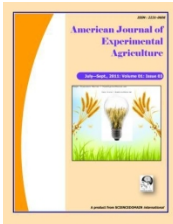

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Effect of NPK Fertilizer on Fruit Development of Pumpkin (*Cucurbita pepo* Linn.)

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Authors' contributions

This work was carried out in collaboration between all authors. Authors FMO and GOA designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author IOO managed and supervised the analyses of the study. All authors read and approved the final manuscript.

Short Communication

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ABSTRACT

The effect of NPK fertilizer on pumpkin fruit development was studied for two cropping seasons in 2010 at the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife, Nigeria in 2010. The experiment was a randomized complete block design. The plants were treated with six NPK rates (0, 50, 100, 150, 200 and 250 kg/ha). Data on fruit weight, circumference, length and dry matter were obtained at 7, 14, 21 and 28 days after fruit formation. Increasing NPK fertilizer enhanced the parameters evaluated across the sampling periods. Fresh fruit weight (g/fruit) in control was 39g, 123g, 822g and 1059g and this increased to 80g, 370g, 1350g and 1630g at 7, 14, 21 and 28 days after fruit formation respectively at 100 kg NPK fertilizer rate. Across the NPK levels, pumpkin fruit growth curve was sigmoid. The fruit took approximately 22 days from fruit formation to fruit maturity across all the NPK fertilizer levels. In conclusion, excessive NPK supply did not significantly increase the rate of fruit growth or the fruit size. Fruit growth duration of pumpkin was not influenced by NPK fertilizer application.

Keywords: Pumpkin; fruit development; NPK fertilizer; fruit weight; fruit dry matter.

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1. INTRODUCTION

Cucurbita pepo Linn commonly known as pumpkin, zucchinis, squash or marrow, belongs to the Cucurbitaceae family. The family consists of two well defined subfamilies, eight tribes, about 118 genera and 825 species [1]. *Cucurbita* or yellow flowered cucurbit is considered to be one of the most morphologically variable genera in the entire plant kingdom. Curcubits (Cucurbitaceae) are among the most important plant families supplying humans with edible products and useful fibers. Members of this family are very similar in above ground development, but they have high genetic diversity for fruit shape and other fruit characteristics, resulting in a variety of uses [2]. *Cucurbita pepo* L. originated from North and Central Americas [3]. Smith [4] noted that one of the first species of *Cucurbita* to be domesticated in the New World was *C. pepo*.

Fertilizer affects the productivity of crops. Poor fruit setting, low crop yield and low nutritional quality result from inadequate levels of the primary nutrients namely: Nitrogen, Phosphorus and Potassium [5,6,7,8]. Application of N, P and K has been reported to increase the growth and productivity of pumpkin and crops generally [9,10]. Mobile phosphorus and potassium have also been reported by MacCarthy et al. [11] to be very important for the setting, development and storage of pumpkin fruits. When P level is optimum, much of energy required for plant metabolism which is stored chemically in the form of complex organic phosphates adenosine triphosphate (ATP) will be made available and released as required. Therefore, important chemical processes involved in growth will be driven steadily. Aduayi et al. [12] reported that NPK is the three major fertilizer elements known to be deficient in most Nigerian soils due to intense pressure on land as a result of continuous cropping.

Though there has been some previous work on the effect of various factors on fruit size at harvest, little is known about their effect on fruit development. Hence, this study aimed at determining the influence of NPK fertilizer on the fruit development of Pumpkin.

2. MATERIALS AND METHODS

Field study was conducted at the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife, Nigeria, for two seasons. The experiment was a randomized complete block design. NPK fertilizer 15:15:15 fertilizer rates were applied at 0, 50, 100, 150, 200, 250 kg/ha. The experiment was replicated six times. There were 6 plots per replication; each plot size was 10 m X 12 m and consisted 7 rows. Alley was 3 m, while the plants were spaced 2 m X 2 m. Land was ploughed twice and harrowed once before sowing. Two seeds per hole were sown and the seedlings were thinned to one plant per stand at 2 weeks after planting (WAP). The NPK fertilizer was added in two equal halves at 2 WAP and 6 WAP. Insecticide (lambda-cyhalothrin) was applied fortnightly from 6 to 10 weeks after planting. Post-emergence herbicide, glyphosate was applied at the rate of 200ml/15litre at 4 and 7 WAP for weed control.

