

# Effects of different poultry waste manure rates and irrigation intervals on okra (*Abelmoschus esculentus* L.) growth and yield performance

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**Summary:** The use of organic addition has been found to be an environmentally beneficial method for enhancing quality of crops with good soil quality. Similarly, selection of suitable irrigation period is an important factor for optimum crop production. A study was conducted to evaluate the effects of chicken manure and irrigation interval on the development and production of okra in a greenhouse. The poultry manure was applied to 5 kg soil at three different rates, namely: 20 t ha<sup>-1</sup> (T<sub>1</sub>), 40 t ha<sup>-1</sup> (T<sub>2</sub>), and 60 t ha<sup>-1</sup> (T<sub>3</sub>), and the fourth group without poultry manure treatment were set up as the control. Four levels of irrigation intervals (3, 6, 9 and 12 days) were selected for the study. Plant height, number of leaves, leaf area (cm<sup>2</sup>), and stem diameter were all assessed as growth metrics. Leaf fresh weight, leaf dry weight, shoot fresh weight, shoot dry weight, root fresh weight, root dry weight, and total plant dry weight were the yield characteristics that were measured. The findings indicated that increasing poultry manure rates enhanced the examined growth and yield parameters, but increasing irrigation intervals decreased the studied growth and yield characteristics of *Abelmoschus esculentus*. The interplay between chicken manure and irrigation intervals, on the other hand, had no significant effect on leaf area and stem diameter. Finally, the application of 60 t ha<sup>-1</sup> poultry manure and a three-day watering interval boosted the development of *Abelmoschus esculentus*.

**Keywords:** *Abelmoschus esculentus*, irrigation, okra, poultry manure, yield

## Introduction

Okra (*Abelmoschus esculentus* (L.) Moench) is a tropical and subtropical annual vegetable that belongs to the *Malhaceae* family. In addition to being a highly nutritious vegetable, okra has medicinal properties. Many minerals, such as phosphorus, potassium, and sulfur, as well as vitamins A and B can be found in it, along with vitamin C. Okra produces fruits for an extended period of time, necessitating a steady supply of plant nutrients, both macro and micro, for higher yields and better quality. For harnessing the higher yields and better quality, adequate quantities of plant

nutrients are pre-requisites, which can be supplied both by organic and inorganic sources. One of the main obstacles in producing higher yields is insufficient or imbalanced nutrient sources. The continuous and indiscriminate use of inorganic fertilizers has resulted in decreased nutrient uptake and adversely affected the quality of vegetables (Agarwal, 2003). Thus, there is a growing need to use other plant nutrient sources for sustainability of okra production. The answer lies in the use of organic manures, which aims at cooperating rather than confronting with nature. A wide range of organic manures like farm yard manure, sheep manure, poultry manure, composts and bio-fertilizers are used. However, poultry manure is superior and nutritionally rich, as it contains growth promoting substances which induce better plant growth.

Water stress is one of the most significant constraints to crop production, and it is becoming a more serious issue in many parts of the world (Passioura, 2007). Rivalry among various sectors, - agricultural, communities, industry, nature, becomes more intense, with agriculture bearing the brunt of the

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demand for precious water resources, since its production per unit water is much lower than that of the other economic sectors. Climate change has caused substantial uncertainty and farming restriction owing to frequent drought occurrences, which has had severe negative consequences on livelihood and food security, particularly for rural people. Because the world water supply is limited, future food and fodder demand for rapidly growing population pressures will likely increase the importance of water stress research (Somerville & Briscoe, 2001). Water stress reduces leaf size, stems extension, and root proliferation, disrupts plant relationships, and lowers plant water use efficiency (Farooq et al. 2008). Water stress is one of the crop growth and yield limiting factors, reducing dry matter production, yield, and yield components by decreasing leaf area and speeding up leaf senescence (Emam & Seghatoleslami, 2005).

