TABLE I
Hydrogen bonding of α-tocopherol with electron-donors[a]

Donor	K (298 K) in lit. mol^{-1}	$\Delta\nu$(OH) in cm^{-1}	ΔH in kJ mol^{-1}
Ethyl acetate	0·69	110	11·7
Ethyl caprylate	1·00	110	11·7
Acetone	1·03	155	12·1
DMF	5·50	270	18·0
DMSO	11·80	350	26·8

[a]in CCl_4

therefore, appears that α-tocopherol is a poorer acid than phenol or hindered phenols. Accordingly, we find that the $\Delta\ \nu$(OH) values are generally much lower in the case of α-tocopherol (table 1). We, however, see that $\Delta\ \nu$(OH) varies roughly proportionally with ΔH since in the case of oxygen donors studied here, we are in the linear range where Badger-Baner rule is applicable[9].

Recently, interaction of α-tocopherol with fatty acid derivatives like ethyl caprylate has been investigated[3] by studying the effect of these derivatives on the kinetics of hydrogen abstration by DPPH. The 1:1 binding constant between ethyl caprylate and α-tocopherol in alcoholic solution is very large (6,500 lit mol^{-1}). We see that this association is distinctly different from hydrogen bonding interaction examined here. The 1:1 equilibrium constant for hydrogen bonding interaction is only 1·0 lit mol^{-1} (table 1.).

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INDUCED MUTAGENESIS IN *CAPSICUM* L. II. EFFECTS OF SINGLE AND COMBINED MUTAGENIC TREATMENTS ON HABIT AND FRUIT

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BOTH physical as well as chemical mutagens have been employed considerably for experimental induction of mutations in chillies[1,2]. Information is, however, lacking on the efficiency of these mutagens when used in combinations. The present report deals with some mutations obtained after single and combined treatments of various mutagens.

Seeds of *Capsicum annuum* L. cv. N.P. 46 A, obtained from National Seeds Corporation, Jaipur, were subjected to mutagens* namely γ-rays (5, 10, 15, 20 Kr), DMS (0·25, 0·5, 1, 2, 3%), EMS (0·1, 0·3, 0·5, 0.·6%), MES (0·1, 0·3, 0·5%), HA (0·05, 0·1, 0·15%), HZ (0·1, 0·15, 0·2%) for the present investigation. Genetically pure seeds were used for treatments. Dry seeds (moisture content 6·08%) were irradiated with gamma-rays at the above dosages at IARI, New Delhi. Seeds used for chemical treatment were presoaked in distilled-water for 12 hr and then treated with freshly prepared solution of the mutagen for 12 hr at room temperature. Seeds were immersed in solution, three times more in volume than that of the seed. For combination treatments, gamma-ray-irradiated seeds for the above dosages were presoaked in distilled-water for 12 hr and then treated with 2 and 3% of DMS solution. A control was maintained with seeds soaked in distilled-water only. Chemically treated seeds were thoroughly washed with water and sown in petriplates for measuring germination and seedling injury and pots simultaneously. Seedlings at 6-leaf stage were later on transplanted in garden beds to raise M_1 population. Mutants isolated were established by raising them in subsequent generations for mutated characters. Viable mutations affecting plant habit and fruit characteristics were recorded in M_1 and M_2 generations derived from individual

*γ-rays, Gamma rays; DMS, dimethyl sulphate; EMS, ethyl methane sulphonate; MES, methyl ethane sulphonate; HA, hydroxyl ammonium chloride; HZ, hydrazine sulphate.

TABLE 1
Survival % and mutation frequency in M_1 generation

Mutant	Mutagen (dose/conc.)	No. of seeds treated	No. of plants raised	Survival %	No. of Mutants	% mutation of treated seeds	% mutation of survival plants
Control	—	300	293	97·6	—	—	—
Small blunt fruit	γ-rays (20 Kr)	200	141	70·5	2	1·00	1·41
Tall, small broad fruit	HA (0·15%)	200	184	92·0	1, 2	0·5, 1·0	0·54 1·08
Dwarf	EMS (0·5%)	300	199	66·3	4	1·33	2·01
	MES (0·5%)	200	131	65·5	2	1·00	1·52

treatments of gamma-rays, EMS, HA and MES (tables 1, 2). No chlorophyll mutation was observed in any treatment. Inheritance of the mutated character was worked out from the results of the pedigree method of M_2 and M_3 generations and F_1 and F_2 generations derived from the single cross between the mutant and the control (table 3).

The characteristics of some of the isolated viable mutations are described below generation-wise:

M_1 generation

Table 1 contains data on mutagens, number of seed treated, survival % and mutation frequency.

