EFFECT OF SOWING DATE AND PLANT SPACING ON VEGETATIVE GROWTH AND SEED YIELD OF FISH BEAN (*TEPHROSIA VOGELII* HOOK. F.) IN THE HUMID RAINFOREST ZONE OF NIGERIA.

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Abstract
A field experiment was conducted in 2019 at Akpabuyo Local Government Area of Cross River State, Nigeria, to evaluate the effects of sowing date and plant spacing on vegetative growth and seed yield of fish bean (Tephrosia vogelii Hook. f.). The experiment was laid out in a 3 × 3 factorial arrangement using a Randomized Complete Block Design (RCBD) with three replications. Treatments consisted of three sowing dates (April, May, and June) and three plant spacings (40 × 40 cm, 60 × 60 cm, and 80 × 80 cm). Data were collected on plant height, number of leaves, number of branches, biomass, days to 50% flowering, and seed yield. Results showed that sowing in April significantly ($p \leq 0.05$) enhanced all vegetative growth parameters and seed yield compared with May and June sowings. Wider spacing of 80 × 80 cm produced significantly higher biomass and seed yield than narrower spacings. The interaction of April sowing and 80 × 80 cm spacing produced the highest seed yield. The study demonstrates that fish bean can be successfully cultivated in the humid rainforest zone of southern Nigeria, with optimum seed yield achieved when planting is done in April at 80 × 80 cm spacing.
Keywords: *Tephrosia vogelii, fish bean, sowing date, plant spacing, seed yield, rainforest.*

Introduction

The increasing demand for environmentally safe pest control and sustainable soil fertility management has renewed interest in the use of pesticidal and soil-improving plants as alternatives to synthetic agro-chemicals. Among these plants, *Tephrosia vogelii* Hook. f., commonly known as fish bean, has received considerable attention due to its pesticidal, medicinal, and soil-improving properties (Asawalam et al., 2008; Alao et al., 2013).

Extracts of *T. vogelii* have been reported to be effective in the control of insect pests of cowpea, roselle, and watermelon (Alao et al., 2013). In addition to its pesticidal properties, the plant improves soil fertility through biological nitrogen fixation and organic matter contributions when used as a green manure and fallow crop (Jama et al., 2000).

Despite these advantages, there is limited agronomic information on the optimal production practices for *T. vogelii*, particularly with regard to sowing dates and plant spacing under the humid rainforest conditions of southern Nigeria. Sowing date influences crop performance by determining the prevailing temperature, rainfall, and solar radiation during vegetative and reproductive stages, while spacing determines the level of inter-plant competition for growth resources.

This study was therefore conducted to determine the effects of sowing date and plant spacing on vegetative growth and seed yield of fish bean in Akpabuyo, Cross River State, Nigeria.

Materials and Methods

Study Area

The experiment was conducted under rain-fed conditions in 2019 at Akpabuyo Local Government Area of Cross River State, Nigeria (8°27'E, 4°28'N). The area lies within the humid tropical rainforest zone and is characterized by a bimodal rainfall pattern with annual rainfall ranging from 2,500 to 3,000 mm. Mean annual temperature ranges between 23 and 35°C, while relative humidity averages about 87% (NIMET, 2020). The soil of the experimental site is sandy loam in texture, strongly acidic, moderate in organic matter, and low in total nitrogen and available phosphorus.

Experimental Design and Treatments

The experiment was a 3 × 3 factorial laid out in a Randomized Complete Block Design (RCBD) with three replications. The factors were:
Sowing date: 16th of April, 16th of May, and 16th of June
Plant spacing: 40 × 40 cm, 60 × 60 cm, and 80 × 80 cm
This resulted in nine treatment combinations. Each block contained all nine treatment plots. The total field size was 40.6 m × 14.2 m.

