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Effect of Population Density and Varieties on the Growth and Yield of Groundnut (*Arachis hypogaea* L.)

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Abstract

The study was conducted at the Prince Abubakar Audu University and Demonstration Farm, Anyigba, during the 2022 farming season. The main objective is to evaluate the Effect of Population Density and Varieties on the Growth and Yield of Groundnut (*Arachis hypogaea* L.) in Anyigba. The treatment consists of two varieties of groundnut and three (3) population density. The experiment was laid in a Randomized Complete Block Design (RCBD) with three replications given a total plot of twenty seven (18) plots. Varieties are Samnut 24 and Local, population density are 40,000 plant/ha, 60,000 plant/ha and 80,000 plant/ha. The parameters measured includes, plant height, Number of leaves, leaf Area, Stem girth, days to first flowering, days to 50% flowering, Number of pod/plant Number of seeds/pod, 100 seed weight and total yield From the result obtained, different density treatments affect the growth, development, and yield of Groundnut (*Arachis hypogaea* L.) with plant population 40,000 plant/ha plants grow, develop better for growth parameter (plant height, Number of leaves, leaf Area, Stem girth, Number of pod/plant and 100 seed weight) while for yield 80,000 plant/ha had the highest. The varietal differences recorded in this research indicated that Samnut 24 had a better performance on growth and yield parameters measured than local. Most of the weeks had no significant ($p<0.05$) effect on the interaction of Plant population and varieties, It is therefore recommended that farmers should employed the plant population of 40,000 plant/ha and introduction of improve Variety (Samnut 24) for production of Groundnut in the study Area.

Keywords: Varieties; Density; Optimum; Source; Nutrients

Introduction

Groundnut (*Arachis hypogaea L.)* is a leguminous crop belonging to the family *Fabaceae* and is cultivated in the semi-arid and subtropical regions of the world. It is a self-pollinated, annual herbaceous plant growing 30 to 50 cm (1.0 to 1.6 ft.) tall. Groundnuts are known by many other local names such as peanut, earthnut, monkey nut, pygmy nut and pignut. Groundnuts are rich in essential nutrients which are potential to provide health benefits [1]. The major groundnut producing countries in the world are India, China, Nigeria, Senegal, Sudan, Burma and the United States of America [2]. Cultivated groundnut has two subspecies, *hypogaea* and *fastigiata*, which in turn have two botanical varieties (*var, hypogaea and var. aequatoriana*). Each of these botanical varieties has different plant, pod and seed characteristics. However, most of the commercially cultivated varieties belong to the *hypogaea* (common name/ market type: *Virginia* or *runner), fastigiata* (*Valencia*), and *vulgaris* (Spanish) botanical variety groups. Plant density in a given area greatly influences growth and development of crops particularly the yield and yield components. In order to reduce low pod yield, pests and diseases infestation, competition for light, nutrients and water, determining

optimum plant density for groundnut varieties is imperative to maximize productivity of the crop [3]. Planting groundnut in wide rows or spacing is reported to lead to sub-optimum plant population densities and lower yields [4]. Few farmers plant the crop in well defined (spaced) rows or ridges, which when adopted tend to achieve optimum plant populations. Generally, altering plant population densities can affect crop growth and development, yield, quality factors and pest development in groundnut [5]. Optimum plant population density in groundnut varies between environments, cultivars and management practices, Planting density of groundnut is often low in farmer's field and especially when the crop is not grown in rows resulting in low yields [6]. However, there are no recommendations on optimum plant density for groundnut varieties with different growth habit to increase the productivity of the crop. Therefore, There is need to increase plant population introducing high yielding varieties by farmers in the study area as the available of land for farming purpose continue to decrease in order for optimum yield to be achieved. Therefore the objective the study is to evaluate the Effect of Population Density and Varieties on the Growth and Yield of Groundnut (*Arachis hypogaea L.)*.

Material and Methods

Experimental Site

The field experiment was carried out at the teaching and research farm of Prince Abubakar Audu University Anyigba. It lies on Latitude $7^0$15 N and $7^0$29 N Longitude $7^0$11E and $7^0$12'N with altitude of 420m above sea level [7]. The two varieties of groundnut were Samnut 24 and Local was sourced from National Cereals Research Institutes Badeggi Niger State.

