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Mutation spectrum and mutagenic effectiveness of gamma rays in banana cv Grand Naine

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ABSTRACT

A study on morphological and chlorophyll type of mutants, mutation frequency and mutagenic effectiveness induced by different doses of gamma was conducted on banana cv Grand Naine. The experiment consisted of treatments including control and six doses at 10, 20, 30, 40, 50 and 60 Gy of gamma rays. The mutation spectrum revealed that the extent of mutation induced with gamma irradiation was 18.25 per cent and dwarf stature dominated the spectrum. The mutation frequency ranged from 3.2 to 54.74 per cent in different treatments under study in banana plantlets as affected by gamma irradiation. The treatment 40 Gy induced the highest mutation frequency (54.74%) and mutation effectiveness (0.15 Mp/kR) over remaining treatments under investigation.

Keyword: Mutation; spectrum; frequency; effectiveness; gamma; banana

INTRODUCTION

Genetic variation is the starting point of any breeding programme. Asexual behavior is often an inseparable barrier in using cross breeding as a tool for genetic improvement. Several clones of banana with good agronomic traits such as plant height, fruit size and quality were evolved as spontaneous mutations from cultivated clones. However the frequency of such mutations is extremely low as compared to induced mutations (Rowe 1984). van Harten (1998) proposed mutation techniques as a tool for plantain and banana improvement. The complexity of *Musa* genetics needs a more effective conventional breeding programme and prospects of using biotechnology in bananas are very high. The present study investigates the spectrum of morphological and chlorophyll mutants along with frequency and effectiveness of gamma rays in banana cv Grand Naine.

MATERIAL and METHODS

The shoot tip cultures of banana cv Grand Naine were exposed to ^{60}Co gamma rays doses ranging from 0, 10, 20, 30, 40, 50 and 60 Gy @ 20 Gy/min. The irradiated explants were sub-cultured (M_1V_0) onto shoot proliferation medium (MS medium containing 2 mg/l BAP). Further sub-culturing was performed at an interval of 30 days up to M_1V_4 generation and then transferred for rooting media (1/2th strength MS medium supplemented with 2 mg/l IBA and 3 g/l activated charcoal) to obtain rooted plantlets. The experiment was laid out in completely randomized block design with seven treatments (0, 10, 20, 30, 40, 50 and 60 Gy) and replicated thrice. In hardening stage the M_1V_4 plantlets were treated with 1 per cent carbendazim for 5 minutes and then transferred to portray containing sterilized cocopeat and kept under polyhouse for 4 weeks for primary hardening. Plants were further transferred to polybags containing red soil + FYM (1:1:1 v/v) potting mixture to be raised under shade house for eight weeks period. Five plants from each treatment per replication were randomly selected and tagged for recording biometric observations till the completion of study. Observations on the spectrum of chlorophyll and morphological mutations were recorded in M_1V_4 as suggested by Gustafsson (1975). Frequency of both chlorophyll and viable mutations were estimated using the formulae suggested by Gaul (1958). Mutagenic effectiveness was estimated using the formulae suggested by Konzak et al (1965)

RESULTS and DISCUSSION

The mutagenic effect can be measured in both the terms of quantity and quality by studying the spectrum and the frequency of morphological and chlorophyll mutations. Type of mutants (morphological and chlorophyll) and mutation frequency observed at different irradiation levels in M_1V_4 at hardening stage (90 DAP) of banana plantlets var Grand Naine are presented in Table 1 (Plate 1). In present study total 86 putative mutant plants were obtained in M_1V_4 generation resulting in 18.25 per cent mutation frequency at hardening stage in nursery. Among the

Table 1. Mutation spectrum induced by gamma irradiation in banana plantlets

Mutants type	Per cent mutation spectrum
Total mutation spectrum	18.25
Long shoot	9.30
Dwarf shoot	74.41
Leaf-like stem	3.48
Chlorophyll mutants	9.30
Pigmented mutants	3.48

a) T_1 (0 Gy), T_5 (40 Gy), T_7(60Gy)

b) T_5 (40 Gy)

c) T_4 (30 Gy)

d) T_5 (40 Gy)

Plate 1. Mutation spectrum of putative mutants identified during hardening. a) Dwarf shoot, b) Leaf like shoot, c) Viridis type, d) Striata type

Table 2. Types of mutants and mutation frequency induced by gamma irradiation in banana plantlets

