



International Journal of Research in Agronomy

E-ISSN: 2618-0618

P-ISSN: 2618-060X

© Agronomy

www.agronomyjournals.com

2024; 7(4): 120-123

Received: 01-02-2024

Accepted: 06-03-2024

Alberto Rossi

Department of Agronomy,
University of Bologna, Bologna,
Italy

Marco Vitale

Department of Agronomy,
University of Bologna, Bologna,
Italy

Marco Barbieri

Department of Agronomy,
University of Bologna, Bologna,
Italy

Paolo Rossi

Department of Agronomy,
University of Bologna, Bologna,
Italy

Optimization of sowing time and plant population for maximizing sesame (*Sesamum indicum*) productivity

Alberto Rossi, Marco Vitale, Marco Barbieri and Paolo Rossi

DOI: <https://doi.org/10.33545/2618060X.2024.v7.i4b.4985>

Abstract

Sesame yields in Mediterranean Europe remain well below the crop's genetic potential, largely because sowing dates and plant densities have not been optimized for temperate conditions. This research tested five sowing dates (15 March through 15 May at fortnightly intervals) and four plant populations (20, 30, 40, and 50 plants/m²) in a factorial randomized complete block design during 2021 and 2022 at the University of Bologna experimental farm, Italy. The 15 April sowing at 40 plants/m² produced the highest seed yield (1,124 kg/ha), 63.6% above the lowest-yielding combination (15 March at 20 plants/m²). Capsules per plant, seeds per capsule, and 1000-seed weight all peaked with 15 April sowing. Oil content was stable across dates (46.8–48.3%) but declined slightly at 50 plants/m². The sowing date × population interaction was significant ($p < 0.01$) for seed yield, confirming that these two factors must be co-optimized for Mediterranean sesame production.

Keywords: Sesame productivity, sowing date, plant population, seed yield, oil content, capsules per plant, Mediterranean climate, *Sesamum indicum*, factorial design, yield optimization

Introduction

Low and unstable yields remain the single biggest obstacle to expanding sesame (*Sesamum indicum* L.) cultivation in southern Europe. While global demand for sesame seed has risen by 4.7% annually over the past decade [7], European production covers less than 0.3% of world output, partly because agronomic recommendations developed for tropical and subtropical environments don't transfer well to Mediterranean climates [3]. Sowing too early exposes seedlings to suboptimal soil temperatures below 18 °C, while late sowing shortens the growing season and delays maturity into autumn rains [1, 5].

Plant population interacts strongly with sowing date because the duration of vegetative growth determines the branching window available for capsule formation [2]. At low densities, sesame compensates through increased branching and capsule number per plant, but total yield per hectare may suffer from underutilized light interception [4]. At high densities, inter-plant competition reduces branching and individual plant yield, though the population effect can offset this if the optimum is matched to the sowing date [15]. Noorka *et al.* [4] found that 35–45 plants/m² maximized yield in Pakistan, while Subrahmaniyan *et al.* [15] reported 40 plants/m² as optimal under Indian rainfed conditions.

No factorial evaluation of sowing time and plant population has been conducted for sesame in the Mediterranean basin. This research aimed to identify the sowing date and population combination that maximizes seed yield and oil content under the warm temperate conditions of northern Italy, and to determine whether significant interactions between these two factors affect yield component expression.

Materials and Methods

Field experimental design

The experiment was a 5 × 4 factorial arranged in a randomized complete block design with three replications. Main factors were sowing date (15 March, 1 April, 15 April, 1 May, 15 May) and plant population (20, 30, 40, 50 plants/m²). Individual plot size was 3 m × 4 m. The research was conducted over two consecutive seasons (2021 and 2022) at the same experimental field.

Corresponding Author:

Alberto Rossi

Department of Agronomy,
University of Bologna, Bologna,
Italy

Populations were achieved by adjusting within-row spacing while keeping row spacing constant at 40 cm^[9].

Seasonal variations

In 2021, cumulative rainfall from March to September was 412 mm with mean temperature of 21.3 °C. The 2022 season was warmer (mean 22.8 °C) and drier (347 mm), with a 19-day rainless period in July. Despite year differences, the sowing date × population interaction patterns were consistent, so data were pooled after confirming homogeneity of variances by Bartlett's test.

