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Enhancing Genetic Variability and Yield Potential in Chia (Salvia hispanica L.) through Gamma-Irradiation-Induced Mutation Breeding

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Introduction:

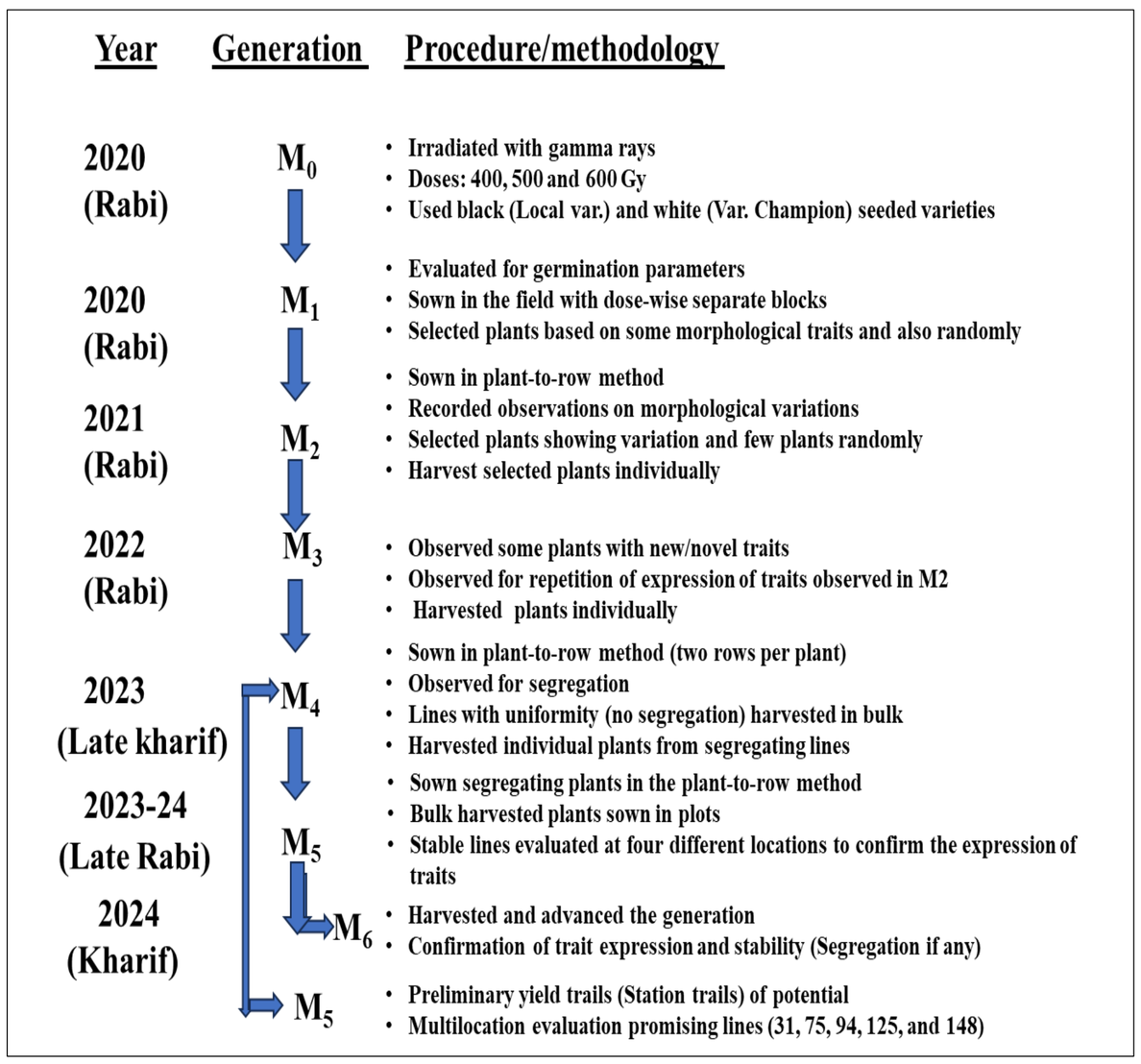
Chia is major plant-based source of omega-3 fatty acid and being popularized in India as demand increasing particularly in metropolitan cities. As newly introduced crop, there are no authentic and high yielding varieties available in India. However, the growers are being used the seeds from super- or online-markets. It is very crucial to create genetic variability which can be used as base for developing high yielding varieties.

Objective:

- To create genetic variability in chia through gamma rays induced mutation

Methodology:

- Black (local variety from market) and white (var. Champion) seeded chia varieties were irradiated with gamma rays at doses of 400, 500, and 600 Gy.
- More than 1,000 M_1 plants were selected randomly and M_2/M_3 plants were sown plant-to-row method during 2021.
- The selected M_4 progenies (125 and 94) were sown in plots during kharif 2024 with 3 replication to evaluate their yield performance.
- Promising diverse mutant lines evaluated during 2023-24 at NIASM, Baramati; ICAR-CRIDA, Hyderabad; and ICAR-IISS, RS, Bengaluru



Results:

- ✓ Frequency: 0.0097 to 0.1065 with highest in 500 Gy
- ✓ About 200 mutants advanced to M_3 generation along with micro and macro mutants (Fig. 1)

