Seed pre-treatment strategy effect on the emergence and vegetative yield of fluted pumpkin (*Telfairia occidentalis* (F.) Hook)

*[1]Emmanuel B. Effa, [1]Ekama D. Elemi, [1]*Glory E. Uwak, [1]Aniefiok E. Uko and [2]Otobong B. Iren*
[1]Department of Crop Science, University of Calabar, Nigeria
[2] Department of Soil Science, University of Calabar, Nigeria
*Corresponding author: uwak.glory@yahoo.com

Abstract
A field experiment was conducted at the Teaching and Research Farm, University of Calabar, Calabar during the early cropping season of April – September, 2017 and 2018 to investigate the effects of seed pretreatment strategies on emergence and vegetative yield of fluted pumpkin. The study was arranged in Randomized Complete Block Design (RCBD) with three replications. Treatments included five levels of shed drying (in days) – 1, 2, 4, 6 and the control in which seeds were sown as soon as extracted from the pods. Data were collected on percentage germination, vine length (cm), number of leaves per plant, number of regrowth, leaf area (cm^2) as well as fresh and dry weight of shoots. Data were subjected to analyses of variance (ANOVA) procedure and significant means compared using Fishers' Least Significant Difference at 5 % probability level. Results revealed that drying fluted pumpkin seeds under shed for 4 days prior to sowing enhanced germination percentage (85.20 and 90.00 %), vine length, regrowth (robust development of lateral branches) as well as shoot weight (2.59 t/ha), leaf fresh weight (3.18 t/ha) in 2017 and leaf fresh weigh (3.42 t/ha) in 2018. Drying seeds of fluted pumpkin for four days is hereby recommended for adoption by farmers for optimum yield in Calabar and its environs.

Keywords: Sustainable yield, fluted pumpkin, shed dried, optimum yields, leafy vegetable

Introduction

Fluted pumpkin (*Telfairia occidentalis* (F.) Hook) is a tropical vine crop grown in West Africa for its leaf and edible seeds (Kajihus *et al.*, 2010). It is an annual herb with profuse branching, widely cultivated in southern Nigeria and is quickly gaining acceptance in the Northern Nigeria because of the economic importance of its leaves and seeds in the world market (Hortnews 2005), as well as it nutritional content when used as pot herb or vegetable. It belongs to the family Cucurbitaeae (Ehiagbonare, 2008). Other crops in the family include; gourds, melon, pumpkins, squashes and cucumber. They are characterized by their fleshy fruits and the seeds of many members has been noted for their oil bearing properties. Other names of fluted pumpkin include; fluted gourd, *Telfairia* nut, Calabaza costullade (Spanish), Iroko (Nigeria), krobonko (Ghana), pondo koko, oroko, gonugbe (Sierria Leone). In south Eastern Nigeria, it is called Ugu (Igbo) and Ikong-Ubong (Efik and Ibibio).

Fluted pumpkin is a dioecious perennial liana and leafy vegetable. The edible parts include the tender shoot tips, leaves, petioles and seeds. The seeds are eaten boiled, while the leafy parts are utilized in the preparation of soups, stews and sauces (Akoroda, 1990). Horsefall and Spiff (2005) reported that African indigenous vegetables remain popular in rural areas where they are often considered to be more nutritive than exotic vegetables. The oily seeds according to Schippers (2000) have lactating properties and are widely consumed by nursing mothers. Sap from the leaves because of its high chlorophyll content finds usefulness in medicinal or herbal compositions as blood tonic for anemic or weak patients (Akoroda, 1990). Although the leaves are rich in vitamins and iron, the plant also contains considerable amounts of anti-nutritional principles such as phytic acid, tannins and saponins which could cause health problems (Schippers, 2000).

It has been suggested that fluted pumpkin originated in South East Nigeria and was distributed by the Igbos who have cultivated this crop since time immemorial and spread to other areas of Nigeria where they have settled (Akoroda, 1990: Schippers, 2000). The importance of seed pretreatment for sustainable vegetable crop production cannot be overemphasized as it plays a major role in preventing soil-borne infections and pest infestation (Akande *et al.*, 2010). Agriculture relies on the growth of seeds. The increasing menace of seed deterioration after sowing and during periods of dormancy is worrisome and has unequivocally placed fluted pumpkin farmers in an overwhelmingly difficult situation considering the cost of inputs and relatively scarce planting stock due to its competitive demand for food and for planting.