Drought is a significant factor restricting agricultural output and has resulted in a decline in food production by lowering water and nutrient intake (Du et al. 2010). Climate change and competition from other water users have depleted water resources (Farahani et al. 2007). Irrigation is a reliable approach to mitigate climatic consequences because it is utilized to supplement occasional or irregular rainfall, as well as during dry seasons (Idoga et al. 1998). Okra can grow in poor soils, although it likes well-drained sandy loams with a pH of 6-7 and high organic matter content (Lamont 1999, Adilakshmi et al. 2008, Akanbi et al. 2010, Akande et al. 2010). In order to develop its young edible fruits over a reasonably long length of time, okra requires a moderate rainfall of 80-100 cm that is evenly distributed. An ideal temperature range for growth, flowering, and fruiting is 20°C to 30°C (Akinyele & Temikotan 2007, Dada & Fayinminnu 2010). Despite the nutritional quality of these crops, large production is limited to the rainy season owing to scarcity of water supply during off season. In the light of the above and owing to limited literature on the response of *Abelmoschus esculentus* on poultry waste manure and irrigation, an investigation was carried out to assess the effects of poultry manure and irrigation interval on the growth and yield performance of okra (*Abelmoschus esculentus*) in a greenhouse.

## Material and Methods

The experiment was carried out at Ebonyi State University Screen House of Biotechnology Research and Development Centre in Abakaliki, Nigeria located on latitude 6°22'26"N and longitude 8°6'6"E. The average atmospheric temperature was 32-35°C (Epidi et al. 2008).

Soil samples were taken using a soil auger at a depth of 0-15 cm. The soil was sieved through a 2 mm mesh sieve to remove large objects, dead woods and root fragments and was air dried for 7 days. The soil samples weighing 5 kg were put into plastic pots with a height of

22 cm and a diameter of 23.5 cm with perforations in the bottom for draining of excess water and set in a completely random design. The poultry manure (PM) was applied to the 5 kg soil at 3 rates, namely: 20 t ha<sup>-1</sup> (T<sub>1</sub>), 40 t ha<sup>-1</sup> (T<sub>2</sub>), and 60 t ha<sup>-1</sup> (T<sub>3</sub>). The group without poultry manure treatment was set up as the control. Each treatment was replicated four times. These treatments were labeled accordingly. The PM was thoroughly mixed with the 5 kg soil in the experimental pots and after two weeks of consistent watering in the greenhouse, the plastic pots were weighed 48 hours later to calculate their weight at field capacity based on the assumption that free gravity water had ceased draining (Richard & Weaver, 1994). In each pot, 4 seeds were planted at a depth of 2.0 cm. The seedlings were thinned down to 2 seedlings per pot after germination and establishment. Water stress was now induced by observing irrigation intervals of 3, 6, 9 and 12 days based on field capacity water content. For 56 days, plant height, leaf length, leaf breadth, stem diameter, number of leaves, and leaf area were all measured on a weekly basis. Plants were separated into leaves, stems, and roots in each replicate. In order to determine dry weight, these were placed in separate envelopes and oven dried for 4 days at 70° C.

Sandy loam soil samples from each treatment were collected in triplicates, air dried, and sieved through a 2 mm mesh prior to analysis to remove coarse rock and plant material, and then thoroughly mixed to ensure uniformity. The soil physico-chemical properties of the sieved soil samples were determined using a standard procedure developed by Sertsu & Bekele (2000).

The data collected were subjected to analysis of variance (ANOVA) at 5% using SPSS version 23 and the means were separated using Tukey's HSD test.

