

Research Article

Growth and Yield Parameters of Two Cameroon Improved Potato Varieties as Influenced by Seed Size

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Abstract

Potato (*Solanum tuberosum* L.) is one of the most important vegetable crop in the world and it is fourth among food crops after rice, wheat and maize. Potato is widely cultivated for its cheap source of carbohydrates, vitamins (B₁ and C) as well as minerals. In Cameroon, where potato provides a livelihood for most producers, especially in the Western highland, production is challenged by unavailability of appropriate seeds of local varieties or Cameroon improve varieties. Many decades ago, some improved varieties (Cipira and Jacob) were released by the Institute of Agricultural Research for Development, (IRAD) Bambui, North West Region, Cameroon. The current study evaluated the performance of these varieties considering seed sizes. Four seed sizes (20 mm, 25 mm, 30 mm and 35 mm diameter) and two varieties (Cipira and Jacob) were evaluated in a randomized complete block trial in Bambili in 2022. Growth parameters such as plant emergence, plant height, vigour and number of stems did not vary significantly for different seed sizes ($P > 0.05$) nor for varieties ($P > 0.05$). However, they tend to increase with increase seed size. The number of plants at harvest followed a similar pattern as the growth parameters. The highest number of tubers harvest for both varieties were obtained from tuber seed size of 35 mm. The total weight of harvested tubers was 3.87 Kg/plot, 2.9 Kg/plot, 2.8 Kg/plot and 2.73 Kg/plot from 35 mm, 30 mm, 20 mm and 25 mm, respectively for Cipira ($P < 0.05$). It was 3.77 Kg/plot, 3.3 Kg/plot, 2.6 Kg/plot and 2.5 Kg/plot from seed sizes of 35 mm, 30 mm, 25 mm and 20 mm, respectively for Jacob ($P < 0.05$). For improved yield, Cipira at 30 mm and 35 mm seed sizes are recommended.

Keywords

Potato, Seed Size Grades, Varieties, Growth, Diseases, Yield, Bambili, Bambui

1. Introduction

Irish potato (*Solanum tuberosum* L.), ranked as the firth most important industrial crop [1] is one of the most important

tuber crops in the world and it is fourth among food crops after rice, wheat and maize [2]. Potato belongs to the family

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Received: 13 March 2024; **Accepted:** 26 March 2024; **Published:** 11 April 2024



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Solanaceae and it has a global distribution [3, 4]. Annual production is about 300 million tons from approximately 20 million hectares of arable land [5]. Potato is a cheap source of carbohydrates, vitamins (B₁ and C) as well as minerals from its tubers [6]. It is estimated that 100g of potato tuber have 79.9g water, 78 kcal Energy, 16.8g carbohydrates, 2.4g protein, 36.0mg calcium, 49.0mg phosphorus, 31.0mg ascorbic acid, 2.2mg niacin, 1.1mg iron, 0.12mg thiamine and 0.06mg riboflavin [7].

In Cameroon, potato is cultivated mainly in the highland zones (Altitude: 1000 to 3000m above sea level) and in six of the ten regions of the country, providing a source of income for many. Over 80% of national production comes from the West and North West regions of the country [8]. Potato ranks fifth in tons produced among the major staple crops behind cassava, plantain, cocoyam/taro and maize in Cameroon [9]. Production has witnessed a threefold increase in the last two decades, driven largely by the ever-increasing domestic demand and a large export market to neighboring countries such as Gabon, Equatorial Guinea, Chad, Nigeria and Central Africa Republic [8]. Although potato production has increased in Cameroon lately, production is still lagging behind due to increasing domestic and export market demands, pest and disease attacks, soil fertility problems and poor irrigation systems [8, 10].

In Cameroon, there has been a consistent decline in availability of seeds of local varieties to farmers as a result of closure of some research centers or their inability to function fully. This has led to the degeneration of Cameroonian improved varieties with continuous use by farmers. This has led to the reduction of seed quality used by farmers. Potato farmers have turned to use poor quality seeds with varying seed sizes for planting which faces a plethora of challenges especially with growth, disease resistant and yield [11].