Tropical soils are adversely affected by suboptimal soil fertility, degradation leading to the deterioration of nutrient status and changes in macro/micro fauna populations thus, leading to seed decay and poor crop establishment. Judicious use of appropriate fertilizers is key to increasing yield of several crops. Several workers have demonstrated the effects of nutrients on sustainably increased yields on different crops (Effa *et al.*, 2011; Iren *et al.*, 2012; Shiyam *et al.*, 2016; Uko *et al.*, 2018). The increasing relevance of fluted pumpkin seeds as oil source for industrial purposes, food for humans, feed for livestock and as planting stock has undoubtedly increased the demand for fluted pumpkin production. These issues are placed at the door steps of agronomists to ensure that standardized techniques of ensuring seed protection and emergence which translates to vigorous vegetative growth and enhanced yield are implemented. This work therefore investigated the effects of seed drying as a pre-treatment techniques to promote fluted pumpkin crop establishment, vigorous growth and improved yield on a sustained basis.

Materials and Methods

Field experiments were conducted at the Teaching and Research Farm of the Faculty of Agriculture, University of Calabar during the 2017 and 2018 rain fed cropping seasons. Calabar is located in the South Eastern humid rainforest zone of southern

Nigeria (4.5° – 5.2°, 8.0° – 8.3°E), 39 m above sea level. It has a bimodal annual rainfall distribution ranging from 3000 – 3500 mm, a mean annual temperature of 27 ° – 35 °C and relative humidity between 75 -85 % (CRBDA, 2015). The experiment was laid out in Randomized Complete Block Design with three replications. Treatments comprised five levels of shed drying (1, 2, 4, 6 days and the zero drying, control, in which the seeds were sown as soon as extracted from the pods). Each plot size was 4 m x 3 m (12 m^2), separated by 1.0 m spacing and 2.0 m between replications. Fluted pumpkin was sown at spacing of 1 m x 1 m giving a population of 10,000 plants per hectare. Soil samples were collected from the site at 0 – 15 cm depth using a soil auger prior to land preparation. Composite samples were analyzed for physico-chemical properties as described by IITA (1982). Germinated plants were staked for better exposure to solar radiation and ventilation around plants. Weeding was occasionally carried out manually at 5 and 10 weeks after planting to minimize competition. Ten plants were randomly tagged per plot for determination of average vine length (cm) measured from the soil mark at the base of the plant to the vine tip, number of leaves, number of regrowth, leaf area (cm^2), shoot weight, leaf fresh weight, and leaf dry weight (t/ha). Data collected were subjected to analysis of variance procedure and treatment means compared using Fishers' Least Significant Difference (LSD) at 5% probability level (Gomez and Gomez, 1984).

Results and discussion

Soil physico-chemical analysis

The soil properties in the two experimental periods are presented in Table 1. The soils had low acidity with a pH of 5.08 and 5.20, organic carbon content of 1.6 and 1.85 %, and total nitrogen of 0.12 and 0.13 %. Available phosphorus was 52.63 and 51.96 mg/kg while the soil texture was described as sandy loam (Table 1).

Effects of pre-seed drying on germination and vine length:

The effects of seed drying on germination and length of fluted pumpkin vines in 2017 and 2018 are presented in Table 2. Germination percentage increased although not significantly, as duration of drying increased from 0 - 4 days. Percentage germination increased significantly ($p<0.05$) from seeds dried for 4 days above 0 - 2 and 6 days respectively in both years (85.20 and 90.00 %). The length of vines at 9 - 15 weeks after planting in 2017 and 2018 seasons was longest from seeds that were dried for four days ($p<0.05$) than vines from seeds that were dried longer or lesser than four days.

Effects of pre-seed drying on number of leaves: Number of leaves at 6 - 15 WAP increased from zero days of seed drying and peaked at 4 days thereafter declining among plants subjected to six days of seed drying (Table 3). Foliar density or number of leaves was significantly higher ($p<0.05$) in both years when seeds had undergone drying for four days than all other drying periods which were statistically at par with each other (p>0.05).