## Results and discussion

The physico-chemical characteristics of soil receiving different dosage of poultry manure are as presented below (Table 1). The application of waste manure brought about an increase in the organic matter of the soil, and a decrease in the bulk density with no soil textural change. There was an increase in available micronutrients, EC, pH, P, K, Ca and Mg in comparison to the control (0 t ha<sup>-1</sup>). In the treatment receiving 60 t ha<sup>-1</sup>, the highest amounts of N (0.26 mgkg<sup>-1</sup>), P (31.30 mgkg<sup>-1</sup>), K (0.24 mgkg<sup>-1</sup>), Ca (8.00 mgkg<sup>-1</sup>) were recorded. Cu (33.20 mgkg<sup>-1</sup>), Fe (115.95 mgkg<sup>-1</sup>), Mn (18.34 mgkg<sup>-1</sup>), Na (0.17 mgkg<sup>-1</sup>) and Mg (4.65 mgkg<sup>-1</sup>) were also maximum in the treatment with 60 t ha<sup>-1</sup>. The pH of the soil increased from 5.40 at 0 t ha<sup>-1</sup> to 6.70 on application of PM at 60 t ha<sup>-1</sup>. The soil electrical conductivity increased from 7.40 to 7.56 at 60 t ha<sup>-1</sup>. There was an increase in the organic matter of the soil from 1.28 mgkg<sup>-1</sup> to 6 mgkg<sup>-1</sup> with increasing levels of poultry manure. The textural class of the soil was sandy loam. Soil of this textural class lacks retention capacity for basic nutrients and water (Ukabiala et al.

2016). The pH of the soil was slightly acidic and thus could have arisen from the leaching out of basic cations due to frequent irrigation. There was an increase in the micro and macronutrients of the soil on application with of poultry waste manure. These nutrients increased with increase in the quantity applied. Our results are in agreement with Ewulo & Omoju (2015), Amusan and Ojeniyi (2011), Adekiya et al. (2012), and Voor et al. (2018). The addition of poultry manure to soil increases soil organic matter, N and P, and aggregate stability, creating a favorable environment for biological processes in the rhizosphere and nutrient availability for plants (Adesodun et al. 2005, Valiki et al. 2015). The increase in soil organic matter may be responsible for the enhanced availability of total N, bioavailable P, exchangeable K, Ca, and Mg found with increasing rates of poultry manure. This is due to the fact that soil organic matter has been widely reported as a reservoir of many plant nutrients, implying that plant nutrients are inextricably linked to it (Robertson et al. 2004, Raper 2009).

The application of PM increased soil pH, which could be due to increased organic matter content in the soil. This supports Magdoff (1998) that organic matter serves as a source of plant nutrients, has a high cation exchange capacity, and acts as a pH buffer in the soil. Our results agree with Voor et al. (2018), but are contrary to the previously published report on maize (Ewulo & Omoju, 2015). The poultry manure release of specific exchangeable bases is responsible for the rise in soil pH caused by poultry manure application. This supports the findings of Nottidge et al. (2010), who discovered a significant increase in soil pH as a result of an increase in exchangeable bases after the addition of organic amendments. Similarly, other researchers

(Marschner 1995, Walker et al. 2005) reported significant changes in soil pH as a result of organic matter oxidation and CO<sub>2</sub> emission in the soil after the addition of organic material.

*The growth and yield characteristics of *Abelmoschus esculentus* grown at different poultry waste amendment rates at 56 days after sowing (DAS)*

The application of the different rates (20 t ha<sup>-1</sup> (T<sub>1</sub>), 40 t ha<sup>-1</sup> (T<sub>2</sub>), and 60 t ha<sup>-1</sup>(T<sub>3</sub>)) of PM positively increased okra growth characteristics to a varying degree compared with the control (T<sub>0</sub>). There were significant variations (p<0.05) on okra plant height, number of leaves, leaf area and stem diameter due to PM application rates (Table 2). The highest plant height, number of leaves, leaf area and stem diameter mean values of 32.14, 7.67, 91.37 and 495.87 respectively of okra plants in pots treated with 60 t ha<sup>-1</sup> (T<sub>3</sub>) were observed and it was statistically comparable to plants in pots treated with 20 t ha<sup>-1</sup> (T<sub>1</sub>) and the control (T<sub>0</sub>) (Table 2). The effect of poultry manure on the yield of *Abelmoschus esculentus* is as shown in Table 3. The yields of *Abelmoschus esculentus* were significantly affected in all the treatments (p<0.05). In terms of leaf fresh weight, leaf dry weight, shoot fresh weight, shoot dry weight, root fresh weight, root dry weight, and total plant dry weight, the poultry waste manure application rate 60 t ha<sup>-1</sup> (T<sub>3</sub>) yielded the highest mean yield of 5.23, 0.82, 16.48, 3.29, 1.41, 0.51, and 3.80. The mean yield values for the control (T<sub>0</sub>) were the lowest. The organic modifications of the soil, as well as the supply of nutrients for crops, are driving factors for the application of PM. The improved morphological development of okra must be attributed to the plant's

