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Research Article

Correlation of the Effect of Spacing and Cow Dung Manure on the Growth and Yield of Radish (*Raphanus sativus* L.) in Sudan Savannah of Nigeria

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ABSTRACT

Anexperiment was carried out at the Teaching and Research Farm of Faculty of Agriculture, Bayero University Kano and Kano State Institute of Horticulture, Bagauda, during the rainy season of 2015 to investigate the effect of spacing and cow dung manure rates on the growth and yield of radish. The experiment comprised four levels of spacing (5, 10, 15, and 20 cm) and five rates of cow dung manure (0, 5, 10, 15, and 20 t ha^{-1}). It was laid out in a Randomized Complete Block Design (RCBD) with three replications. The experiment's correlation analysis revealed positive associations between root yield and other parameters assessed at BUK and Bagauda. The results from regression analysis showed that planting at 12.5 cm spacing and applying 10 t ha^{-1} of cow dung manure is the optimum for yield in radish in the Sudan Savannah agro-ecological zone of Nigeria.

Keywords: Cow Dung; Effect; Growth; Manure; *Raphanus sativus*; Yield

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INTRODUCTION

Radishes (*Raphanus sativus* L.) are a common vegetable with a unique flavour and crunchy texture. Radishes come in various colours, from reddish-purple to rosy pink, white, and green or black, and are available in spicy or mild variants, round or rectangular, huge or small. (Pervez *et al*. 2004). Radish is used as a root vegetable, a fruit vegetable, a leafy vegetable, an oil crop or a cover plant. The characteristics and economic importance of radish differ between different areas of the world. In the East, there are radish cultivars having large roots with various shapes called “Asian big radish” and those grown for production of immature pods or oil seeds, whereas radish is a small vegetable grown within one month in the West. Asian big radish is expected to eventually become popular in the West. Several researchers have investigated the effect of spacing on radish growth and yield (Malik *et al*. 1999, Pervez *et al*. 2004). Radishes yield is influenced by spacing due to competition (for moisture, air, nutrients, radiation, etc.) and the shading effect. Wide spacing can result in yield

decrease due to inadequate growth factor usage. However, development suffers if the space between crops is too tight or critical. Many other factors influence spacing, including soil fertility, crop growth pattern, and cultural practices (Malik *et al*. 1999; Musa *et al.,* 2017). Plant population is determined by spacing; hence plant population should be such that maximum solar radiation is utilized.

Manure is also an essential source of humus, and it has a long-term beneficial effect on the soil's structure and carbon economy. Hormones, antibiotics, and vitamins are also contained in farmyard manure. Studies have shown that they stimulate root growth and the growth of microorganisms (yeast cultures) (Ahmed *et al.,* 2000; Bashir *et al.,* 2014). Different factors contributed immensely to the slow growth and decrease in yield of radish plant, hence this research work is aimed to address this factors in order to enhance the plant growth and maximize the yield. The present study seeks to correlate the effect of spacing and cow dung manure on the yield of radish (*Raphanus sativus* L.) in the Sudan savannah of Nigeria.

MATERIALS AND METHODS

This research was conducted during the rainy season of 2015 at two locations,Teaching and Research Farm of Faculty of Agriculture Bayero University Kano (11^{o} 58' N, 8^{o} 28' E)and Kano State Institute of Horticulture, Bagauda, Kano State (11^{0} 48' N, 8^{0} 34' E). The treatments consisted of five manure rates (0, 5, 10, 15, and 20 t ha-1) and four spacings (5, 10, 15, and 20 cm). These rates were factorially combined to give 5 x 4 treatments. The treatments were laid out in a Randomized Complete Block Design (RCBD) with three replications. The land was cleared and harrowed to a fine tilt with no ridge. The Gross plot size was 1.8 m^2 (length 1.8 m and breadth 1 m) with a net plot size of 0.9 m^2 and an alley of 1 m between each plot. There were twenty plots for each replicate. The French Breakfast cultivar of radish seeds was sown at four different intra-row spacing; 5 cm, 10 cm, 15 cm, and 20 cm, with three seeds per hole. There were four rows distanced at 25 cm from each other in every plot. The two middle rows were the net plots, while the other two were the border rows. Planting at an intra-row spacing of 5 cm gave 200,000 plants ha-1, while 10 cm gave 100,000 plants ha-1, 15 cm gave 66,666 plants ha-1 and 20 cm gave 50,000 plants ha-1. Five plants were systematically sampled and tagged from the net plot in every plot. The tagged plants were used as samples for data collection. The radish variety was obtained from the Agro-Tropic Seed Company at Sabon Gari, Kano state. Cow dung manure (dried) was incorporated into the soil two weeks before planting at five rates 0, 5, 10, 15, and 20 t ha^{-1}. The manure was from the same source, and chemical analysis was carried out to determine the Nitrogen, Phosphorous, Potassium, Organic Carbon, and organic matter content. Weeds were controlled manually using hoe and hand at 2, 4, and 6 WAS. Pest control was done organically using neem extract. Plant growth and yield parameters were monitored in-situ, and the correlations of the growth and yield indices were compared.

