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GROWTH AND YIELD OF BEETROOT (BETA VULGARIS) AS AFFECTED BY THE APPLICATION OF DIFFERENT SOURCES AND VARYING RATES OF NUTRIENTS OF ANIMAL ORIGIN IN GIDAN KWANU, MINNA, NIGER STATE OF NIGERIA

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ABSTRACT
Two experiments were conducted concurrently at the Horticultural Nursery of the Department of Crop Production, Federal University of Technology. Gidan Kwanu, Minna (latitude 6° 30' N and Longitude 9⁰ 40' E) during the dry season of 2016. The objective of the two trials was to determine the nutrient source and rates required in the production of beetroot *(Beta vulgaris)*. The experimental treatment consists of three organic nutrient sources namely; cow dung, poultry manure and goat droppings at ratio by weight of 1:1:2 and 1:1:4 of sand: topsoil and organic nutrient. The experiments were laid arranged in completely randomized design.(CRD) and replicated thrice. Improved seeds of beetroot were soaked for 24 hours and sown at 3cm depth. Data were collected on growth parameters such as crop germination, crop vigor, plant height, number of offshoot, leaf area index, shoot girth, and fresh leafy yield. All data collected were subjected to analysis of variance (ANOVA) and the means were separated using Duncan multiple range test(DMRT). Result obtained indicated that 10t ha^{-1} poultry manure exhibited better growth performance of beetroot and resulted in higher fresh leafy yield than all other organic sources and rates. The study therefore recommends the application of poultry manure at the rate of 10 t ha^{-1} for beetroot farmers in the study area.

KEY WORDS
Nutrient sources, nutrient rate, growth, leafy yield, beetroot.

Olericulture is a branch of science of horticulture related to vegetable production. Beetroot is a vegetable that is grown throughout the world.. Beetroots (*Beta vulgaris* L.) are known are best cultivated in cooler weather conditions but can also be cultivated in hot weather conditions. Vegetable production is mostly done on a small scale level to feed the farmer's family and where there is surplus it is been sold out by the farmer to generate income for the family mainly as a result of high nutrients required by vegetable. Chude *et al.* (2005) defined soil fertility as the capacity of the soil to provide adequate and balanced amount of nutrient for growth of plants. Several studies have also supported the assertion that the growth, development, yield as well as the quality of beetroot is influenced by application of nitrogenous fertilizer to the plant. Chatterjee *et al.*(2018) and Swedrzynska *et al.*(2017) observed that application of nitrogen fertilizer to beetroot plant at lower rate than the optimum rate required may results to lower yield and application above optimum rate may also leads to imbalanced partitioning of assimilates, increased concentrations of impurities and higher water retention by the beetroots resulting in lower amount of dry matter IFOAM (2005), described organic agriculture as a type of production system that supports and maintains the good health status of the ecosystems, biodiversity and humans and is been advocated as a measure in solving soil fertility problem. Organic farming is an envirometal friendly farming system that involves the use of natural resources that is readily available locally and the use of synthetic agricultural inputs such as pesticides herbicides, chemical fertilizers, growth hormones, antibiotics or gene manipulation are therefore avoided which in turn ,helps to sustain ecosystems and reduce pollution. Adeoye (2005), asserted that organic matter reduces the usage of external inputs by departing from the use of chemosynthetic fertilizers, pesticides and pharmaceuticals,but gives room for the laws of nature to come to play in producing crops that are disease free and resistance, as well as increase in agricultural yields.. Anderson, Jolly and Green (2005) also opined that organic farming involves the avoidance of the use of synthetic herbicides, pesticides and inorganic chemical fertilizers to control weeds and crop pests and to supply required nutrients but rather it involves the use of natural materials such as animal manures, off-farm organic wastes. crop residues, legumes and green manures as well as the usage of mechanical cultivation, crop rotation farming system and the control of crop pests biologically in order to improve and maintain soil productivity for better crop yield. In his own opinion,Conor (2004) sees organic farming as a modern farming methods which helps in the supply of food without the needs to pollute and degrade the environment with chemical and other by-products from the industry. The National Organic Standard Board (NOSB) also sees organic farming as a production system that helps to restore, enhance and maintain ecological harmony based on its ability to enhances and promotes biodiversity due to minimal usage of off-farm inputs (ATTRA, 2007). In otherword, organic farming is a production system that is more than just the usage or non-usage of certain agricultural inputs but a production system that brings about a sustainable ecosystems that supports the production of safe food to maintain good nutrition, as well as given good consideration to animal welfare plus maintainance of social justice (IFOAM, 2002; IFOAM, 2005).

