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Gap Analysis of Sugar Beet Seed in Iran

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Introduction: The concept of the yield gap is crucial in agricultural productivity, representing the variance between the actual yield attained by farmers and the attainable yield under ideal management practices (Sadeghzadeh Hemayati *et al*., 2024). This discrepancy is a critical concern in crop production, as it underscores the potential for increased output and efficiency (Hanse *et al*., 2018). The present study delves into the sugar beet seed yield gap in Ardebil, Iran's sole sugar beet seed production region. The objective was to meticulously examine and pinpoint the key factors contributing to this yield gap, thereby offering insights into enhancing sugar beet seed production in Iran.

Materials and methods: The study was conducted during the 2022- 2023 growing season in Ardebil, Iran. Four prominent sugar beet cultivars- Shokoufa, Nika, Dena, and Arta- were selected for the investigation. These cultivars were propagated across 87 farms, which were all included in the study to ensure a comprehensive analysis. To gather the necessary data, a detailed questionnaire was utilized. This questionnaire was designed to capture a wide range of variables, totalling 266, which encompassed various aspects such as soil characteristics, field management practices, climatic parameters, and the quantitative and qualitative attributes of the seeds produced by the farmers. This extensive data collection enabled a thorough examination of the factors influencing sugar beet packable seed production. The analysis of the yield gap and the contribution of each factor to this gap was performed using the Boundary Line Analysis (BLA) method. BLA is a statistical technique that helps in identifying the maximum attainable yield under given conditions and in evaluating the extent to which actual yields fall short of this potential (Makowski et al., 2007; Tinker & Nye, 2000; Webster, 2007).

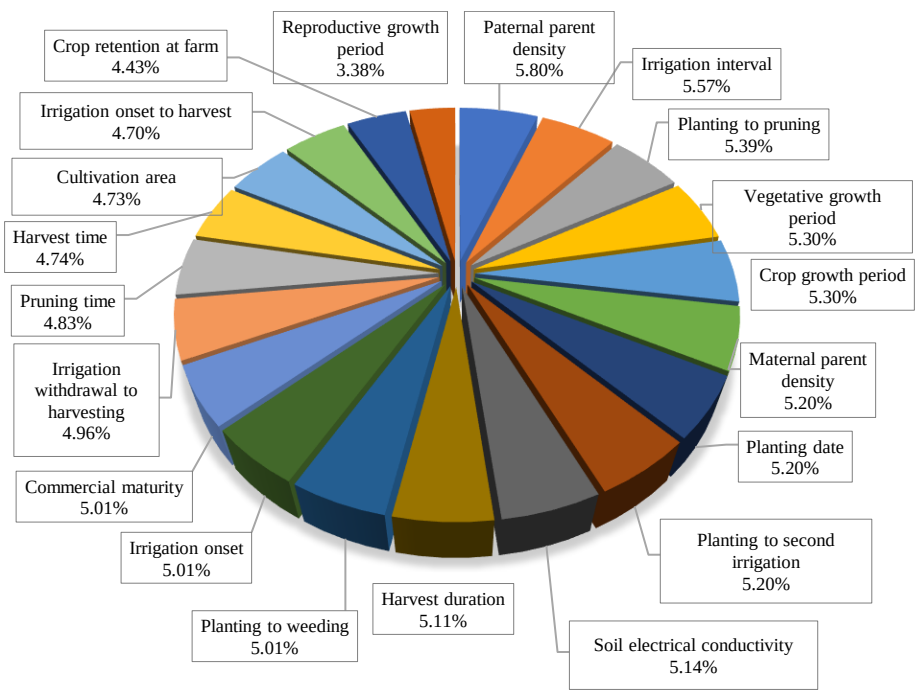

Figure 1: Breakdown of yield gap contributions among 20 variables in packable seed production

Results and Discussion: The BLA revealed a comprehensive list of 20 variables that significantly contribute to the yield gap in sugar beet seed production (Figure 1). Among these factors, several key variables stood out as having a more pronounced impact on the yield gap. The density of the paternal parent emerged as the most critical factor, accounting for 5.80% of the yield gap. This finding underscores the importance of optimizing pollination strategies to enhance seed production. Closely following, the irrigation interval and the distance between planting and pruning were identified as significant contributors, each responsible for 5.57% and 5.39% of the yield gap, respectively. These results highlight the need for precise water management and timely pruning practices to maximize yield. The duration of both the vegetative and crop growth periods was found to be equally important, each contributing 5.30% to the yield gap. This indicates that the timing and duration of growth stages are crucial for achieving optimal yields. Additionally, the density of the maternal parent, planting date, and the distance between planting and the second irrigation each accounted for 5.20% of the yield gap, emphasizing the need for careful planning and execution of these agronomic practices. Soil electrical conductivity and harvest duration were also significant, contributing 5.14% and 5.11%, respectively. These findings suggest that soil quality and the efficiency of harvesting operations play vital roles in determining yield outcomes. Furthermore, several other factors, such as the distance between planting and weeding, irrigation onset, and commercial maturity, each contributed 5.01% to the yield gap, while the distance between irrigation withdrawal and harvesting accounted for 4.96%. These variables collectively point to the importance of managing the timing and intervals of various field operations. Pruning time and harvest time were found to be slightly less impactful, contributing 4.83% and 4.74% to the yield gap, respectively. Nonetheless, these factors remain important for optimizing yield. The cultivation area and the distance from irrigation onset to harvest each accounted for 4.73% and 4.70% of the yield gap, indicating the relevance of field size and irrigation scheduling. The duration of crop retention at the farm and the duration of the reproductive growth period were the least impactful among the identified factors, contributing 4.43% and 3.38% to the yield gap, respectively. Yet, these variables should not be disregarded, as they still influence the total yield outcome.

Conclusion: Based on these findings, the study proposes a field calendar for sugar beet seed production in Ardebil. This calendar is designed to guide farmers in optimizing the timing and management of various agricultural practices, with the aim of achieving the maximum attainable yield in the region. By adhering to the recommended field calendar, it is anticipated that the yield gap can be significantly reduced, leading to improved productivity and economic benefits for sugar beet seed production in Iran.

Keywords: Actual yield, Agronomic management, Attainable yield, Boundary line analysis.

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