Treatment and Experimental Design

The experiment was laid in a Randomized Complete Block Design (RCBD) with three replications given a total plot of twenty seven (18) plots. The treatments was randomly allocated to each plot with in the blocks or reps. the treatment consist V1, V2 and population density at (P_1) 40,000 plant/ha (P_2) 60,000 plant/ha and (P_3), 80,000 plant/ha respectively to plots.

Soil Sample Preparation

Soil sample were taken from the upper layer (1-15cm) of the soil on the field at four different locations and then bulked together and thoroughly mixed to form a composite sample. The soil sample was analyzed for physical and chemical properties in the Soil Science laboratory of Prince Abubakar Audu University using the methods described in Black [8].

Data Collection and Analysis

Growth Parameter

Plant height (cm): Three (3) plants was randomly selected and tagged for measurement. Their heights was taken from the surface of the soil to the apex of the plant at two weeks interval from 3,5,7 and 9 weeks after sowing (WAS). The measurement was done using a meter rule.

Number of leaves per plant: The total number of leaves was determined by simple count. The average number of leaves per plant was then be determined by dividing the total leaf number by the population selected.

Leaf area (cm^2): The leaf area was determined by the use of a measuring tape to measure the length and breadth area by constant (0.75)

Stem girth (cm): Stem girth was measured with a thread and a meter rule. The stem girth was obtained from the tagged plants per plot.

Days to First Flowering: This was determined by counting the number of days from sowing to first flowering in each plot**.**

Days to 50% flowering: This was determined by counting the number of days from sowing to when 50% of the plants in the plots has flowered.

Yield parameters

Number of seeds per pod (g): To obtain this parameter, 15% pods were randomly sampled, hand-shelled, and the seeds were counted. The total number of seeds was then be divided by the population selected.

100-seed weight (g): From the threshed grain of each plot, a 50 seeds sample was drawn and multiplied by 2; the result obtained was weighed using an electronic weighing scale.

Pod yield/ha: Plants from each plot was harvested and the pods were stripped and sun-dried for some days and the dry weight was measured using an electric weighing balance. Data obtained was extrapolated to pod yield/ha.

Statistical analysis

The data collected were collated and subject to analysis of variance (ANOVA). Significantly different means was separated using fishers least significant difference test (F-LSD) at 5 % level of probability.

Results and Discussion

Result of Pre-Sowing Soil (0-15) Test Value for the Experimental Site in 2023 Cropping Season

The physicochemical properties of the experimental site of the result indicated as shown in the table 1, the soil is of sandy loam textural class and slightly acidic with a pH of 4.65. It had an organic matter content of 1.85% and organic

carbon of 1.05%. The N, Mg and K contents were 0.22%, 0.19mg kg^{-1} and 1.10cmol kg^{-1} respectively.

Effect of Population Density and Varieties on Plant Height (cm) and number of leaves of Groundnut (*Arachis hypogaea L.)*

Effect of population density and varieties on Plant Height (cm) of Groundnut as represented in table 2. Plant population of 40,000 plant/ha, 60,000 plant/ha and 80,000 plant/ha had no significant ($p<0.05$) effect on plant Height throughout the sampling period. Varieties had significant ($p<0.05$) effect on the Plant height, with Samnut 24 having the highest mean value of 3.90cm 5.62cm and 7.79cm at 3, 5 and 7 WAS, while the least was local with 3.44cm 4.87cm and 6.62cm, mean value at 3, 5 and 7 WAS. There was no significant ($p<0.05$) effect on the interaction of Plant population and varieties on the plant height as observed at 3 and 7 WAS while at 2 WAS There was significant ($p<0.05$) effect at plant height.