In Nigeria as in other African countries, majority of farmers are small-scale traditional farmers whose practice is essentially organic; therefore, organic farming is not new in Nigeria. However, what the farmers need to carry out is an ideal recommended practice that could enhance growth and yield of crops. Beetroot, classified as cool season vegetable is also grown in hot areas of the tropics. Production of the crop is presently low, with little or no information on the cultural practices, especially in Nigeria. Beetroot is required to grow best in soils rich in organic nutrients. Continuous cropping of vegetables on a particular soil is usually associated with loss of organic matter and soil nutrients due to the harvesting of almost all parts of the vegetables from the field. The loss of these nutrients is usually not replenished fast leading to low soil fertility experienced in the savanna zones of Nigeria where most vegetable are grown (Chude *et al.* 2005).

Beetroots (*Beta Vulgaris* L.) are valuable crops due to its nutritional content and medicinal importance. Beetroots are especially good for the liver and for prevention of heart disease. They are highly rich in phytochemical, protein, carbohydrate, calcium, phosphorous and vitamin C whih makes it an ideal vegetable for health conscious people (Deuter and Grundy, 2004). Beetroot is also rich source of folic acid which makes it useful for pregnant women. Beetroots are also useful medically as anti-oxidant, anti-depressant, anti-microbial, antifungal, anti-inflammatory, diuretic, expectorant and carminative. It is highly rich in nitrates and sugar which makes it as one of the natural foods for athletes in boosting their energy(Yadav *et al*., 2016). Presently, there is limited or no research work on the growth of the crop in the savanna zones where vegetable strive best. More so, with the low production of beetroot, emphasis is placed on the root organ not the leafy vegetable which have been reported to contain higher nutrient content than Amaranth and are fast growing. Various researchers have carried out works on soil fertility using animal manure on vegetable productions. Animal manures contain high nutrient content, cheap and readily available. Based on the importance of beetroot enumerated above, the study is carried out to investigate the effect of different sources of nutrient at varying rates on the growth and yield of beetroot (*Beta vulgaris L*.) at Gidan Kwanu, Minna, Niger state of Nigeria.

MATERIALS AND METHODS OF RESEARCH

The studies were carried out at the horticultural nursery unit, Department of Crop Production, School of Agriculture and Agricultural Technology, Federal University of Technology Minna, Niger state of Nigeria. The geographical location of the site is latitude 6° 32' N and longitude 9° 40‘E,which lies at the southern Guinea savanna zone of Nigeria.

The experimental treatments were made of three nutrient sources namely; cow dung, poultry manure and goat droppings and the control which had zero nutrient. The treatments were applied at 10 and 15 tons per hectare, respectively and no application of manure that served as control.

The experimental treatments were arranged in Complete Randomized Design. The treatment combinations were replicated three times resulting in 21 plots per experimental trial.

The potting mixture was mixed with the potting materials that were collected as cured samples. The mixtures were measured on weight basis and experimental treatment combination. The field weighing scale was used to determine the weight. The mixture was done using the hand shovel until uniform constituents was attained. Each bag was labeled for identification on treatment basis and the potting bag was filled with the potting mixture using the hand trowel. Each potting mixture contained a mixture of 1river sand: 1 top soil + organic manure except for the control that contained only the river sand and top soil alone.

Improved seed of beetroot were purchased from reputable seed supplier in Kano, Kano State of Nigeria. Bakker Brothers of Holland marketed the seed, with validity date of 2018. It has germination percent of 85% and 99% respectively

Seeds were soaked for 24 hours, drained in sieve. Seed sowing was done by spot placement of seed per hole at 3cm depth intra-row spacing in the potting mixture alter watering appropriately.

Thinning and replacement of the seedling was carried out within 7 days after sowing in order to ensure uniform plant spacing of 3 cm gap within and between plants.

Supplementary application of organic manure was done uniformly 4 weeks after sowing (WAS) using cured manure of 10 g per stand per treatment.

