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(RESEARCH ARTICLE)

# Effect of organic phosphorus (cow dung) on the growth and yield of water melon (*Citrullus lanatus* (Thunb.) in Anyigba, Kogi state, Nigeria

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## Abstract

Field experiment was conducted at Kogi State University Research and Students' Demonstration Farm, Anyigba in the Guinea Savanna agro-ecological region in North Central Nigeria during the raining season of 2019 to determine effect of phosphorus (P) on the growth characteristics and individual yield of water melon. The experiment consisted of a variety of water melon (*Kaolack*) treated to five (5) levels of P: 0, 25, 50, 75, and 100 kg $P_2O_5$/ha on the growth characteristics and yield of water melon, laid out in Randomized Complete Block Design (RCBD), with five replications. Data were obtained for both growth characteristics and yield parameters, such as number of leaves, vine length, number of branches, days to first flowering, days to 50% flowering, number of fruits harvested, weight of harvested fruits, and fruit yield / ha. The results showed no significant ($P \geq 0.05$) effect of cow dung-based P on number of leaves, vine length, number of stem branches at 9WAS, days to 50% flowering and number of harvested fruit. However average fruit weight and fruit yield per hectare responded significantly to P treatment with 50 kg $P_2O_5$/ha giving the highest response in relation to water melon yield thus recommended for the experimental area.

**Keywords:** Vine length; Number of stem branches; Number of leaves; Days to flowering; Fruit weight; Fruit yield.

## 1. Introduction

Water melon (*Citrullus lanatus* [Thunb.] Matsum & Nakai) formerly called *Citrullus vulgaris*, "*vulgaris*" meaning "common" or "ordinary fruit" originated from Northern Africa (Egypt) [1]. It was a valuable and portable source of water for desert situations and when natural water supplies were contaminated. Today, it is grown in Italy, India, Southern Asia, Europe, North and South America [2]. Water melons are members of the cucurbitaceae family [1]. As a major cucurbit crop 7.5% of the world area was devoted to its production in 2003 [3]; with is production and consumption greater than that of any other species in the family [3]. The potentials of water melon as a cash producing crop is enormous for farmers especially those residing near urban areas. Fresh water melon can be eaten in a variety of ways and is also often used to flavor summer drinks and smoothies, it is most often cut into slices and eaten raw. Additionally, it can be cubed and put in a fruit salad. Water melons contains vitamin, A, C, $B_6$, $B_1$, folate, niacin and dietary fiber in the form of pectin [2]. They also contain manganese, selenium, copper, sodium, zinc, calcium, phosphorus, magnesium and large amounts of potassium. Water melon grows both in the humid and drier savannah agro-ecologies. In Nigeria, the cultivation of water melon which was originally confined to the drier savannah regions of the north, is now gradually gaining grounds in the Southern part of the country. However the largest production of the crop comes from the Northern part of Nigeria where suitable agro-ecology exist, nevertheless, a good crop yield could be achieved in other agro-ecological zones through proper intensive management.

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The major constraint to crop growth and yield is soil fertility, and peasant farmers in the North Soil amendments are important in North Central Nigerian soils because of its low organic matter content due to constant bush burnings and subsequent erosions. Central zone of Nigeria depends on inorganic fertilizer for the restoration of lost nutrients, but its continuous use can lead to soil acidity [4]. The long term use of NPK fertilizer has a depressing effect on yield, and this can cause a decline in fruit number and delay in fruit setting which subsequently delays ripening and leads to the proliferation of the vegetative parts [4]. Due to the use of NPK fertilizer, the identified production constraints can be ameliorated by the application of nutrient-rich organic amendments. The use of organic manures have been reported to have a comparatively higher advantage over inorganic fertilizers [5]. Harnessing the nutrient energy from biological wastes is very important in crop production. When these wastes are recycled as manure and utilized for agriculture, it reduces the pollution of streams and rivers [6]. In other to improve the yield of water melon, the soil nutrient content should be increased to boost the fertility which can be achieved by either using organic matters such as cattle manure, poultry manure, animal waste or use of compost [7]. Cow dung is an important source of bio-fertilizer used in many developing countries. It is a very effective's alternatives to chemical fertilizers; enhancing productivity in long term while maintaining the soil health and enhancing the microbial populations [7]. Cow dung manures increases soil organic matter content, leading to improve water infiltration and water holding capacity as well as increased cation exchange capacity [7]. In the past decades, intensive use of chemical fertilizers was advocated for crop production in the tropics in order to alleviate nutrient deficiencies [8]. Presently the use of chemical fertilizers on highly weathered, low organic matter and nutrient poor soil without compensatory organic fertilizer under intensive farming system and shortened fallow period could lead to nutrient imbalance and soil acidity with an attendant poor crop yield [8]. In view of these problems, the use of organic manure (cow dung) as a substitute for chemical fertilizers or in combination with chemical fertilizer at a reduced rate has become vital especially in this era of organic agriculture that reduces the negative effect of chemical fertilizers on climate change.