Some of the varieties cultivated in Cameroon include: Cipira, Tubira, Bambui Wanda, Desire, Cardinal, Banso, Mondial, Spunta and Diamant. The certified local varieties include: Cipira, Tubira, Bambui Wanda, Jacob and Maffo. Banso is a local landrace that has been cultivated since potato cultivation in Nso, North West Region of Cameroon. Cipira, and Jacob are Cameroonian improved varieties which are high yielding, disease resistant and has high dry matter content, released in 1993 [8]. Over three decades now, it is imperative to ascertain their performance on growth and their productivity in the current ever-changing climate conditions. Therefore, this study was designed to provide information on the growth and yield performance of two Cameroonian improved varieties Cipira and Jacob, planted at different seed sizes in the western highland zone of Cameroon.

2. Materials and Method

2.1. Experimental Site

A study was carried out in Bambili, North West Region of

Cameroon, from the 07th of April 2022 to 30th of July 2022. Bambili is found in Mezam Division in the North West Region of Cameroon. It has an altitude of 1558m and a tropical monsoon climate with an average annual temperature of 30 °C. Bambili has an annual rainfall of 854mm and average humidity of 84% which are acceptable for potato production. Weather parameters obtained from the Institute of Agricultural Research for Development (IRAD), Bambui, during the study period are reported (Table 1). The soil is generally acidic and rich in organic carbon, with a sandy-loam texture and a total nitrogen of 0.3 to 0.8% [12].

Table 1. Weather parameters of study site.

Weather parameters	Months			
	April	May	June	July
Relative Humidity (%)	74.15	83.90	88.22	90.99
Temperature (°C)	22.75	21.19	20.02	19.08
Rainfall (mm)	143	216	254	367

RH – Relative humidity

2.2. Treatments, Experimental Design and Field Establishment

2.2.1. Treatments

The treatments used in the study are combinations of seed sizes (diameter of seeds in mm) and varieties (Table 2).

Table 2. Treatment combinations of varieties and seed sizes used in the study.

Seed sizes (mm)	Variety	Treatment codes
20	Cipira	T1
25	Cipira	T2
30	Cipira	T3
35	Cipira	T4
20	Jacob	T5
25	Jacob	T6
30	Jacob	T7
35	Jacob	T8

2.2.2. Experimental Design

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications (R). Each rep-

licate consists of four experimental units (plot or hill) to which each treatment was assigned. Each experimental unit or hill measured 6 m x 0.5 m x 0.4 m. The experimental unit was prepared using a handheld hoe. The block/replicate was separated by a path of 1 m.

2.2.3. Field Establishment

The land was cleared, ploughed and ridged. Organic manure (poultry manure) was applied at planting. The crest of the ridge was opened with hoe and 200g of manure applied on the furrow created. The manure was then mixed and carefully covered with soil. Sprouted seeds of each tuber seed sizes were planted by placing the seed tuber on the furrow at the crest of the ridge. The seeds were planted 30cm between plants and beginning on each ridge at half the planting distance (15cm). Ridges within a block were separated by 80cm. The seeds were planted at a depth of 5cm, covered with soil and properly firmed with hands. A total of 20 seeds were planted per ridge/treatment. Weeding and moulding was done six weeks after planting. Weeds were removed manually and subsequently moulding with a hoe. The experiment was then kept weed free till harvesting. Rainfed irrigation was the source of water. No pesticides were used in this study.

2.2.4. Data Description and Collection

(i). Growth Parameters

Plant emergence

Plant emergence was collected 21days after planting. By this time all the plants are expected to have germinated. The number of plants that had emerged from the soil was counted and recorded, and the plant emergence was expressed as a percentage.

Plant Height (cm)

Plant height was recorded 58 days after planting. A sample of five plants were randomly selected and their heights measured with a meter ruler, from the base of plant to last leaf of the plant. The average height of the 5 plants was calculated and recorded as the height of the plant in each of the treatment.

Plant Vigor

Plant vigor was taken 40 days after planting. It was taken using a scale of 1, 3 and 5 where:

1 = Thin plant with weak branches, 3 = Averagely Vigorous plants and 5 = Very vigorous plants.

Leaf Area Index (LAI)

Leaf area index was recorded 60days after planting. A sample of five plants were randomly selected and the length and width of their leaves measured with a meter ruler. An average of the length and width of the 5 plants was calculated, multiplied by a constant of 0.75 (Elings, 2000) and recorded as the leaf area index of the plant in each of the treatment.

Number of Stems

Number of stems was recorded 60days after planting. A sample of five plants were randomly selected and their stems counted. The average number of stems from the 5 plants was calculated and recorded as the number of stems of the plant in each of the treatment.