Hand pulling of weed was carried out manually at 4 WAS in order to avoid inter plant competition with the crop.

Pest and disease control was carried out on weekly basis from 3 WAS when noticeable infestation was observed with the application of Kerate using the hand sprayer.

Harvesting was carried out manually by cutting the leaves when its exhibited sign of maturity with large and green healthy leaves.

Observation was carried out on the beetroot growth and yield on the following parameters:

Germination count of seeds was taken at 1 and 2 week alter sowing to determine the survival of seedling according to the treatment. The percent germination was also ascertained.

The crop vigour was observed at 1, 3, 5 and 7 week after sowing (WAS) by visual observation of the crop growth and development to ascertain the healthy nature of the crops. The scale of 5 was applied where 1 (one) indicated poor, unhealthy plant and (five) very vigorous and healthy plant. The crops were scored appropriately using the scale.

Two plant stands were tagged with various colored water straw per treatment for observation. The plant height was taken at 2, 4, 6 and 8 WAS. The plant height was done by measuring a plant from its base to the tip of the subtending leaves with a metre rule. The mean height of the two tagged plants was obtained and recorded appropriately per treatment.

Number of offshoot leaves was counted at 2, 4, 6 and 8 WAS per plant on two tagged plants per potting bag. Mean obtained was recorded.

Leal area was obtained by measuring the length and width of the leaves of a tagged plan and multiplying the measured length and width together. The length was obtained by measuring from the base to the tip while the width was determined by measuring the widest part of the leaves from one end to the other. This was measured at 2, 4, 6 and 8 WAS. The mean values of the leaf area was determined and recorded per plant per treatment.

This was taken at maturity alter harvesting by cutting the base and when the plant exhibited sign of maturity the matured leaves were harvested in succession and the cumulative weight obtained per plot.

The harvested leaves per plot were dried at room temperature to obtained the dry matter yield per plot in kilogramme.

Data collected from this study were subjected to analysis of variance (ANOVA) as described by Snedecor and Cochran (1994). The means were separated using Duncan Multiple Range Test (DMRT) as suggested by Duncan (1955) at 5% level of probability.

RESULTS AND DISCUSSION

Mean Values of Germination Count, and Seedling Vigour Score of Beetroot for the Two Trials. Table 1 shows the mean values of germination count, and seedling vigour score of beetroot for the two trials as affected by different nutrient sources applied at varying rates at the study site in 2016. The result revealed that significance difference (P≤ 0.05) was observed at 2 weeks after sowing (WAS) on germination count. Application of poultry manure at the rate of 10 tons per hectare produced the highest germination count of 79.4 % compared to the lowest germination count of 24. 6 % obtained with goat droppings application at the rate of 15 tons per hectare. Higher germination percentages observed with poultry manure, cow dung and goat dropping at lower rate of 10 tons per hectare could be the ability of the seedling to tolerate the rate and higher rate than that may be toxic to the plant.

The seedling vigour score of beetroot taking at 1, 3, 5 and 7 WAS showed significant difference across the treatments with application of poultry manure at the rate of 10 tons per hectare having the higest vigour score of 4.7 that was constant at 1,3,5 and 7 WAS which was statistically differ from the vigour score values obtained for seedlings that had zero nutrient application which is the control treatment during the same period of observation. At 1WAS, the vigour score of 4.7 recorded for plants that had poultrymanure application at the rate of 10 tons per hectare was statistically at par with the vigour score of 4,0 recorded for those plants with application of cow dung at the rate of 10 tons per hectare but differs significantly from the other treatments. At 3 WAS, the vigour score of 4.7 recorded for plants that had poultrymanure application at the rate of 10 tons per hectare was statistically at par with the vigour score of 4,0 and 4.7 recorded for those plants with application of cow dung at the rate of 10 tons per hectare and application of goat droppings at the rate of 10 tons per hectare, respectively, but differs significantly from the other treatments. The seedling vigour also exhibited better and improved growth performance with lower rate of 10 tons per hectare, an indication that the number of leaves increased properly with poultry manure application of 10 tons per hectare. The better growth performance of the crop with poultry manure application allow ability of the plant to photosynthesize efficiently.

