زانكۆی سەلاحەدین - هەولێر
Salahaddin University-Erbil

Exploring the Influence of Sowing Date and Plant Density on Chamomile Leaf Area Index

Research Project
Submitted to the department of (Field Crops and Medicinal Plants) in partial fulfillment of the requirements for the degree of BSc. in Field Crops

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A B S T R A C T

The study was conducted at College of Agricultural Engineering Sciences during the winter season 2023 - 2024 to investigate the influence sowing date and plant density on growth indices in Chamomile (*Matricaria chamomilla* L.) The experiments were carried out using pots with a depth of 24 cm and a diameter of 26 cm. The pots were filled with a sieved soil. Initially, the seeds were planted densely, but later thinned to nine, twelve and fifteen plants per pot, replicated three times resulting in 18 experimental units. The growth and growth indices of chamomile can be influenced by several factors, including sowing date and plant sowing density. The highest mean value of plant height was reached at interaction first sowing date with high plant sowing density S_1D_3, their mean value was (5.7 cm^2). As for number of branches per plant the higher mean value was (7.7) obtained at interaction second sowing date with low plant sowing date. In addition, the maximum mean value of leaf area (LA) and leaf area index (LAI) was reached at interaction first sowing date with high plant sowing density their mean value (34.46 cm^2 and 1.33). It is important for growers to consider date of sowing and plant sowing density when managing the growth and development of chamomile plants. Understanding the ideal timing for these factors can result in higher yields and better quality of plants.

KEY WORDS: Chamomile, Growth indices, Sowing date, Plant density.

1. INTRODUCTION

Chamomile (*Matricaria chamomilla* L.) is an herbaceous plant belonging to the Asteraceae family, it is characterized by its small, daisy-like flowers with white petals and yellow centers, the plant typically grows to a height of 20-60 centimeters and has a branching, erect stem covered in fine hairs, the leaves are alternate, bipinnate, and finely dissected, giving them a feathery appearance (Smith and Johnson, 2022 and Mehriya *et al*., 2022). German chamomile grows in many soils and climates but favors cool weather. It is a 4-6 month crop grown by transplanting or direct sowing seeds. Growing conditions also affect essential oil content and quality (Salamon, 2006 and Srivastava and Gupta, 2015). Growth analysis can be used to account for growth in terms that have functional or structural significance, the type of growth analysis requires measurement of plant biomass and assimilatory area (leaf area) and methods of computing certain parameters that describe growth (Radford, 1967). Maximizing chamomile yield and quality requires a thorough understanding of the factors influencing its growth and development, including sowing date and plant density (Deans and Svoboda, 1993). Sowing date plays a critical role in determining the environmental conditions that chamomile plants experience during key growth stages. Early sowing may expose plants to cooler temperatures and shorter day lengths, potentially affecting their development. In contrast, late sowing may subject plants to higher temperatures and longer day lengths, influencing their growth patterns. Understanding the optimal sowing date for chamomile can help growers synchronize plant growth with favorable environmental conditions, ultimately enhancing yield and quality (Franz *et al*., 1978 and Hadi *et al*., 2004). Plant density is another important factor that can influence chamomile growth. Higher plant densities can lead to increased competition for resources such as light, water, and nutrients (Deans and Svoboda, 1993). Chamomile should be sown as early as possible in the winter in order to enable sufficient growth prior to flowering because there is a possibility that differences in yield-contributing aspects could affect the production of chamomile flowers (Franz *et al*., 1978 and Hadi, 2004). This competition can affect the development of chamomile plants, including their leaf area index (LAI), which is a key indicator of canopy development and photosynthetic potential (Silva *et al*., 2019). By exploring the impact of different plant densities on chamomile's LAI, growers can determine the optimal planting density for maximizing yield and quality. Despite the importance of sowing date and plant density in chamomile cultivation, there is limited research on how these factors specifically influence chamomile's LAI. This study aims to fill this gap by investigating the effects of sowing date and plant sowing density on chamomile's LAI.