Flowering

Fifty percent flowering of the plant in each treatment was recorded 42 days after planting. This was done by counting the number of flowers.

(ii). Yield Parameters

Number of Plant at Harvest per Treatment

Harvesting was done 90 days after planting when the leaves of the plant were yellowish. Harvesting was done manually with hands to avoid destruction of tubers. This was done by counting and recording the number of plants during harvesting in each treatment.

Number of tubers and number of rotten tubers per treatment

The number of tubers per treatment or plot was obtained by counting and recorded. The number of rotten tubers were counted from the total number of tubers recorded, and reported as a percentage of the total.

Total Weight of tubers per treatment

The total weight of tubers per treatment was obtained on-farm. This was done by collecting, weighing (using a scale balance) and recording the weight of all the tubers in each treatment (or plot).

Percentage of Seed Sized, chat size and market size weights of total tubers weight per treatment

The tubers harvested were sorted out into seed sizes (extremely small tubers, < 20 mm), chat sizes (≥ 20 mm) and market size (≥ 35 mm). Then the weight of each set of tubers were recorded and the percentage of each of tubers of the total weight was recorded using the formula below

$$\text{Percentage weight of seed size category} = \frac{\text{Weight of seed size category}}{\text{Total weight of tuber harvested}} \times 100$$

2.3. Data Analyses

Homogeneity of variance and normality tests were conducted using Levene's test and Kolmogorov-Smirnov in SPSS (ver 23), respectively. The data were subjected to one-way Analysis of Variance (ANOVA) test. Where means were significantly different, they were separated using Duncan's Multiple Range Test (DMRT) *posthoc test* at alpha significance (α) level of 0.05 using SPSS (ver. 23). Where the blocking effect was not statistically significant, the ANOVA was redone with the blocking effect removed in order to increase the degree of freedom of the error term, thus increasing the reliability of the analysis [13]. Graphs were plotted using Microsoft Excel for Windows (ver. 2016).

3. Results

3.1. Growth Parameters of Cipira and Jacob Potato Varieties Plant at Different Seed Sizes

3.1.1. Plant Emergence and Plant Height

The number of potato plants that emerged (%) from Cipira variety did not differ significantly ($F = 0.889$, $df = 3, 8$, $P = 0.487$) according to the seed size grade (Table 3). The emergence ranged from 96.67% from 30 mm seed size grade to 100% from 25 mm seed size of Cipira. The emergence was 98.33% for 20 mm and 35 mm seed size of Cipira.

Also, the emergence was not significantly different ($F = 0.250$, $df = 3, 8$, $P = 0.859$) for Jacob variety from the different seed size grades. The emergence was 91.67% for 20 mm seed size and 95.00% for 25 mm, 30 mm and 35 mm seed size of Jacob variety (Table 3).

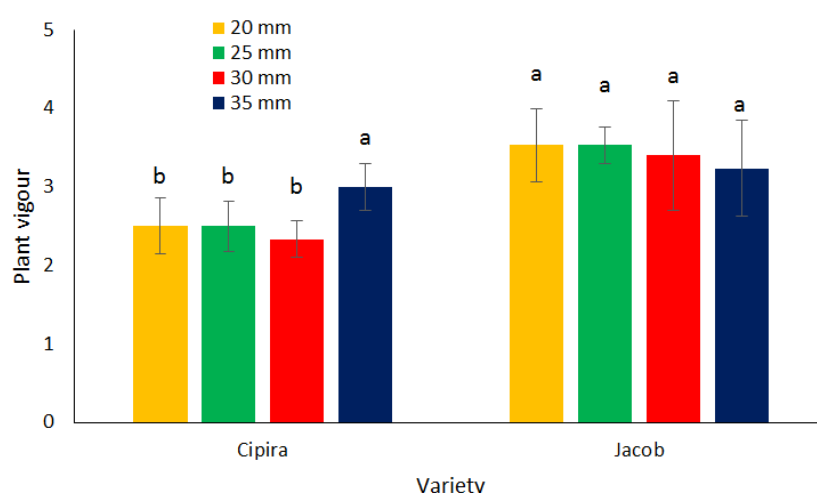
For Cipira variety the plant height did not differ significantly ($F = 1.240$, $df = 3, 8$, $P = 0.357$) based on seed size grades. The highest plant height was 52.90 cm from 35 mm seed size grade, followed by 48.26 cm, 47.63 cm and 43.97 cm from 20 mm, 30 mm and 25 mm seed size grades, respectively (Table 3). The plant height did not differ significantly ($F = 0.432$, $df = 3, 8$, $P = 0.736$) based on seed size grades for Jacob variety (Table 3). The plant height ranged from 38.8 cm from 35 mm seed size to 34.57 mm from 20 mm seed size grade for Jacob variety (Table 3).