T	Dosage (Gy)	Putative types and per cent frequency												Mutation frequency (%)
		Morphological mutant						Chlorophyll mutant				Pigmentation on leaf and pseudostem	Total putative mutant plants	
		LS	DS	LL	TL	CL	SL	Albino	Xantha	Viridis	Striata			
T_1	0	-	-	-	-	-	-	-	-	-	-	-	-	-
T_2	10	03 (1.63)	02 (1.08)	-	-	-	-	-	-	-	01 (0.54)	-	06 (3.2)	3.2
T_3	20	04 (3.47)	09 (7.82)	-	-	-	-	-	-	-	02 (1.73)	-	15 (13.04)	13.04
T_4	30	01 (1.25)	14 (17.5)	-	-	-	-	-	-	01 (1.25)	02 (1.25)	01 (1.25)	18 (22.5)	22.5
T_5	40	-	19 (45.22)	01 (2.38)	-	-	-	-	-	01 (2.38)	02 (4.76)	-	23 (54.74)	54.74
T_6	50	-	13 (42.84)	01 (3.57)	-	-	-	-	-	-	0	-	14 (49.98)	49.98
T_7	60	-	08 (36.32)	01 (4.54)	-	-	-	-	-	-	0	01 (4.54)	10 (45.4)	45.4
Total putative mutant type		8 (1.69)	65 (13.65)	03 (0.63)	-	-	-	-	-	02 (0.48)	07 (1.47)	02 (0.42)	86 (18.25)	18.25

Figures in the parentheses indicate mutation frequency

T= Treatment, LS= Long shoot, DS= Dwarf shoot, LL= Leaf-like, TL= Twisted leaves, CL= Crinkled leaves, SL= Split leaves different types of mutants observed dwarf mutants (74.41%) were predominant followed by chlorophyll mutants (9.3%). Occurrence of dwarf mutants may probably be due to suppressive effect of gamma radiation on cell growth which might have resulted in stunted growth of plants. Similar observations were also reported by Sobhana (2000) in *Dendrobium*.

In the present study chlorophyll mutants observed were striate type whereas other types like albino, xantha and viridis were not observed. The chlorophyll mutation has been frequently used to assess the effectiveness and efficiency of a specific mutagen because of their easy detection and frequent appearance following mutagenic treatment. There was no definite dose-dependent relationship for occurrence of chlorophyll mutants. The reduction in chlorophyll mutation frequency at higher dosages (>40 Gy) might be due to activation of a suppressor which normally kept the rate of chlorophyll synthesis under control as suggested by Singh and Godwad (1974) while induction of chlorophyll mutations may be attributed to changes in structural components of chlorophyll and failure of proto-plastid to develop into plastids with normal size and colour or both (Gustafsson 1975).

Datta et al (1995) opined that the chlorophyll mutation in the irradiated plants was due to changes in the biosynthetic pathways of chlorophyll pigments and the time of chlorophyll synthesis in palisade and spongy mesophyll cells. According to Marigowda and Gangaswamy (1975) variegation in the leaves was produced by nuclear or plastid mutations. They were of the view that spontaneous or induced plastid mutation produced a variety of phenotypes such as cream, white and various shades of pale green colour. This chimeric pattern of variegated leaves depended on the occurrence of mutation in different growing points. Present results are in corroboration with the findings of Rathod (2013) in banana var Rajapuri.

The perusal of data presented in Table 2 reveal that the treatment T_5 ie gamma irradiation applied with 40 Gy induced the highest mutation frequency (54.74%) followed by the treatment 50 Gy (49.98%) and 40 Gy (45.4%). The increase in mutation frequency at higher doses of gamma irradiation might be due to induction of many mutations at higher levels of gamma irradiations. The mutation frequency increases with an increase in dosage or dosage rate but the capacity to regenerate decreases. Similar observation was also reported by Rathod (2013) in banana.

Table 3 reveals that the gamma irradiation treatment doses at middle to higher level showed higher effectiveness than at lower level in inducing mutation in base population. Among the treatments the highest mutation effectiveness (0.15 Mp/kR) was observed in the treatment T_5 (40 Gy gamma irradiation) followed by 50 Gy (0.13 Mp/kR) and 60 Gy gamma irradiation (0.12 Mp/kR). At hardening stage the treatment of 40 Gy proved effective than other doses that might be due to induction of many mutational events per cell which resulted in maximum mutation range of spectrum (morphological and chlorophyll) and higher frequency percentage. Similar results of significance of mutagenic effectiveness of gamma irradiation in inducing mutation have also been observed by Hegde (2006) in turmeric.

Table 3. Mutagenic effectiveness induced by gamma irradiation in banana plantlets

Treatment	Dosage (Gy)	Mutagenic effectiveness (Mp/kR)
T_1	0	-
T_2	10	0.036
T_3	20	0.076
T_4	30	0.08
T_5	40	0.15
T_6	50	0.13
T_7	60	0.12

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