Effect of Population Density and Varieties on Number of leaves of Groundnut (*Arachis hypogaea L.)*

Effect of population density and varieties on Number of leaves of Groundnut as represented in table 2. Plant population on Groundnut (*Arachis hypogaea L.)* had no significant ($p<0.05$) effect at 3, however was significant ($p<0.05$) at 5 and 7 WAS. Plots with Plant population 80,000 plant/ha and 40,000 plant/ha had the highest number of leaves with mean value of 33.08, 81.33, 138.50 and 175.17 at 3, 5 and 7 WAS respectively. the least mean value was obtained from Plant population 60,000 plant/ha with mean value of 31.83 at 3 WAS, also plant population 80,000 plant/ha had the least mean value of 76.67 and 116.83 at 5 and 7 WAS respectively.. Varieties had significant ($p<0.05$) effect on the Plant height, throughout the sampling period, with Samnut 24 having the highest mean value of 34.72, 83.56, and 131.89, while the least was local with 30.22, 73.33 and 121.00 mean value at 3, 5 and 7 WAS. There was significant ($p<0.05$) effect on the interaction of Plant population and varieties on the number of leaves as observed at 3 WAS while at 5 and 7 WAS There was no significant ($p<0.05$) effect at Number of leaves.

Effect of Population Density and Varieties on Leaf area (cm^2) of Groundnut (*Arachis hypogaea L.)*

Effect of population density and varieties on Leaf Area (cm^2) of Groundnut as represented in table 3. Plant population on Groundnut (*Arachis hypogaea L.)* had no significant ($p<0.05$) effect at 3 and 5 WAS, however was significant ($p<0.05$) at 7 WAS. Plots with Plant population 40,000 plant/ha had the wildest leaves with mean value of 1.77, 2.75, 4.42 and 5.42 at 3, 5 and 7 WAS respectively. The least mean value was obtained from Plant population 60,000 plant/ha and 80,000 plant/ha with mean value of 1.76, 2.66 and 4.08, at 3, 5 and 7 WAS respectively. Varieties had no significant ($p<0.05$) effect on the leaf Area at 3 and 5 WAS, at 7 WAS was significant ($p<0.05$), with Samnut 24 having the highest mean value of 4.34 at 7 WAS. While the least was local with 4.34 mean value at 7 WAS. There was no significant ($p<0.05$) effect of interaction of Plant population and varieties on the leaf Area as observed throughout the sampling period.

Effect of Population Density and Varieties on Stem Girth (cm) of Groundnut (*Arachis hypogaea L.)*

Effect of population density and varieties on Stem Girth (cm) of Groundnut as represented in table 3. Plant population on Groundnut (*Arachis hypogaea L.)* had no significant ($p<0.05$) effect at 3, however was significant ($p<0.05$) at 5 and 7 WAS. Plots with Plant population 40,000 plant/ha had the wildest Stem girth with mean value of 0.97cm, 1.21cm and 1.71cm at 3, 5 and 7 WAS respectively, the least mean value was obtained from Plant population 80,000 plant/ha with mean value of 0.96cm, 1.15cm and 1.65cm at 3, 5, 7 WAS respectively. Varieties had significant ($p<0.05$) effect on the Stem girth, throughout the sampling period, with Samnut 24 having the highest mean value of 0.98, 1.23 and 1.72, while the least was local with 0.94, 1.11 and 1.64 mean value at 3, 5 and 7 WAS. There was no significant ($p<0.05$) effect on the interaction of Plant population and varieties on the Stem girth as observed at 3 5, and 7 WAS.

Effect of Population Density and Varieties on Days to first flowering, Day to 50% flowering of Groundnut (*Arachis hypogaea L.)*

Plant population on Groundnut (*Arachis hypogaea L.)* had no significant ($p<0.05$) effect on Days to first flowering, Plots with Plant population 80,000 plant/ha had the highest mean value of 26.17, the least mean value was obtained from Plant population 40,000 plant/ha with mean value of 25.58. Varieties had significant ($p<0.05$) effect on the Days to first flowering, with local having the highest mean value of 27.22, while the least was Samnut 24 with 24.39 mean value. There was no significant ($p<0.05$) effect on the interaction of Plant population and varieties on Days to first flowering as observed. Plant population on Groundnut (*Arachis hypogaea L.)* had no significant ($p<0.05$) effect on Days to 50% flowering, Plots with Plant population 80,000 plant/ha

had the highest mean value of 35.25, the least mean value was obtained from Plant population 40,000 plant/ha with mean value of 34.00. Varieties had significant ($p<0.05$) effect on the Day to 50% flowering, with local having the highest mean value of 36.11, while the least was Samnut 24 with 32.17 mean value. There was no significant ($p<0.05$) effect on the interaction of Plant population and varieties on Day to 50% flowering as observed.

