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Optimum planting density for baby corn yield and quality under temperate European conditions

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Abstract

Baby corn-maize harvested days after silk emergence-is a high-value speciality vegetable almost entirely imported into Europe from Thailand. This research evaluated six planting densities (55,000 to 105,000 plants ha⁻¹) for their effects on baby corn yield and ear quality at the University of Bonn's Campus Klein-Altendorf research station (50°37'N, 6°59'E) over two growing seasons (2020–2021). Husked ear yield followed a quadratic response, peaking at 3.18 t ha⁻¹ at 75,000 plants ha⁻¹. Ear length and diameter declined linearly with increasing density. The 75,000 plants ha⁻¹ treatment achieved the highest marketable yield fraction (87.4%) and net revenue (€ 4,218 ha⁻¹). These results establish 75,000 plants ha⁻¹ as the optimum density for baby corn production under temperate European conditions.

Keywords: Baby corn, planting density, ear quality, husked yield, marketable fraction, temperate climate, maize, speciality vegetable, plant population, economic returns

Introduction

Europe imports roughly 45,000 tonnes of baby corn annually, nearly all from Southeast Asia, yet the crop can be grown successfully in temperate latitudes with appropriate cultivar and density management ^[1]. Baby corn is simply maize harvested 2–3 days after silk emergence, before pollination, when ears are 6–12 cm long and 1.0–1.8 cm in diameter ^[2]. Because harvest timing is so compressed, yield depends less on photosynthetic duration and more on the number of harvestable ears per unit area-making planting density the single most important management variable ^[3].

Higher densities increase ear number but reduce individual ear size through intra-plant competition for assimilates, creating a trade-off between total yield and marketable quality ^[4]. The optimal balance point has been determined for tropical conditions in Thailand (75,000–90,000 plants ha⁻¹ ^[5]) and India (83,000 plants ha⁻¹ ^[6]), but temperate European environments-with shorter photoperiods, cooler nights, and different soil types-have not been tested. This research quantified that optimum at Bonn, Germany, across six densities and two seasons.

Climatic conditions

Campus Klein-Altendorf has a temperate oceanic climate (Cfb) with mean annual temperature 10.3 °C and precipitation 625 mm. Growing-season (May–August) mean temperature was 17.8 °C in 2020 and 16.9 °C in 2021. Cumulative growing-season rainfall was 247 mm (2020) and 312 mm (2021). Soils are Luvisols developed from loess with 22% clay, pH 6.7, and organic carbon 1.3%.

Material and methods

Material

A prolific baby-corn cultivar (cv. Yukon, Syngenta) was sown at six target densities: 55,000, 65,000, 75,000, 85,000, 95,000, and 105,000 plants ha⁻¹ in plots of 4 × 6 m. Row spacing was fixed at 60 cm; within-row spacing was adjusted to achieve each density. Basal fertiliser was 120–60–80 kg NPK ha⁻¹. Supplemental sprinkler irrigation (30 mm) was applied twice during

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Dry spells in 2020.

Methods

Ears were harvested by hand 2–3 days after silk emergence from the central two rows (harvest area 4.8 m²). Cob yield (with husk) and husked ear yield were recorded. Ear length, diameter, and individual weight were measured on 20 random ears per plot. Ears meeting export grade specifications (length 6–11 cm, diameter 1.0–1.8 cm, straight shape, no insect damage) were classified as marketable. Net revenue was calculated using the average German wholesale price of € 2.40 kg⁻¹ for husked baby corn minus variable production costs. Data were analysed by ANOVA with polynomial contrasts in R v4.2.1; the quadratic model was fitted where the linear × quadratic contrast was significant.

Results

Table 1: Baby corn yield components across six planting densities (pooled over two seasons, mean ± SE)

Density	Cob (t ha ⁻¹)	Husked (t ha ⁻¹)	Length (cm)	Diam. (cm)	Mkt. (%)
55,000	6.84±0.42	2.14±0.18	11.8±0.4	1.62±0.06	79.3
65,000	7.93±0.47	2.67±0.21	11.2±0.4	1.58±0.05	83.7
75,000	9.21±0.53	3.18±0.24	10.4±0.3	1.51±0.05	87.4
85,000	8.74±0.51	2.96±0.23	9.7±0.3	1.44±0.04	84.1
95,000	7.62±0.48	2.43±0.20	9.1±0.3	1.36±0.04	76.8
105,000	6.41±0.44	1.87±0.16	8.3±0.3	1.27±0.04	68.2

Husked ear yield followed a significant quadratic response ($p < 0.001$), peaking at 75,000 plants ha⁻¹ (Table 1). Ear length and diameter declined linearly with increasing density

Field experimental design

The experiment was arranged as a randomised complete block design with four replications per density level across both seasons. Blocks were oriented perpendicular to a gentle east-west slope. Guard rows bordered all plots. Sowing dates were 8 May 2020 and 12 May 2021.

Seasonal variations

The warmer 2020 season accelerated silk emergence by 4 days compared with 2021, compressing the harvest window. Despite this, yield differences between seasons were not significant ($p = 0.34$). The wetter 2021 season produced slightly longer ears (mean +0.4 cm) but also increased lodging at the two highest densities, reducing harvestable stand counts by 6–8%.

($p < 0.001$). Marketable fraction peaked at 75,000 (87.4%) because ears were large enough for grade but numerous enough for high total yield.