Table 3. Effect different seed size grade of Cipira and Jacob varieties on potato plant emergence and plant height.

Seed size (diameter mm)	Cipira		Jacob	
	Plant emergence (%)	Plant height (cm)	Plant emergence (%)	Plant height (cm)
20 mm	98.33 \pm 2.89a	48.27 \pm 9.33a	91.67 \pm 2.89a	35.83 \pm 6.46a
25 mm	100.0 \pm 0.0a	43.97 \pm 3.62a	95.00 \pm 8.66a	34.57 \pm 4.32a
30 mm	96.67 \pm 2.89a	47.63 \pm 5.39a	95.00 \pm 5.00a	38.77 \pm 6.58a
35 mm	98.33 \pm 2.88a	52.90 \pm 0.87a	95.00 \pm 5.00a	38.80 \pm 4.76a

Means in the same column with the same letter are not significantly difference (DMRT, $P < 0.05$)

3.1.2. Plant Vigour of Cipira and Jacob Potato Varieties Planted at Different Seed Sizes



Mean bars with the same letter within a variety are not significantly different (DMRT, $P < 0.05$)

Figure 1. Plant vigour of different potato varieties planted at different seed sizes.

The plant vigor from Cipira differed significantly ($F = 9.095$, $df = 3, 8$, $P = 0.047$) with the highest plant vigor (3)

recorded from 35 mm seed size potato. The plant vigor was 2.3 for 30 mm seed size. The plant vigor was 2.5 for 25 mm and 20 mm (Figure 1). The plant vigor did not differ for Jacob variety ($F = 0.38$, $df = 3, 8$, $P = 0.770$) (Figure 1). The plant vigor for Jacob variety ranged from 3.2 (for 35 mm seed size) to 3.5 (for 20mm and 25mm seed size) (Figure 1).

3.1.3. Leaf area Index of Cipira and Jacob Potato Varieties Planted at Different Seed Sizes

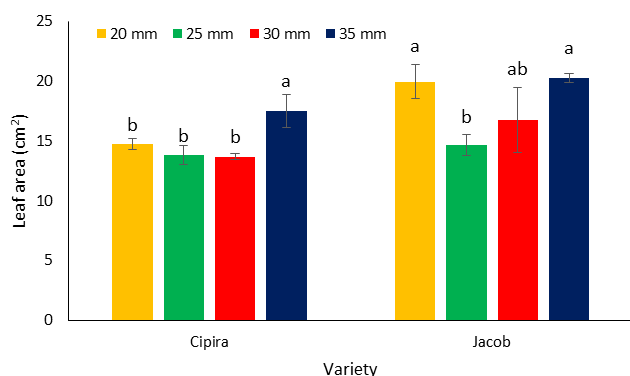


Figure 2. Leaf area index of different potato varieties planted at different seed sizes.

Mean bars with the same letter within a variety are not significantly different (DMRT, $P < 0.05$)

Leaf area index of Cipira and Jacob potato varieties planted at

different seed sizes are presented on figure 2. The highest leaf area index (17.5) for Cipira was recorded from seed sizes of 35 mm and it differ significantly ($F = 11.14$, $df = 3, 8$, $F = 0.034$) from the others. The leaf area for Cipira seed sizes of 20 mm, 25 mm, and 30mm was 14.77, 13.8, and 13.7 respectively (Figure 2).

The leaf area index differed significantly for Jacob potato variety ($F = 8.347$, $df = 3, 8$, $P = 0.008$). The leaf area indices were 20.27, 19.97, 16.73 and 14.67 Jacob variety seed sizes of 35 mm, 20 mm, 30 mm and 25 mm respectively (Figure 2).

