78
CD @ 5%	NS	NS	1.59	1.51	NS	2.02

NS- indicates Non significant; YB – Yelakki bale; RAJ- Rajapuri bale; NR- Nanjangud rasabale

RAJ EMS 0.9% - 2 (7.40), YB EMS 0.9% -2 (7.34), YB35Gy - 10 (7.38), RAJ40Gy - 22 (7.36), RAJ40Gy - 03 (7.30), YB40Gy - 14 (7.30), YB EMS 0.6% -1 (7.28), YB30Gy - 10 (7.22), YB35Gy - 24 (7.21), NR40Gy 07 (7.16), YB EMS 0.9% -1 (7.12), RAJ40Gy - 11 (7.11), RAJ35Gy - 12 (7.07), YB EMS 0.6% -4 (7.04), NR40Gy - 09 (7.03), YB30Gy - 01 (7.01),. The minimum flavour acceptance was recorded in RAJ SA 0.03% - 1 (4.56).

In plant crop, among Yelakki bale mutant lines the maximum flavour acceptance compared to check (6.45) was recorded in YB40Gy - 03 (7.82). In Rajapuri bale mutant lines the maximum flavour acceptance compared to check (6.45) was recorded in RAJ40Gy - 23 (7.58). In Nanjangud rasabale the maximum flavour acceptance compared to check (6.29) was recorded in NR40Gy - 09 (7.03).

Significant difference in flavour acceptance was noted in ratoon crop among different mutant lines of banana (Table 2). The maximum flavour acceptance was recorded in RAJ45Gy - 07 (7.48) which was on par with RAJ35Gy - 12 (7.45), RAJ45Gy - 14 (7.42), RAJ45Gy - 03 (7.36), YB40Gy - 03 (7.34), YB40Gy - 07 (7.29), RAJ40Gy - 03 (7.28), RAJ40Gy - 22 (7.24), RAJ45Gy - 04 (7.21), RAJ EMS 0.9% - 4 (7.02), RAJ45Gy - 15 (7.00), YB35Gy - 24 (6.97), YB EMS 0.9% -2 (6.92), NR40Gy - 07 (6.90), RAJ40Gy - 25 (6.80), YB EMS 0.6%-1 (6.80), YB35Gy - 12 (6.75), YB35Gy - 10 (6.70), YB45Gy - 13 (6.65), YB35Gy - 01 (6.63), YB35Gy - 23 (6.62), YB40Gy - 06 (6.58), YB EMS 0.6%- 4 (6.57), YB35Gy - 04 (6.57), YB40Gy - 04 (6.56), YB30Gy - 10 (6.50), YB40Gy - 08 (6.41), RAJ40Gy - 01 (6.39). The minimum flavour acceptance was recorded in YB25Gy - 05 (4.26). In ratoon crop, in Yelakki bale, the maximum flavour acceptance compared to check (6.07) was recorded in YB40Gy - 03 (7.34). In Rajapuri bale, the maximum flavour acceptance compared to check (6.55) was recorded in RAJ45Gy - 07 (7.48). In Nanjangud Rasabale the maximum flavour acceptance compared to check (5.96) was recorded in NR30Gy - 06 (7.54).There was no significant difference was recorded in plant crop among different mutant lines of banana and data is presented in Table 2. In ratoon crop, the maximum shelf life was recorded in YB45Gy - 08 (9.00 days) and the minimum shelf life was recorded in RAJ40Gy - 08 (4.00 days), RAJ EMS 0.6% -3 (4.00 days), YB35Gy - 12 (4.00 days), YB30Gy - 15 (4.00 days) YB30Gy - 01 (4.00 days). Earlier, the longest green life of banana fruit was observed in irradiated Williams clone w-193/3 while lowest seen in original Williams cultivar. These results are in agreement with Ahmed (2003) who showed that irradiated Grand Naine (clone 1 and clone 2) had longer green life than that of untreated Williams. Similarly, Mohammed (2003) observed highly significant difference between Williams mutants compared to dwarf Cavendish in their fruit green life. Similarly Sales *et al.* (2013) reported that plants treated with 50Gy in Lakatan cultivar showed mean value for four generation showed longer shelf life (14.5 days) than control (13.15 days). This might be due to mutation induction can lead to enhance heritable variation.

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 peel weight, shelf life and flavour acceptance. The application of gamma radiation and chemical mutagen is a promising technique to obtain good quality parameters in banana.

FUTURE SCOPE

(i) Generation of some more mutant lines *in vitro* using physical mutagens at 40 and 45Gy.
(ii) Evaluation of lines for disease resistance by challenging with artificial inoculation of isolated culture or in the sick plot.

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