Table 1 – Mean values of germination count, and seedling vigour score of beetroot for the two trials as affected by different sources of nutrient and varying rates of application

	Germination (%) at			Seedling vigour at			
Treatment	Rate (t/ha)	1WAS	2 WAS	1	3	5	7 (WAS)
Cow dung	10	74.6^a	78.0^a	4.0^a	4.0^a	4.3^{ab}	4.3^a
Cow dung	15	5.4^c	35.4^c	1.0^b	3.7^{ab}	3.7^{ab}	4.0^{ab}
Poultry Manure	10	79.4	79.4^a	4.7a	4.7^a	4.7^a	4.7^a
Poultry Manure	15	8.0^c	53.4^b	1.7^b	3.3^{ab}	3.3^{ab}	4.0^{ab}
Goat Droppings	10	78.0	72.0^a	1.0^b	4.7^a	4.0^{ab}	4.3a
Goat Droppings	15	0.6^c	24.6^a	1.0^b	3.3^{ab}	3.0^b	3.3^{ac}
No Manure	-	4.0^b	56.6^b	1.0^b	2.7^b	3.0^b	2.7^c
±SE	-	4.4	3.6	0.3	0.4	0.4	0.3

Note: WAS = Week after Sowing. ^{abc} = means with different alphabetic superscripts differ significantly from each other (P ≤ 0.05). SE- Standard Error.

Mean Values of Number of Offshoot Leaves of Beetroot for the Two Trials. The result of mean values of number of offshoot leaves of beetroot for the two trials as affected by different nutrient sources applied at varying rates at the study site in 2016 is presented in Table 2. The result revealed that the the number of offshoot leaves was greatly influence significantly by the experimental treatments. The analysis showed that at 2 WAS, plants that were treated wth poultry manure at the rate of 10 tons per hectare had the highest value of number of offshoot leaves of 2.7 that was statistically at par with every other treatments except for the application of goat droppings at the rate of 15 tons per hectare that produced the least number of offshoot leaves of 0.7. At 4WAS, the result also revealed that the number of leaves offshoot was significantly affected by the treatments with cow dung and poultry manure at 10 tons per hectare, respectively having the highest value of 5.0 compared to other treatments and treatment with goat dropping at 15 tons per hectares having the lowest number of leaves offshoo of 2.3. Similarly, there were significant differences ($P<0.05$) across the treatments on number of leaves offshoot at 5 and 7 WAS, respectively. At 6WAS, treatment with poultry manure and cow dung at the rate of 10 tons per hectare, respectively, produced the highest value of number of offshoot leaves of 7.0 that differ significantly from the other treatments with control treatment with zero or no nutrient having the least value of number of offshoot leaves of 3.0. While at 8WAS, plants with application of poultry manure at the rate of 10 tons per hectare produced the higest mean value of number of offshoot leaves of 9.0 which was statistically similar to mean value of 7.8 of number of offshoot leaves produced by plants treated with cow dung at the rate of 10 tons per hectare but significantly different from the other treatments with the control treatment with no nutrient application producing the lowest mean value of number of leaves offshoot of 4.3.

Table 2 – Mean values of number of offshoot leaves of beetroot for the two trials as affected by different sources of nutrient and varying rates of application

Treatment	Rate (t/ha)	Number of leaves at			
		2	4	6	8 (WAS)
Cow dung	10	2.7^a	5.0^a	7.0^a	7.8^a
Cow dung	15	2.0^a	3.0^b	5.0^b	7.7^b
Poultry Manure	10	2.7^a	5.0^a	7.0^a	9.0^a
Poultry Manure	15	2.3^a	3.0^b	5.0^b	7.7^b
Goat Droppings	10	2.3^a	3.0^b	5.0^b	7.7^b
Goat Droppings	15	0.7^b	2.3^c	4.3^c	7.7^b
No Nutrient	-	2.0^a	3.0^b	3.0^d	4.3^c
±SE[3]	-	0.4	0.1	0.1	0.1

Note: WAS = Week after Sowing. ^{abc} = means with different alphabetic superscripts differ significantly from each other ($P \leq 0.05$). SE- Standard Error.