Forty fruits of relative age and size were tagged at the onset of fruit set. From the tagged fruits, 5 developing fruits were harvested at 7, 14, 21, 28, days after fruit formation (DAFF). The following fruit development parameters were taken: fresh weight, dry weight, fruit length and fruit diameter.

All data were subjected to combined analysis of variance SAS [13]. Means squares, where significantly different, were separated using Duncan Multiple Range Test (DMRT) at 5%

level of probability. Regression analysis was performed for traits that had significant season and fertilizer mean squares.

3. RESULTS

3.1 Influence of NPK Fertilizer on Fruit Development Traits of Pumpkin at 7 to 28 Days after Fruit Formation (DAFF)

Results of the effect of NPK fertilizer on fruit development traits of pumpkin at 7 to 28 days after fruit formation (DAFF) were presented on Tables 1 and 2 and Figs. 1 to 4. Fruit development was enhanced with increasing fertilizer rates, however fresh fruit weight, fruit dry matter, fruit length and fruit circumference from the application of 100 to 250 kg/ha at 7 DAFF were similar and significantly better than control and 50 kg/ha NPK application rates. Mean fruit weight and dry matter between 100-250kg NPK was 80.6g and 372g respectively. The values were 36% to 52% and 43 to 56% respectively higher than fertilizer rates below 100kg/ha. Similar trends were observed across the sampling periods. At 21 DAFF, mean fruit weight and mean fruit dry matter between 100-250 kg NPK was 1351.7 g and 185g respectively. Fruit fresh weight reduced at control and 50 kg NPK by 25% to 39% of the mean from 100-250kg NPK while it was 29% to 39% for the fruit dry matter. Fruit development at 14 DAFF also increased with fertilizer rates from the application at 100 to 250kg/ha were similar and significantly better than control and 50 kg/ha NPK application. At 28 DAFF, mean fruit weight and mean fruit dry matter between 100-250 kg NPK was 1636g and 432g respectively. Mean fruit fresh weight value of the mean from 100-250kg NPK was 25% to 39% higher compared to the control and 50kg/ha NPK application. The mean value for fruit dry matter reduced by 30 to 45% at control and 50 kg/ha NPK application.

Generally, fruit length, fruit circumference, fruit fresh weight and fruit dry matter increased with increase in days after fruit formation (which is expected). The fruit development traits also increased as NPK fertilizer application increased. Plants under control (no fertilizer application) being the least followed by the plants that received 50kg/ha of fertilizer and peaked at 100kg/ha NPK compound fertilizer application. There was no significant difference in the increase of fruit development traits of pumpkin that under 100 to 250kg/ha fertilizer application. Hence the curves for fertilizer application from 150 to 250kg/ha fertilizer application were not shown.

Table 1. Fruit development of pumpkin as influenced by NPK fertilizer at 14 DAFF

NPK level (kg/ha)	Fruit fresh weight (g)	Fruit length (cm)	Fruit circumference (cm)	Fruit dry matters (g)
control	123.3c	6.9c	12.6c	27.4c
50	225.3b	8.2b	15.5b	35.7b
100	369.4a	9.7a	20.2a	61.8a
150	361.0a	9.8a	20.2a	61.4a
200	379.3a	9.7a	20.1a	63.4a
250	376.7a	9.7a	20.4a	62.2a

Means with the same letter in each column are not significantly different at 5% level of probability using Duncan's multiple range tests.