Organic manure has been reported by many researchers to give significant improvement in crop growth and yield. It is a reservoir of nutrients which are released during mineralization and humification, thus supplying the necessary elements for plant growth [9]. The application of organic manure has been observed to consistently increase the yields of horticultural crops such as water melon (*Citrullus lanatus*), eggplant (*Solanum melongena*), pepper (*Capsicum annum* L.) and tomatoes (*Lycopercison esculentus*). Cow manure is rich in minerals, especially nitrogen, phosphorus and potassium (elements which are highly in demand by both plants and soils). It also supports the growth of beneficial microorganism when mixed with the soil, improves the texture of the soil and helps to maintain moisture [10]. After nitrogen, phosphorus has more wide influence on the natural ecosystem than any other essential plant element [11]. Phosphorus is second to Nitrogen as the most limiting element for plant growth [12]. This element plays a vital role in good plant growth and a major part in the process of photosynthesis and provides plants with energy [13]. Plants also need phosphorus to produce RNA, DNA enzymes and proteins [14]. Phosphorus application has significant effect on watermelon yield components and yield, as well as vegetative growth [15]. More leaves translate to better chlorophyll development and higher stomatal conductance hence, enhanced photosynthesis [16].

Most soils of North-central Nigeria are inherently low in fertility [17] and soils used in cultivation of water melon should be well drained and rich in organic matter content. Considering the poor financial status of most farmers and the high cost of agrochemicals there is need to find alternative means of maintaining the fertility of soil, reduce the cost of inputs at the same time increase the level of production. Objectives of the study is to: 1) Assess the effect of phosphorus (P) on the growth characteristics and yield of watermelon using cow dung. 2) Determine the rate of phosphorus (P) that is needed for optimum growth and yield of watermelon from the cow dung manure.

## 2. Material and methods

### 2.1. Location of the experiment

The study area lies within latitude $7^{o}\ 15^{1}$ to $7^{o}\ 29^{1}$N and longitude $7^{o}\ 11^{1}$ to $7^{o}\ 32^{1}$E and with an altitude of 420 mm above sea level in the southern Guinea savannah Agro ecological zone of Nigeria, with average temperature of 27 $^{o}$C and an annual average rainfall of 1260 mm.

### 2.2. Soil analysis of the experimental site

The composite soil samples were collected to a depth of 0 – 15 cm and 15 – 30 cm air dried, crushed and sieved with 2 mm mesh then subjected to physico-chemical properties of the soil.

The percentage sand, silt and clay were determined according to [18]; the textural classes of the soils were determined using the textural triangle [19].The total nitrogen (N) was determined using the Kjeldahl digestion method where the samples were digested with concentrated $H_2SO_4$ and titrated with 0.1 N standard hydrochloric acid (HCL) [20]. Available phosphorus (P) was determined using [21] extraction procedure.

For Determination of soil electrical conductivity, ten grams (10 g) of soil from each sample was placed into 100 ml beaker. Twenty-five milliliters (25 ml) of distilled water was added to the beaker. The beaker was allowed to stand for 30 minutes, stirring occasionally with a glass rod. The electrical conductivity of the soil solution was taken using the EC electron [22].

Determination of organic carbon was by wet oxidation method [23]. Exchangeable bases (Ca, Mg, K, and Na) were extracted with 1 N $NH_4OAc$ buffered at pH 7.0 [24]. The pH of the soil solution in each beaker was taken using pH meter [25]. Exchangeable acidity ($Al^{3+}$ and $H^+$) were extracted with KCl [24].

### 2.3. Treatment and experimental design

The experiment was laid out in a Randomized Complete Block Design (RCBD) with five replications. The treatment consisted of four levels of organic P and a control: $T_1$ (25 kg $P_2O_5$/ha), $T_2$ (50 kg $P_2O_5$/ha), $T_3$ (75 kg $P_2O_5$/ha) and $T_4$ (100 kg $P_2O_5$/ha) obtained from application of cow dung. Each main block (replication) was divided into five plots, each measuring 3m x 3m and separated by 1m leeway.

### 2.4. Cow dung analysis

The cow dung to be applied on the experimental area, was analyzed to obtain the major nutrient contents; nitrogen (N), phosphorus (P) and potassium (K).

### 2.5. Planting

The watermelon seed was sown to a depth of 2 – 3 cm at 2 - 3 seeds per hole later thinned to one plant per stand two weeks after sowing (WAS).

### 2.6. Weed and insect control

Weeds were controlled manually using the hoe at two weeks after plant sowing and subsequently, hand pulling ones a month. Insect pests were controlled using Cypermethrin 10EC, Imidapropid 10 EC and Permethrin insecticide.

