Scientia Horticulturae 168 (2014) 46–50

Contents lists available at ScienceDirect

Scientia Horticulturae

journal homepage: www.elsevier.com/locate/scihorti

Planting date and fertilizer affect antioxidants in pumpkin fruit

F.M. Oloyede[a,*], O.C. Adebooye[b], E.M. Obuotor[c]

[a] Department of Crop Production and Protection, Obafemi Awolowo University, Ile-Ife, Nigeria
[b] Department of Agronomy, Osun State University, Osogbo, Osun State, Nigeria
[c] Department of Biochemistry, Obafemi Awolowo University, Ile-Ife, Nigeria

ARTICLE INFO

Article history:
Received 29 July 2013
Received in revised form 6 January 2014
Accepted 8 January 2014

Keywords:
Cucurbita pepo
Total phenol
Flavonoid
Anthocyanin

ABSTRACT

The concentration of antioxidants in vegetables are dependent on factors including sowing date and level of fertilizer applied. A field experiment was conducted in 2007 and 2008, to study influences of sowing date and fertilizer rate on antioxidant activities and concentrations of antioxidant phenolic compounds in pumpkin (*Cucurbita pepo* L) fruit. Sowing dates were: 1 April (1), 15 April (2), 1 May (3) and 15 May (4) and fertilizer levels of 0, 90, 180 and 270 kg ha^{-1} comprised of NPK (15:15:15) were used. The yield of pumpkin fruit ranged between 10 and 50 tons ha^{-1} depending on agronomical inputs. Plants established on 1 April had the highest antioxidant activity (81%). Concentrations of total phenol, flavonoid, cyanidin and proanthocyanidin in fruit decreased as sowing date was delayed. The highest antioxidant activities was between 90 and 180 kg ha^{-1} of NPK Concentrations of total phenol, flavonoid, cyanidin and proanthocyanidin in fruit was reduced at fertilizer rates above 180 kg ha^{-1}. Early sowing of pumpkin and rates of between 90 and 180 kg ha^{-1} NPK could provide optimal antioxidant contents of pumpkin fruit.

1. Introduction

Cucurbita pepo Linn. commonly known as pumpkin and locally called "Elegede" in Southwestern Nigeria, is one of the neglected and underutilized plant species (NUS) in Nigeria. In the Southwestern Nigeria "Elegede" is mostly consumed among the rural dwellers as leafy, seed and fruit vegetables. The young leafy shoots are harvested before the onset of flowering. The palatable vegetable deserts from this crop is relished in Southwestern Nigeria. The young fruits of 2 weeks of age and mature fruits are either steamed or dried and added to prepare vegetable stews while the seeds are used as alternative to melon "egusi". 100–180 kg/ha of NPK (15:15:15) fertilizer application and early planting season (April–July) will bring about an optimal pumpkin fruit yield of about 17–21 tons/ha in Nigeria (Oloyede, 2011; Oloyede et al., 2012a,b).

A diet high in vegetables, especially those containing glucosinolates, flavonoids, polyphenols and carotenoids, may protect against human disease. Levels of phytonutrients in vegetables are determined by several abiotic and biotic factors (Verherk et al., 2009; Oloyede and Adebooye, 2005; Oloyede et al., 2012a,b).

Phytochemicals play a role in plant defense, and frequently increase in concentration in plants under stress (Radovich et al., 2004, 2005; Oloyede and Adebooye, 2013). However, the impact of environmental factors varies (Pant et al., 2009). Glucosinolate and carotenoid concentrations are positively related to nitrogen uptake and growth; total phenolics are negatively related to plant nitrogen status (Pant et al., 2009; Oloyede et al., 2012a).

Pumpkin (*C. pepo* L) has high antioxidant activities and bioactive compounds (Oloyede et al., 2012b; Oloyede and Adebooye, 2013). Young leaves; young and mature fruit, and seed are edible and utilized as vegetables. Pumpkin is drought resistant but is underutilized in many countries. Effects of sowing date and fertilizer rate were evaluated to describe effects on fruit yield, antioxidant levels and activities in pumpkin.

2. Material and methods

2.1. Field study

The study was conducted during 2007–2008 at the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife, Nigeria at 7°28′N latitude and 4°33′E longitude, and about 244 m above sea level. The area has a bimodal rainfall pattern with peaks in June and September. The soil of the site was classified as sandy loam. 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 experiment consisted of 16 treatments which were combination of the planting dates: 1 and 15 April and 1 and 15 May and NPK 15:15:15 fertilizer rates of 0, 90, 180 and 270 kg ha^{-1}. The experiment was laid out in randomized complete block design (RCBD) with three replicates. Land preparation was done when there had been enough

* Corresponding author. Tel.: +234 7069766796.
E-mail address: funmilayooloyede@yahoo.co.uk (F.M. Oloyede).

0304-4238/$ – see front matter © 2014 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.scienta.2014.01.012

Table 1
Monthly meteorological data recorded during the Cropping years (2007 and 2008).