The data collected were subjected to analysis of variance (ANOVA) as described by Snedecor and Cochran (1967), and the results correlated using the SAS statistical software (version 9.3). Regression analysis was carried out using the JMP statistical software. Significant treatment means were separated at a 5 % probability level using the Duncan Multiple Range Test (Duncan, 1955).

RESULTS

Correlations

Correlation analysis was carried out to determine the association between various parameters. The data from BUK in Table 1 revealed that root yield correlated positively with plant height at 7 WAS, total biomass, and root length. Root length exhibited a significant and positive correlation with plant height at 7 WAS, the number of leaves at 7 WAS, total biomass, and root yield. No significant correlation was observed between root yield and number of leaves at 7 WAS; root diameter and plant height at 7WAS, root diameter with the number of leaves at 7 WAS. The number of leaves and root length correlated negatively with root diameter.

The data from Bagauda in table 2 revealed that root yield had a significant positive correlation with the number of leaves at 7 WAS, total biomass, root length, root diameter, leaf area, and leaf area index. The data further revealed that root length correlated positively with the number of leaves at 7 WAS, total biomass, root diameter, leaf area, and leaf area index. Root diameter correlated positively with the number of leaves at 7 WAS, total biomass, root length, leaf area, and leaf area index. A negative correlation was observed between root diameter and plant height at 7 WAS. No significant correlation

was observed between root yield and plant height at 7 WAS, root length and plant height at 7 WAS.

Regression

The relationship between different spacing levels and cow dung manure rates with root yield was worked out using regression analysis on the data obtained from both BUK and Bagauda. The results revealed that the regression of root yield to spacing was linear at BUK (figure 1). Based on the results obtained, the optimum root yield of radish was obtained at 12.5 cm spacing which gave a yield of 11.77 t ha^{-1}. The analysis also revealed that the regression of root yield to spacing was linear at Bagauda (Figure 2). Optimum root yield was obtained at 12.5 cm spacing, leading to a yield of 7.38 t ha^{-1}.

The regression of root yield to cow dung manure showed a quadratic relationship at BUK and Bagauda (figures 3 and 4). In BUK, the optimum yield was obtained at 10 t ha^{-1} of the manure, which gave a yield of 11.77 t ha^{-1} (Figure 3). While at Bagauda, the optimum yield was obtained at 10 t ha^{-1} of the manure, which gave a yield of 7.38 t ha^{-1} (Figure 4).

Table 1: Matrix of correlation coefficient showing the association between measured parameters of Radish at BUK 2015 rainy season

Variables	Ht7was	Nlv7was	Totbiom	Rtlenth	Rtdia	Lfarea	Lfarndx	Rotyild
Ht7was	1.00							
Nlv7was	0.124	1.00						
Totbiom	0.337**	0.046	1.00					
Rtlenth	0.416**	0.334**	0.754**	1.00				
Rtdia	0.037	-0.026	0.103	-0.064	1.00			
Lfarea	-0.024	0.061	0.210	0.142	0.166	1.00		
Lfarndx	-0.014	0.058	0.259*	0.146	0.144	0.903**	1.00	
Rotyild	0.292*	0.086	0.931**	0.709**	0.102	0.126	0.184	1.00

*Significant at 5% level of probability and ** Significant at 1% level of probability.