### 2.7. Harvest

Harvesting was done manually at regular intervals.

### 2.8. Data collection and analysis

Data were collected from four randomly selected and tagged plants from each plot. These data includes the growth characteristics and yield parameters:

#### *2.8.1. Number of leaves per plant*

All leaves on four randomly sampled and tagged plants were manually counted at 3, 6 and 9 WAS and recorded as average of four plants.

#### *2.8.2. Vine length (cm)*

This was determined by measuring the vine length from the base to the tip of each tagged plant using a measuring tape at 3, 6 and 9 WAS and recorded as average of four plants.

#### *2.8.3. Number of branches per plant*

Determination of the total numbers of branches per plant was carried out at 3, 6 and 9 WAS by manually counting the number of branches on the four tagged plants per plot and recorded as average of four plants.

#### *2.8.4. Days to first flowering*

This was determined by counting the number of days it took for each plot to start flowering.

*2.8.5. Days to 50% flowering*

It was determined as the number of days it took 50% of the plants in the net plot to flower.

*2.8.6. Number of fruit per plot*

This was obtained as the number of fruits harvested from the net plot.

*2.8.7. Average weight of fruit (kg)*

The fruits harvested from each plot was weighed and the average was taken as the average weight of fruit.

*2.8.8. Fruit yield per hectare (tons/ha)*

The total number of fruits harvested from each net plot were weighed and the conversion was made on per hectare bases to give fruit yield per hectare.

### 2.9. Statistical analysis

The growth parameters and fruit yield data collected were subjected to Analysis of Variance (ANOVA) for a Randomized Complete Block Design experiment and significance means were separated using Least Significant Difference (LSD).

## 3. Results and discussion

### 3.1. Result of organic manure analysis

Table 1 below shows Nitrogen, Phosphorus and Potassium content of the cow dung used: 1.48% N, 1.89% P and 1.02% K. An indication that the cow dung used had more of P than N and K. The observation is contrary to higher percentage of N compared with P obtained in poultry dung as reported by [10].

**Table 1** Result of organic manure analysis

| Organic manure | N (%) | P (%) | K (%) |
|---|---|---|---|
| **Cow dung** | 1.48 | 1.89 | 1.02 |

### 3.2. Result of soil analysis

**Table 2** Result of soil analysis

| Soil Properties | Soil samples | |
|---|---|---|
| | A (0-15cm) depth | B (15-30cm) depth |
| pH ($H_2O$) | 5.32 | 5.30 |
| pH (KCl) | 4.94 | 4.90 |
| % Organic C | 0.77 | 0.48 |
| % Organic matter | 1.33 | 0.83 |
| % N | 0.04 | 0.02 |
| Available P (mg/kg) | 11.25 | 9.89 |
| Na (C mol/kg) | 0.68 | 0.52 |
| Mg (C mol/kg) | 2.63 | 2.21 |
| K (C mol/kg) | 2.31 | 2.09 |
| Ca (C mol/kg) | 4.30 | 4.11 |
| % Sand | 75.24 | 74.24 |
| % Clay | 22.48 | 22.48 |
| % Silt | 2.28 | 3.28 |
| CEC (C mol/kg) | 10.95 | 10.07 |
| Textural class | Sandy clay loam | Sandy clay loam |

The physical and chemical properties of the soil used in the experiment are presented in Table 2 below. The classification is sandy clay loam with pH value of 5.30 - 5.32 thus slightly acidic. This pH value should favour nutrient availability to crop plants since pH of most agricultural soils in Nigeria has been reported to range from 4.0 - 6.5 [26]. Available phosphorus was between 9.89 and 11.25 mg/kg which was below the critical value of 15 mg/kg [27], thus an indication that P should be a limiting factor holding back water melon yield. In addition, organic carbon content was 0.48 - 0.77 g/kg, which was also below the critical value of 3.4 g/kg [28] while total nitrogen was between 0.02 and 0.04 also below the critical value of 0.15 g/kg [29]. The experimental soil shows deficiencies in most nutrients, often below the critical levels required for crop production.

### 3.3. Effect of cow dung manure on the growth characteristics

Table 3 below shows that P did not significantly ($P \geq 0.05$) influence leaf number at 3WAS, 6 WAS and 9 WAS, also Phosphorous application did not show any significant ($P \geq 0.05$) effect on vine length throughout the period of data collection as shown on Table 4. Both observations are indication that addition of organic P did not induce any significant change in soil P, seeing that outcomes from the control treatment compared favourably with other treatments. Probably the experiment should have sought to increase the soil P above the critical level.