Effect of Population Density and Varieties on Yield Parameters of Groundnut (*Arachis hypogaea L.)*

Effect of population density and varieties on Yield of Groundnut as represented in table 5. Plant population on Groundnut (*Arachis hypogaea L.)* had no significant ($p<0.05$) effect on Number of pods/plant, Plots with Plant population 40,000 plant/ha had the highest number of pods with mean value of 11.17, the least mean value was obtained from Plant population 80,000 plant/ha with mean value of 10.33. Varieties had significant ($p<0.05$) effect on the Number of pods/plant, with Samnut 24 having the highest mean value of 12.50, while the least was local with 8.78 mean value. There was no significant ($p<0.05$) effect on the interaction of Plant population and varieties on Number of pods/plant, as observed.

Plant population on Groundnut (*Arachis hypogaea L.)* had no significant ($p<0.05$) effect on Number of seeds/pod, Plots with Plant population 40,000 plant/ha had the highest number of pods with mean value of 3.00, the least mean value was obtained from Plant population 80,000 plant/ha with mean value of 2.88. Varieties had significant ($p<0.05$) effect on the Number of seeds/pod, with Samnut 24 having the highest mean value of 3.00, while the least was local with 2.78 mean value. There was significant ($p<0.05$) effect on the interaction of Plant population and varieties on Number of seeds/pod, as observed.

Plant population on Groundnut (*Arachis hypogaea L.)* had significant ($p<0.05$) effect on 100-Seeds weight (g), Plots with Plant population 40,000 plant/ha had the highest seed weight with mean value of 37.67, the least mean value was obtained from Plant population 80,000 plant/ha with mean value of 34.83. Varieties had significant ($p<0.05$) effect on the 100-Seeds weight (g), with Samnut 24 having the highest mean value of 38.00, while the least was local with 34.22 mean value. There was no significant ($p<0.05$) effect on the interaction of Plant population and varieties on 100-Seeds weight (g), as observed.

Plant population on Groundnut (*Arachis hypogaea L.)* had significant ($p<0.05$) effect on Yield (kg/ha), Plots with Plant population 80,000 plant/ha had the highest seed weight with mean value of 16,683.33, the least mean value was obtained from Plant population 40,000 plant/ha with mean value of 1333.33. Varieties had significant ($p<0.05$) effect on the Yield (kg/ha) with Samnut 24 having the highest mean value of 1666.67, while the least was local with 1333.33 mean value. There was no significant ($p<0.05$) effect on the interaction of Plant population and varieties on Yield (kg/ha), as observed.

Soil Characteristics	Value
P^H (H_2O)	4.65
P^H(CaCl)	4.38
%Organic carbon	1.053
%Organic matter	1.85
%Total N	0.052
Available P ppm	10.33
Ca (cmol/kg)	0.267
K (cmol/kg)	1.102
N (cmol/kg)	0.222
Mg (cmol/kg)	0.19
% Sand	75
% Silt	8
% Clay	17
Textural Class	Sandy Loam

Table 1: Result of Pre-Sowing Soil Test Value for the Experimental Site in 2023 Cropping Season.

	Plant Height cm			Number of leaves		
Treatments	3WAS	5WAS	7WAS	3WAS	5WAS	7WAS
Plant Population (P)						
40,000 plant/ha	3.62	5.25	7.23	32.50	81.33[a]	138.50[a]
60,000 plant/ha	3.67	5.24	7.07	31.83	77.33[b]	124.00[b]
80,000 plant/ha	3.72	5.25	7.26	33.08	76.67[b]	116.83[b]
Significance	ns	Ns	Ns	ns	*	*
LSD (0.05%)	-	-	-	-	1.58	8.58

Variety (V)						
Samnut 24	3.90[a]	5.62[a]	7.75[a]	34.72[a]	83.56[a]	131.89[a]
Local	3.44[b]	4.87[b]	6.62[b]	30.22[b]	73.33[b]	121.00[b]
Significance	*	*	*	*	*	*
LSD (0.05%)	0.07	0.06	0.20	0.70	2.61	10.61
Interaction						
PP x V	ns	*	ns	*	ns	ns
CV%	1.95	0.89	2.51	1.18	1.57	2.12

Means having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level of probability. LSD- Least Significant Difference N.S- Not Significant. *- significant

Table 2: Effect of Population Density and Varieties on Plant Height (cm) and Number of leaves of Groundnut (*Arachis hypogaea L.)* in Anyigba Kogi State 2023 Growing Season.

