American Journal of Agriculture and Forestry
2023; 11(6): 247-253
http://www.sciencepublishinggroup.com/j/ajaf
doi: 10.11648/j.ajaf.20231106.15
ISSN: 2330-8583 (Print); ISSN: 2330-8591 (Online)

Selection of Potato (*Solanum tuberosum*) Genotypes for Adaptability, Diseases Resistant and Yields for Farmers of Bamenda, Cameroon

Lendzemo Eugene Tatah[1, *], Tange Denis Achiri[2], Likejungki Verla[1], Mbulav Etienne Sighansenyuy[1], Chi Christopher[3], Njualem Dominic Khumbah[1, 3]

[1]Department of Crop Production Technology, College of Technology, University of Bamenda, Bambili, Cameroon

[2]Department of Agronomic and Applied Molecular Sciences, Faculty of Agriculture and Veterinary Medicine, University of Buea, Buea, Cameroon

[3]School of Tropical Agriculture and Natural Resource, Catholic University of Cameroon, Bamenda, Cameroon

Email address:

teugenelendzemo@yahoo.com (Lendzemo Eugene Tatah), achiritange@gmail.com (Tange Denis Achiri), mbulav@gmail.com (Mbulav Etienne Sighansenyuy), papasunny2001@yahoo.com (Chi Christopher), njualemdk@yahoo.com (Njualem Dominic Khumbah)

[*]Corresponding author

To cite this article:

Lendzemo Eugene Tatah, Tange Denis Achiri, Likejungki Verla, Mbulav Etienne Sighansenyuy, Chi Christopher et al. (2023). Selection of Potato (*Solanum tuberosum*) Genotypes for Adaptability, Diseases Resistant and Yields for Farmers of Bamenda, Cameroon. *American Journal of Agriculture and Forestry*, *11*(6), 247-253. https://doi.org/10.11648/j.ajaf.20231106.15

Received: November 1, 2023; **Accepted**: December 1, 2023; **Published**: December 8, 2023

Abstract: Irish potato (*Solanum tuberosum* L.) is an important tuber crop in the world, and it is the fourth most consumed food crop after rice, wheat and maize. Irish potato is a viable source of livelihood and income for many producers, especially in the Western highland of Cameroon. However, like many other crops in Cameroon, Irish potato production is challenged by the unavailability of local or improved varieties of seeds. As a remedy, farmers often rely on imported varieties without information on their adaptability in the local environment in relation to productivity and disease infection. Hence, this study was conducted to evaluate the adaptability of four European potato varieties (Safari, Vogue, Arsenal and Kondor) in relation to a local variety (Banso) and a Cameroonian improved variety (Cipira). The study was conducted in Bambili, North West Region of Cameroon from April to August 2021, and established in a randomize complete block design. All the measured growth and yield parameters differed significantly ($P < 0.05$). Banso, Cipira and Kondor varieties had the highest plant emergence (15, 15, and 13, respectively). Banso and Cipira matured earlier than all European varieties. The productivity of Cipira (7.78 t ha^{-1}) out-performed all other varieties with significantly ($P < 0.01$) higher yield than Banso (4.0 t ha^{-1}), Kondor (3.33 t ha^{-1}), Arsenal (2.5 t ha^{-1}), Vogue (1.92 t ha^{-1}), and Safari (0.72 t ha^{-1}). The European varieties (Vogue, Arsenal and Safari) exhibited significantly ($P < 0.05$) higher late blight incidence as compared to the other varieties. The Cameroon improved Cipira and local Banso varieties are therefore recommended for growers in the Western Highland of Cameroon, while the European Kondor variety can be used in the event of scarcity or unavailability of Cipra and Banso varieties. Overall, the findings of this study highlight the need for viable seed system to make available local and Cameroon improved varieties and limit importation of underperforming Irish potato seeds.

Keywords: Irish Potato, Adaptability, Disease Resistant, Yield, Cameroon

1. Introduction

Irish potato (*Solanum tuberosum* L.) is a Solanaceae with global distribution [1, 2]. It is an important crop in the world and it is ranked as the fourth most consumed food crop after rice, wheat and maize [3]. Annual production is about 359 million metric tons from approximately 20 million hectares of arable land [4]. This plant is widely cultivated for its cheap source of carbohydrates, vitamins (B_1 and C) as well as

minerals from its tubers [5, 6]. In Cameroon, potato is cultivated mainly in the highland zones at altitude 1000 to 3000m above sea level across six of the ten regions of the country. Over 80% of the national production comes from the West and North West regions (Western Highland) of the country [7]. Potato ranks fifth in tons produced among the major staple crops behind cassava, plantain, cocoyam/taro and maize in Cameroon [8]. Production has witnessed a threefold increase in the last two decades [9], driven largely by the ever-increasing domestic demand and a large export market to neighbouring countries [7].