3.1.4. Number of Stems and Flowers of Cipira and Jacob Potato Varieties Planted at Different Seed Sizes

For Cipira variety, the number of stems did not show variation ($F = 1.391$, $df = 3, 8$, $P = 0.314$). Based on seed sizes, the numbers of stems were 6 for 30 mm, 5 for 25 mm and 20 mm (Table 4). The number of flowers did not differ significantly ($F = 2.00$, $df = 3, 8$, $P = 0.657$) for the Cipira variety based on seed size (Table 4). The number of flowers for 20 mm seed size was 13 and 12 for 25 mm, 30 mm and 35 mm seed sizes.

For the Jacob variety, the number of stems was 4 for seed size of 35 mm and it differed significantly ($F = 6.031$, $df = 3, 8$, $P = 0.019$) from seed size of 20 mm (2). The number of stems was 2 for 25 mm and 30mm seed size (Table 4).

The number of flowers did not vary significantly ($F = 0.558$, $df = 3, 8$, $P = 0.657$) across the different seed sizes for the Jacob variety. The number of flowers was 14 for 20 mm and 30 mm seed sizes, 15 for 25 mm seed size and 13 for 35 mm seed size (Table 4).

Table 4. Effect different seed size grade of Cipira and Jacob varieties on potato plant number of stems and number of flowers.

Seed size (diameter mm)	Cipira		Jacob	
	Number of stems	Number of flowers	Number of stems	Number of flowers
20 mm	5 ± 0.81a	13 ± 2.7a	2 ± 0.42b	14 ± 1.5a
25 mm	5 ± 1.90a	12 ± 1.0a	3 ± 0.53a	15 ± 0.6a
30 mm	6 ± 0.40a	12 ± 1.0a	3 ± 0.34ab	14 ± 1.5a
35 mm	6 ± 0.90a	13 ± 1.0a	4 ± 0.75a	13 ± 2.0a

Means in the same column with the same letter are not significantly difference (DMRT, $P < 0.05$)

Table 5. Effect different seed size grade of Cipira and Jacob varieties on potato plant number of stems and number of flowers.

Seed size (diameter mm)	Cipira	Jacob
	Number of plants harvested	Number of plants harvested
20 mm	18 ± 1.15a	18 ± 0.0a
25 mm	20 ± 0.57a	19 ± 1.52a

Seed size (diameter mm)	Cipira	Jacob
	Number of plants harvested	Number of plants harvested
30 mm	18 \pm 0.57a	18 \pm 0.58a
35 mm	19 \pm 1.15a	19 \pm 0.57a

Means in the same column with the same letter are not significantly difference (DMRT, $P < 0.05$)

3.2. Yield Parameters of Cipira and Jacob Potato Varieties Plant at Different Seed Sizes

3.2.1. Number of Plants Harvested for Cipira and Jacob Potato Varieties Planted at Different Seed Sizes

For the Cipira variety, the number of plants harvested per plot ranged from 18 plants (20 mm and 30 mm seed size) and it did not differ significantly ($F = 1.700$, $df = 3, 8$, $P = 0.244$) (Table 5). The number of plants harvested per plot for Jacob variety did not differ across the different seed sizes. ($F = 0.407$, $df = 3, 8$, $P = 0.752$) (Table 5). The number of plants harvested per plot for Jacob variety was 18 for 20 mm and 30 mm seed sizes, 19 for 25 mm and 35 mm seed sizes (Table 5).

3.2.2. Number of Tubers Harvested for Cipira and Jacob Potato Varieties Planted at Different Seed Sizes

The number of tubers harvested per plot for Cipira variety differed significantly ($F = 7.294$, $df = 3, 8$, $P = 0.011$) across different seed sizes (Figure 3). The highest number of tubers recorded was 150 tubers from 35 mm seed size, followed by 122, 93 and 80 tubers from 30 mm, 25 mm and 20 mm seed sizes (Figure 3). The number of tubers harvested per plot for Jacob variety varied significantly across seed size ($F = 11.690$, $df = 3, 8$, $P = 0.003$) (Figure 3). The number of tubers har-

vested per plot was 112, 91, 84 and 70 tubers from 35 mm, 30 mm, 25 mm and 20 mm seed sizes respectively (Figure 3).

The percentage of tubers harvested per plot that was rotten is reported in the table 6. The percentage of rotten potato tubers for Cipira across different seed sizes did not vary significantly ($F = 0.335$, $df = 3, 8$, $P = 0.801$) with the values ranging from 5.44% (from 20 mm seed sizes) to 7.35% and 7.38% from 35 mm and 30 mm seed sizes respectively (Table 6).