KEY:

Ht7was (plant height 7 WAS) Nlv7was (number of leaves 7 WAS) Totbiom (total biomass per plant) Rtlenth (root length) Rotyild (root yield per hectare) Rtdia (root diameter) Lfarea (leaf area) Lfarndx (leaf area index)

Table 2: Matrix of correlation coefficient showing the association between measured parameters of Radish at Bagauda, 2015 cropping season
Key

	Ht7was	Nlv7was	Totbiom	Rtlenth	Rtdia	Lfarea	Lfarndx	Rotyild
Ht7was	1.00							
Nlv7was	0.133	1.00						
Totbiom	0.086	**0.520	1.00					
Rtlenth	0.086	**0.468	**0.795	1.00				
Rtdia	-0.011	*0.288	**0.783	**0.472	1.00			
Lfarea	0.103	**0.650	**0.723	**0.637	**0.440	1.00		
Lfarndx	0.099	**0.369	**0.571	**0.469	**0.453	**0.731	1.00	
Rotyild	0.014	**0.510	**0.928	**0.710	**0.792	**0.655	**0.538	1.00

*Significant at 5% level of probability and ** Significant at 1% level of probability

KEY:

Ht7 (plant height 7 WAS) Nlv7was (number of leaves 7 WAS) Totbiom (total biomass per plant) Rtlenth (root length) Rotyild (root yield per hectare) Rtdia (root diameter) Lfarea (leaf area) lfarndx (leaf area index)

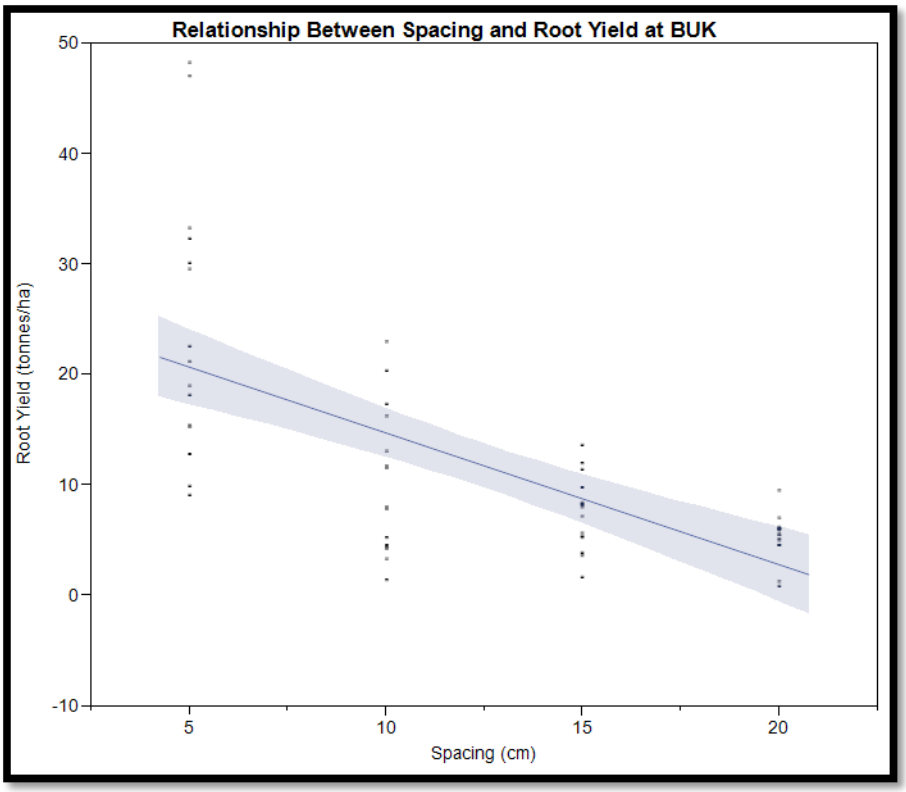

Figure 1. Relationship between spacing and root yield of radish at BUK during the 2015 wet season

Linear Fit

Yield (t ha^{-1}) = 26.671555 - 1.1917926*Spacing (cm)