2. MATERIALS AND METHODS

2.1. Experimental Setup and Design:

The study was conducted at College of Agricultural Engineering Sciences during the winter season 2023 - 2024 to determine effect of two sowing date and three plant densities on some parameters of growth and growth indices in chamomile (*Matricaria chamomilla* L.) A pot experiment will be conducted using a Completely Randomized Design (CRD), using pots with a depth of 24 cm and a diameter of 26 cm. The pots were filled with a sieved soil. Initially, the seeds were planted densely, but later thinned to nine, twelve and fifteen plants per pot, replicated three times resulting in 18 experimental units.

2.1.1. Sowing Dates:

Two sowing dates were selected to represent different growing conditions: Seeds were sown directly into the pots on (20 Nov. 2023) for early sowing and on (10 Dec. 2023) for normal sowing.

2.1.2. Plant Densities:

Three plant densities were evaluated: low sowing density (9 plants per pot), moderate sowing density (12 plants per pot), and high sowing density (15 plants per pot). The number of seeds sown per pot was adjusted to achieve the desired plant density.

2.2. Data Collection:

Measurements were taken from three randomly selected plants per pot, plant height, number of branches per plant, leaf area LA and the average leaf area index LAI was calculated for each treatment combination.

2.3. Statistical Analysis:

Data were subjected to analysis of variance (ANOVA) to determine the effects of sowing date and plant sowing density on chamomile's LAI. Means were compared using (Duncan, 1975) letters at a significance level of α=0.05.

2.4. Measurement Growth and Growth Indices

2.4.1. Plant Height (cm)

2.4.2. Number of Branches per plant

2.4.3. Leaf Area (LA)

2.4.4. Leaf Area Index (LAI) = $\frac{\text{area of green leaf per plant}}{\text{area occupied by plant}}$

3. RESULTS AND DISCUSSION

3.1. Measurement Growth and Growth Indices

3.1.1. Effect Sowing Date

3.1.1.1. Plant Height and Number of Branches per Plant

The data recorded for chamomile (*Matricaria chamomilla* L.) plant height and number of branches per plant revealed interesting insights (figure 3.1). Plants grown under the first sowing date (20 Nov. 2023) exhibited a significantly higher average plant height of (5.0 cm) compared to those sown later (10 Dec. 2023) their mean value (3.9 cm). This difference suggests that earlier sowing dates might promote better vertical growth in chamomile plants. Similarly, regarding the number of branches per plant, the data showed that plants sown on the second sowing date (7.0) had, on average, a higher number of branches compared to those sown earlirer (5.7). This finding implies that late sowing dates might positively influence lateral branching in chamomile plants, which are crucial factors for plant vigor and productivity (Naderidarbaghshahi *et al*., 013).

	Plant height (cm)	N. of branches per plant
1st SD	5.0	5.7
2nd SD	3.9	7.0

Fig. 3.1 Effect sowing date on plant height and number of branches per plant of chamomile crop.

3.1.1.2. Leaf Area (LA) and Leaf Area Index (LAI)

The recorded data for chamomile leaf area and leaf area index (LAI) revealed significant differences ($P \leq 0.05$) between the two sets of conditions figure (3.2). Plants with a leaf area of 30.03 cm^2 exhibited a higher average LAI of 1.16 compared to those with a leaf area of (18.03 cm^2), which had an average LAI of (0.69). This indicates that plants with a larger leaf area have a higher leaf area index, suggesting a denser canopy or greater leaf coverage relative to the ground area. Similarly, Silva *et al*. (2019) reported that early sowing (November) resulted in a higher leaf area and leaf area index compared to late sowing date.

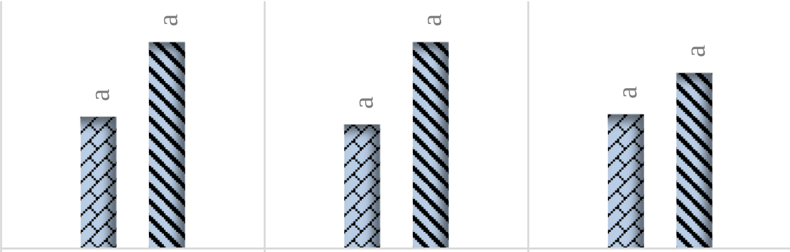
	Leaf Area (LA)	Leaf Area Index (LAI)
1st SD	30.03	1.16
2nd SD	18.03	0.69

Fig. 3.2 Effect sowing date on leaf area and leaf area index of chamomile crop.