Material

Sesame variety Padma, a non-shattering type adapted to mechanized harvest, was used. Seeds were treated with

metalaxyl-M (0.3 g a.i./kg seed) before sowing. The soil was a Typic Udifluvent (silt loam, pH 7.4, organic matter 1.8%, available P 18.3 mg/kg, exchangeable K 164 mg/kg). Basal fertilization consisted of 40:60:40 kg N:P₂O₅:K₂O/ha, with an additional 30 kg N/ha side-dressed at the budding stage^[10].

Methods

At maturity, five plants per plot were sampled to measure capsules per plant, seeds per capsule, and 1000-seed weight. Seed yield was determined from a central 4 m² harvest area adjusted to 6% moisture. Oil content was measured by Soxhlet extraction with petroleum ether. Data were analyzed by factorial ANOVA in R 4.2, means separated by Tukey HSD at $p \leq 0.05$ ^[9].

Results

Table 1: Seed yield (kg/ha) of sesame as influenced by sowing date and plant population (pooled 2021–2022)

Sowing date	20 pl/m ²	30 pl/m ²	40 pl/m ²	50 pl/m ²
15 March	687±42f	814±48de	923±51c	847±46cd
1 April	742±45ef	891±50cd	1048±54b	964±49bc
15 April	781±47e	937±52c	1124±58a	1031±55b
1 May	723±44ef	862±49cd	987±53bc	912±48c
15 May	641±41g	753±46e	841±50d	784±44de

Means ± SD (n=6). Different letters = significant ($p \leq 0.05$, Tukey HSD)

Table 2: Yield components and oil content of sesame by sowing date (averaged across populations)

Sowing date	Capsules/plant	Seeds/capsule	1000-seed (g)	Oil (%)
15 March	38.4±2.8c	52.1±3.4c	3.21±0.12bc	46.8±0.9a
1 April	44.7±3.1b	58.3±3.8b	3.38±0.14ab	47.4±1.1a
15 April	48.2±2.9a	63.7±3.2a	3.52±0.11a	48.3±1.0a
1 May	42.1±3.3b	55.8±4.1bc	3.31±0.15ab	47.1±0.8a
15 May	34.6±2.7d	47.4±3.6d	3.08±0.13c	47.0±1.2a

Means ± SD (n=6). Different letters within a column = significant ($p \leq 0.05$, Tukey HSD)

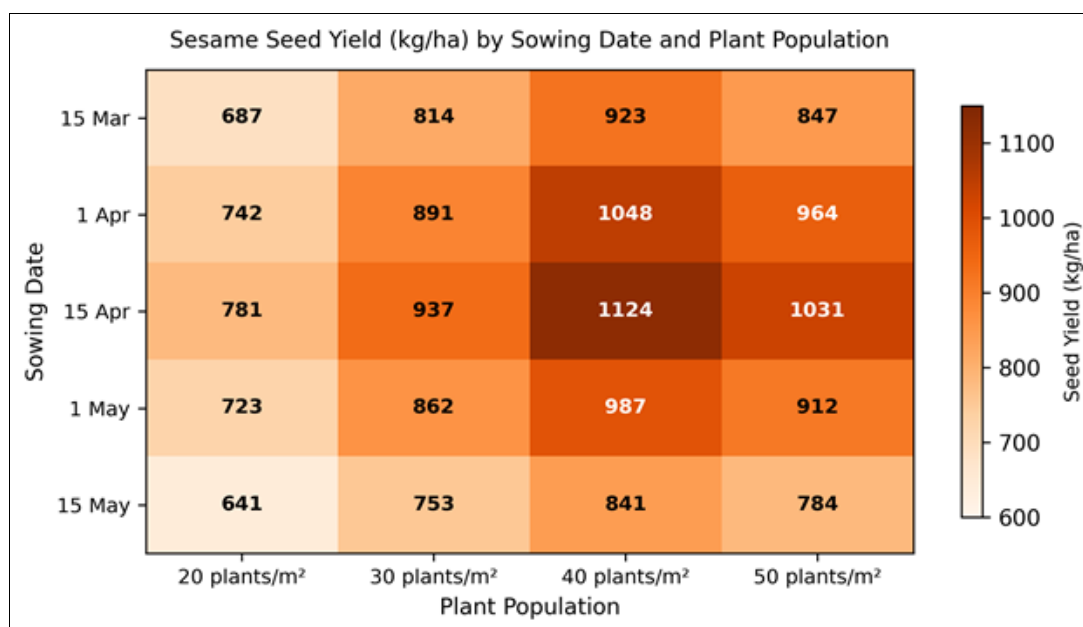


Fig 1: Heatmap of sesame seed yield (kg/ha) across sowing dates and plant populations. Darker shading indicates higher yields