RSquare = 0.427344

Optimum spacing and yield

Spacing (cm)	12.5
Yield (t ha^{-1})	11.77

Lower confident level = -3.36032

Upper confident level = 0

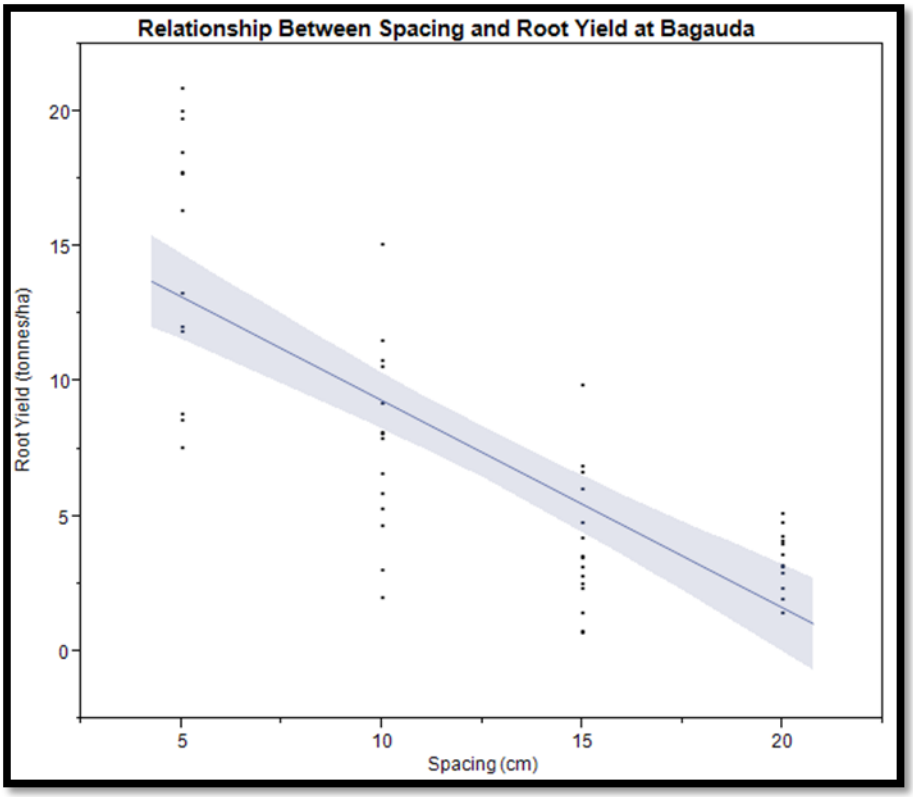

Figure. 2. Relationship between spacing and root yield of radish at Bagauda during the 2015 wet season.

Linear Fit

Yield (t ha^{-1}) = 16.9936 - 0.7688374*Spacing (cm)