For the Jacob variety, the percentage for rotten tubers harvested per plot did not differ significantly ($F = 1.33$, $df = 3, 8$, $P = 0.330$) across different seed sizes (Table 6). The values recorded were 0.73%, 1.78%, 1.90% and 2.38% from 30 mm, 35 mm, 20 mm and 25 mm seed sizes respectively (Table 6).

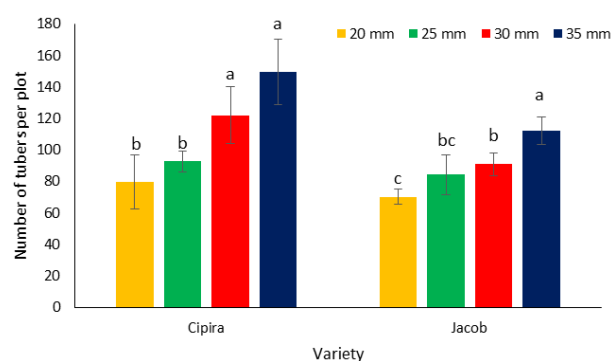


Figure 3. Number of tubers harvested per plot from different potato varieties planted at different seed sizes. Mean bars with the same letter within a variety are not significantly different (DMRT, $P < 0.05$).

Table 6. Effect different seed size grade of Cipira and Jacob varieties on the percentage of rotten tubers.

Seed size (diameter mm)	Cipira	Jacob
	% of rotten tubers	% of rotten tubers
20 mm	5.44 \pm 2.5a	1.90 \pm 0.58a
25 mm	5.76 \pm 4.2a	2.38 \pm 1.73a
30 mm	7.38 \pm 2.1a	0.73 \pm 0.58a
35 mm	7.35 \pm 3.2a	1.78 \pm 0.2a

Means in the same column with the same letter are not significantly difference (DMRT, $P < 0.05$)

3.2.3. Weight of Harvested Tuber for Cipira and Jacob Varieties Plant at different Seed Sizes

The weight (kg) of potato tubers harvested per plot for Cipira at different seed sizes varied significantly ($F = 11.04$, $df = 3, 8$, $P = 0.003$) (Figure 4). The total weight for seed size of 35 mm was 3.87kg, followed by 2.9kg, 2.8kg and 2.73kg from

seed sizes of 30 mm, 20 mm, 25 mm respectively (Figure 4). The total tuber weight (kg) of Jacob potato variety from different sizes vary significantly ($F = 8.04$, $df = 3, 8$, $P = 0.042$) with the highest (3.77kg) from 35 mm seed size. The total tuber weight was 3.3kg, 2.6kg and 2.57kg from 30 mm, 25 mm, 20 mm seed sizes of Jacob variety (Figure 4).

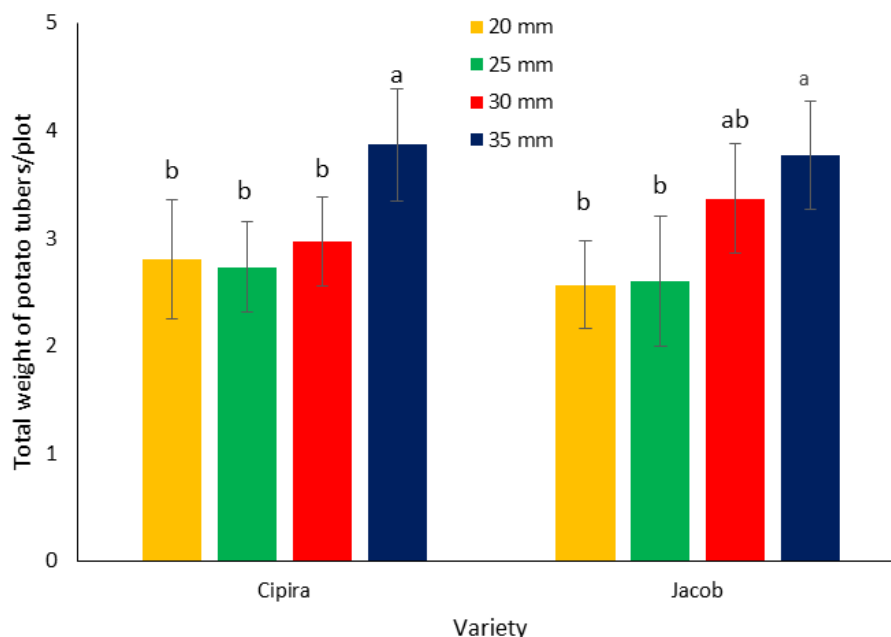


Figure 4. Total weight of harvested tuber per plot from different potato varieties planted at different seed sizes. Mean bars with the same letter within a variety are not significantly different (DMRT, $P < 0.05$).