Months	2007 total rainfall/month (mm)	2008 total rainfall/month (mm)	2007 average temperature/day (°C)	2008 average temperature/day (°C)	2007 sunshine hour (h)	2008 Sunshine hour (h)
January	NR	0.0	26.1	25.0	7.21	8.23
February	NR	0.0	29.2	27.8	7.37	6.11
March	NR	41.7	29.8	28.1	6.74	7.42
April	116	238	28.4	27.7	7.53	5.89
May	165.3	51.3	27.2	26.6	5.72	6.41
June	218.8	193	25.9	25.7	6.93	5.67
July	182.6	313.1	24.9	24.8	4.02	4.39
August	188.2	255.5	24.5	24.6	3.28	3.50
September	207.7	273.8	24.9	25.4	0.64	3.56
October	218.9	160	25.7	26.2	6.37	7.12
November	36.3	0.0	26.9	27.6	7.42	7.92
December	24.7	31.1	26.0	27.1	6.29	7.11

Source: Nigerian meteorological agency.
NR = not recorded.
NR: not recorded.

Table 2
Combined analysis of variance showing means squares for antioxidant activities and its components in mature Pumpkin fruits as influenced by Planting date and NPK (15:15:15) fertilizer.

Source	DF	Antioxidant activities (%)	Phenol (mg/100 g)	Flavonoid (mg/100 g)	Anthocyanin (mg/100 g)	Proanthocyanidin (mg/100 g)
Planting date	3	9212.25**	13956401**	18321.63**	0.269**	0.321**
Fertilizer	3	689.85**	5974903**	4509.98**	0.135**	0.325**
Rep	2	0.1830	0.2034	0.3911	0.444	0.134
Planting date × fertilizer	9	52.006**	880336**	308.27**	0.010**	0.049**
Error	30	0.2145	0.1233	0.0824	0.305	0.341
CV (%)		0.79	0.60	0.40	0.52	0.23

** Highly significant ($P = 0.01$).

rain to moisten the soil, no irrigation was applied. There were 4 plots per blocks and 12 stands of plants per plot. The plot size was 8 m × 4 m and the plants were spaced 2 m × 2 m. NPK 15:15:15 rates were applied 15 days after planting as ring dressing. The insecticide (lambda-cyhalothrin) was applied biweekly from 6 to 10 weeks after planting. In addition to manual weed control, the post-emergence herbicide, glyphosate was applied at the rate of 200 mL/15 L at 4 and 7 weeks after planting. At 7 weeks, only the weeds at the alley were controlled by herbicide. Beyond 7 weeks, the plant suppressed weeds itself, only those that could not be suppressed were removed manually. At 15 weeks after planting, fruits were harvested from the middle rows in the plot. 10 fruits each were selected randomly from each plot for laboratory analyses.

2.2. Laboratory analyses

Five-grams from dry and milled fruit samples were cold extracted for 24 h using 80% methanol. A crude extract was obtained by evaporation of the methanol soluble extract to dryness. Antioxidant activities or hydrogen donating or radical scavenging, of extracts was determined using the stable radical DPPH (2,2-diphenyl-2-picrylhydrazyl hydrate) according to Brand-Williams et al. (1995). The DPPH reacts with an antioxidant compound which can donate hydrogen thereby reducing it. A color change from deep violet to light yellow was measured spectrophotometrically at 517 nm. Total phenol content was determined by the method of Singleton and Rossi (1965) using the Folin–Ciocalteau reagent in an alkaline medium. Total flavonoid content was determined using an $AlCl_3$ method (Lamaison and Carnet, 1990). The proanthocyanidin content was determined using a modified AlCl/Butan–1-0l assay method of Porter et al. (1986). Total anthocyanin content was determined using the pH differential method of Fuleki and Francis (1968) as described by Guisti and Wrolstad (2001).

2.3. Statistical analysis

Data were subjected to analysis of variance SAS (ver. 9.1, SAS, Inc., Cary, NC). If an interaction was significant it was used to explain results. If interactions were not significant means were separated using Duncan Multiple Range Test. Regression analysis was performed where appropriate on quantitative and continuous data.

3. Results

Rainfall and hours of sunshine were different and temperatures similar for the cropping years (Table 1). The crops grown during the first and second planting durations (April–July) had less total rainfall, higher average temperature, and higher total sunshine for both 2007 and 2008. Crops grown during the third and fourth planting durations (May–August) had higher total rainfall, lower average temperature and lower total sunshine hour for 2007 and 2008. Pumpkin fruit yield as affected by planting date was presented on Table 3, optimal yield of about 50 tons/ha was obtainable when sown early. The yield reduced by 60% to 92% as the planting time was delayed (source: Oloyede and Adebooye, 2013).

Planting date affected anti-oxidant activities and components of fruit significantly ($P = 0.01$) (Table 2). Anti-oxidant activity was 21.1% higher in the first, than in the second, planting date; 20.6%

Table 3
Effect of planting date on pumpkin fruit yield.

Planting date	Fruit yield (tons ha^{-1})
1 (April 1)	53.56a
2 (April 15)	49.93a
3 (May 1)	21.27b
4 (May 15)	4.17c

Source: Oloyede and Adebooye (2013).
Means with the same letter in each column are not significantly different at 5% level of Probability using Duncan's Multiple range test.