RSquare = 0.584062

Optimum spacing and yield

Spacing (cm)	12.5
Yield (t ha^{-1})	7.383133

Lower confident level =-1.26314

Upper confident level =-1.26314

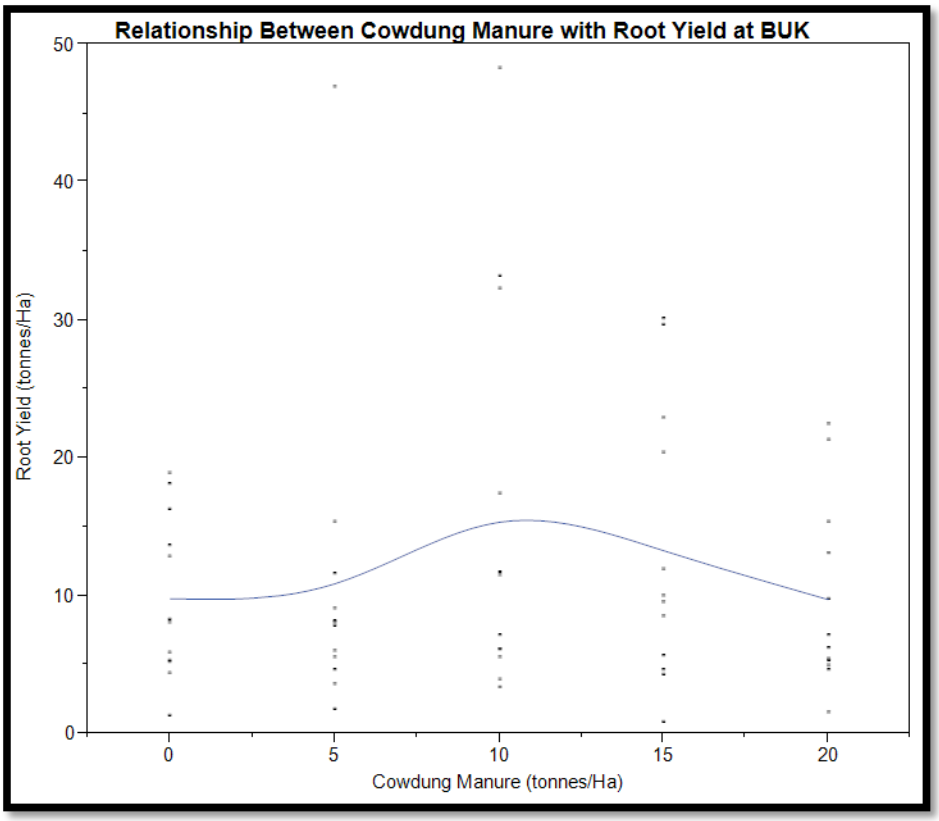

Figure. 3. Relationship between manure and root yield of radish at BUK during the 2015 wet season.

Linear Fit

Yield (t ha^{-1}) = 11.319072 + 0.0455076*Manure (t ha^{-1})

RSquare= 0.035414

Optimum manure and yield

Manure (t ha^{-1})	10
Yield (t ha^{-1})	11.774

Lower confident level = 2.179642

Upper confident level =0

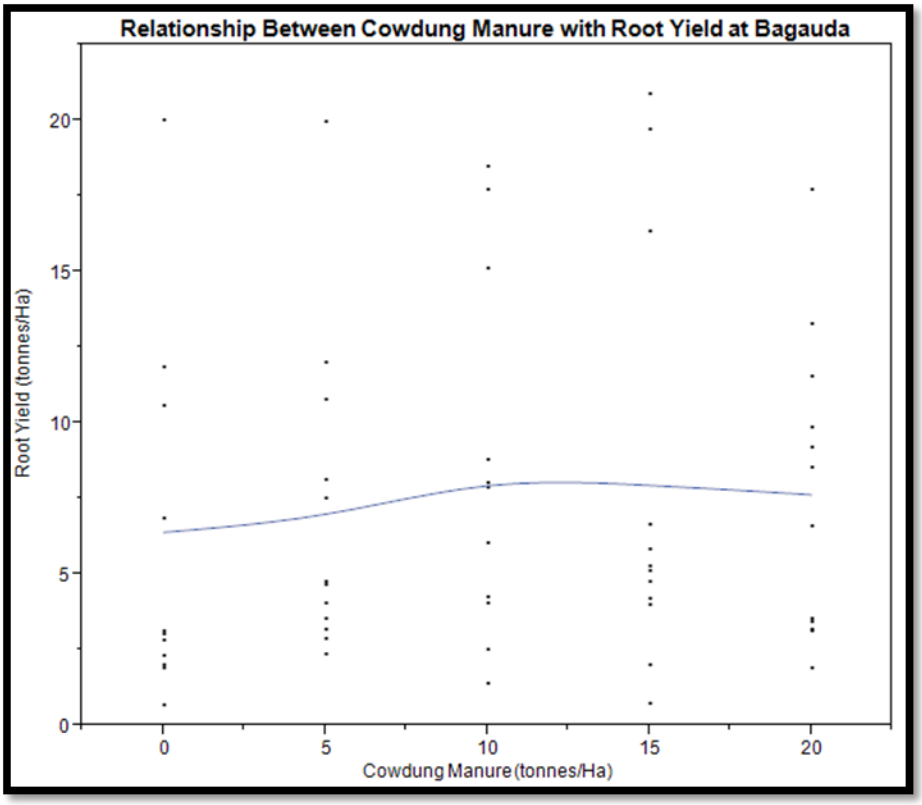

Figure. 4. Relationship between manure and root yield of radish at Bagauda during the 2015 wet season.
Linear Fit
Yield (t ha^{-1}) = 6.6955054 + 0.0687628*Manure (t ha^{-1})
RSquare = 0.01089

Optimum manure and yield

Manure (t ha^{-1})	10
Yield (t ha^{-1})	7.38

Lower confident level =0
Upper confident level =0

DISCUSSION

Root yield per plant had a positive and significant association with plant height at seven weeks after sowing, total biomass and root length at BUK. This means the higher the plant height, total biomass and root length, the higher the root yield. This is similar to the results of Musa *et al.* (2020) who found that root yield per plant in radish showed a positive and significant association with root length. They also noted that path analysis revealed a positive direct effect on root yield through total plant weight and root length. Musa *et al.* (2020) reported that maximum radish yield was obtained due to higher fresh shoot weight, root length, and thickness of root, and there was a significant positive correlation.