	Leaf area (cm^2)			**Stem girth (cm)**		
Treatments	3WAS	5WAS	7WAS	3WAS	5WAS	7WAS
Plant Population (P)						
40,000 plant/ha	1.77	2.75	4.42[a]	0.97	1.21[a]	1.71[a]
60,000 plant/ha	1.76	2.68	4.18[b]	0.96	1.15[b]	1.67[b]
80,000 plant/ha	1.77	2.66	4.08[b]	0.96	1.15[b]	1.65[b]
Significance	ns	ns	*	ns	*	*
LSD (0.05%)	-	-	0.17	-	0.03	0.04
Variety (V)						
Samnut 24	1.79	2.69	4.34[a]	0.98[a]	1.23[a]	1.72[a]
Local	1.73	2.71	4.11[b]	0.94[b]	1.11[b]	1.64[b]
Significance	Ns	Ns	*	*	*	*
LSD (0.05%)	-	-	0.16	0.02	0.04	0.05
Interaction						
PP x V	ns	ns	Ns	ns	ns	ns
CV%	1.77	2.41	1.03	1.87	2.43	2.01

Means having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level of probability. LSD- Least Significant Difference N.S- Not Significant. *- significant

Table 3: Effect of Population Density and Varieties on Leaf area (cm^2) and Stem girth (cm) Groundnut (*Arachis hypogaea L.)* in Anyigba Kogi State 2023 Growing Season.

Treatments	**Days to first flowering**	**Day to 50% flowering**
Plant Population (P)		
40,000 plant/ha	25.58	34.00
60,000 plant/ha	25.67	34.17
80,000 plant/ha	26.17	34.25
Significance	ns	ns
LSD (0.05%)	-	-
Variety (V)		

Samnut 24	24.39[b]	32.17[b]
Local	27.22[a]	36.11[a]
Significance	*	*
LSD (0.05%)	0.42	0.22
Interaction		
PP x V	Ns	ns
CV%	0.36	0.63

Means having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level of probability. LSD- Least Significant Difference N.S- Not Significant. *- significant

Table 4: Effect Of Population Density and Varieties on Days to first flowering and Day to 50% flowering of Groundnut (*Arachis hypogaea L.)* in Anyigba Kogi State 2023 Growing Season.

Treatments	Number of pods/plant	Number of seeds/pod	100-Seeds weight (g)	Yield (kg/ha)
Plant Population (P)				
40,000 plant/ha	11.17[a]	3.00	37.67[a]	1,333.33[b]
60,000 plant/ha	10.42[b]	2.83	35.83[b]	1,483.33[ab]
80,000 plant/ha	10.33[b]	2.83	34.83[b]	1,683.33[a]
Significance	*	ns	*	*
LSD (0.05%)	0.59	-	1.20	272.39
Variety (V)				
Samnut 24	12.50[a]	3.00[a]	38.00[a]	1,666.67[a]
Local	8.78[b]	2.78[b]	34.22[b]	1,333.33[b]
Significance	*	*	*	*
LSD (0.05%)	0.63	0.18	1.37	189.15
Interaction				
PP x V	Ns	*	ns	ns
CV%	4.35	5.16	0.82	6.55

Means having the same letters are not significantly different according to Duncan's Multiple Range Test (DMRT) at 5% level of probability. LSD- Least Significant Difference N.S- Not Significant. *- significant

Table 5: Effect of Population Density and Varieties on Yield Parameters of Groundnut (*Arachis hypogaea L.)* in Anyigba Kogi State 2023 Growing Season.