Table 1. The impact of poultry waste manure on soil physicochemical properties

Element	Unit	T <sub>0</sub>	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>
Textural class	-	Sandy loam	Sandy loam	Sandy loam	Sandy loam
pH	-	5.40	5.60	6.10	6.70
Electrical conductivity	dS m <sup>-1</sup>	7.40	7.45	7.48	7.56
Bulk density	gmcm <sup>-3</sup>	0.89	0.73	0.70	0.70
Calcium	mgkg <sup>-1</sup>	4.80	6.48	6.79	8.00
Magnesium	mgkg <sup>-1</sup>	2.58	4.00	4.30	4.65
Organic matter	mgkg <sup>-1</sup>	1.28	1.40	5.00	6.00
Total N	mgkg <sup>-1</sup>	0.08	0.13	0.17	0.26
Available P	mgkg <sup>-1</sup>	21.00	27.00	27.98	31.30
Copper	mgkg <sup>-1</sup>	13.38	19.76	24.61	33.20
Iron	mgkg <sup>-1</sup>	69.90	88.96	94.55	115.95
Manganese	mgkg <sup>-1</sup>	6.97	8.98	13.69	18.34
Sodium	Cmolkg <sup>-1</sup>	0.07	0.14	0.16	0.17
Potassium	Cmolkg <sup>-1</sup>	0.121	0.13	0.22	0.24

easy availability and best conditions for quick absorption by the roots. Poultry manure has been shown to improve the vegetative growth of okra due to its high nutrient content, rapid mineralization, optimal C/N ratio, nitrogen availability, and growth promoting substances. Earlier studies have found similar positive effects of PM (Onwu et al. 2014, Tihamiyu et al. 2012, Ali et al. 2014, Voor et al. 2018). According to Uka et al. (2013), using poultry droppings resulted in plants with the greatest plant height, leaf area, and fresh weight.

#### *Effects of irrigation days on *Abelmoschus esculentus* growth and yield characteristics*

The analyses of observations showed that different irrigation days responded differently to growth characteristics of okra. Irrigation intervals (water stress) had a significant ( $p < 0.05$ ) effect on all growth parameters studied. The results showed reduction in the values of the parameters when compared with control (3 days) resulting from increasing irrigation intervals (3 days > 6 days > 9 days > 12 days irrigation intervals). In comparison to the 6, 9, and 12 day-period irrigation, irrigation every three days significantly increased mean okra plant height, number of leaves, leaf area, and stem diameter (31.03, 7.35, 109.97, and 512.38), respectively

(Table 2). The irrigation interval had a significant ( $p < 0.05$ ) effect on yield in the test crop *Abelmoschus esculentus*. When irrigated every three days, okra plants had the highest mean leaf fresh weight (4.29 g), leaf dry weight (0.88 g), shoot fresh weight (20.87 g), shoot dry weight (3.58 g), root fresh weight (1.81 g), root dry weight (0.59 g), and total plant dry weight (4.17 g), and lowest when irrigated every 12 days (Table 3). The results of this study are similar to those reported by Al-Ubaydi et al. (2017), Ghannad et al. (2014a), but contrary to Habtamu et al. (2014) who reported that an increase in plant height as irrigation interval increases from 3 to 6 days and a gradual decrease after 6 days and a maximum number of leaves at 6 days irrigating frequency. According to Guitierrez-Boen & Thomas (1999), a decrease in soil water availability influences the velocity of diffusion of numerous plant nutrients, and thus their composition and concentration. Similarly, Schaff & Skogley (1982) found that the lack of water reduced the diffusive transport of numerous plant nutrients to the root system. A significant decrease in nutrient uptake has been recorded during periods of water stress (Marschner 1995), due to decreased ion transport to the root. Abd-El-Kader et al. (2010) observed a reduction in the morphological