Effects of pre-seed drying on regrowth:

Effects of seed drying on regrowth and ratoon production at 6-15 WAP in 2017 and 2018 are presented in Table 4. Results indicated that in 2017, regrowth of vines was not significant (p>0.05). During 2018 however, at 9-15 WAP, significant regrowth was observed (p<0.05), when at 9 WAP, regrowth ranged from 3.90 – 4.75 vines, being statistically similar among plants from seeds that were dried for 1-6 days and significantly higher than plants from the undried seeds (3.89). At 12 WAP, vines from seeds dried from 2-4 days were statistically similar in regrowth, but significantly higher than vines from all other durations of drying. At 15 WAP, drying for 4-6 days resulted in similar regrowth, significantly higher than regrowth among plants whose seeds were dried for 1 - 2 days and in turn higher than regrowth of plants in control plots that had not been subjected to seed drying.

Effects of pre-seed drying on leaf area:

Leaf area of fluted pumpkin was not significant at 15 WAP in 2017 only (Table 5). At 6 and 9 WAP, leaf area from plants that were air dried for 2 - 4 days was statistically similar (p>0.05) but significantly higher than leaf area from plants that had 0 - 1 days of seed drying. Leaf area was however highest from seeds that were dried for 6 days at 15 WAP, followed by 4 days drying, which were both significantly higher than leaf area of 0 - 2 days dried plants in 2017 (Table 5). In 2018, drying for four days resulted in the highest leaf area values (p<0.05), followed by 2 and 6 days drying, which were in turn higher than other durations of drying.

Effects of pre-seed drying on foliage characteristics:

Effects of seed pre-drying on leaf dry weight in 2017, shoot weight and leaf dry weight in 2018 alone were not significant (p>0.05). Shoot weight in 2017 increased significantly (p<0.05) among plants whose seeds were air dried from 0-4 days, and reduced when seeds had been dried up to 6-days. The leaf fresh weight in both years increased with increasing days of seed drying up to 4 days of seed drying but decreased thereafter, but not significantly in 2018 (p>0.05), as all other periods of drying were statistically similar but higher than the plants from undried seeds (Table 6).

The texture of the soil at the study site was loamy sand which is fragile in nature and susceptible to leaching and erosion by surface run-off water. Anikwe (2006) confirms the status and characteristics of such soils. Also, the low exchangeable bases and organic carbon content of the soil coupled with low soil pH, which are indicators of low soil fertility typifies the soil of the study site as being of poor fertility status. Soils with these attributes need effective soil management. Soils of this nature are low in organic matter and could benefit from nutrient addition in form of fertilizer and organic manure. Fluted pumpkin seeds dried under shed for 4 days significantly (P<0.05) enhanced percentage germination as well as vine length in both seasons.

It could be deduced that, pretreating seeds by reducing moisture content has a positive effect on early growth of fluted pumpkin which could be attributed to improved germination conditions provided by the treatment. This result is in consonance with the findings of Gills (1988) who reported that limited desiccation enhances germination especially during wet periods. More so, seed drying at lower temperatures for longer periods, activates enzymatic reactions which culminate in emergence. Positive effects of shed drying on emergence of fluted pumpkin seeds also agrees with the findings of Schippers (2002) who observed rapid germination rates in shed dried fluted pumpkin seeds and also resonates with the reports of Odiaka *et al.* (2008).

Seed drying reduces excess moisture on and within seeds as well as shrinks mucilaginous coating on the seed. According to Prajapati *et al.* (2013), the presence of mucilage on the seed coat prevents the plant from early seedling development. Plants that have delayed early development will have a lag period and not be able to catch up with siblings that developed earlier. This was evidenced in this study with the four day dried seeds giving better emergence and performance throughout the study, than those seeds that were either not dried at all or had a shorter drying period. Drying seeds beyond an optimum time could also lead to shrinking of the embryo hence reducing its precocity during sprouting and germination. Longer drying periods may have demanded a longer time for seeds to reabsorb moisture and initiate germination. This may be the case with seeds dried up to six days that had a lag in germination and growth in this study and is in agreement with the findings of Banful *et al.* (2011) on sour-sop that air drying under shade and sun-drying for three consecutive days improved earliness to germination and percent total germination.