3.2.4. Percentage Weight of Harvested Graded Potato Tubers for Cipira and Jacob Varieties Planted at Different Seed Sizes

The weight of harvested potato tuber graded by seed size, chat size and market size are expressed as a percentage (%) of the total weight and presented on the Table 6. For Cipira variety, the weight (%) for seed size grade did not differ significantly ($F = 1.483$, $df = 3, 8$, $P = 0.291$) (Table 7). The value ranged from 70.54% to 66.91% from 25 mm and 30 mm seed sizes. The weight of the chat size grade for Cipira did not vary significantly ($F = 0.880$, $df = 3, 3$, $P = 0.491$) across seed sizes. The value for the chat size percentage seed weight was 20.86%, 20.89%, 20.23% and 10.36% from 30 mm, 35 mm, 25 mm, and 20 mm seed sizes, respectively (Table 7). The percentage weight of market size grade for Cipira varied across seed sizes significantly ($F = 9.71$, $df = 3, 8$, $P = 0.047$)

(Table 7). The highest value was 22.48% from 20 mm seed size, followed by 13.78%, 9.99% and 9.16% from 30 mm, 35 mm, and 25 mm seed sizes, respectively (Table 7).

For Jacob variety, the weight (%) for seed size grade differed significantly ($F = 11.483$, $df = 3, 8$, $P = 0.031$) (Table 7). The value ranged from 70.56% to 78.13% from 35 mm and 30 mm seed sizes. The weight of the chat size grade for Jacob varied significantly ($F = 9.880$, $df = 3, 8$, $P = 0.041$) across seed sizes. The value for the chat size percentage seed weight was 11.43%, 13.65%, 15.57% and 16.84% from 30 mm, 20 mm, 35 mm, and 25 mm seed sizes, respectively (Table 7). The percentage weight of market size grade for Jacob varied across seed sizes significantly ($F = 10.71$, $df = 3, 8$, $P = 0.043$) (Table 7). The highest value was 13.86% from 35 mm seed size, followed by 10.43%, 11.99% and 8.57% from 30 mm, 25 mm, and 20 mm seed sizes, respectively (Table 7).

Table 7. Effect different seed size grade of Cipira and Jacob varieties on the percentage weight of graded harvested tubers.

Seed size (diameter mm)	Cipira			Jacob		
	Seed size	Chat size	Market size	Seed size	Chat size	Market size
20 mm	67.15 ± 9.3a	10.36 ± 2.9b	22.48 ± 6.6a	77.78 ± 7.3b	13.65 ± 10.5b	8.57 ± 1.4c
25 mm	70.54 ± 10.1a	20.23 ± 4.3a	9.16 ± 5.9c	71.17 ± 5.5a	16.84 ± 4.3a	11.99 ± 5.4b
30 mm	66.69 ± 10.5a	20.86 ± 20.2a	13.78 ± 16.6b	78.13 ± 9.9a	11.43 ± 3.9c	10.43 ± 3.1b
35 mm	68.52 ± 7.8a	20.29 ± 13.6a	9.99 ± 7.9c	70.56 ± 3.5b	15.57 ± 6.0a	13.86 ± 4.1a

Means in the same column with the same letter are not significantly difference (DMRT, $P < 0.05$)

4. Discussion

The performance of Jacob and Cipira varieties of Irish potato planted at different seed sizes showed that the plant emergence was generally above 90% for both varieties and even reaching 100% for Cipira at 25mm seed size. This demonstrates that Cipira and Jacob emergent is not seed dependent. Thus, high establishment could be as an attribute to the fact that Cipira and Jacob are both improved varieties by the Institute of Agriculture for Development (IRAD) in collaboration with International Potato Center (CIP) for Cameroonian market [14-16].