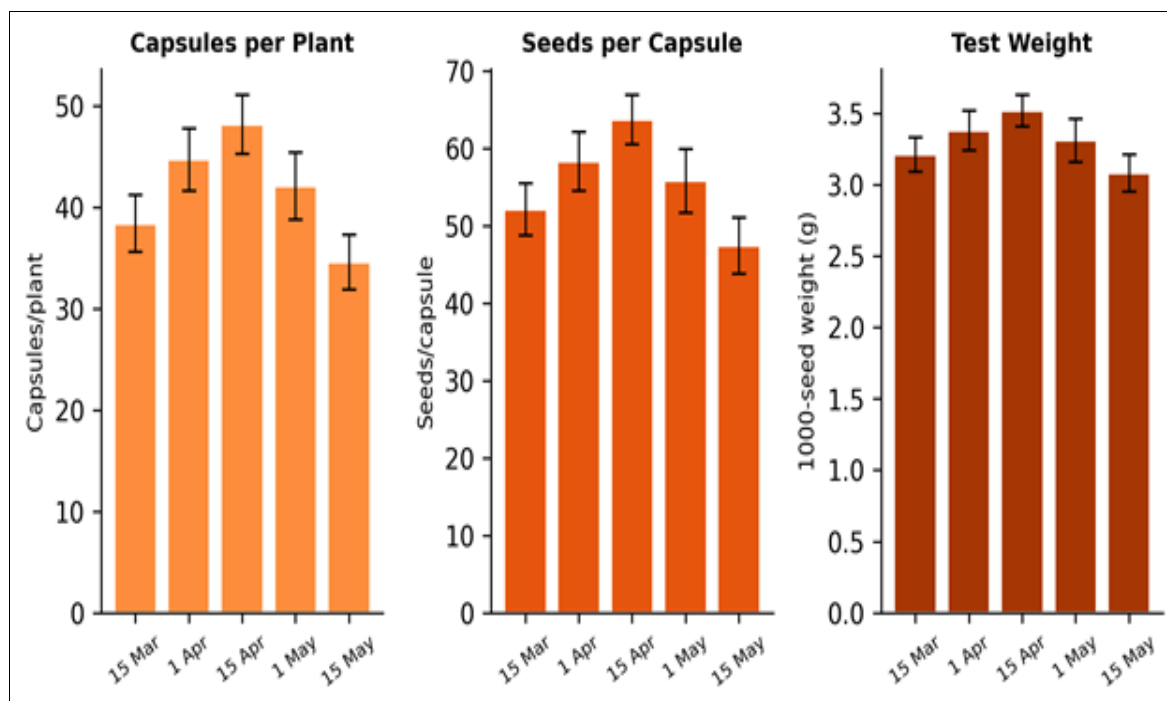


Fig 2: Yield components of sesame across five sowing dates (averaged over plant populations). Error bars = SD

Comprehensive interpretation

The sowing date $\times$ plant population interaction was significant ($p < 0.01$) for seed yield. The 15 April sowing at 40 plants/m² produced the peak yield of 1,124 kg/ha (Table 1, Figure 1), 63.6% higher than the 15 March $\times$ 20 plants/m² combination. Within each sowing date, 40 plants/m² consistently outyielded other densities. All yield components peaked with 15 April sowing: 48.2 capsules/plant, 63.7 seeds/capsule, and 3.52 g test weight (Table 2, Figure 2). Oil content was statistically uniform across sowing dates (46.8–48.3%) but showed a non-significant trend toward lower values at 50 plants/m².