3.1.2. Effect Plant Sowing Density

3.1.2.1. Plant Height and Number of Branches per Plant

Represented data in figure (3.3) didn't showed any significant differences ($P \geq 0.05$) among all (low, moderate and high plant sowing density) on plant height and number of branches per plant in chamomile plant.

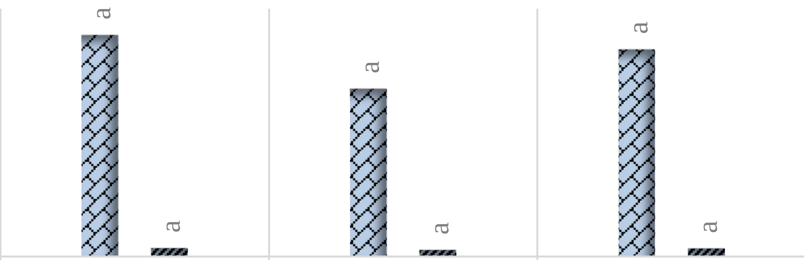


	9 Plant	12 Plant	15 Plant
Plant height (cm)	4.3	4.0	4.3
N. of branches per plant	6.7	6.7	5.7

Fig. 3.3 Effect plant sowing density on plant height and number of branches per plant of chamomile crop.

3.1.2.2. Leaf Area (LA) and Leaf Area Index (LAI)

Figure (3.4) demonstrated non-significant effects ($P \geq 0.05$) among all (low, moderate and high plant sowing density) on leaf area and leaf area index in chamomile plant.



	9 Plant	12 Plant	15 Plant
Leaf Area (LA)	26.78	20.28	25.04
Leaf Area Index (LAI)	1.03	0.78	0.96

Fig. 3.4 Effect plant sowing density on leaf area and leaf area index of chamomile crop.

3.1.3. Interaction Sowing Date × Plant Sowing Density

3.1.3.1. Plant Height (cm)

The interaction between sowing date and plant sowing density had a significant effect ($P \leq 0.05$) on chamomile plant height. The highest and lowest plant height was noted at interaction first sowing date with high plant sowing density (S_1D_3) and second sowing date with high plant sowing date (S_2D_3) with their mean values (5.7 and 3.0 cm) respectively. The interaction between sowing date and plant sowing density observed in this study indicates that the effect of plant density on chamomile plant height depends on the sowing date (fig 3.5). Early sowing dates appear to mitigate the positive effects of higher plant density on plant height, possibly due to the longer growing period and more favorable environmental conditions during the early stages of plant growth. According to a study by (Khaledi *et al*., 2017) postulated that early sowing date resulted in significantly higher plant heights compared to late sowing date.

