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GAMMA-RAYS AND EMS INDUCED MACROMUTANTS IN CELERY (*APIUM GRAVEOLENS* L.), FENNEL (*FOENICULUM VULGARE* MILL.) AND AJOWAN (*TRACHYOSPERMUM AMNI* L.)

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Sixteen (15 viable types) macromutant (*chloroxantha*, *thick stem* I, *thick stem* II, *slender stem*, *pigmented stem*, *lax branching* I, *lax branching* II, *funnel*, *bushy*, *drooping branched*, *dwarf*, *broad pinnae*, *elongated pinnae*, *narrow pinnae*, *early flowering* and *late flowering*) types have been induced in M_2 generation of celery (*Apium graveolens* L.), fennel (*Foeniculum vulgare* Mill.) and ajowan (*Trachyospermum amni* L.) following treatments with gamma-rays (2, 4, 8 and 10 kR) and EMS (0.25% and 0.50% - 2h and 4h durations). Total mutation frequency was noted to be higher in celery (15.5%) than fennel (4.3%) and ajowan (4.2%). Gamma irradiation was more potent in inducing higher frequency of mutation than EMS in celery and ajowan.

Keywords : Ajowan; Celery; EMS; Fennel; Gamma-Rays; Macromutants.

Introduction

As India is a leading producer, consumer and exporter of spices[1] there should be a constant approach to evolve high yielding varieties than the existing ones which could meet up the challenge of upsurging demands of spices in National and International markets. Induced mutations provide an important source of developing and creating genetic variations, thereby offering scope for selection of improved plant types and the methodology has been successfully administered in different plant species[2-7]. With a view to it, improvement in seed spices of Umbelliferae, namely celery (*Apium graveolens* L.), fennel (*Foeniculum vulgare* Mill.) and ajowan (*Trachyospermum amni* L.) has been initiated by the authors and this communication describes the frequency and types of macromutants induced at M_2 following treatments with gamma-rays and ethyl methane sulfonate (EMS).

Material and Methods

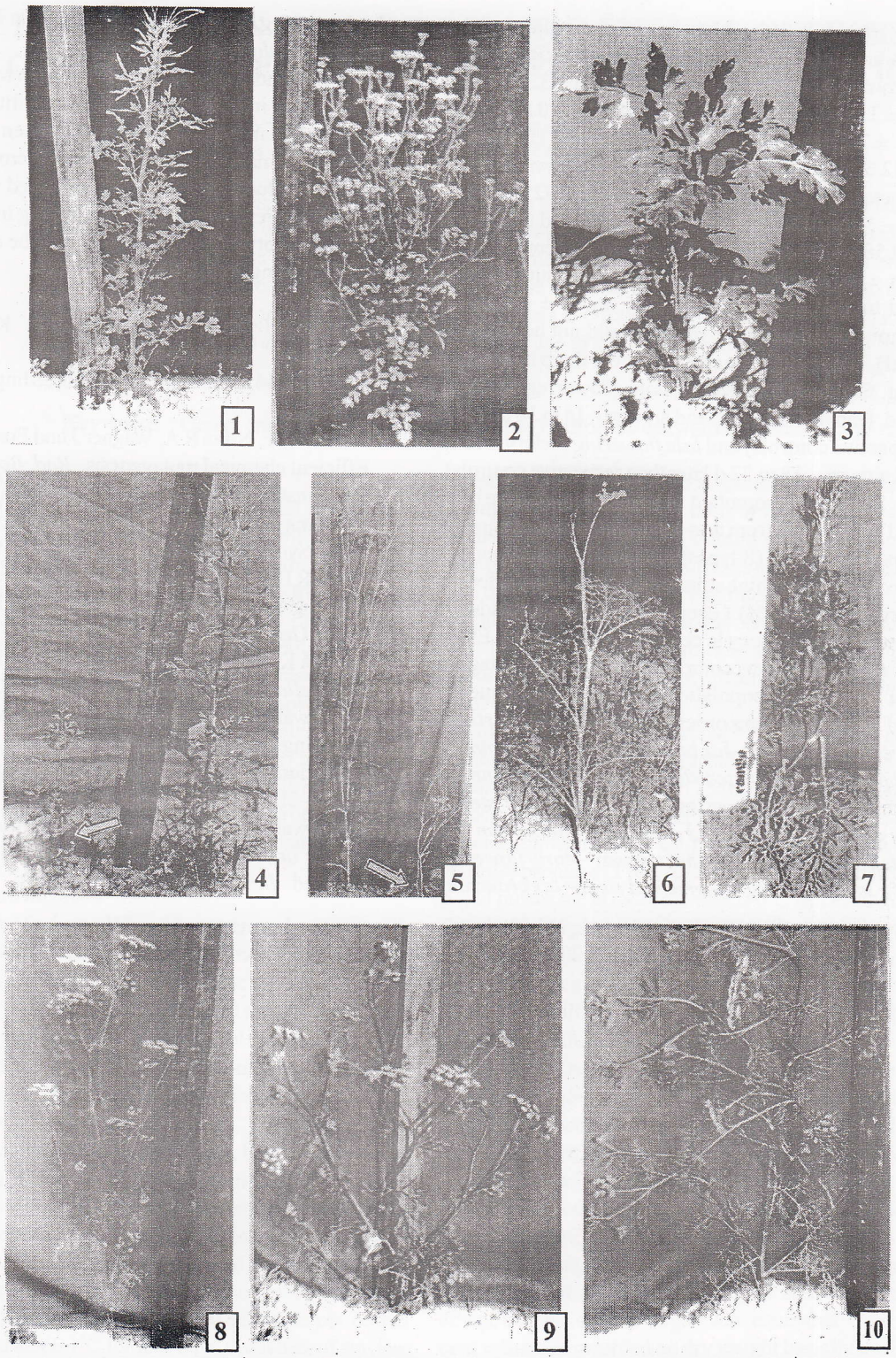
Dry seeds of celery (moisture content 8.0%), fennel (9.3%) and ajowan (7.7%) obtained from Zonal Adaptive Govt. Research Station, Krishnanagar, West Bengal, were gamma irradiated (2, 4, 8 and 10 kR doses from ^{60}Co source at CRIJAF, Nilganj, West Bengal) and treated with EMS (0.25%, 0.50% for 2h and 4h durations with intermitant shaking, temp.- 22°C ± 1°C, pH - 6.8; dilutions in 0.2M phosphate buffer). Doses were monitored after trials. Control and treated seeds (EMS treated seeds were thoroughly washed in running water for 3 to 4 hours) were sown (50 seeds in each lot) in the experimental field (15 cm. between plants and 30 cm. between lines) to raise M_1 generation. Selfed seeds of each surviving M_1 plant were harvested separately and the M_2 was raised as plant progenies. Macromutants were carefully screened throughout the life period of the M_2 plants and the frequency of macromutants was estimated in per cent. The mutant traits were confirmed in M_3 generation from selfed segregation of M_2 mutants. The colours of pigmented stem mutants were confirmed from Horticultural Colour Chart I and II (1968).