Table 2. Effects of different poultry manure amendment rates and irrigation days on the growth characteristics of *Abelmoschus esculentus* at 56 DAS

Treatment	Growth characteristics			
	Plant height (cm)	Number of leaves	Leaf area (cm <sup>2</sup> )	Stem diameter (mm)
T <sub>0</sub>	17.73±1.47 <sup>a</sup>	4.58±0.47 <sup>a</sup>	21.67±4.38 <sup>a</sup>	240.08±28.93 <sup>a</sup>
T <sub>1</sub>	25.18±1.08 <sup>b</sup>	6.48±0.39 <sup>b</sup>	42.31±6.55 <sup>b</sup>	374.22±27.07 <sup>b</sup>
T <sub>2</sub>	29.22±0.98 <sup>c</sup>	7.20±0.40 <sup>b</sup>	85.55±11.75 <sup>c</sup>	454.95±29.13 <sup>bc</sup>
T <sub>3</sub>	32.14±1.13 <sup>c</sup>	7.67±0.42 <sup>b</sup>	91.37±12.31 <sup>c</sup>	495.87±31.85 <sup>cc</sup>
Irrigation interval				
3rd day	31.03±1.27 <sup>a</sup>	7.35±0.39 <sup>a</sup>	109.97±14.42 <sup>a</sup>	512.38±31.74 <sup>a</sup>
6th day	28.54±1.04 <sup>a</sup>	7.03±0.40 <sup>a</sup>	67.38±9.79 <sup>b</sup>	425.20±26.65 <sup>ab</sup>
9th day	23.37±1.29 <sup>b</sup>	6.13±0.45 <sup>ab</sup>	32.74±4.12 <sup>c</sup>	345.25±29.58 <sup>bb</sup>
12th day	21.32±1.45 <sup>b</sup>	5.42±0.49 <sup>bb</sup>	30.81±4.42 <sup>c</sup>	282.30±31.19 <sup>bb</sup>

At 5%, the means in a column followed by the same letters do not differ significantly ( $P < 0.05$ )

Table 3. Effect of poultry manure and irrigation days on yield of *Abelmoschus esculentus* at 56 DAS

Treatment	Yield						
	Leaf fresh weight (g)	Leaf dry weight (g)	Shoot fresh weight (g)	Shoot dry weight (g)	Root fresh weight (g)	Root dry weight (g)	Total Plant dry weight (g)
T <sub>0</sub>	1.54±0.40 <sup>a</sup>	0.24±0.07 <sup>a</sup>	6.43±1.74 <sup>a</sup>	1.27±0.36 <sup>a</sup>	0.51±0.19 <sup>a</sup>	0.16±0.05 <sup>a</sup>	1.43±0.41 <sup>a</sup>
T <sub>1</sub>	2.23±0.36 <sup>a</sup>	0.36±0.09 <sup>a</sup>	9.49±2.46 <sup>ab</sup>	1.70±0.30 <sup>ab</sup>	0.88±0.26 <sup>ab</sup>	0.23±0.07 <sup>ab</sup>	1.93±0.36 <sup>a</sup>
T <sub>2</sub>	3.81±0.21 <sup>b</sup>	0.71±0.11 <sup>b</sup>	14.38±2.65 <sup>ab</sup>	2.24±0.36 <sup>ab</sup>	1.08±0.25 <sup>ab</sup>	0.42±0.08 <sup>bbc</sup>	2.66±0.44 <sup>ab</sup>
T <sub>3</sub>	5.23±0.36 <sup>c</sup>	0.82±0.11 <sup>b</sup>	16.48±3.26 <sup>bb</sup>	3.29±0.63 <sup>bb</sup>	1.41±0.19 <sup>bb</sup>	0.51±0.08 <sup>cc</sup>	3.80±0.71 <sup>bb</sup>
Irrigation interval							
3rd day	4.29±0.49 <sup>a</sup>	0.88±0.10 <sup>a</sup>	20.87±2.39 <sup>a</sup>	3.58±0.54 <sup>a</sup>	1.81±0.12 <sup>a</sup>	0.59±0.06 <sup>a</sup>	4.17±0.60 <sup>a</sup>
6th day	3.56±0.47 <sup>ab</sup>	0.62±0.12 <sup>ab</sup>	14.28±1.55 <sup>b</sup>	2.64±0.19 <sup>a</sup>	1.19±0.13 <sup>b</sup>	0.38±0.07 <sup>b</sup>	3.01±0.26 <sup>a</sup>
9th day	2.99±0.65 <sup>ab</sup>	0.39±0.08 <sup>bbc</sup>	8.41±1.49 <sup>c</sup>	1.51±0.23 <sup>b</sup>	0.55±0.15 <sup>c</sup>	0.22±0.05 <sup>bc</sup>	1.73±0.28 <sup>b</sup>
12th day	1.97±0.58 <sup>bb</sup>	0.24±0.07 <sup>c</sup>	3.22±0.78 <sup>c</sup>	0.78±0.21 <sup>b</sup>	0.31±0.11 <sup>c</sup>	0.13±0.04 <sup>c</sup>	0.90±0.25 <sup>b</sup>