Planting Material and Field Establishment

Seeds of *Tephrosia vogelii* were obtained from the Gene Bank of the International Institute of Tropical Agriculture (IITA), Ile-Ife in 2019. The land was manually cleared, stumped, and tilled to a depth of 15–20 cm using hoes and spades. Plots were then demarcated according to the experimental layout. Two seeds were sown per hole and later thinned to one plant per stand at two weeks after emergence.

Crop Management

Weeding was carried out manually at 3 and 7 weeks after planting. No fertilizer was applied in order to assess the natural growth response of the crop. The crop was grown under strictly rain-fed conditions without irrigation.

Data Collection

Data were collected at 13 weeks after planting (WAP) on the following parameters:

- Plant height (cm)
- Number of leaves per plant
- Number of branches per plant
- Total dry biomass per plant (g)
- Days to 50% flowering
- Seed yield (kg ha^{-1})

  Biomass was determined by oven-drying sampled plants at 70°C to constant weight.

Statistical Analysis

Collected data were subjected to analysis of variance (ANOVA) using GenStat (Release 10.3). Where treatment effects were significant, means were separated using Duncan's Multiple Range Test (DMRT) at 5% probability level.
Results

Effect on Plant Height

Sowing date and plant spacing significantly ($p \leq 0.05$) affected the height of fish bean plants at 13 WAP. April sowing produced significantly taller plants than May and June sowings. Plants spaced at 80 × 80 cm were significantly taller than those at narrower spacings. The tallest plants were obtained from April sowing at 80 × 80 cm spacing, while the shortest plants occurred in June sowing at 40 × 40 cm spacing.

Effect on Number of Branches

The number of branches per plant was significantly influenced by sowing date, spacing, and their interaction. April-sown plants produced significantly more branches than those planted in May and June. Wider spacing (80 × 80 cm) resulted in more branches than denser plant populations. The highest number of branches was recorded in April at 80 × 80 cm spacing.

Effect on Number of Leaves

Leaf production followed trends similar to plant height and branching. April sowing produced significantly more leaves per plant than May and June sowings. Wider spacing significantly increased leaf number. The interaction effect showed that April planting at 80 × 80 cm produced the highest number of leaves.

Effect on Biomass Production

Biomass accumulation was significantly influenced by both sowing date and spacing. Plants established in April produced the highest biomass, while June sowing produced the lowest. Wider spacing (80 × 80 cm) significantly enhanced biomass accumulation compared to closer spacings.

Effect on Days to 50% Flowering

Days to 50% flowering differed significantly among sowing dates but were not substantially affected by spacing. May sowing flowered earliest, followed by April, while June sowing delayed flowering the most.

Effect on Seed Yield

Seed yield was significantly influenced by sowing date, spacing, and their interaction. April sowing produced the highest seed yield, followed by May, while June produced the lowest. Plants spaced at 80 × 80 cm produced significantly higher seed yield than those at 60 × 60 cm and 40 × 40 cm. The highest seed yield was recorded under the interaction of April sowing at 80 × 80 cm spacing.

Table 1: Physio-chemical properties of soil in the experimental sites for 2019 and 2020 planting.

	2019	2020
Physical properties		
Sand (%)	75.70	79.30
Silt (%)	15.20	10.00
Clay (%)	9.10	10.70
Texture	Loamy sand	Loamy sand
Chemical Properties		
pH (H_2O)	5.47	5.55
Total Nitrogen (%)	0.07	0.11
Available phosphorus (mg/kg)	47.57	64.25
Organic Carbon (%)	1.87	1.81
Exchangeable potassium (cmol/kg)	0.08	0.08
Exchangeable Calcium (cmol/kg)	6.86	7.40
Exchangeable Magnesium (cmol/kg)	1.95	1.93
Exchangeable Sodium (cmol/kg)	0.07	0.06
Exchange acidity (H^+)	0.45	0.64
Effective Cation Exchange Capacity (ECEC)	9.41	10.11
Base saturation (%)	95.21	93.66