Results and Discussion

Compared to their controls (Figs. 1,8), the type of macromutants noted are (Table 1, Figs. 2-7, 9-10) : *Chloroxantha* (pale greenish yellow coloured weak seedlings, appeared only in fennel – 4 kR gamma-rays and 0.25%, 4h EMS, died within 20-27 days after their emergence), *thick stem* I (noted in some treatments of celery : 4 kR – 0.86 %, 0.50%, 2h EMS – 1.30%, 0.50%, 4h EMS – 1.16%; fennel : 4 kR – 1.55% and ajowan : 2 kR – 3.57%, 4 kR – 6.25%), *thick stem* II (trait was concomitantly associated with crumpled pinnae of leaves, detected only in ajowan 2 kR gamma-rays – 3.57% and 0.25%, 4h EMS – 0.29%), *slender stem* (noted only in fennel, maximum appearance in 0.50%, 2h EMS – 2.78%), *pigmented stem* (celery :control colour – nickel green **57**/$_2$, mutant colour - chrysocolla green **56**; fennel : control colour – viridian green **55**/$_3$, mutant colour - viridian green **55**; ajowan : control colour - nickel green **57**/$_1$, mutant colour – willow green $_{000}$**862**), *lax branching* I (high number of primary branches which were lax natured), *lax branching* II (lax natured primary branches forming dome shaped appearance, spotted only in irradiated ajowan samples), *funnel* (due to the organization of the primary branches, studied in gamma irradiated celery - 2 kR – 1.61% and 4 kR – 0.86%), *bushy* (the mutant manifested bushy appearance due to increased number of branches),

Table 1. Frequency of macromutation types evaluated at M_2 in three genotypes following gamma irradiations and EMS treatments.