Root diameter had no significant association with plant height at seven weeks after sowing, the number of leaves at seven weeks after sowing, and root length. This means that change in plant height at seven weeks after sowing, number of leaves at seven weeks after sowing, and root length, did not influence root diameter. At seven weeks after sowing and root length, the number of leaves showed a negative association with root diameter.

Root length was positively correlated with plant height at seven weeks after sowing, total biomass, root yield, and the number of leaves at seven weeks after sowing. An increase in any of the mentioned characters translates to an increase in root length because they are essential. This is similar to the findings of Musa *et al*. (2017), who noted that root

length in radish showed a positive and significant correlation with root yield per plant. Musa *et al*. (2020) reported that maximum radish yield was obtained due to higher fresh weight, length, and thickness of root, and there was a significant positive correlation. Similarly, Bashir *et al.* (2014) reported that root length and diameter, which are the yield contributing characters, revealed a significant positive correlation with all the characters (shoot height, root length, root diameter, number of leaves/plant, fresh weight of root and shoot and LAI).

At Bagauda, root yield had a significant positive correlation with the number of leaves at seven weeks after sowing, total biomass, root diameter, leaf area, LAI, and root length. This result infers that an increase in any mentioned characters will increase root yield. This is similar to the findings of Habu *et al*. (2012), Juan *et al*. (2010) and Oke (2012), who mentioned that root yield per plant in radish showed a positive and significant association with root length. They also mentioned that root yield per plant showed a positive and significant correlation with the number of leaves per plant at harvest. Musa *et al*. (2022) reported that radish yield exhibited a significantly high positive correlation with root length, root diameter, number of leaves, and LAI.

Root diameter positively correlated with the number of leaves at seven weeks after sowing, root length, leaf area, and LAI. This infers that an increase in any of the mentioned characters will increase root diameter. Musa *et al*. (2022) reported that root length and diameter, which are the yield contributing characters, revealed a significant positive correlation with all the characters in radish (shoot height, root length, root diameter, number of leaves/plant, fresh weight of root and shoot and LAI).

Root length showed a positive correlation with the number of leaves at seven weeks after sowing, total biomass, root diameter, root yield, leaf area, and LAI. This means that increase in any of the mentioned characters will increase root length. This is similar to the findings of Bashir et al. (2014), who reported that root length and diameter, which are the yield contributing characters, revealed a significant positive correlation with all the characters in radish (shoot height, root length, root diameter, number of leaves/plant, fresh weight of root and shoot and LAI). It's also similar to the findings of Anyaegbu (2010), who reported that maximum radish yield as obtained was due to higher fresh weight, length, and thickness of root, and there was a significant positive correlation.

The relationship between different spacing levels and cow dung manure rates with root yield revealed a linear regression at BUK and Bagauda. The analysis revealed that yield decreases with an increase in spacing. Regression analysis of manure and cow dung manure revealed a quadratic relationship. This indicates an increase in yield with the increase of cow dung manure from 0 to 10 t ha^{-1}, where optimum yield was obtained. Yield decreased with increased application of cow dung manure from 10 t ha^{-1} upwards.

CONCLUSION

The results of this study revealed positive associations between root yield and other parameters assessed at BUK and Bagauda. Results from regression analysis showed that planting at 12.5 cm spacing and application of 10 t ha^{-1} of cow dung manure is the optimum for yield in radish in the Sudan Savannah agro-ecological zone of Nigeria. We recommend that further research involving different varieties be conducted for more knowledge on the crop requirement in the Sudan Savannah.

Conflict of Interest

The authors declare that there is no competing financial interests or personal relationships that could have appeared to influence this research work.

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