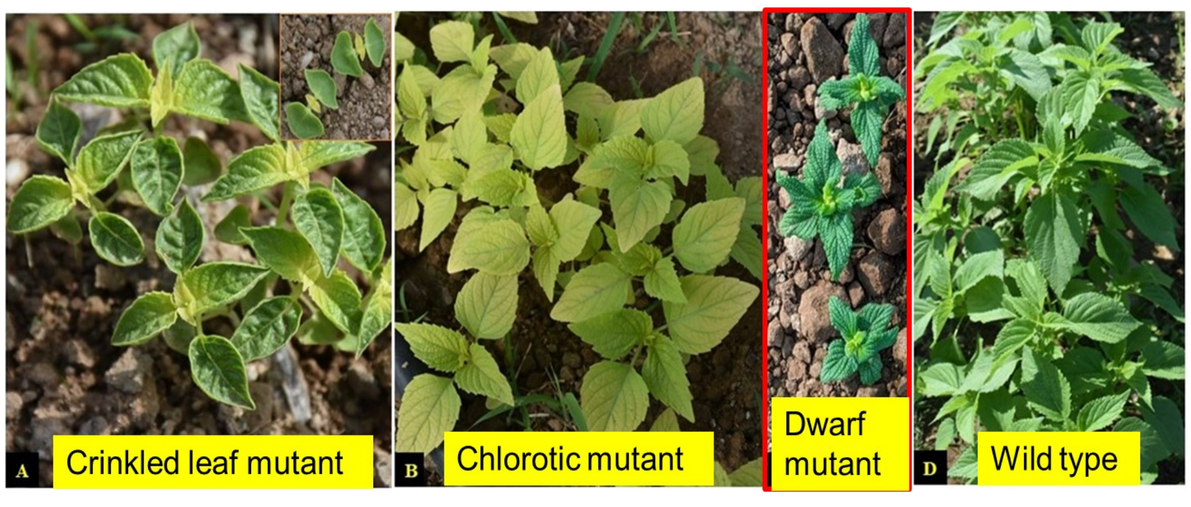
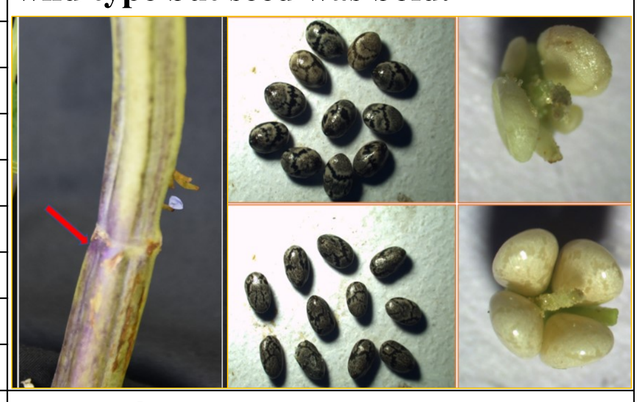


Fig. 1. Promising macro mutants selected in M_3 /M_4

Table. 1 Number of potential mutant lines considered for preliminary yield (station) trials.

Mutants	DFF	DM	Yield	Distinguishable traits
Pedigree of 94th plant				Purple pigmentation on stem, petiole and spike (calyx). These lines were 8-12 days early as compared to wild type. 
94-1-1	72	103	1095	
94-1-3	83	104	1004	
94-2-1	85	110	965	
94-2-2	86	109	-	
94-2-3	81	105	896	
94-2-4	86	109	-	
94-3-1	86	113	1019	
94-3-3	81	111	1026	
94-3-4	86	109	-	
94-3-5	87	112	997	
Pedigree of 125th plant				Purple pigmentation on stem, petiole and spike (calyx). Late flowering and maturity compared to wild type. Two seeded per floret instead of four in the wild type but seed was bold. 
125-1-1	98	151		
125-1-2	96	152		
125-1-3	96	124		
125-1-4	85	127		
125-1-5	88	130		
125-1-4	101	152		
125-2-1	97	155		
125-2-2	94	149		
125-2-6	96	129		
125-2-7	95	123		
125-3-2	98	155		
125-3-7	101	130		
Black	83	115	852	Purple flower, balck seed
White	86	117	606	White flower, white seed

- ✓ The selected entries (94 and 125) of M_5 were evaluated in replication for yield during kharif 2024.
- ✓ Mutant line 94-1-1 recorded the highest yield of 2.46 kg/plot (1094.81 kg/ha), which represented an 80.68% increase over Champion (605.93 kg/ha) and 28.52% over Black selection-1 (851.85 kg/ha), with earlier maturity (103 days vs. 117 and 115 days).
- ✓ 94-3-3 and 94-3-1, also showed yield improvements ranging from 65% to 70% over Champion, coupled with moderately reduced maturity durations (111 and 113 days).

Table 2. Number of promising mutant lines potential for registration as genetic stocks.

Mutant	DFF	DM	Special traits
52-3-2	76-94	115-122	Dwarf, sturdy, dark and crinkled elongated leaves. Potential for ornamental plant type.
52-3-5	85	118-120	
52-3-6	80-92	116-122	
31-1-1	75-77	100-105	Entire plant is chlorotic.
148-1-1	89-92	115-120	Cup shaped cotyledon and crinkled leaves.
148-1-3			
75-1-6	105	155-160	Tall, late, long spike with intermittent pinnate leaves phyllody type.
75-1-14	107	155-160	
86-1-1	96	125-130	Branching spike
80-1-2	95	123-128	Rounded spike
138-3-8	85-90	120-125	Branching spike
138-2-6	88-90	122-126	
65-2-1/2/3/4	91-96	120-122	Spike with closed corolla (delayed dropping of corolla from floret)
11-1-…	66-70	95-100	Early flowering
141-1-1	60	90	Extra early flowering

Conclusion:

- ✓ Dose: 400-600 Gy is best for inducing mutation
- ✓ The segregation in M_3/M_4 indicating the importance of delayed selection for polygenic and recessive traits.
- ✓ High yielding entries (Table 1) will be evaluated under AICRP potential crops- Varieties
- ✓ Morphologically diverse lines (Table 2) can be registered as genetic stocks.

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