Although potato production has increased in Cameroon lately, production is still lagging behind due to poor soil fertility couple with pest and disease problems [7, 10, 11]. Moreover, obtaining viable seeds has emerged as a major challenge for most farmers, as it has become imperative to use improved seeds to boost productivity [12, 13]. Seed systems constitute both formal and informal sectors and an integrated system where farmers adopt improved varieties from the formal sector, and informally save seeds from own-harvest for subsequent use [14-16]. However, long-term seed storage may affect viability that might eventually affect seed establishment, crop growth and productivity [17, 18]. There has been a consistent decline in availability of local seed varieties in Cameroon has led to the importation of improved varieties of many crops including Irish potato. Nonetheless, introducing foreign crop varieties into a new environment without appropriate screening for adaptability, disease and yield performances may be counter-productive [9].

The objective of this study is to determine the best-bet seed varieties that could be promoted within a viable seed system in Cameroon. Amongst the many potato varieties cultivated in Cameroon, Banso was evaluated as a local landrace that has been traditionally cultivated in this study area, while Cipira is a Cameroonian improved variety which is high-yielding and disease-resistant [10]. The importation and cultivation of European Irish potato varieties (e.g., Arsenal, Kondor, Safari and Vogue) has increased in Cameroon due to scarcity or unavailability of local seeds. Therefore, this study was conducted in the western highland of Cameroon to evaluate the adaptability and performance of four imported European Irish potato varieties in relation to a local landrace (Banso) and an improved (Cipira) variety in Cameroon. It was hypothesized that the local landrace and improved Cameroonian varieties shall be highly adapted to the local environment, and out-perform the imported European varieties in terms of disease resistance and productivity.

2. Materials and Methods

2.1. Study Site

The experiment was conducted from the 14th of April 2021 to the 11th of August 2021 in Bambili, Mezam Division, of the North West Region of Cameroon. It has an altitude of 1558m and a tropical monsoon climate. During the study period, the average temperature, relative humidity (%) and rainfall (mm) were 18.52°C, 87.6% and 325.4 mm, respectively (figure 1).

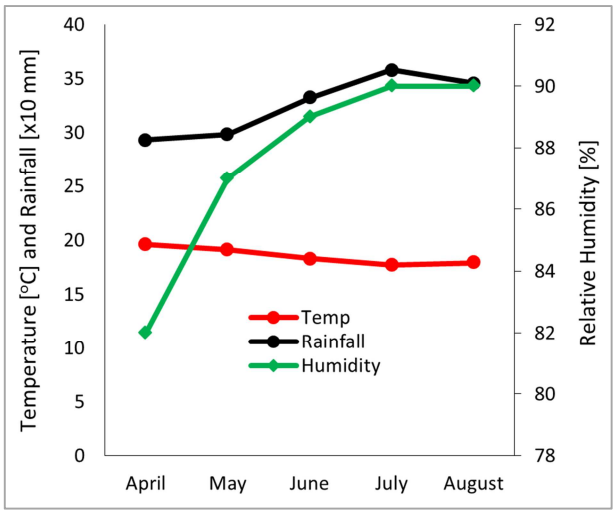

Figure 1. *Weather parameters during the study period (April – August) of 2021.*

2.2. Potato Varieties

Six potato varieties were evaluated in this study including two Cameroonian varieties (Banso and Cipira) and four European varieties (Vogue, Safari, Arsenal and Kondor). The Banso is a local landrace while Cipira is an improved Cameroonian variety of Irish potato. Arsenal is an early main crop [20], potato variety bred from AR 92-1146 X Silvester, and it is suitable for cultivation in most soil types but is susceptible to common scab, while regular irrigation ensures uniformity of growth and yield performance. Kondor is an intermediate maturity potato variety bred from konst 61 333 X and Wilja by JPG konst, and originates from the Netherlands. It is estimated to produce high to very high yield with very high early harvest yield potential [21]. Safari is a late maturity potato variety bred from Obelix X Amadeus by Branston Ltd with very high yield and round oval tubers [22]. Vogue is an early maturing potato cultivar that is a cross between Amorosa and Marabel, which is bred for the traditional market in North African and southern European countries [23]. These seeds were obtained from the Institute for Agricultural Research and Development (IRAD) Bambui.

2.3. Experimental Setup and Planting

The land was manually cleared with a cutlass and hand-tilled with a hoe to make raised beds that would facilitate tuber development. The experiment was laid out in a randomized complete block design with four blocks. Each block was made up of six ridges measuring 6 m × 1 m × 0.2 m, each separated by 0.5 m and the blocks were separated by 1 m buffer strips. The potato cultivars were randomly assigned to the different ridges per block. Planting of the potato seeds was done manually on the 14th of April 2021 and the sprouted seeds of each variety were planted by placing the seed tuber in the furrow on the crest of the ridge.

