Planting date and spacing optimization for *Kaempferia galanga* L.

Abstract

Kaempferia galanga L., a rhizomatous plant species, is highly valued for its medicinal and culinary properties. This study investigated the impact of planting date and spacing on the growth and yield of *K. galanga*. The experiment was conducted over three consecutive years, with three planting dates (April 15, April 30, and May 15) and four spacing treatments (20 cm x 20 cm, 30 cm x 30 cm, 40 cm x 40 cm, and 50 cm x 50 cm). The results showed that planting date and spacing significantly affected canopy diameter, yield per plant, rhizome yield per hectare, and oil yield per hectare. The optimal planting window for maximizing yield and oil production was April 15-30, with a spacing of 20 cm x 20 cm. Wider spacing resulted in higher yield per plant, while closer spacing led to higher rhizome yields per hectare.

التعليق **[M1]:** Abstract should begin with a sentence regarding the importance and necessity of the research.

Keywords

Kaempferia galanga L., Planting date, Spacing, Rhizome yield, Agronomic optimization

Introduction

Kaempferia galanga L., commonly known as Kencur, Sand Ginger, or lesser Galangal, is a plant species belonging to the Zingiberaceae family. Native to tropical Asia, particularly in India, Southeast Asia, and southern China, this herb has been used for centuries in traditional medicine, cooking, and rituals. The plant grows up to 30 cm tall, with narrow, lance-shaped leaves and small, white or yellowish flowers. The rhizome is the most valuable part, with a pungent, aromatic flavor and a sweet, slightly bitter taste. *K. galanga* prefers well-drained soil and partial shade, making it a popular crop in tropical regions.

التعليق **[M2]:** Source

In traditional medicine, the rhizome is used to treat various ailments, such as digestive issues, fever, and respiratory problems. The plant is also used as a spice and flavoring agent in traditional dishes like curries and soups. Additionally, *K. galanga* is used in traditional ceremonies and rituals for its perceived spiritual and medicinal properties. Recent studies have validated the traditional uses of *K. galanga*, revealing its potential pharmacological properties, including anti-inflammatory, antioxidant, and antimicrobial activities (Munda, *et al.*, 2018). The plant's essential oils and bioactive compounds have also been explored for potential applications in medicine and industry.

The demand for *K. galanga* rhizomes is increasing due to their medicinal properties, making it essential to standardize agronomic practices that ensure higher yield and quality. Planting date and spacing are critical factors that affect crops' growth, yield and quality (Abbas *et al*., 2019). The optimal planting date and spacing can vary depending on the crop species, climate, and soil conditions. This study aimed to standardize the planting dates and spacing for *Kaempferia galanga* L. to achieve higher rhizome yields.

Materials and Methods

The experiment was conducted at the All India Coordinated Research Project on Medicinal, Aromatic plants, and Betel vine (AICRP on MAP&B), Thrissur, Kerala, India, over three consecutive years (2021, 2022, and 2023). The experimental site is located in a humid tropical climate region, with geographical coordinates of 13° 32'N latitude and 76° 26'E longitude and an elevation of about 40 meters above Mean Sea Level (MSL).

The soil at the experimental site is a lateritic sandy loam of the Oxisol group, comprising 46.8% sand, 21.6% silt, and 31.3% clay. The soil has a moderate organic carbon content of 0.49% and available nutrients, including 250.21 kg/ha nitrogen, 30.96 kg/ha phosphorus, and 240.50 kg/ha potassium. The soil pH is slightly acidic, measuring 5.3.

The experiment was laid out in a split-plot design, with three planting dates (April 15, April 30, and May 15) as the main plot and four spacing treatments (20 cm x 20 cm, 30 cm x 30 cm, 40 cm x 40 cm, and 50 cm x 50 cm) as the subplot. Each plot measured 3 meters x 3 meters. The rhizomes were harvested after 9 months of planting, and data were recorded on canopy diameter, yield per plant, rhizome yield per hectare, and oil yield per hectare.

The data were statistically analyzed using the KAU GRAPES online software, as described by Gopinath *et al*. (2020).

Results And Discussion

Direct effect of planting time and spacing

The canopy diameter of the plants was significantly influenced by the spacing treatment but not by planting dates. The widest spacing of 50 cm x 50 cm resulted in the highest canopy diameter (48.44 cm), followed by the spacing of 40 cm x 40 cm (47.78 cm). In contrast, the closest spacing of 20 cm x 20 cm resulted in the lowest canopy diameter (41.33 cm).

Similarly, the yield per plant was affected by planting date and spacing. The April 30 planting date resulted in the highest yield per plant of 71.92 g, which was on par with the April 15 planting (70.33 g). The widest spacing (50 cm x 50 cm) resulted in the highest yield per plant (84.44 g), followed by 40 cm x 40 cm (75.67 cm). The lowest per-plant yield was obtained in the closest spacing of 20 cm x 20 cm (43.89 cm).