The plant height did not vary significantly even though; it increased with increased seed size. The finding is a consistent wish of [17] who recorded an increased in plant height with increase in seed size, irrespective of the variety in study in Ethiopia. Hossain et al. [18] also recorded an increased in plant height as plant seed size is increased. From small (25-30g), medium (35-45g), large (45-55g) in relation to tuber seed sizes. Plant vigor also increased with seed size for Jacob even though not significantly different. The study revealed that Cipira and Jacob slightly showed opposite plant vigor performance with regards to seed size.

In general, the finding of this study is in line with the findings of [18] who recorded height plant vigor between 8-10 from a point scale from large potato seed sizes compared to plant vigor of 5-7 and 3-7 from medium and small potato seed [19] sizes respectively.

Like plant height and plant vigor, the leaf area followed a similar pattern. The leaf area increased with increased seed size for both improved varieties. However, the leaf area was higher for Jacob over Cipira variety. Tuber seed size is document as a great influencer of leaf area. For instance, in a similarly study, [17] reported leaf area of 3.83, 3.6 and 3.03 from seed sizes of 48-55mm, 35-45mm and 25-34mm respectively. A similar observation was also made by [18, 20].

The numbers of stem were homogeneous for seed sizes of Cipira and heterogeneous for Jacob. Nevertheless, the number of stems followed a similar pattern like the other growth pa-

rameters. Higher number of stems is reported from larger seed sizes than from small seed sizes by [17, 18].

Seed size did not influence the number of flowers of both varieties. However, the number of flowers was generally higher in Jacob than Cipira. Like the number of flowers, the number of plants at harvest did not differ. The values were almost the same for both Cipira and Jacob this finding suggest that the number of plants at harvest is not dependent on the seed size nor variety. The current findings is in contrast with that of [11] who reported that the number of plants at harvest increase with increase seed size. It must be noted that the observation of [11], showed very slight differences. Clearly, the number of tubers harvested per plot for Cipira and Jacob all increased with increased seed size. In fact, the number of tubers harvested per plot for Cipira from 35mm seed size almost doubled that harvested from 20mm seed size. A similar trend was observed for Jacob.

However, Cipira performed better than Jacob for all seed sizes even though Cipira and Jacob are known as improved varieties with high yielding potentials [21]. Cipira is widely reported as a high yielding variety [16]. Deffo and Demo [16] conducted a study on farmers acceptance of some varieties of potato in Cameroon and they reported a 78% acceptance of Cipira by farmers.

The number of tubers harvested was strongly influenced by seed size positively. That is; large seeds produce more tubers at harvest. One reason for this could be that large seed sizes meant that the amount of reserve material is greater than in smaller seeds which could translate into a higher number of tubers [22, 23].

The findings of the current studies about the number of tubers produced par with that of [18, 20]. The phenomena observe is well explained by [24, 25] who reported that potato plants that are established from large and very large seeds produce smaller but many tubers while those small to medium seed sizes produce few but large tubers.

The percentage of rotten tubers did not differ with regards to seed sizes. This implies that seed size did not influence rottenness in potato, which is a sign of a decrease. Secondly, the overall percentage of tubers rotten for both varieties was very low for both varieties. This could be because these im-

proved varieties were developed for high yielding and high resistance to diseases [16, 26].

The weight of tubers harvested followed the pattern of the number of tubers per plot. Weight increased with increased tuber size. The reason for this is in line with the observation of [22, 23].

It was also observed that for the percentage of total tuber harvested that seed sizes were higher than those of chat and market sizes. In particular, the percentage of market size tuber was higher from 20mm seed size compared from 35mm seed size for Cipira and the reverse was true for Jacob the observation of Cipira is in accordance with the observation of [22, 23, 25] as mentioned earlier, even though not the case for Jacob. It is suggested that other factors such as environmental may be at play [20].

5. Conclusion

The findings of this study revealed that seed size is an important factor that influences growth yield, disease prevalence of potato. No much variation was observed on growth parameters based on seed sizes for the two varieties. However, yield was significantly influenced by seed size. The number of potato and weight generally increased with increased seed size. Generally, Cipira performed better than Jacob variety.

Therefore, it is suggested that farmers consider seed size as a critical factor on potato production. For optimal yields and low disease prevalence, Cipira at seed size 35mm is recommended.

Abbreviations

DMRT: Duncan's Multiple Range Test

CIP: International Potato Center

IRAD: Institute of Agricultural Research for Development

Conflicts of Interest

The authors declare no conflicts of interest.

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