Table 2. Fruit development of pumpkin as influenced by NPK fertilizer at 28 DAFF

NPK level (kg/ha)	Fruit fresh weight (g)	Fruit length (cm)	Fruit circumference (cm)	Fruit dry matters (g)	Fruit growth rate(g/day)	Fruit growth duration (day)
control	1058.5c	13.98c	38.0c	238.9c	11.0c	22.5a
50	1273.3b	15.09b	44.2b	303.0b	14.0b	22.3a
100	1621.9a	17.21a	52.4a	429.0a	19.9a	22.0a
150	1653.0a	17.33a	52.5a	428.5a	19.9a	22.0a
200	1623.0a	17.22a	52.5a	434.7a	20.2a	22.0a
250	1644.6a	17.11a	52.6a	435.7a	20.3a	22.0a

Means with the same letter in each column are not significantly different at 5% level of probability using Duncan's multiple range test.

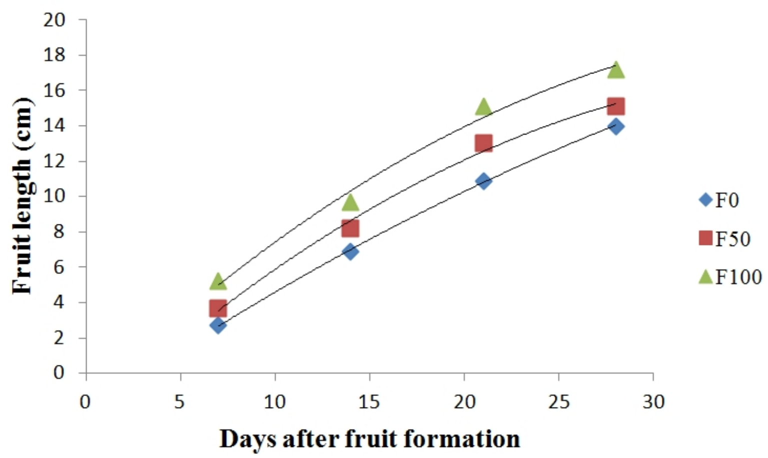

Fig. 1. Fruit length of pumpkin across the sampling periods as affected by NPK fertilizer

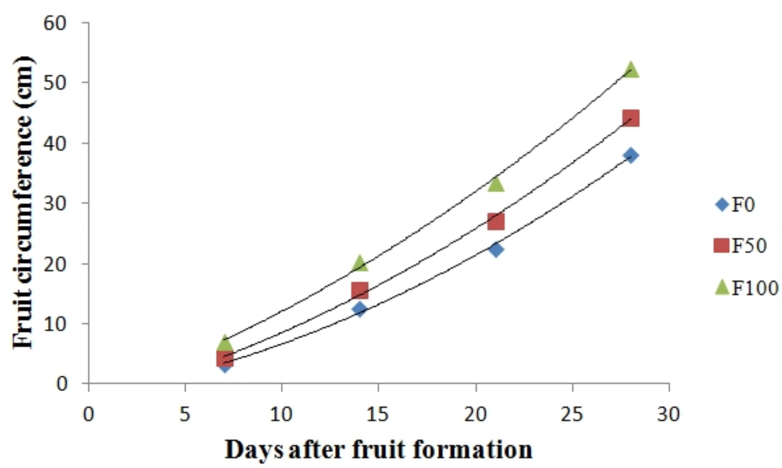

Fig. 2. Fruit circumference of pumpkin across the sampling periods as affected by NPK fertilizer