Mean Values of Leaf Area of Beetroot for the Two Trials. The result of the mean values of leaf area of beetroot for the two trials as affected by different sources of nutrient at varying rate is presented in Table 3. The result indicates leaf area of beetroot was significantly affected by the different treatments at 4, 6 and 8WAS. The application of 10 ton per hectare of both cow dung and poultry manure at 4, 6, and 8 WAS affected leaf area were statistically at par and significantly ($P < 0.05$) differ from every other treatments. At 4 WAS, both cow dung and poultry manure at rate of 10 tons per hectare had the highest mean value of leaf area of 0.6cm^2, respectivel, while the control treatment, both poultry manure and goat droppings at the rate of 15 tons per hectare had the least mean value of leaf area of 0.2cm$^{2.}$ At 6 WAS, plants treated with poultry manure at the rate of 10 tons per hectare had the highest mean value of leaf area of 32.0cm^2 which was at par with 31.2cm^2 for cow dung, but the least mean vaue of leaf area of 14.3cm^2 was observed with control treatment with zero or no nutrient. Similar result was observed at 8 WAS with poultry manure having the highest mean value of leaf area of 36.2cm^2 that was statistically the same wth 35.0cm^2 for cow dung and the control with zero or no nutrients application had the lowest mean value of leaf area of 16.2 cm^2 . The increase of leaf area with nutrient application at 10 tons per hectare on beetroot plant may be because addition of organic manure artificially or naturally provides adequate organic matter which is a storehouse for nutrients and provides active site for nutrient retention. The poultry manure is known to have higher nitrogen that is paramount in photosynthetic activity and buildup of the plant tissue.

Table 3 – Mean values of leaf area of beetroot for the two trials as affected by different sources of nutrient and varying rates of application

Treatment	Rate (t/ha)	Leaf area (cm^2) at		
		4	6	8 (WAS)
Cow dung	10	0.6^a	31.2^a	35.0^a
Cow dung	15	0.3^b	20.7^{bc}	24.7^b
Poultry Manure	10	0.6^a	32.0^a	36.2^a
Poultry Manure	15	0.2^c	23.3^b	25.3^b
Goat Droppings	10	0.3^b	22.7^b	24.3^b
Goat Droppings	15	0.2^c	19.2^c	20.3^c
No Nutrient	-	0.2^c	14.3^d	16.2^d
±SE	-	0.0	1.1	1.7

Note: WAS = Week after Sowing. ^{abc} = means with different alphabetic superscripts differ significantly from each other (P ≤ 0.05). SE- Standard Error.

Mean Values of Plant Height of Beetroot for the Two Trials. Table 4 presents the result of the mean values of plant height of beetroot as affected by different s sources of nutrient and varying rates of application as supplied by different animal manuresi n the study site in 2016. Beetroot plant height was significantly affected the various treatments at 2,4,6 and 8 WAS, respectively. Poultry manure application at 2. 6 and 8 WAS using 10 tons per hectare significantly produced taller beetroot plants compare to all other nutrients application but was statistically similar to the usage of cow dung at the rate of 10 tons per hectare except at 2WAS that the two treatments differ significantly from each other. However at 4WAS, plants treated with cow dung at 10 tons per hectare produced taller plants (15.5cm) that was statistically similar to the plant height of 15.0cm produced by the application of poultry manure at the rate of 10 tons per hectare but differs significantly from all the other treatments with the mean least value of plant height of 7.8cm been observed from beetroot treated with goat droppings at the rate of 15 tons per hectare. All the treatments with organic nutrient from different animal sources had taller plant heights that were significantly different ($P < 0.05$) from the control treatment that had zero or no organic manure at 6 and 8 WAS. However, the usage of poultry manure and cow dung at the rate of 10 tons per hectare, respectively, consistently produced taller beetroot plants that were statistically different from the control treatment that had zero or no nutrients throughout the experimental period. The highest plant height obtained with the 10 tons of poultry manure per hectare from this study may be associated with the high nitrogen content in the manure compared to other animals manure and this helps the plant in building up its leafy tissues, which might have leads to an increase in the uptake of phosphorous and potassium by the plant, increase number of leaves and promotes growth attributes in general. The result obtained in this present study was in agreement with the work of Okokoh and Bisong (2011) that reported that application of 10 to 15 tons of poultry manure per hectare resulted in the increase of plant height for amaranthus vegetable. Aremu and Gad (2015) also observed that plant growth characters of roselle were significantly higher when poultry manure al the rate of 2 tons per hectare was applied ccompare to non-application of manure that servrs as control