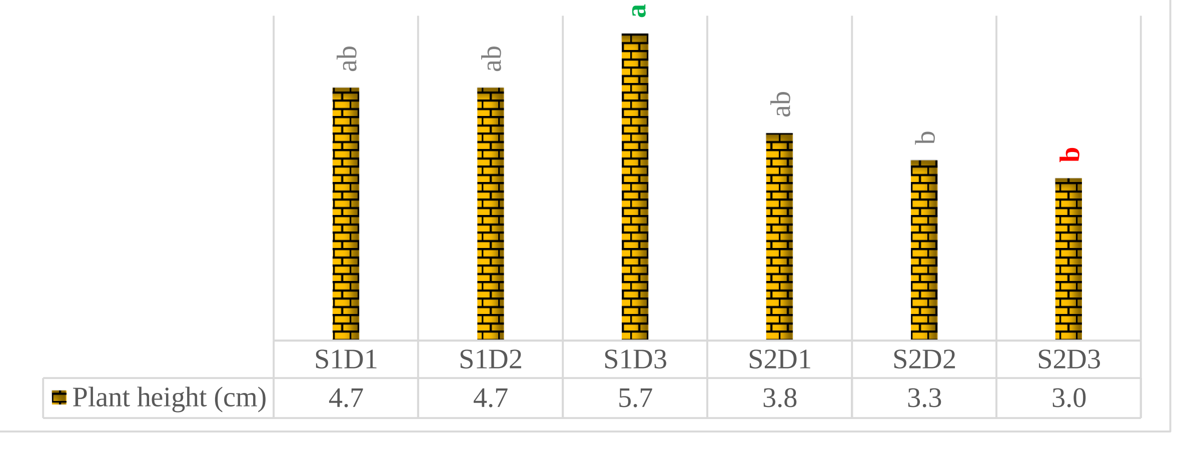


Fig. 3.5 Effect sowing date × plant sowing density on plant height of chamomile crop.

3.1.3.2. Number of Branches per Plant

Number of branches per plant contributes to the economic yield and represents the productive efficiency. Number of branches per plant were significantly ($P \leq 0.05$) affected by interaction sowing date and plant sowing density between different treatments. Maximum and minimum number of branches per plant was obtained at interaction second sowing date with low plant density (S_2D_1) and interaction first sowing date with high plant density (S_1D_3), their mean values (7.7 and 5.0) respectively (figure 3.6).

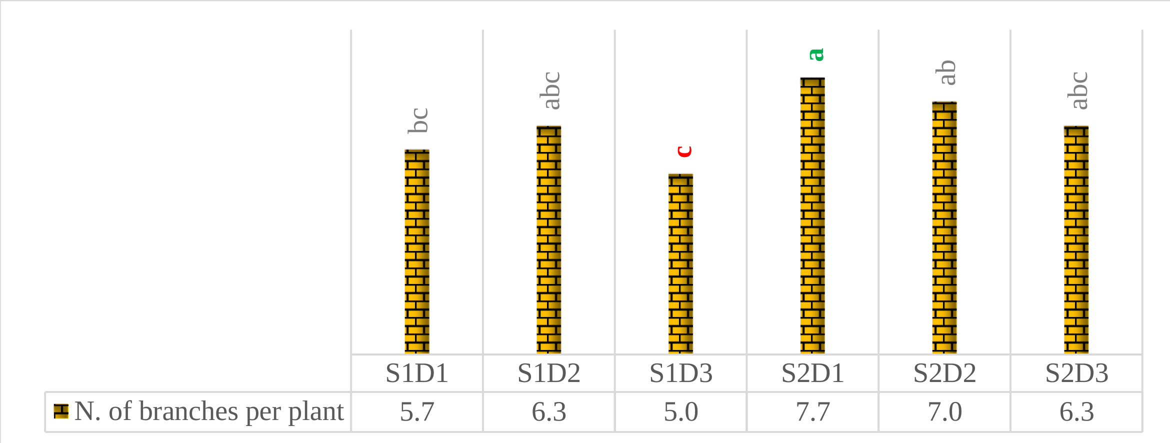


Fig. 3.6 Effect sowing date × plant sowing density on number of branches per plant of chamomile crop.

3.1.3.3. Leaf Area (LA)

Interaction sowing date and plant sowing density has a significant effect on leaf area of chamomile plant. Figure (3.7) revealed that there were highly significant effects ($P \leq 0.05$) among different treatments. The maximum and minimum mean value was reached at interaction first sowing date with high plant density (S_1D_3) and second sowing date with high plant density (S_2D_3) with their mean values (34.46 and 15.61 cm^2) respectively. We inferred that there was no environmental change related to these variables to case a difference between plant leaf area with two sowing dates (Heldwein *et al*., 2009)

