

INTEGRATED APPROACHES TO IMPROVING STRESS RESISTANCE IN TOMATOES

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The study evaluates the transgenerational effects of combining induced mutagenesis with targeted selection schemes to improve drought tolerance in tomatoes (*Solanum lycopersicum*). Specifically, we analyzed the germination rate under current drought stress (DS) as a function of ancestral X-ray irradiation in the M0 generation (0, 250, 300, and 350 Gy). The objective was to compare the efficiency of two distinct M1 selection criteria: a general productivity-based selection (Study 1) and a directed physiological selection based on the plants' ability to set fruit under extreme thermal stress of 42–50° C for at least one hour daily (Study 2). The evaluation of the M2 progenies was carried out by determining the germination index under optimal conditions (Control) and under PEG 6000-induced water deficit stress (DS). The biological material included tomato genotypes exposed to X-ray irradiation in M0, along with non-irradiated.

Our results revealed distinct transgenerational responses in seed germination heavily dependent on both the genetic background and the M1 selection environment. The ancestral irradiation factor did not uniformly alter baseline germination, but acted as a background vulnerability factor under current DS, particularly at high doses of 300–350 Gy. Concurrently, the parental stress history served as a specific modulator, with distinct environmental schemes either stabilizing or selectively collapsing the progeny's norm of reaction depending on the genotype. In Study 1, X irradiation exerted no visible reductive pressure under either control (5% reduction) or drought conditions (10 % reduction); variations were predominantly determined by the native potential of the selected lines, with isolated instances of index stimulation (from 74 to 89%). Conversely, in Study 2, where seeds developed under extreme parental thermal stress, the presence of irradiation exacerbated the adaptive decline. In the As30L genotype, transitioning to irradiated variants drastically decreased DS

germination from 38% to 23%, whereas in the As42L genotype, the mutagenic effect was fully buffered, with DS germination remaining stable at 55.0% across both non-irradiated and irradiated variants.

Seed origin left a specific imprint on the stress response: a comparative analysis of As30 lines between the two parental environments showed a germination index of 88% (78-96%) under control conditions and 67% (50-90%) under DS for Study 1, dropping to 61% (43-77%) under control and 28% (10-43%) under DS for Study 2. Meanwhile, the As40 genotype demonstrated superior homeostatic stability, recording 96% (88-100%) under control and 66% (42-96%) under DS in Study 1, while maintaining 88% (80-93%) under control and 46% (30-73%) under DS in Study 2.

In conclusion, high-temperature selection collapses the adaptive norm of sensitive lines under drought, while robust genotypes maintain homeostasis. Thus, combining mutagenesis with parental stress is a genotype-dependent strategy gated strictly by the baseline tolerance of the genetic background. Furthermore, these divergent responses indicate that extreme ancestral heat acts as a selective filter rather than an inductor of universal tolerance, meaning that multi-stress breeding programs must prioritize initial genetic architecture over mutagenic stimulation to avoid cumulative vigor loss.

Keywords: Tomato, drought, germination rate, X-ray, parental environment.

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