

# Factors influencing the growth and yield of grains of paradise: extra income for farmers

## Abstract

The Forestry Commission of Ghana has adopted forest plantations as a strategy to ensure landscape restoration, enhance environmental quality and develop a sustainable resource base to satisfy future timber demands. Modified Taungya System (MTS) is a co-management system between the Forestry Commission and smallholder farmer that allows inter-cropping of timber and food crops. Practitioners and farmers observed decline in NTFPs from the wild, which in recent times have become a threat to source of livelihood that often contributes significantly to household incomes. NTFPs were introduced in MTS to engage farmers to protect the forest from wildfire and decreased theft incidences. However, farmers had to leave these lands because their crops were not doing well during canopy closure. Grains of Paradise amongst others were found to do well under shade but the best silvicultural practice to apply is indefinite. This study was undertaken to research and determine the best condition (tree stand spacing and percentage of shade) suitable for Grains of Paradise cultivation. Primary data were collected from the field. The results shows that Grains of Paradise can grow well and produce high yield under tree stands with a planting distance of 4 x 4m and a shade cover of 86% and. The Production of GoP should be introduced to other MTS farmers and interested farmers throughout the country as an alternative livelihood.

**Keywords:** grains of paradise, yield, height, spacing, shade

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## Introduction

One of the reforestation programmes is the Modified Taungya System (MTS); a co-management system between the Forestry Commission and smallholder farmers that allows intercropping of timber and food crops. It entitles farmers to 100% of the food produce and a 40% share in the timber revenues in return for their contribution to tree planting, maintenance and protection.

The benefits of the MTS to alleviating the scarcity of farming land and improving households' livelihoods have been documented. In addition, creation of a legal source of future timber supply, gender-friendliness and contribution to creating climate-smart landscapes are well acknowledged.

One of the challenges of MTS is the lack of mid-term benefits for farmers after canopy closure, when food crops can no longer be grown. This is a disincentive to farmers under the scheme.

In order to address the challenges faced by the MTS farmers and ensure a long-term farming system the introduction of shade tolerance NTFPs in the MTS could provide the needed short-term benefits. One of the NTFPs used that is tolerant and could be used under MTS is grains of paradise.

Unfortunately, not much has been studied on the appropriate shading regime and tree stand spacing suitable for GoP, which this study seeks to address. This inadequate knowledge has limited the production of the species on a commercial scale and reduce the incentive for adoption by farmers. There is therefore a need to identify the factors suitable for the growth and yield performance of GoP.

## Materials and method

This study was carried out in the Asenanyo Forest Reserve of the Nkwie Forest District in the Ashanti Region, Ghana. It is a moist-semi deciduous forest with an annual temperature of 28°C and annual rainfall of about 1,500 mm on the average.

This experiment was structured to study the influence of tree stand spacing and percentage level of shade on the growth and yield performance of grains of paradise. Plots were established in existing MTS farms using factorial in a randomized complete block design.<sup>1</sup> The factors considered were tree stands spacing, which was examined at three levels (2m x 2m; 3m x 3m; 4m x 4m).

## Results and discussions

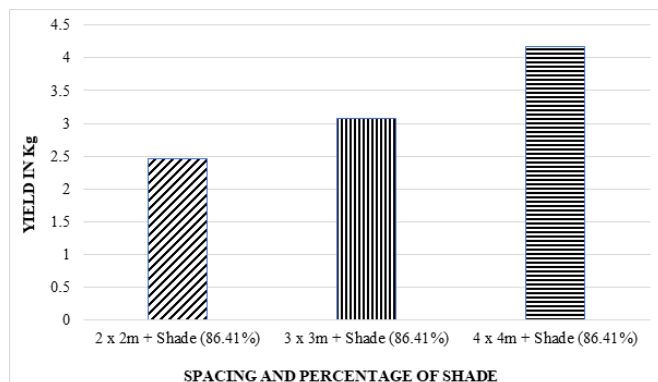
### Effect of shade and spacing on height of grains of paradise

According to Pouliot et al.,<sup>2</sup> tallest plants are found under non-sunlight conditions. Planting GoP in a 4 x 4m tree plantation stand with 86.41% and above shade level positively increases the height of GoP crop. The interaction between the spacing of GoP and shade levels produce a p-value of 2.92E-09,  $p < 0.05$ . Hence, spacing and level of shade together had significant effect on plant height. This finding can be attributed to the observation of Castro-Camba et al.,<sup>3</sup> who reported that plant height increased with increase in levels of shade due to increase in the content of gibberellins in plants grown under shade. Therefore, tree stand spacing and shading of GoPs have greater influence on the plant growth in height (Table 1).