Elongation of vines follows early germination and seedling establishment, the appearance and accumulation of foliage characteristics. Higher number of leaves is tied to higher percentage germination and early seedling establishment which has implications for vigor and the commencement of photosynthesis and assimilate partitioning. Pruning for the development of ratoons and regrowth is the rule of thumb in fluted pumpkin production to overcome apical dominance and stimulate branching. Early establishment facilitates timely pruning and the onset of secondary vine branching and elongation. According to Effa *et al.* (2023) observation, early pruning of Amaranth resulted in a more robust regrowth and production of secondary branching.

Numbers of leaves and leaf area, a measure of the photosynthetic apparatuses of the crop were significantly enhanced with shed drying seeds for 4 days before sowing. The trend of increase observed in number of leaves with increasing days of drying up to 4 days could be attributed to a spark in meristematic activities involving mitotic and meiotic cell division initiated by enzymes as a result of rapid apical development which could have provided a level platform for leaf display and adequate solar interception which hitherto increased the rate of photo-assimilation as opined by Elemi (2013) who reported that longer vines in fluted pumpkin enhance better solar interception by greater exposure of the leaves. Enhanced meristematic activities recorded under shed drying for 4 days culminated in improved development of lateral branches as reported by Elemi *et al.* (2017). Yield components (fresh and dry weight of shoots) were significantly enhanced with increasing days of shed drying up to 4 days before sowing. This is unequivocally attributed to the enhanced proliferation of leaves associated with elongated vines and robust regrowth associated with these treatments which may have enhanced better partitioning of photo-assimilates throughout the plants vegetative parts in accordance with the findings of Elemi *et al.* (2017).

Conclusions and recommendations

Field experiments investigated the effects of varying seed pretreatment strategies on emergence and vegetative yield of fluted pumpkin in the South East Rainforest Agro-ecological zone. When seeds were dried under shed prior to sowing for 4 days there was a significantly enhanced germination percentage, vine length, robust development of lateral branches (regrowth) as well as fresh and dry shoot weight (kg/ha) of fluted pumpkin. This study suggests that, for increased productivity of fluted pumpkin on a sustained basis especially in the humid zones, seeds should be pretreated by shed drying for 4 days for effective germination and enhancement of vigorous growth.

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Table 1: Physico-chemical properties of soil in the experimental sites during 2017 and 2018

Property	Value	
	2017	2018
pH (H_2O)	5.08	5.20
Organic carbon (%)	1.6	5.35
Nitrogen (%)	0.12	0.13
Phosphorus (mg/kg)	52.63	22.93
Calcium (cmol/kg)	1.34	1.23
Magnesium (cmol/kg)	0.22	0.25
Potassium (cmol/kg)	0.14	0.15
Sodium (cmol/kg)	0.08	0.09
Exchangeable acidity (cmol/kg)	3.04	3.20
ECEC (cmol/kg)	4.71	4.84
Base saturation (%)	37.79	35.54
Clay (%)	8.0	9.00
Silt (%)	14.0	14.0
Sand (%)	78.0	77.0
Textural Class	Sandy loam	sandy Loam

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Table 2: Effect of Seed pre-treatment on Germination percentage and vine length (cm) of fluted pumpkin in 2017 and 2018 cropping season

Treatments	2017 Germination percentage	2017 Vine length (cm) Weeks after sowing 9	12	15	2018 Germination percentage	2018 Vine length (cm) Weeks after sowing 9	12	15
Shed drying days								
0	71.90	72.30	80.71	92.71	78.80	80.50	111.10b	123.00
1	75.90	75.00	85.30	115.20	80.00	83.00	118.00b	129.40
2	78.60	76.40	87.50	118.00	85.20	85.20	121.50a	138.20
4	85.20	89.20	98.20	124.20	90.00	91.00	131.00a	159.00
6	73.80	85.00	90.40	121.00	84.20	86.10	125.50a	143.40
LSD 0.05	6.38	1.34	7.20	3.80	3.50	1.21	9.20	8.20
SE±	1.95	2.16	1.18	1.74	1.16	1.20	1.80	1.40