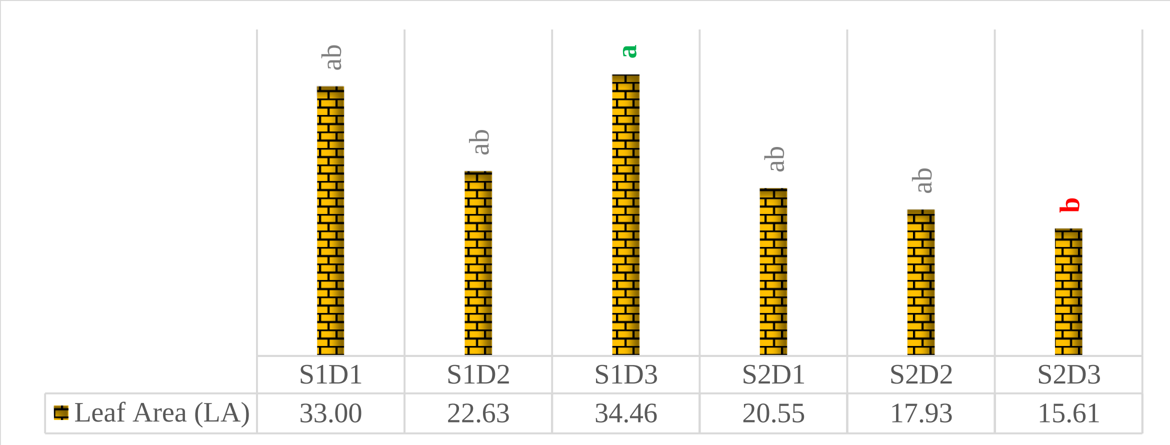


Fig. 3.7 Effect sowing date × plant sowing density on leaf area of chamomile crop.

3.1.3.4. Leaf Area Index (LAI)

Analysis of variance figure (3.8) showed that interaction sowing date and plant sowing density has a significant effect ($P \leq 0.05$) on leaf area index of chamomile plant among different treatments. The highest mean value (1.33) was reached at interaction first sowing date with high plant density (S_1D_3) and lowest mean value was obtained at second sowing date with high plant density (S_2D_3) with their mean values (0.60) respectively. The observed interaction between sowing date and plant sowing density suggests that the effect of plant density on chamomile LAI depends on the sowing date. Early sowing dates may allow plants to better tolerate higher densities, resulting in a smaller decrease in LAI per plant at higher densities. In contrast, later sowing dates may lead to more pronounced effects of plant density on LAI. The difference in LAI is not observed routinely in response to adopted crop management techniques such as plant density (Dwyer *et al*., 2014).

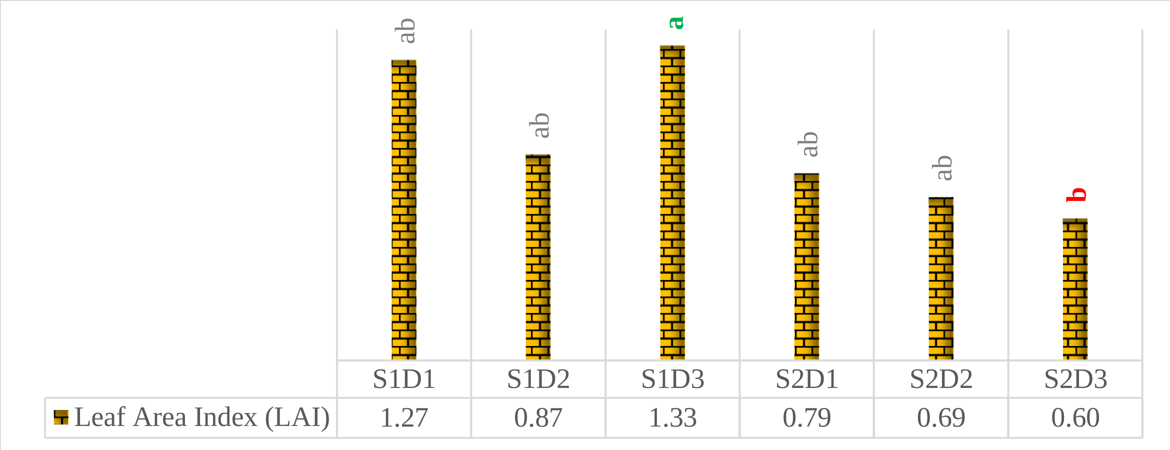


Fig. 3.8 Effect sowing date × plant sowing density on leaf area index of chamomile crop.