Mean + SE in the same column with different letters in superscript differs significantly ( $P < 0.05$ )

Table 4. Interactive effect of poultry manure amended soil and irrigation days on selected growth characteristics of *Abelmoschus esculentus*

Treatment	Irrigation days	Plant height (cm)	Leaf number	Leaf area (cm <sup>2</sup> )	Stem diameter (mm)
T <sub>0</sub>	3rd day	26.71	6.81	50.44	407.25
	6th day	24.23	6.62	25.93	361.18
	9th day	14.91	3.87	9.23	162.12
	12th day	5.05	1.00	1.05	29.75
	Mean	17.72	4.57	21.66	240.07
T <sub>1</sub>	3rd day	28.08	6.93	87.66	454.37
	6th day	25.89	6.56	30.91	399.31
	9th day	25.45	6.43	27.37	340.43
	12th day	21.29	6.00	23.29	302.75
	Mean	25.18(42.10)	6.48(41.79)	42.31(95.34)	374.22(55.88)
T <sub>2</sub>	3rd day	32.43	7.68	140.50	540.81
	6th day	30.41	7.18	104.83	482.12
	9th day	27.56	7.06	52.91	429.50
	12th day	26.45	6.87	43.93	367.37
	Mean	29.21(16.00)	7.20(11.11)	85.54(102.17)	454.95(21.57)
T <sub>3</sub>	3rd day	36.90	8.00	161.28	647.06
	6th day	33.63	7.75	107.82	458.17
	9th day	29.70	7.56	54.47	486.62
	12th day	28.33	7.37	41.90	391.62
	Mean	32.14(10.03)	7.66(6.39)	91.37(6.82)	495.87(8.99)
Poultry manure		*	*	*	*
Irrigation days		*	*	*	*
Poultry manure × Irrigation days		*	*	NS	NS

\*P<0.05= Significant ( ) = Percentage Increase

characteristics of okra due to increasing irrigation intervals. The irrigation enables the mineral elements to be dissolved and conveyed to various plant parts and the water is highly imported into the photosynthetic apparatus, making water an important factor affecting plant growth (El-Sahookie et al. 2009).

