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The Thesis Submitted for the Degree of Ph.D (in the field of Agroecology)

Effect of phosphorus fertilizers, planting management and drought stress on agrophysiological aspects Isabgol (*Plantago ovata* L.)

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Abstract
In many agricultural, horticultural, and medicinal plants, particularly in arid and semi-arid regions of the world, a lack of water is one of the most significant environmental factors that inhibits growth and performance. Phosphorus is the second most essential nutrient for plants, after nitrogen, and the location of seeds in the soil can affect plant growth. In order to investigate the effect of phosphorus fertilizers, planting management, and drought stress on the agrophysiological characteristics of isabgol (*Plantago ovata* L.), an experiment was conducted over the course of two agricultural years (2020 and 2021) at the research farm of Zabol University located in Chah Nime. The experiment was conducted using a split-factorial design with three replications of randomized complete blocks. The main-factor is irrigation following 60, 120, and 180 mm of evaporation from the class A evaporation pan and the second-factor of the experiment include: the combination of planting seeds on a flat surface or on a ridge and various types of phosphorus fertilizers (100 grams of Phosphate Barvar-2, and 50 kg of triple super phosphate fertilizer, 25 kg of triple super phosphate plus 50 g 2 Phosphate Barvar-2, and the control). The average interaction between drought stress and phosphorus fertilization in planting methods revealed that the highest values of plant height, number of leaves per plant, spike length and weight, number of spikes per plant, number of seeds per spike, weight of 1000 seeds, yield seed, biological yield, mucilage yield, and chlorophyll a were obtained from the irrigation treatment after 60 mm of evaporation from the evaporation pan along with the combination of phosphorus fertilization. In contrast to other characteristics, the highest carotenoid and mucilage percentages were obtained from the irrigation treatment after 180 mm of evaporation from the evaporation pan and the combined application of chemical and biological phosphorus fertilizers from the method of planting seeds on the ridge. The use of chemical and biological phosphorus fertilizers in the first cropping year makes the soil fertile and improves morphological and physiological characteristics in the second cropping year, including plant height, number of leaves per plant, spike length, number of seeds per spike, spike weight, weight of 1000 seeds, mucilage percentage, seed and biological yield, mucilage yield, chlorophyll a and proline. In the second year, the highest and lowest seed yields were obtained under normal irrigation conditions and severe drought stress, with 1085 kg per hectare and 456 kg per hectare, respectively. Also, conventional irrigation treatment, combined application of chemical and biological phosphorus fertilizer from the flat planting method produced the highest yield of mucilage with 112 kg/ha, while severe drought stress and no fertilizer application produced the lowest yield of 52 kg/ha. These values was obtained using the furrow and ridge planting method. According to the results, it is possible to attain an acceptable yield by enhancing the physical and chemical properties of the soil through the use of biological and chemical fertilizers in conjunction with regular irrigation and the flat planting method. The results indicated that irrigation after 60 mm of evaporation from the evaporation pan combined with the application of phosphorus fertilizers using the flat planting method is appropriate for planting isabgol in the Sistan region.

Keywords: irrigation, proline, nutrients, carotenoid, flat planting, active substance