Discussion

The result of the study shows significant ($p<0.05$) effect on Population Density and Varieties on the Growth and Yield of Groundnut (*Arachis hypogaea L.)* this result is in accordance with Mukhtar [8] who confirmed that the taller plants observed at higher plant density (15cm) is attributed to competition by crops to intercept radiation. In addition, plants at high density tend to increase stem growth at the expense of assimilate partitioning to reproductive tissue while the shortest plant height and canopy spread measured with lower plant density (25cm) might be due to wide spacing arrangement which supported wider canopy sizes probably as a result of more available space for horizontal growth compared to the space available to closely spaced crop. Furthermore Mukhtar [9] confirmed that the taller plants observed at higher plant density is attributed to competition by crops to intercept radiation. In addition, plants at high density tend to increase stem growth at the expense of assimilate partitioning to reproductive tissue. The shortest plant height measured with plant density of 40,000 plants/ha might be due to wide spacing arrangement which supported wider canopy sizes probably as a result of more available space for horizontal growth compared to the space available to closely spaced crop. However, close spacing resulted in complete and early canopy closure and this is consistent with the findings of Mulatu [10] reported varying growth patterns in some groundnut genotypes which

could be due to differences in their genetic makeup. The effect of the high plant density resulted in significantly lesser number of leaves than those in the low plant density. This is consistent with the findings of Tillman [4]. Dapaah [11] stated the wider spacing or lower plant density supported more branches per plant probably because of more available space for horizontal or lateral growth compared to close spaced or higher plant density crops. Ibrahim [12] reported the significant differences among the varieties could be attributed to genotypic make up of groundnut variety. When combined a significant differences were also recorded and SAMNUT 24 significantly outperformed SAMNUT 26 and 25 respectively. Similar finding was also significant difference obtained from haulms weight may be due to anatomical, physiological and morphological differences in the genotypes of the varieties tested. The varietal differences recorded in this research indicated that SAMNUT 24 had a better performance on growth and yield parameters measured than local respectively. Konlan [13] reported that 100 seed weight decreased with increasing plant density in peanut. These findings are supported by Gulluoglu [14] who indicated that decreasing plant density provides higher photosynthesis per plant. Increased competition for growth resources unit area^{-1} at higher plant population was the major reason for decreased pod weight due to poor translocation of photosynthates from vegetative parts to pods at the time of maturity. Similar results of increased pod weight with lower plant population compared to higher plant population was also reported by Awal and Aktar [15] The interaction effect on number of seeds per plant indicates the genetic control of the trait as well as it being subject to environmental influence. This supports the findings of Kolan [13] that significant difference in yield could be attributed to varietal composition. Mukhtar [9] who reported that increase in plant population leads to increase in yield for any given variety and increase pod yield with increase in plant population density of groundnut up to the maximum. These findings are supported by Gulluoglu [14] who indicated that decreasing plant density provides higher photosynthesis per plant. Increased competition for growth resources unit area-1 at higher plant population was the major reason for decreased pod weight due to poor translocation of photosynthates from vegetative parts to pods at the time of maturity. The varietal difference with regards to number of seeds per pod might be attributed to plant genetic factors than agronomic practices The ability of the groundnut variety to out yield the other variety in two different locations shows that the factors controlling yield in the variety is genetically stable.

Conclusion and Recommendation

The result was in agreement with those obtained on haricot bean, who reported that hundred seed weight decreased with increase in plant density. The result was in agreement with those obtained on haricot bean, who reported that hundred seed weight decreased with increase in plant density. The result was in agreement with those obtained on haricot bean, who reported that hundred seed weight decreased with increase in plant density Based on the result of this research work it can be concluded that the different density treatments affect the growth, development, and yield of Groundnut (*Arachis hypogaea L.)* with plant population 40,000 plant/ha plants grow, develop better for growth parameter (plant height, Number of leaves, leaf Area, Stem girth, Number of pod/plant and 100 seed weight) while for yield 80,000 plant/ha had the highest. The varietal differences recorded in this research indicated that Samnut 24 had a better performance on growth and yield parameters measured than local. Most of the weeks had no significant ($p<0.05$) effect on the interaction of Plant population and varieties, however was significant ($p<0.05$) for Number of seed/pod. Planting density and improve Variety are among the main factors that play an essential role in the growth, yield, and quality of Groundnut. It is therefore recommended that farmers should employed the plant population of 40,000 plant/ha and introduction of improve Variety (Samnut 24) for production of Groundnut in the study Area. Nevertheless, more researches should be conducted to ascertain the validity.

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