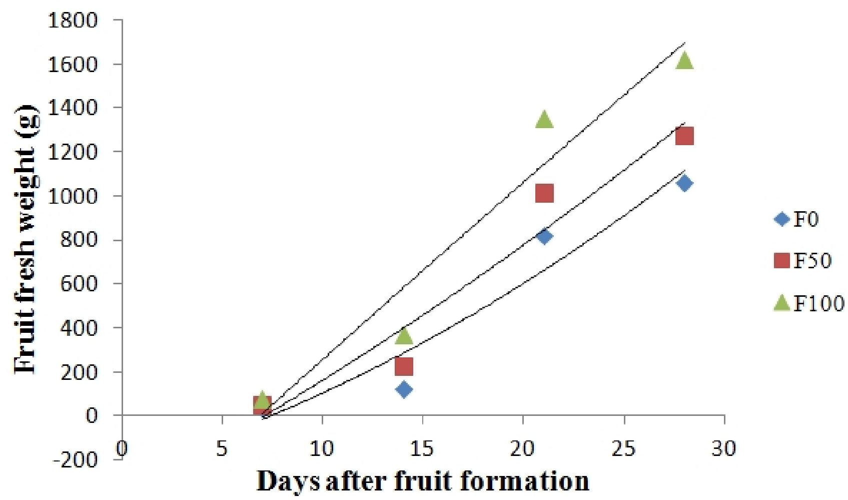

Fig. 3. Fruit fresh weight of pumpkin across the sampling periods as affected by NPK fertilizer.

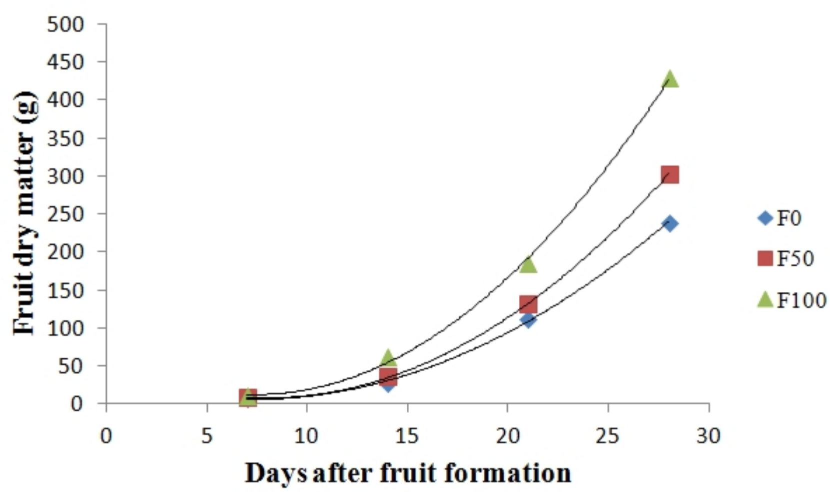

Fig. 4. Fruit dry matter of pumpkin across the sampling periods as affected by NPK fertilizer

3.2 Influence of season by NPK fertilizer on fruit development traits of pumpkin across the sampling periods

Results of season by NPK fertilizer on fruit development traits of pumpkin across the sampling periods showed that fruit length, fruit circumference, fresh fruit weight and fruit dry matter were higher across the fertilizer levels in the early season than in the late season. Fig. 5 showed that the response of fresh fruit weight at 7 DAFF fitted into quadratic equation with R^2 ranging 0.94 to 0.95. Fresh fruit weight generally increased from the control to reach the optimum at 100 kg/ha of NPK fertilizer application. Optimal fresh fruit weight was 315 g/fruit and 460 g/fruit for late and early seasons respectively. The response of fruit fresh weight at 28 DAFF fitted into quadratic equation with R^2 ranging from 0.91 to 0.95. Fruit weight was 1755 g/fruit for the early season. The fruit weight was lower in late season with 1450 g/fruit (Fig. 6). Pumpkin growth curve as presented in Fig. 7 is sigmoid.