**Table 3** Effect of cow dung manure on number of leaves

| | Number of leaves | | |
|---|---|---|---|
| **P treatments (kg P2O5)** | **3WAS** | **6WAS** | **9WAS** |
| 0 | 6.00 | 20.31 | 52.00 |
| 25 | 5.87 | 23.62 | 63.93 |
| 50 | 5.77 | 18.37 | 45.87 |
| 75 | 5.87 | 20.18 | 60.25 |
| 100 | 5.75 | 25.50 | 69.25 |
| LSD, 0.05 | Ns | Ns | Ns |

Ns = not significant

### 3.4. Number of branches

P application had significant ($P \leq 0.05$) effect on number of branches at 3WAS and 6WAS, but not at 9WAS (Table 5), though the control showed the least number of branches consistently at 6 and 9WAS. Also days to first flowering was significantly influenced by P application (Table 6), but not days to 50% flowering (Table 7).

**Table 5** Effect of cow dung manure on number of branches

| | Number of branches | | |
|---|---|---|---|
| **Treatments (kg P2O5)** | **3WAS** | **6WAS** | **9WAS** |
| 0 | 0.25 | 1.81 | 2.12 |
| 25 | 0.25 | 2.50 | 3.00 |
| 50 | 0.50 | 1.93 | 2.56 |
| 75 | 0.25 | 2.18 | 2.37 |
| 100 | 1.00 | 2.12 | 2.93 |
| LSD, 0.05 | 0.207* | 0.650* | Ns |

* = Significant at 5% probability

**Table 6** Effect of cow dung manure on days to first flowering

| Treatments (kg P2O5) | Days to first flowering |
|---|---|
| 0 | 42.00 |
| 25 | 40.25 |
| 50 | 37.50 |
| 75 | 40.25 |
| 100 | 41.25 |
| LSD, 0.05 | 3.56* |

* = Significant at 5% probability

**Table 7** Effect of cow dung manure on days to 50% flowering

| Treatments (kg $P_2O_5$) | Days to 50% flowering |
|---|---|
| 0 | 56.50 |
| 25 | 55.50 |
| 50 | 54.50 |
| 75 | 54.75 |
| 100 | 54.50 |
| Significance | Ns |

NS = Not significant at 5% probability

### 3.5. Number of fruit per plot

There were no significant ($P \geq 0.05$) differences regarding effect of P on number of harvested fruits (Table 8), however average fruit weight responded to P application, with 50 kg $P_2O_5$ giving the best response (Table 9); translating into better performance per ha (Table 10). Thus inclusion of organic Phosphorus given at 50 kg $P_2O_5$/ha, is recommended for the study area.

**Table 8** Effect of cow dung manure on number of fruits per plot

| Treatments (kg P2O5) | Number of fruits per plot |
|---|---|
| 0 | 7.75 |
| 25 | 7.25 |
| 50 | 7.25 |
| 75 | 8.00 |
| 100 | 6.50 |
| LSD, 0.05 | Ns |

NS = Not significant at 5% probability

**Table 9** Effect of cow dung manure on average weight of fruit (kg)

| Treatments (kg P2O5) | Average weight of fruit (kg) |
|---|---|
| 0 | 1.15 |
| 25 | 1.92 |
| 50 | 2.97 |
| 75 | 1.37 |
| 100 | 1.32 |
| LSD, 0.05 | 0.45* |

* = Significant at 5% probability

**Table 10** Effect of cow dung manure on fruit yield per hectare (tons/ha)

| Treatments (kg P2O5) | Fruit yield per hectare (tons/ha) |
|---|---|
| 0 | 9.97c |
| 25 | 15.55b |
| 50 | 26.02a |
| 75 | 12.17c |
| 100 | 9.57c |
| LSD, 0.05 | 3.17* |

* = Significant at 5% probability

## 4. Conclusion

Considering the poor financial status of most farmers and the high cost of agrochemicals there is need to find alternative ways of maintaining the fertility of soil, reduce the cost of inputs at the same time increase the level of crop yield, thus, the use of cow dung which is rich in both N, P and K. However, to get meaningful impact of such nutrient application, there is the need to consider the critical level of each nutrient against soil inherent nutrient status as a guide to organic nutrient additions – if any meaningful result is to be obtained. The implication of this, is that, there will be the need to conduct soil test as a bench mark to formulating nutrient additions. For this experiment the results showed no significant effect of cow dung-based P on number of leaves, vine length, number of stem branches at 9WAS, days to 50% flowering and number of harvested fruit. However average fruit weight and fruit yield per hectare responded significantly to P treatment with 50 kg $P_2O_5$/ha giving the highest response in relation water melon yield thus recommended. The results obtained generally suffice to suggest that the application of poultry manure will improve water melon growth which will eventually result in improved yield.

## Compliance with ethical standards

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Kogi State University, Anyigba Faculty of Agriculture, Kogi State University, Anyigba

### *Disclosure of conflict of interest*

No observed conflict of interest whatsoever.

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