



Culture Management and Application of Humic Acid in Favor of *Helianthus annuus* L. Oil Yield and Nutritional Homeostasis in a Dry Environment

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Abstract

This research aimed to investigate the prospected desirable influences of sowing date, planting density, and soil enrichment with humic acid (HA) on the growth and uptake of macro and micronutrients and their implications on the productivity of sunflower plants grown in dry, saline, and nutrient-deficient environment. Two field trials were conducted in two seasons (2018 and 2019) by planting the sunflower plants on two dates, one early (on May 5) and the other late (on May 30) under three planting densities of 95.2 (high), 71.4 (medium), and 57.1 (low) thousand plants ha^{-1} and soil enrichment with three rates of HA [0 (HA_0), 24 (HA_{24}), and 48 kg ha^{-1} (HA_{48})]. Early sowing date with soil HA_{48} under low planting density was the best combination for optimizing sunflower's growth, while early sowing date with HA_{48} under high planting density was best for the macro and micronutrient contents of shoots and seeds, as well as seed, oil (OY), and protein yields. With the application of automatic linear modeling analysis, seed yield, oil%, stem diameter, harvest index, shoot dry weight, plant height, and seed yield plant^{-1} were selected as the characteristics most contributing to OY in predicting stressed sunflower's OY. Due to the ever-climate changes, choosing an appropriate sowing date, as a non-monetary practice, and optimal planting density with adequate anti-stress (*e.g.*, HA) substance to enrich the low-fertile saline soils is the safest effective way to maintain global food security and sustainable agricultural development in dry environments.