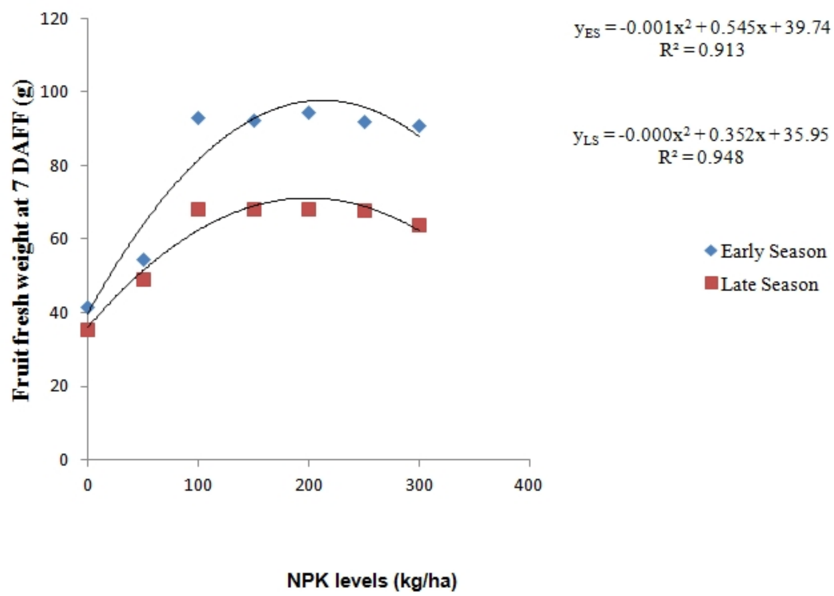

Fig. 5. Fruit fresh weight of pumpkin at 7 DAFF as affected by season x fertilizer

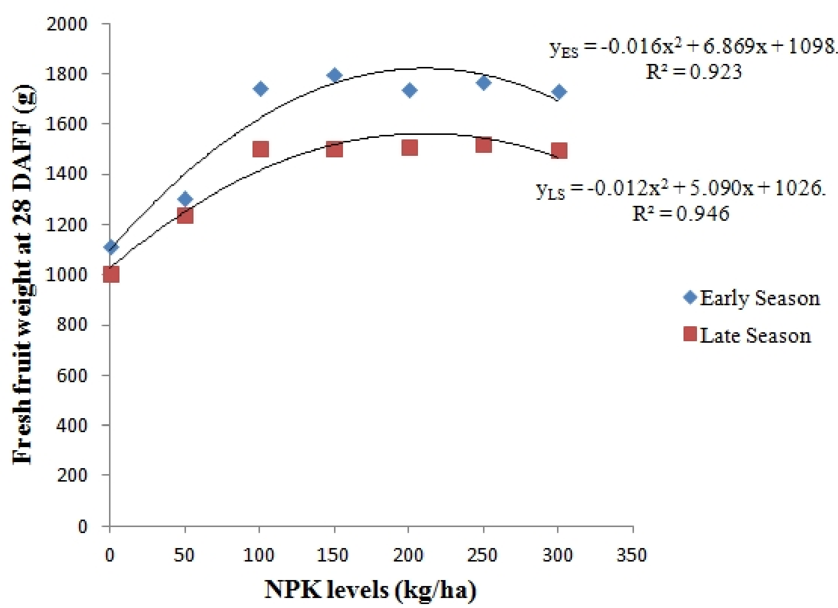

Fig. 6. Fresh fruit weight of pumpkin at 28 DAFF as affected by Season x fertilizer