### Effect of shade and spacing on yield of grains of paradise

Yield of GoP under a 4 x 4m tree stand was very high. The wide spacing allowed for pods to increase in size and therefore increasing the yield of GoP seeds (Figure 1).

This result is in line with a study by Mahender et al.,<sup>4</sup> who reported that a wider spacing produced highest rhizome yield per ginger plant (203.02 g). They attributed the higher rhizome yield in the wider spacing to better availability of nutrients, moisture and space for the enlargement of rhizomes, which similarly could have accounted for the high yield in the 4 x 4m spacing in this study.



**Figure 1** Yield of GoP under three levels of tree stand spacing and same percentage of shade.

**Source:** Field studies.

This finding is also in agreement with Yadav et al.,<sup>5</sup> and observation by Ijoyah et al.,<sup>6</sup> who observed that higher planting spacing produced highest fruit yield per hectare.

The fresh and dry weights of twenty GoP pods and the seeds yielded from these pods in a 4 x 4m tree stands were high (Table 2).

**Cost benefit analysis of grains of paradise establishment**

Grains of paradise takes at most a year and a half to yield. Therefore, in the first year no revenue is generated.

To maximize GoP yield in an MTS farm, a 4 x 4m tree stand with a shade level of more than 86.41% would have to be considered. The production cost for grains of paradise on a hectare of land using root shoots as the planting material through direct planting at the end of the second year is about GH¢ 2,650.00 (US\$179.17). The yield of grains of paradise at the end of the second year is estimated to generate a revenue of GH¢ 7,019.20 (US\$546.67). This will give a profit of GH¢ 4,369.20 (US\$367.50) at the end of the second year (Table 3) (Table 4).

**Table 1** An ANOVA table indicating the interaction between spacing and shade level on GoP height

Source of variation	SS	df	MS	F	P-value	F crit
Sample	2.3804876	2	1.1902438	30.91686	1.13E-09	3.168246
Columns	5.6148207	2	2.8074103	72.92313	4.53E-16	3.168246
Interaction	2.6937646	4	0.6734412	17.49279	2.92E-09	2.5429175
Within	2.0789035	54	0.0384982			

**Source:** Field studies.

**Table 2** Fresh, dry and seed weights of 20 GoP pods under three levels of tree stand planting space

Planting spacing (m)	Fresh Weight (kg/ha)	Dry weight (kg/ha)	Seeds weight (kg/ha)
2 x 2	42.22	17.22	11.18
3 x 3	42.5	20.56	11.53
4 x 4	42.92	20.83	11.67

**Source:** Field studies.

**Table 3** Production cost of GoP using root shoots by direct planting under 4 x 4m tree stands in year one

Item	Quantity	Unit prices/shoot		Amount	
		GH¢	US\$	GH¢	US\$
<b>Planting Material</b>					
Root shoots	500	2	0.17	1,000.00	83.33
<b>Equipment</b>					
Cutlass	4	50	4.17	200	16.67
Wheelbarrow	1	300	25	300	25
<b>Labour</b>					
Clearing	2 person/1 day	60	5	120	10
Peg cutting and pegging	2 person/1 day	60	5	120	10
Planting	2 person/2days	60	5	240	20
1st weeding	2 person/1 day	60	5	120	10
Harvesting	1 person/1days	50	4.17	50	4.17
<b>Total</b>				<b>2,150.00</b>	<b>179.17</b>

**Table 4** Proposed returns from the establishment of grains of paradise under a 4 x 4m tree stands using root shoots

Year	Cost		Yield Kg	Revenue		Profit	
	GH¢	US\$		GH¢	US\$	GH¢	US\$
1st	2,150.00	179.17	0	0	0	-2,150.00	-179.17
2nd	500	41.67	43.87	7,019.20	584.93	6,519.20	543.27
Total	2,650.00	220.83		7,019.20	584.93	4,369.20	364.1

\*1 GH¢ = \$12 USD; 1Kg = GH¢160.00

**Source:** Field studies.

## Conclusion

The study revealed that spacing and level of shade have significant effect on the yield and growth of GoP. Tree stands with a planting distance of 4 x 4m proved to be the best planting spacing for GoP for high growth and yield. Based on the yield of GoP, it can be concluded that cultivation of GoP is very profitable after the first year of establishment.

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## Conflicts of Interest

The authors declare that there are no conflicts of interest.

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