Table 4 – Mean values of plant height of beetroot for the two trials as affected by different sources of nutrient and varying rates of application

Treatment	Rate (t/ha)	Plant height (cm) at			
		2	4	6	8 (WAS)
Cow dung	10	2.2^b	15.5^a	18.0^a	35.0^a
Cow dung	15	1.2^c	8.5^b	19.0^a	24.7^b
Poultry Manure	10	3.3^a	15.0^a	18.8^a	36.2^a
Poultry Manure	15	1.8^b	8.67^b	12.8^b	25.3^b
Goat Droppings	10	1.8^b	8.8^b	16.0^a	24.3^b
Goat Droppings	15	1.0^c	7.8^b	13.0^b	20.3^c
No Nutrient	-	1.0^c	9.0^b	10.0^c	16.3^d
±SE	-	0.1	1.1	1.1	1.2

Note: WAS = Week after Sowing. ^{abc} = means with different alphabetic superscripts differ significantly from each other (P ≤ 0.05). SE- Standard Error.

Mean Values of Fresh and Dry Leafy Weight(Yield) of Beetroot for the Two Trials. Table 5 presents the result of the mean values of both fresh and dry leafy weight (yield) of beetroot per plot at harvest , respectively, as influenced by different sources of nutrient at varying rates of application as supplied by different animals manure in the study site in 2016. The result revealed a significant difference (P <0.05) among the treatments for both yield parameters measured. Poultry manure application at 10 ton/ha gave 12.6kg/plot of fresh leafy yield and was comparable to cow dung of 11.11kg/plot but significantly differs from the control with no nutrients and other treatments. All other treatments produced lower fresh leafy yield at higher rates of 15 ton/ha and goat droppings at 10 ton/ha.

Table 5 – Mean values of fresh and dry leafy weight(yield) of beetroot for the two trials as affected by different sources of nutrients and varying rates of application

Treatment	Rate (t/ha)	Fresh leafy yield at harvest(Kg)	Dry leafy weight at harvest(Kg)
Cow dung	10	11.11^{a}	8.89a
Cow dung	15	5.96^{c}	4.77c
Poultry Manure	10	12.6^{a}	10.08a
Poultry Manure	15	8.9^{ba}	7.12ba
Goat Droppings	10	6.6^{bc}	5.28bc
Goat Droppings	15	4.0^{c}	3.2c
No Nutrient	-	3.5^{c}	2.8c
±SE	-	1.2	0.96

Note: WAS = Week after Sowing. ^{abc} = means with different alphabetic superscripts differ significantly from each other (P ≤ 0.05). SE- Standard Error.

The least fresh leafy yield of 3.5kg/plot was obtained with no nutrient application. At harvest, both poultry manure rates of 10 ton/ha and cow dung at 10 ton/ha had significantly higher plant dry weight compared to the control and all other treatments. The poultry manure at the rate of 10 tons per hectare produced the highest mean value of dry leafy weight of beetroot of 10.08Kg that was statistically similar to that of 8. 89Kg produced by cow dung at the rate of 10 tons per hectare while the least mean value of dry leafy weight of beetroot (2.8kg) was realized from the control treatment which had zero or no nutrients application. The corresponding taller height observed with poultry manure at 10 tons per hectare throughout the observation period is also an indication of improved plant growth, thus leading to higher plant dry yield matter accumulation and resultant fresh leafy yield obtained at harvest.

CONCLUSION

Potting experiment was conducted at horticultural nursery of the Department of Crop Production, Federal University of Technology Gidan Kwano, Minna during the dry season of 2016. The objective was to determine the effect of different sources of nutrient at varying rates on growth and leafy yield of beetroot (*Beta vulgaris*).The experimental treatments consists of three organic nutrient sources namely; cow dung, poultry manure and goat droppings at the rates of 10 tons and 15 tons per hectare, respectively,with no nutrient as control. The result obtained indicated that 10 tons per hectare of poultry manure exhibited better growth performance of beetroot and resulted in higher leafy yield. Therefore, application of poultry manure at the rate of 10 tons per hectare may be recommended for leafy yield of beetroot production for farmers in the study area which is located in the southern Guinea savanna ecological zone of Nigeria.

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