The effect of irrigation intervals on the growth and yield of okra could be attributed to the plant stomatal activities, which are influenced at these intervals. The intervals between irrigation had an effect on the opening and closing of the stomata, particularly the stomata of the leaf (Anant et al. 2009), and the plant was saved from drought. Reduced plant height, leaf area, yield, and other characteristics at higher irrigation intervals may be due to decreased cell enlargement and increased leaf senescence as a result of reduced turgor pressure (Shao et al. 2008, Farooq et al. 2009), or to decreased photosynthesis and altered canopy structure (Shao et al. 2008). According to Leithy et al. (2006), decreased plant growth is linked to a lower rate of photosynthesis due to deteriorating stomatal behavior. The development of an optimum leaf area for photosynthesis and yield development (Jaleel et al. 2009) is a must, because when the leaf area is smaller, the

capacity to capture light decreases, resulting in a lower photosynthesis rate (Khalid 2006) and growth. Furthermore, the impact of reduced irrigation on plant growth could be due to a lack of adequate moisture in the rhizosphere and lower nutrient absorption (Singh et al. 1997). Plant size and growth may be reduced as a result of a decrease in the activity of meristemic tissues responsible for elongation when exposed to water stress (Siddique et al. 1999).

#### *Interactive effect of poultry manure and irrigation days on selected growth characteristics of Abelmoschus esculentus*

The interaction between poultry manure amended soil and irrigation days on the growth of *Abelmoschus esculentus* are presented in Table 4. In okra plant height and number of leaves, the levels of interaction between PM amended soil and irrigation intervals were statistically significant ( $p < 0.05$ ). The PM application rate (60t ha<sup>-1</sup> T<sub>3</sub>) and the third day irrigation interval produced the tallest and most leafy okra plants. Plant height and number of leaves were significantly ( $p < 0.05$ ) influenced by poultry manure amended soil and irrigation intervals (Table 4). Plant height, number of

Table 5. Interactive effects of poultry manure and irrigation days on yield of *Abelmoschus esculentus*

Treatment	Irrigation Days	Leaf fresh weight (g)	Leaf dry weight (g)	Shoot fresh weight (g)	Shoot dry weight (g)	Root fresh weight (g)	Root dry weight (g)	Total plant dry weight (g)
T <sub>0</sub>	3rd day	2.75	0.50	11.50	2.38	1.30	0.38	2.75
	6th day	2.25	0.30	10.00	2.00	0.60	0.15	2.15
	9th day	1.15	0.18	4.20	0.70	0.13	0.10	0.80
	12th day	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Mean	1.54	0.24	6.43	1.27	0.51	0.16	1.43
T <sub>1</sub>	3rd day	3.50	0.78	19.73	2.60	1.78	0.50	3.10
	6th day	2.70	0.30	10.35	2.30	1.28	0.25	2.55
	9th day	1.75	0.20	5.00	1.28	0.30	0.10	1.38
	12th day	0.95	0.15	2.88	0.63	0.15	0.05	0.68
	Mean	2.23(44.81)	0.36(50.00)	9.49(47.59)	1.70(33.86)	0.88(72.55)	0.23(43.75)	1.93(34.97)
T <sub>2</sub>	3rd day	4.70	1.08	23.38	3.35	2.00	0.70	4.05
	6th day	3.78	0.88	18.28	2.98	1.40	0.50	3.48
	9th day	3.50	0.60	10.88	1.68	0.60	0.30	1.98
	12th day	3.25	0.30	5.00	0.98	0.30	0.18	1.15
	Mean	3.81(70.85)	0.71(97.22)	14.38(51.53)	2.24(31.76)	1.08(22.73)	0.42(82.61)	2.66(37.82)
T <sub>3</sub>	3rd day	6.20	1.18	28.88	5.98	2.18	0.80	6.78
	6th day	5.50	1.00	18.50	3.28	1.50	0.60	3.88
	9th day	5.55	0.60	13.55	2.40	1.18	0.38	2.78
	12th day	3.68	0.50	5.00	1.50	0.78	0.28	1.78
	Mean	5.23(37.27)	0.82(15.49)	16.48(14.60)	3.29(46.88)	1.41(30.56)	0.51(21.43)	3.80(42.86)
Poultry Manure		*	*	*	*	*	*	*
Irrigation Days		*	*	*	*	*	*	*
Poultry Manure × Irrigation Days		*	*	*	*	*	*	*

