ABSTRACT

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The field survey summarized the major abiotic problems in Akabare chili production in Nepal. Eight landraces (BJ77, C44, C45C, C62, C64B, C64C, DKT77, and PPR77) selected from 28 Akabare chili landraces from observation trials were evaluated for their physiological responses under individual and combined drought and heat stresses at the early vegetative and pre-flowering stages in climate chambers and the generative stage in field conditions. At the seedling stage, the landraces C44, DKT77, and C45C exhibited higher values of chlorophyll fluorescence (F*v*/F*m*), net photosynthetic rate (PN*N*), stomata conductance (g*s*), chlorophyll content index (CCI), transpiration rate (E), leaf temperature depression, water use efficiency (WUE) under stress conditions, leading to improved stomata anatomy and biomass. All landraces showed significantly low values of F*v*/F*m*, PN*N*, E, g*s*, and WUE under heat stress, further reduced under drought stress, and severely declined under combined stress. Total biomass exhibited a 57.48% reduction under combined stress, followed by 37.8% under drought and 21.4% under heat stress compared to the control. During the pre-flowering stage, six Akabare chili landraces (BJ77, C44, C45C, C64C, DKT77, and PPR77) were subjected to the same stress treatments, revealing significant differences in F*v*/F*m*, PN*N*, g*s*, leaf cooling, E, and biomass production among the landraces. Tolerant landraces (C44, DKT77, and C45C) maintained high F*v*/F*m*, PN*N*, and CCI values, exhibited improved leaf cooling, and showed enhanced biomass production compared to sensitive landraces (C64C, BJ77, and PPR77). The study observed a 13.9% decrease in total biomass under heat stress, a further 21.5% reduction under drought stress, and a substantial 38.7% decline under combined stress. A higher reduction in physiological traits during the pre-flowering stage compared to the seedling stage indicated the higher sensitivity of the generative phase to stressors. Four landraces (C44, DKT77, BJ77, and C64C) were evaluated at the fruiting stage under 55-day-long drought stress conditions in the field. The drought stress resulted in a 28.1% reduction in total biomass and a 26.2% decrease in total fruit dry weight compared to normal conditions. Tolerant

landraces (C44 and DKT77) outperformed their counterparts (BJ77 and C64C), exhibiting significantly higher Fv*v*/Fm*m* values, improved wilting scores, higher CCI, and increased biomass accumulation. A notable positive correlation was observed between Fv*v*/Fm*m*, CCI, and other responses in terms of the total fruit dry weight. Landraces exhibiting high Fv*v*/Fm*m* values sustained PSII functionality and photosynthetic efficiency under stress conditions by effectively cooling leaves and preserving chlorophyll. Landraces showed strong positive connections between their variations in Fv*v*/Fm*m*, PN*N*, gs*s*, CCI, and dry matter accumulation during stressful periods. The physiological responses observed in tolerant and sensitive landraces during the early vegetative and pre-flowering stages closely mirrored those evident during the fruiting stage in the field. These findings contribute to a deeper understanding of the physiological mechanisms underlying drought and heat tolerance in Akabare chili landraces.