The variations in yield due to planting dates can be attributed to the prevailing weather parameters during the plant growth period. Research has shown that optimal weather conditions, such as temperature and rainfall, during the growing season can significantly impact plant growth and development (Tripura and Hegde, 2021). The variation in rhizome yield per plant can be attributed to the differences in planting dates and spacings. Wider spacing provided more plant growth space, resulting in higher rhizome yields. In contrast, narrower spacing resulted in competition among plants for resources, leading to lower rhizome yields.

The narrower spacing of 20 x 20 cm resulted in a higher plant population and rhizome yields per hectare (13289 kg/ha). In contrast, the wider spacing of 50 x 50 cm resulted in a lower plant population, leading to lower rhizome yields per hectare (3555 kg/ha). Appropriate plant density is an important crop management practice that can optimize canopy light distribution and increase canopy photosynthetic capacity (Yao *et al*., 2016). Several studies have emphasized the significance of optimal plant density in achieving maximum yield potential in various crops (Meng *et al*., 2022; Jia *et al*., 2023; Osunleti *et al*., 2023).

The oil yield per hectare was also affected by planting date and spacing. The April 15 planting date resulted in the highest oil yield per hectare (82.62 kg/ha), indicating that this date allowed for optimal growth and development of the plants. Similarly, the closest spacing (20 cm x 20 cm) resulted in the highest oil yield per hectare.

Interaction effect of planting dates and spacing

The interaction between planting dates and spacing significantly impacted rhizome yield per plant, per hectare, and oil yield (Table 2.). The highest rhizome yield per plant (88.33 g/plant) was achieved by planting on April 30 with a spacing of 50 x 50 cm, closely followed by planting on April 15 with the same spacing (85.67 g/plant). In contrast, lower per-plant yields were observed with May planting and closer spacing of 20 cm x 20 cm.

Conversely, the per hectare rhizome yield exhibited a different trend, with higher yields obtained from closer spacing (20 cm x 20 cm) combined with April planting (April 15 or 30). A similar trend was observed for oil yield per hectare, highlighting the complex interactions between planting dates, spacing, and yield parameters.

Conclusion

This study conclusively shows that planting date and spacing significantly impact the growth and yield of *K. galanga*. The optimal planting window for maximum yield and oil production is April 15-30, with a spacing of 20 cm x 20 cm. These findings have significant implications for *K. galanga* cultivation and production, informing evidence-based agronomic practices to boost productivity and sustainability.

References

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Table 1. The effect of planting dates and spacing on crop diameter (cm), yield per plant (g), yield (kg/ha) and oil yield (kg/ha) of *Kaempferia galanga* L. (Pooled mean of three years)

Treatments	Canopy diameter (cm)	Rhizome yield/plant (g)	Rhizome yield (kg/ha)	Oil yield (kg/ha) Fresh weight basis
Main plot (Date of planting)				
April 15	45.08	70.33	8262	82.62
April 30	47.17	71.92	7889	78.89
May 15	44.75	64.42	7117	717.0
CD(0.05)	NS	2.67	375	5.01
Subplot (Spacing)				
20 cm x 20 cm	41.33	43.89	13289	13.28
30 cm x 30 cm	45.11	71.56	8829	88.29
40 cm x 40 cm	47.78	75.67	5220	52.20
50 cm x 50 cm	48.44	84.44	3555	35.55

CD (0.05)	1.79	5.13	1122	1122
CV(%)	9.99	7.51	11.45	10.11

Table 2. Interaction effect of treatments on per plant and per hectare rhizome yield and oil yield of *Kaempferia galanga* L. (Pooled mean of three years)

Treatment combination	Rhizome yield/plant (g)	Rhizome yield (kg/ha)	Oil yield (kg/ha)
15th April 20 x 20 cm	45.00	9000	89.10
15th April 30 x 30 cm	73.00	6489	64.24
15th April 40 x 40 cm	77.67	3883	38.45
15th April 50 x 50 cm	85.67	2741	27.14
30th April 20 x 20 cm	46.67	9333	92.40
30th April 30 x 30 cm	74.33	6607	65.41
30th April 40 x 40 cm	78.33	3917	38.78
30th April 50 x 50 cm	88.33	2827	27.98
15th May 20 x 20 cm	40.00	8000	79.20
15th May 30 x 30 cm	67.33	5985	59.25
15th May 40 x 40 cm	71.00	3550	35.15
15th May 50 x 50 cm	79.33	2539	25.13
CD (0.05)	8.89	728.68	7.21
CV (%)	8.84	9.82	7.72