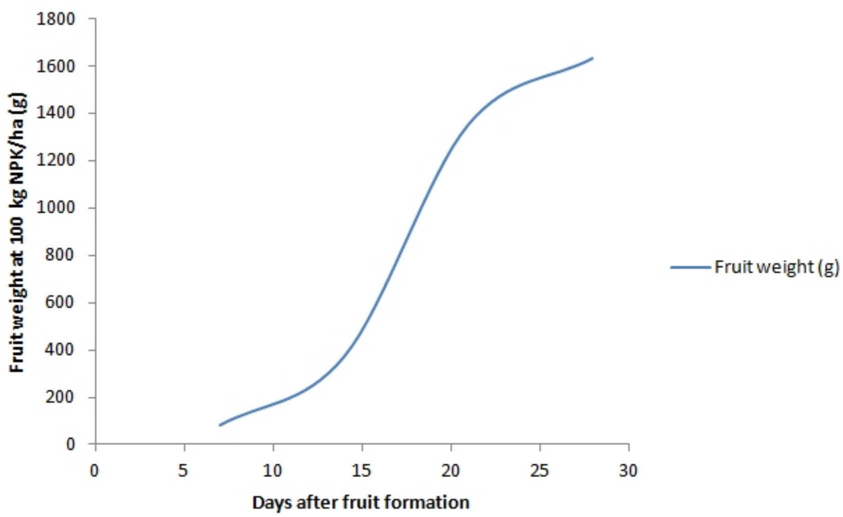

Fig. 7. Pumpkin fruit growth curve at 100 kg/ha NPK fertilizer level

4. DISCUSSION

In this study, fruit development was enhanced by NPK fertilizer across the sampling periods. The dependence of fruits weight on fertility and season in Cucurbits had earlier been reported [14,15]. The optimum NPK level in this study was 100 kg/ha where the fruit fresh weight, fruit circumference, fruit length and dry matter were higher than all other lower NPK levels and did not significantly differ from higher NPK levels. Fruit number and fruit weight of pumpkin have been reported to be depressed in Lithuania due to increased fertilizer [9,7].

Fertilizers are sources of plant nutrients that can be added to soil to supply its natural fertility. They are intended to supply plant needs directly rather than indirectly through modification of such properties such as soil pH and structure. There is usually a dramatic improvement in both quantity and quality of plant growth when appropriate fertilizers are added [16]. This corroborates the findings in these studies, NPK 15:15:15 compound fertilizer significantly increased the fruit developmental traits of pumpkin up to 100 kg/ha application level. After which law of diminishing returns set in. Similar findings have been reported [7,8].

In this study, as the NPK fertilizer application increased above 100 kg NPK/ha, there was no significant influence of additional application on the fruit growth and fruit size. This might be as a result of nutrient losses through leaching. Nutrient losses through leaching are generally higher in humid than in dry climates. High rainfall as obtains in the location of the study has been reported as one of the reasons for low plant-available nutrient contents [17]. According to Kirda et al. [18], increasing N rates does not necessarily improve grain yield and quality of wheat unless tailored to crop requirements for a variety of conditions. Inappropriate N management may result in lodging and loss of N through leaching, denitrification and volatilization. Split application of N-fertilizer has been shown also to result in higher plant recovery and higher grain yields in wheat [19].

As observed in this study, at the onset of fruit set, fruit growth was very slow. At the 21st day after fruit formation, the growth reached its peak after which it started to decline. This corroborates past findings on apples and grapes that at full bloom, fruit let growth is slow, or cease for a few days [20,21,22]. The duration of this preliminary period of slow growth varies from season to season [23], this may be related to the interval between pollination and fertilization, though fertilization is reported to occur before the end of this period in the grape [22]. The time from pollination to fertilization appears to be very variable; in the apple it has been shown to take from 48 hours [24] to 12 days [25]. After fertilization there is a phase of rapid growth, which is exponential at first in cucurbits [26] and apples [23]. Subsequently, the rate of growth may decline until harvest, giving a simple sigmoid type of growth curve, or there may be a period of little or no expansion between the rapid enlargement after fertilization and the final swelling. The simple sigmoid type of growth curve is characteristic of cucurbits and tomatoes [27]. And this was confirmed in these studies.

5. CONCLUSION

Most studies on agronomy of horticultural crops are directed towards the effect of agronomic practices on the overall yield. What happens during the fruit growth and development will have a bearing on the optimal fruit yield. In addition, the study on fruit growth duration of crops is not common. The main findings achieved and conclusions arrived at are:

- NPK fertilizer influenced pumpkin fruit developmental traits such as fruit fresh weight, fruit length, fruit circumference, and fruit dry matters positively, however, beyond 100 kg/ha, NPK fertilizer supply did not significantly increase the traits.
- Fruit growth rate (g/day) was also influenced positively by NPK fertilizer application up to 100 kg/ha.
- Fruit growth duration of pumpkin was not influenced by NPK fertilizer application. The fruit took approximately 22 days from fruit formation to fruit maturity across all the NPK fertilizer levels.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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