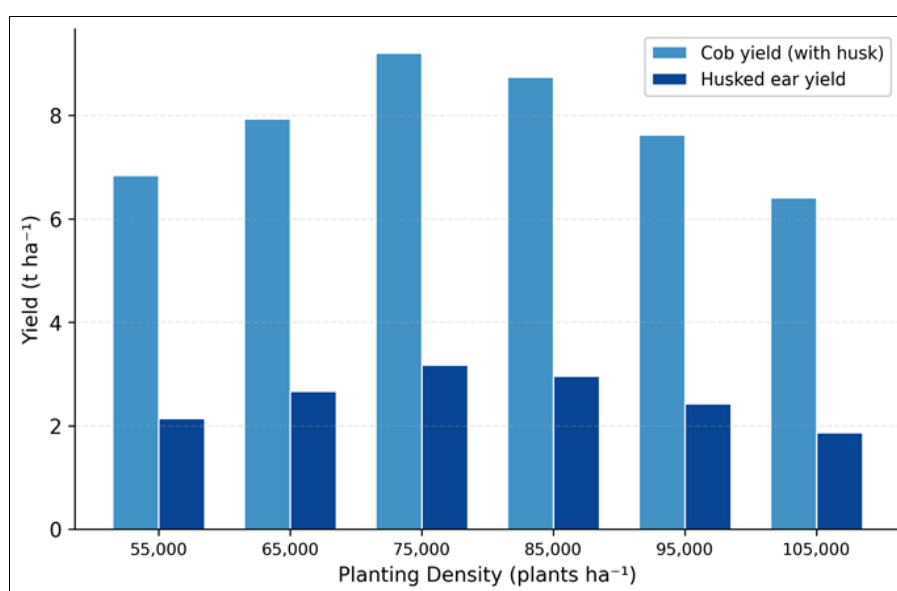


Fig 1: Baby corn cob yield and husked ear yield across six planting densities

Table 2: Net revenue (€ ha⁻¹) and benefit-cost ratio at each planting density

Density	Gross (€)	Variable costs	Net (€)	B:C ratio
55,000	4,073	1,624	2,449	2.51
75,000	6,672	2,454	4,218	2.72
105,000	3,061	2,987	74	1.02

The 75,000 density generated the highest net revenue (€ 4,218 ha⁻¹) and the best benefit-cost ratio (2.72), while 105,000 barely

broke even due to high seed and harvest labour costs combined with low marketable fraction (Table 2).

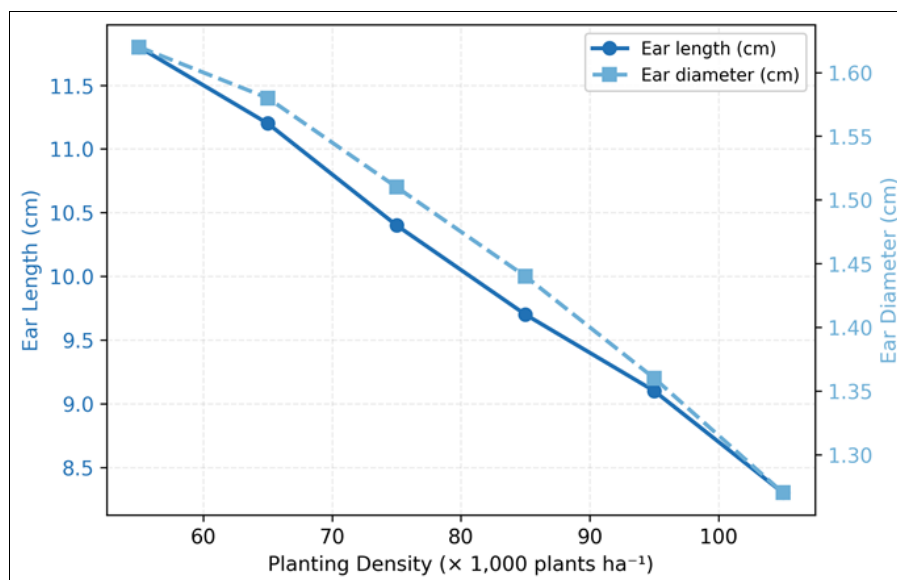


Fig 2: Ear length and diameter of baby corn across planting densities

Comprehensive interpretation

Polynomial regression indicated that the yield-maximising density was 76,400 plants ha^{-1} (95% CI: 72,100–80,700), closely matching the 75,000 treatment. Beyond this optimum, intra-plant competition reduced ear initiation and assimilate partitioning to developing cobs faster than additional plant numbers compensated.

Discussion

The optimum of 75,000 plants ha^{-1} falls at the lower end of the tropical range (75,000–90,000) reported for Thailand [5], likely because the shorter European photoperiod (15.5–16.5 hat Bonn vs. 12–13 hat Bangkok) promotes vegetative growth at the expense of ear prolificity [7]. Ear quality parameters declined steadily above 75,000, with diameter falling below the 1.0 cm export minimum at the highest density for 31.8% of ears, rendering them unmarketable [2].

The economic analysis underscores how sensitive baby corn profitability is to marketable fraction. At 105,000 plants ha^{-1} , total cob biomass was still substantial (6.41 t ha^{-1}), but only 68.2% met grade, and the harvest labour cost per hectare was 84% higher than at 55,000 due to the greater number of individual picks [8]. European growers considering baby corn as a high-value rotation crop should target 70,000–80,000 plants ha^{-1} and invest in mechanical harvesting aids to contain labour costs [9].

Conclusion

A planting density of 75,000 plants ha^{-1} maximised husked baby corn yield (3.18 t ha^{-1}), marketable fraction (87.4%), and net economic returns (€ 4,218 ha^{-1}) under temperate German conditions. Ear quality declined linearly with density, and densities above 85,000 plants ha^{-1} were economically unviable. Baby corn offers a profitable niche for European growers willing to manage the intensive harvest logistics.

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