Attributes		No. of plants scored	Frequency of macromutation types (%)																Total frequency (%)
			Chloroxantha	*Thick stem* I	*Thick stem* II	*Slender stem*	*Pigmented stem*	*Lax branching* I	*Lax branching* II	*Funnel*	*Bushy*	*Drooping branched*	*Dwarf*	*Broad pinnae*	*Elongated pinnae*	*Narrow pinnae*	*Early flowering*	*Late flowering*	
Celery	**Gamma-rays**	216	0.00	0.46	0.00	0.00	0.46	2.31	0.00	0.93	0.46	0.00	3.24	0.93	0.00	1.85	3.24	3.24	17.1
	EMS	299	0.00	1.00	0.00	0.00	1.67	1.34	0.00	0.00	0.00	0.00	2.01	2.01	0.00	1.67	2.01	2.68	14.4
	Total	515	0.00	0.78	0.00	0.00	1.17	1.75	0.00	0.39	0.19	0.00	2.52	1.55	0.00	1.75	2.52	2.91	15.5
Fennel	**Gamma-rays**	833	0.12	0.36	0.00	0.36	0.36	0.00	0.00	0.00	0.00	0.00	0.48	0.00	0.48	0.60	1.44	0.00	4.2
	EMS	742	0.13	0.00	0.00	1.21	0.00	0.00	0.00	0.00	0.00	0.00	1.21	0.00	0.13	0.13	1.48	0.00	4.3
	Total	1575	0.13	0.19	0.00	0.76	0.19	0.00	0.00	0.00	0.00	0.00	0.83	0.00	0.32	0.38	1.46	0.00	4.3
Ajowan	**Gamma-rays**	136	0.00	1.47	0.74	0.00	2.94	0.00	3.68	0.00	0.74	1.47	0.74	0.00	0.00	0.00	0.00	5.88	17.6
	EMS	1936	0.00	0.00	0.52	0.00	0.15	0.36	0.00	0.00	0.00	0.00	1.03	0.00	0.00	0.00	1.70	0.00	3.3
	Total	2072	0.00	0.97	0.97	0.00	0.34	0.34	0.24	0.00	0.48	0.97	1.01	0.00	0.00	0.00	1.59	0.39	4.2



Figs. 1-10 : Control and mutant plant types. 1. Control celery plant. 2. *Lax branching* I mutant of celery. 3. *Broad pinnae* mutant of celery. 4. *Dwarf* (→) mutant of celery. 5. *Dwarf* (→) mutant of fennel. 6. *Thick stem* I mutant of fennel. 7. *Thick stem* II mutant of ajowan. 8. Control plant of ajowan. 9. *Lax branching* I mutant of ajowan. 10. *Drooping branched* mutant of ajowan.

drooping branched (the branches of the mutant plants were pendulous in nature, appeared only in 8 kR ajowan – 2.70%), *dwarf* (celery : height-mutant 50.3 cm. ± 3.32, control 72.2 cm. ± 3.58; fennel : height-mutant 44.5 cm. ± 0.82, control 69.9 cm. ± 2.91; ajowan : height-mutant 24.2 cm. ± 1.75, control 42.63 cm. ± 1.65), *broad* and *narrow pinnae* (*broad pinnae* mutant detected only in celery : 4 kR – 1.72%, 0.25%, 4h EMS – 3.45%, 0.50%, 2h EMS – 1.30% and 0.50%, 4h EMS – 0.58%, average area 5.0 sqcm. ± 0.80 compared to 3.8 sqcm. ± 0.71 in controls; *narrow pinnae* mutant plants appeared both in celery [area – 1.95 sqcm. ± 0.67] and fennel; however, area of the pinnae could not be assessed in fennel), *elongated pinnae* (apex of the pinnae was drooping, found only in fennel), *early flowering* (celery – 12 to 16 d, fennel – 11 to 15 d and ajowan – 14 to 18 d earlier than respective controls) and *late flowering* (celery – 15 to 23 d and ajowan – 18 to 22 d later than respective controls).

Sixteen macromutant types (15 viable) have been observed and the spectrum was higher in celery and ajowan (10 types) than fennel (8 types). Total mutation frequency was noted to be much higher in celery (15.5%) than fennel (4.3%) and ajowan (4.2%). Gamma irradiations have induced higher mutation frequency in celery and ajowan than EMS; while, the frequency was comparable with both mutagens in fennel. Over the M_2 population, total mutation frequency occurred in the following order : celery – *late flowering* > *dwarf* = *early flowering* > *lax branching* I = *narrow pinnae* > *broad pinnae* > *pigmented stem* > *thick stem* I > *funnel* > *bushy*; fennel – *early flowering* > *dwarf* > *slender stem* > *narrow pinnae* > *elongated pinnae* > *thick stem* I = *pigmented stem* > *chloroxantha*; ajowan – *early flowering* > *dwarf* > *late flowering* > *pigmented stem* = *lax branching* I > *lax branching* II > *thick stem* I = *thick stem* II = *drooping branched* > *bushy*.

Morphological mutants evolved in M_2 generation is a dependable index of the genetic variability released in the species. Plant type mutation has been ascribed to changes in the 'major genes'[8]. From the macromutant types it seems that induced mutations have affected various plant parts of celery, fennel and ajowan resulting into alteration of the plant ideotypes, which may further be exploited for efficient breeding in the crops.

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