Table 2: Effect of sowing date and plant spacing on growth and yield of fish bean

Treatment	Plant height (cm)	No. of branches	No. of leaves	Biomass (g)	Days to 50% flowering	Seed yield (kg ha^{-1})
16th April	93.30a	11.12a	14.01a	87.80a	164.13b	3524a
16th May	85.50b	7.83b	12.50ab	68.60b	152.00c	1174b
16th June	71.30c	6.60b	10.62b	49.40c	187.04a	472c
80 × 80 cm	89.40a	10.30a	13.22a	85.80a	166.82a	3385a
60 × 60 cm	84.20ab	8.58ab	12.14ab	70.40b	169.02a	2105b
40 × 40 cm	74.50b	7.68b	11.77b	57.60c	167.33a	1623c
16th April × 80 × 80cm	99.80a	11.60a	15.80a	97.30a	163.13c	5035a
16th April × 60 × 60cm	97.40ab	11.07a	13.13ab	90.10ab	166.33b	3172b
16th April × 40 × 40cm	82.60bc	10.70ab	13.10ab	76.20bc	162.93c	2365c
16th May × 80 × 80cm	89.70ab	9.20ab	13.50ab	77.20bc	152.53d	1540d
16th May × 60 × 60cm	83.10bc	8.27bc	12.33abc	74.70c	152.60d	1080e
16th May × 40 × 40cm	77.80cd	6.03cd	11.67bc	53.80de	150.87d	901f
16th June × 80 × 80cm	78.80cd	8.23bc	12.00bc	58.20d	186.33a	735f
16th June × 60 × 60cm	72.00de	6.40c	10.97bc	46.60de	188.13a	384g
16th June × 40 × 40cm	63.10e	5.17d	8.90c	43.50e	186.67a	298g

Means followed by the same letter within a column are not significantly different at $p \leq 0.05$ using DMRT.

Discussion

The superior vegetative growth and seed yield observed in April-sown fish bean can be attributed to favorable environmental conditions during early crop establishment. April planting coincided with moderate rainfall and adequate sunshine, which likely enhanced seed germination, root development, nodulation, and photosynthetic efficiency. Similar observations were reported by Frimpong (2004), who noted improved vegetative performance in early-planted legumes.

In contrast, the poor growth recorded in June sowing may be due to excessive rainfall, reduced solar radiation caused by persistent cloud cover, and possible soil oxygen deficiency arising from temporary waterlogging. High rainfall during early vegetative growth has been shown to suppress nodulation and nitrogen fixation due to reduced oxygen diffusion into root nodules (Minchin, 1997).

The superior performance of fish bean at wider spacing (80 × 80 cm) may be attributed to reduced intra-specific competition for light, soil moisture, and nutrients. Wider spacing allows better canopy development, improved photosynthetic efficiency, and greater assimilate translocation to reproductive sinks. This finding agrees with the reports of Amany (2014) and Masa et al. (2017), who observed enhanced yield components in legumes under wider plant spacing.

Higher seed yield recorded under wider spacing also suggests that individual plants had greater access to growth resources, resulting in better pod filling and seed development. Conversely, closer spacing increased competition, leading to reduced seed size and yield per plant despite higher plant population.

Conclusion

The study demonstrated that sowing date and plant spacing significantly influence the vegetative growth and seed yield of fish bean (*Tephrosia vogelii*) under humid rainforest conditions. Early sowing in April significantly enhanced growth and seed yield compared with later sowing in May and June. Wider spacing of 80 × 80 cm promoted superior vegetative growth and seed yield compared with closer spacings.

Recommendations

1. Fish bean should be sown in April for optimum growth and maximum seed yield in the humid rainforest zone of Cross River State.
2. A plant spacing of 80 × 80 cm is recommended for seed multiplication and commercial cultivation.
3. Further studies should evaluate nutrient management and multi-season yield stability of T. vogelii under different agro-ecological zones.

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