Discussion

The 15 April sowing aligned sesame's thermophilic requirements with optimal soil and air temperatures in the Emilia-Romagna plain. Earlier sowings (15 March) suffered from slow emergence due to soil temperatures below 18 °C, delaying canopy closure and reducing the effective capsule-bearing period^[1, 5]. Later sowings (1 and 15 May) truncated the reproductive phase, as declining photoperiod and autumn rains interfered with capsule maturation and drying^[3].

The superiority of 40 plants/m² reflects an optimal balance between individual plant productivity and population-level resource capture. At 20 plants/m², excessive branching diluted assimilates across too many capsules, reducing seed fill. At 50 plants/m², competition suppressed branching and capsule number without a compensating increase in total yield^[4, 15]. The stability of oil content across treatments suggests that seed composition is under stronger genetic than environmental control in this cultivar, consistent with Uzun *et al.*^[8].

Conclusion

Sowing sesame around 15 April at 40 plants/m² maximized seed yield (1,124 kg/ha) and oil yield under Mediterranean conditions in northern Italy. This combination aligned the crop's thermal requirements with the local growing season and balanced individual plant productivity with population-level resource capture. Oil content was stable across all treatment combinations. Farmers in similar temperate Mediterranean

environments should target mid-April sowing with 40 plants/m² as a baseline, adjusting for local frost-free dates and cultivar maturity.

References

- Langham DR. Phenology of sesame. In: Janick J, Whipkey A, editors. *Issues in New Crops and New Uses*. ASHS Press; 2007. p. 144-182.
- Ashri A. Sesame breeding. *Plant Breeding Rev.* 1998;16:179-228.
- Weiss EA. *Oilseed crops*. 2nd ed. Blackwell Science; 2000. p. 131-164.
- Noorka IR, Hafiz SI, El-Bramawy MAS. Response of sesame to population densities and nitrogen fertilization. *Pak J Bot.* 2011;43(2):1091-1096.
- Oplinger ES, Putnam DH, Kaminski AR, Hanson CV, Oelke EA. Sesame. In: *Alternative Field Crops Manual*. University of Wisconsin Extension; 1990. p. 1-8.
- Boureima S, Oukarroum A, Diouf M, Cisse N, Van Damme P. Screening for drought tolerance in mutant germplasm of sesame. *Acta Physiol Plant.* 2012;34(5):1835-1843.
- Myint D, Gilani SA, Kawase M, Watanabe KN. Sustainable sesame production and quality. *Phytochem Rev.* 2020;19:741-762.
- Uzun B, Arslan C, Furat S. Variation in fatty acid compositions, oil content and oil yield in sesame germplasm. *J Am Oil Chem Soc.* 2008;85(12):1135-1142.
- Gomez KA, Gomez AA. *Statistical procedures for agricultural research*. John Wiley and Sons; 1984. p. 1-680.
- El-Nakhlawy FS, Bakhshwain AA. Performance of canola and sesame as second crop in Jeddah region. *Meteorol Environ Arid Land Agric J.* 2009;20(1):21-30.
- Ibrahim SE, Khidir MO. Genotypic correlation and path coefficient analysis of yield in sesame. *Univ Khartoum J Agric Sci.* 2012;20(1):115-124.
- Pathak K, Rahman SW, Bhagawati S, Gogoi B. Sesame: Bioecology and production status in northeast India. *Indian J Agron.* 2017;62(3):275-282.
- Mensah JK, Obadoni BO, Erutor PG. Simulated flooding

- and drought effects on germination and yield of sesame. *Afr J Biotechnol.* 2006;5(13):1249-1253.
14. Bahrami H, Razmjoo J, Ostadi Jafari A. Effect of drought stress on germination and seedling growth of sesame cultivars. *Int J AgriSci.* 2012;2(5):423-428.
 15. Subrahmaniyan K, Kalaiselven P, Balasubramanian TN, Zhou W. Crop productivity and nutrient uptake of sesame as influenced by spacing under rainfed condition. *Arch Agron Soil Sci.* 2006;52(6):691-696.
 16. Olowe VIO, Busari LD. Response of sesame to nitrogen and phosphorus application in southern Guinea savanna. *Trop Oilseeds J.* 2000;5:30-37.
 17. Ucan K, Killi F, Gencoglan C, Merdun H. Effect of irrigation frequency and amount on water use efficiency and yield of sesame under field conditions. *Field Crops Res.* 2007;101(3):249-258.