LSD = Least significant difference .NS = Not significant and SE± = Standard Error

Table 3: Effect of seed pre-treatment on mean number of leaves per plant of fluted pumpkin in 2017 and 2018 cropping season

Treatments	2017 No. of leaves Weeks after sowing 6	9	12	15	2018 No. of leaves Weeks after sowing 6	9	12	15
Shed drying days								
0	17.00	21.20	28.90	39.20	17.20	26.20	36.30	44.30
1	19.20	26.10	39.00	48.00	28.20	39.20	44.20	53.20
2	23.40	32.30	43.50	56.20	38.10	44.30	49.50	74.20
4	26.00	34.50	46.00	68.00	39.00	52.40	62.30	88.90
6	22.60	32.00	44.20	57.30	25.30	49.30	49.90	81.30
LSD 0.05	0.48	1.30	1.70	2.50	2.80	4.30	8.30	8.00
SE±	1.20	0.62	0.50	1.80	1.40	1.20	2.00	2.10

LSD = Least significant difference .NS = Not significant and SE± = Standard Error

Table 4: Effect of seed pre-treatment strategies on number of regrowth of fluted pumpkin in 2017 and 2018 cropping season

Treatments	2017 Vine regrowth Weeks after sowing 6	9	12	15	2018 Vine regrowth Weeks after sowing 6	9	12	15
Shed drying days								
0	3.77	3.81	4.30	4.31	3.89	3.90	4.35	4.01
1	3.73	3.85	4.50	4.51	3.89	4.70	4.51	4.53
2	3.82	4.00	4.60	6.61	3.90	4.71	4.73	4.65
4	3.97	4.10	4.85	4.81	3.95	4.75	4.89	4.90
6	3.80	3.89	4.00	4.62	3.85	4.60	4.50	4.70
LSD 0.05	NS	NS	NS	NS	1.20	0.23	0.32	0.30
SE±	0.19	0.16	0.23	0.21	1.01	0.10	0.20	0.23

LSD = Least significant difference .NS = Not significant and SE± = Standard Error

Table 5: Effect of seed pre-treatment strategies on leaf area (cm^2) of fluted pumpkin in 2017 and 2018 cropping season

Treatments	2017 Leaf area (cm^2) Weeks after sowing				2018 Leaf area (cm^2) Weeks after sowing			
	6	9	12	15	6	9	12	15
Shed drying days								
0	58.00	71.30	80.20	90.20	64.20	78.40	84.30	88.00
1	61.20	76.40	81.50	83.10	73.40	80.00	92.00	101.20
2	70.30	80.30	81.70	83.50	86.50	8.40	96.30	107.40
4	77.90	80.60	85.20	89.30	89.50	91.30	102.30	114.30
6	73.20	86.20	88.30	88.70	86.60	88.00	98.40	101.50
LSD 0.05	3.40	6.20	2.64	NS	1.49	3.30	3.80	8.20
SE±	1.26	2.30	2.03	1.10	2.30	1.20	1.40	1.10

Table 6: Effect of seed pretreatment on shoot weight, cumulative fresh and dry weight (Kg/ha) of fluted pumpkin in 2017 and 2018 cropping season

Treatment	2017			2018		
	Shoot weight (t/ha)	Leaf fresh weight (t/ha)	Leaf-dry weight (t/ha)	Shoot weight (t/ha)	Leaf fresh weight (t/ha)	Leaf – dry weight (t/ha)
Shed drying days						
0	2.15	2.79	1.13	2.19	2.90	1.29
1	2.37	2.93	1.18	2.48	3.32	2.48
2	2.44	2.93	1.18	2.49	3.39	2.49
4	2.59	3.18	1.23	2.60	3.42	2.60
6	2.49	3.04	1.23	2.49	3.34	2.49
$LSD_{0.05}$	0.02	0.11	NS	NS	0.21	NS
SE±	1.01	0.03	0.01	0.03	0.11	0.03

LSD = Least significant Difference, NS= Not significant, SE±= Standard error