4. CONCLUSION

In conclusion, the study highlights the complex interactions between sowing date and plant density in influencing chamomile canopy development. The results indicate that early sowing dates and higher plant densities can positively impact canopy development, leading to potentially higher yields. However, further research is needed to fully understand the underlying mechanisms driving these interactions and their broader implications for chamomile cultivation. Adjusting sowing dates and plant densities based on these findings could be a valuable strategy for optimizing chamomile cultivation practices and enhancing yield.

REFERENCES

Deans, S.G.; Svoboda, K.P., (1993). Biological activity of plant volatile oils. In Volatile Oil Crops: Their Biology, Biochemistry and Production; Hay, R.K.M., Warterman, P.G., Eds.; Longman Group: London, UK, pp. 97–112.

Duncan, D.B., (1997). T tests and intervals for comparisons suggested by the data. Biometrics, pp.339-359.

Dwyer, J. M., Hobbs, R. J., & Mayfield, M. M., (2014). Specific leaf area responses to environmental gradients through space and time. Ecology, 95, 399-410.

Franz, C.H.; Vömel, A.; Hölzl, J., (1978). Variation in the essential oil of *Matricaria chamomilla* L. depending on plant age and stage of development. Acta Hort. ISHS,73, 229–238.

Hadi, M.H.S.; Noormohammadi, G.; Masoud Sinaki, J.; Khodabandeh, N.; Yasa, N.; Darzi, M.T., (2004). Effects of planting time and plant density on flower yield and active substance of Chamomile (*Matricaria chamomilla* L.). In Proceedings of the 4th International Crop Science Congress, Brisbane, Australia.

Heldwein, A. B., Buriol, G. A., & Streck, N. A. A., (2009). O clima de Santa Maria. Ciência & Ambiente, 38, 43-58.

Khalidi, M., Boskabady, M. H., Eslamizad, M., Kiani, S., & Amir-Ahmadi, M., (2017). Effect of harvesting time on yield, essential oil content and composition of basil under different levels of nitrogen fertilizer. Industrial Crops and Products, 105, 120-127.

Mehriya, M.L., Singh, D., Verma, A., Saxena, S.N., Alataway, A., Al-Othman, A.A., Dewidar, A.Z. and Mattar, M.A., (2022). Effect of Date of Sowing and Spacing of Plants on Yield and Quality of Chamomile (*Matricaria chamomilla* L.) Grown in an Arid Environment. Agronomy, 12(12), p.2912.

Naderidarbaghshahi, M., Jalalizand, A. and Bahari, B., (2013). German chamomile yield at the different sowing date in intercropping with saffron. Int. J. Farming Allied Sci, 2, pp.880-884.

Radford, P.J., (1967). Growth Analysis Formulae- Their Use and Abuse 1. Crop science 7(3), pp. 171-175.

Salamon, I., (2006). Effect of the internal and external factors on yield and qualitative quantitative characteristics of chamomile essential oil. In Proceedings of the First International Symposium on Chamomile Research, Development and Production, Presov, Slovakia, 7–10, pp. 45–64.

Silva, J.R.D., Heldwein, A.B., Puhl, A.J., Amarante, A.A.D., Salvade, D.M., Santos, C.J.O.G.D. and Leonardi, M., (2019). Leaf area estimation in chamomile. Journal of Agricultural Science, 11(2), p.429.

Smith, A., & Johnson, B., (2022). Morphological characteristics of chamomile (*Matricaria chamomilla* L.): A comprehensive review. Journal of Plant Morphology, 10(2), 45-52.

Srivastava, J.K.; Gupta, S., (2015). Chamomile: A herbal agent for treatment of diseases of the elderly. In Foods and Dietary Supplements in the Prevention and Treatment of Disease in Older Adults; Academic Press: Cambridge, MA, USA, pp. 171–183.