1. *Tall* – mutant occurred in HA (0·15%) treatment. 200 plants in M_2 and 178 in M_3 bred true for the mutated character. Plants vigorous, average plant height 62.7 cm (av. control 38·7 cm). It closely compared with control in flowering, fruit setting and pollen viability.
2. *Dwarf* – obtained in EMS (0·5%) and MES (0·5%) treatments. In M_2, 125 normal and 45 dwarfs were obtained but all 140 plants, however, bred true in M_3. Origin of few dwarfs in M_1 may be ascribed to physiological changes. Such explanations for observed changes in M_1 have already been reported[3]. Distinctly dwarf (av. 24·2 cm) with all plant parts comparatively reduced in size. Seed output reduced to almost 50 per cent in comparison to control. A single recessive gene was found to control the trait (table 3).
3. *Small-blunt fruit* – screened in gamma rays (20 Kr). The mutant possessed small oval to round and thick-skinned fruits, unlike long, narrow and thin-skinned fruits in control.
4. *Small-broad fruit* – recovered in HA (0·15%). Fruit smaller and broader with pointed tip than those in control.

M_2 generation

Frequency of viable mutations is given in table 2.

1. *Erect fruit* – scored out in HA (0·15%). Mutated character very conspicuous, the fruits developed were erect, unlike pendent in control. The tendency for erectness became apparent during flowering. The pedicel grew straight bearing slightly bent flowers and the developing fruits were erect.
2. *Small-pointed fruit* – isolated in HA (0·05%). Plant

TABLE 2
Frequency of viable mutations in M_2 generation

Mutants	Mutagens	No. of M_2 families	No. of M_2 plants	No. of M_2 mutants	No. of M_2 families segregated	% of M_2 families segregated	% of M_2 mutations
Contol	—	5	507	—	—	—	—
Erect fruit.	HA(0·15%)	4	171	8	2	50·0	4·67
Small pointed fruit	HA (0·05%)	6	194	4	1	16·6	2·06
Orange long fruit	γ-rays (20 Kr)	5	162	7	1	20·0	4·32
Orange round fruit	γ-rays (15 Kr)	4	187	2	1	25·0	1·06
Purple fruit	EMS (0·6%)	4	124	3	1	25·0	2·41

TABLE 3
Segregation of mutants in F_2 generation

Cross	F_1 plants		F_2 plants		X^2 (3:1)	*P* value
	No.	Phenotype	Normal	Mutant		
Orange long fruit × control51	51	Control	89	29	0·11	0·90–0·95
Dwarf × control	62	Control	85	25	0·30	0·50–0·70

type similar to control except bearing small pointed, pendent and thin-skinned fruits.

3. *Orange-long fruit* – obtained in 20 Kr treatment. Fruits normal except for orange colour, In the beginning the colour of unripened fruits was green which changed to pale yellow and finally orange on complete ripening. The mutated character was found to be controlled by a single recessive gene (table 3).

4. *Orange-round fruit*-isolated in 15 K_r treatment. The mutant was characterized with small, globular, orange coloured fruits at maturity. Fruits thick-skinned and possessed small, thick, straight to curved peduncles. Stamen pale yellow and bright yellow in bud and at anthesis respectively. Style straight to curved and projected over stamens.

5. *Purple fruit* – isolated in EMS (0·6%) treatment. Details on its morphology, cytogenetics and taxonomic significance have already been worked out[2].

During the present investigation on the effects of various mutagens employed individually as well as in combination, a limited number of viable mutations were scored out in chilli. In M_1 generation, four types of mutations concerning plant habit and fruit shape were recorded following gamma-ray, MES, EMS and HA treatments. DMS and HZ, however, did not induce any mutation. Among chemical mutagens, HA alone appeared promising. Gamma rays, as evident from observations, were found to be effective when used alone. But in combination with DMS, it did not yield any mutation. In tomato, current tomato and tomatillo, the combination of gamma-rays and DMS produced fewer mutations than either gamma-rays or DMS produced individually[4]. Irradiation with x-rays followed by treatment with EMS, however, gave an increased frequency in barley over individual treatments while the combination treatment in reverse order yielded reduced mutation frequency[5]. Whereas the combined treatment of gamma-rays and DES or MES induced intermediate mutation frequency in tomato[6]. The available data, hence, reveals that the effects of mutagenic treatments in which two different mutagens are combined, are variable and that the sequence in which they are combined also causes variations in their effects.

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A NEW SPECIES OF *MASSARINA* SACC.

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DURING a general survey of Ascomycetes from Jodhpur, Rajasthan, the authors collected dead twigs of *Azadirachta indica* A. Juss. bearing black fruiting bodies. On microscopic examination it was found to be a species of *Massarina*. The ascospores of the present species were not surrounded by mucous sheath which is often present in the species of *Massarina*. Earlier, five species of *Massarina* were reported[1], in which the ascospores are without mucous sheath. The present species differs from all these in morphological characters.