\*P&lt;0.05= Significant ( ) = Percentage Increase

leaves, leaf area, and stem diameter were all highest with 60 t ha<sup>-1</sup> (T<sub>3</sub>) and 3rd day of irrigation. With respect to plant height (5.05), leaf number (1.00) and area of leaves (1.05), the lowest values were recorded in control (T<sub>0</sub>) combine with the 12-day irrigation period. The increases in plant height, number of leaves, leaf area, and stem diameter caused by PM amendment and irrigation interval were 38.15%, 17.47%, 219.75%, and 58.89%, respectively. The interactive effect of PM amended soil and irrigation days on yield of *Abelmoschus esculentus* are presented in Table 5. The interaction between PM and irrigation interval was significant (p<0.05) on yield of *Abelmoschus esculentus*. Root dry weight and total plant dry

weight were obtained with T<sub>3</sub> combined with 3rd day irrigation. The highest values of leaf fresh weight (6.20), leaf dry weight (1.18), shoot fresh weight (28.88) shoot dry weight (5.98), root fresh weight (2.18), root dry weight (0.80) and total plant dry weight (6.78) were recorded with T<sub>3</sub> combined at 3rd day of irrigation. On the other hand, lowest values of (0.00) were recorded for the entire yield studied with T<sub>0</sub> combined with 12th day irrigation period. There was an increase of 125.45%, 136%, 151.13%, 67.69%, 110.55% and 146.55% respectively. Interactive effect of PM amended soil and Irrigation days enhanced the growth and yield of *Abelmoschus esculentus*. Low water supply levels,

according to Chemura (2014), highlight the importance of organic manure in regulating soil water for plant use. Similarly, Ibrahim & El-Samad (2009) reported that increasing the amount of organic manure in the soil reduces water use significantly.

## Conclusions

There was an increase in the micro and macronutrients of the soil on application of poultry waste manure. In the treatment receiving 60 t ha<sup>-1</sup>, the highest amounts of micro and macronutrients, pH, and electrical conductivity of the soil were observed. Poultry waste manure had a positive effect on *Abelmoschus esculentus* growth in terms of plant height, number of leaves, leaf area, stem diameter, and yield parameters such as leaf fresh weight, leaf dry weight, shoot fresh weight, shoot dry weight, root fresh weight, root dry weight, and total plant dry weight. Increased irrigation intervals, on the other hand, had a negative impact on *Abelmoschus esculentus* growth and yield. The use of 60 t ha<sup>-1</sup> poultry manure and a three-day irrigation interval will enhance the growth of *Abelmoschus esculentus*, according to this study.

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## Uticaj različitih doza živinskog stajnjaka i navodnjavanja na rast i prinos bamije (*Abelmoschus esculentus* L.)

Ufere Uka · Smart Nwinyinya · Kanayo Chukwuka

**Sažetak:** Istraživanje je sprovedeno na Državnom univerzitetu Ebonyi, Abakaliki, Nigerija u cilju ocene uticaja živinskog stajnjaka i navodnjavanja na razvoj i proizvodnju bamije u stakleniku. Živinski stajnjak je dodat u 5 kg zemljišta u tri različite doze: 20 t ha<sup>-1</sup> (T<sub>1</sub>), 40 t ha<sup>-1</sup> (T<sub>2</sub>) i 60 t ha<sup>-1</sup> (T<sub>3</sub>), a četvrta grupa bez živinskog stajnjaka je bila kontrola. Periodi navodnjavanja useva su bili 3, 6, 9 i 12 dana. Merene su sledeće karakteristike: visina biljke, broj listova, lisna površina (cm<sup>2</sup>) i prečnik stabljike, lisna masa, masa izdanka, masa korena, ukupna suva masa. Rezultati su pokazali da je viša doza živinskog stajnjaka povećala rast i prinos bamije, ali povećanje perioda navodnjavanja je smanjilo rast i prinos biljaka. Kombinacija 60 t ha<sup>-1</sup> živinskog stajnjaka i trodnevni period navodnjavanja je pogodovao razvoju bamije.

**Ključne reči:** *Abelmoschus esculentus*, bamija, navodnjavanje, prinos, živinski stajnjak

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