The seeds were planted 30cm apart and at 5cm depth, covered with soil and properly hand-firmed, giving a total of 20 plants per ridge.

2.4. Management Practices

A compounded fertilizer NPK (11-11-22) was used for the experiment and applied at a rate of 1.2 t ha^{-1} which is equivalent to 32g per plant applied in the furrow at planting. Manual weeding with hoes and mulching was done at four weeks after planting. Disease control was done chemically using Monchamp 720 WP which is a systemic and contact fungicide containing 120g per kilogram of cymoxanil and 600g per kilogram of Mancozebe. It was applied at a dose of 50g per 15litres of water. Pest control was effected with the insecticide Cyperfresh EC (Cypermethrin 100g) applied at a dose of 60mL per 15litres of water. The insecticides and fungicide were mixed and applied together at the third and sixth weeks after planting. The field was irrigated at the one week after planting and later relied on rainfed irrigation. The plants haulms were removed two weeks before harvesting so as to improve hardening of tubers.

2.5. Data Collection

2.5.1. Agronomic Parameters

Plant emergence was recorded as the number of counted plants that emerged after four weeks of planting. The emergence is expressed as a percentage. At the seventh week after emergence, plant height, Leaf Area Index (LAI), number of stems, and plant vigor were recorded. Four plants were randomly selected per ridge and the height was measured with a meter rule. A meter rule was used to measure the length and width of one leaf from the middle portion from the four plants that were sampled for all other parameters, and the LAI was calculated by multiplying the product of the length and width by a constant 0.75 [24]. Earliness was measured as the day when 50% of the potato in a plot showed senescing and began to dry. The number of stems was counted from four randomly selected plants per plot. Plant vigour was measured on a 5-point scale (1-5). The 5-point scale is defined in Table 1.

Table 1. *Five-point scale used to measure potato plant vigour.*

Scale	Definition
1	Very weak plant with thin stems, small leaves and pale colour
2	Weak plant, small to medium size leaves with patches of pale colouration
3	Intermediate or acceptable plant; medium size stem and green leaves,
4	Strong plant, normal stem size and sufficient green foliage
5	Very robust plant, very thick stems and abundant foliage

2.5.2. Late Blight Incidence (%) and Viral Incidence

Late blight and viral incidences were estimated at the seventh week after planting. The number of plants showing signs of infection (M) was recorded and expressed as a percentage of the number of plants that emerged (N). The following equation was used to estimate the late blight incidence.

$$Late\ blight\ incidence\ (\%) = \frac{M}{N} \times 100$$

The number of plants showing viral incidence (V) (i.e., mosaic leaf pattern, crinkled leaves, and stunted growth) was counted per plot and expressed as a percentage of the number of plants per plot (N). The following formula was used to estimate the viral incidence.

$$Viral\ incidence\ (\%) = \frac{M}{N}\ x\ 100$$

2.5.3. Potato Yield

Potato was harvested at 120 days after planting when most of the plant had senesced. The number of tubers per plant was recorded, rotten tubers were isolated and counted (recorded as a percentage of tubers harvested) and the weight of tubers was measured using a top-lift scale. The weight of tuber per plant on each plot was extrapolated to that of a hectare and reported as productivity (yield in tons per hectare, t ha^{-1}).

2.6. Statistical Analysis

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 Tukey Honestly Significantly Difference (Tukey HSD) *posthoc test* at alpha (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 [25].

3. Results

3.1. Emergence (%)

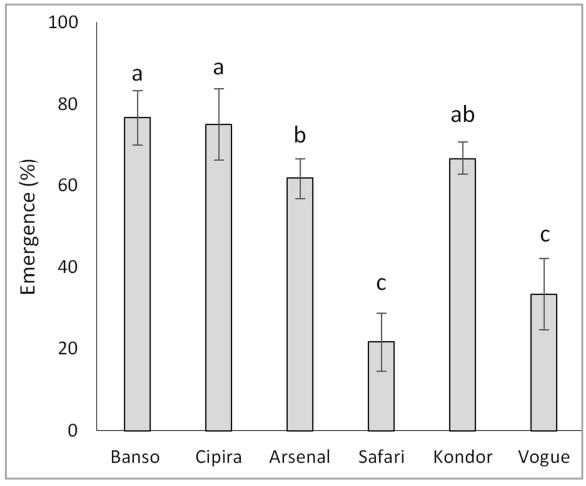

Figure 2. *Emergence (%) of potato varieties. Mean bars with different letter are significantly different (P <.05, Tukey HSD).*

Plant emergence differed significantly (F = 6.035, df = 5, 12, P = .005) between potato varieties, with the highest values

76.66% and 75.0% observed from Banso and Cipira varieties, respectively (figure 2). These were followed by Kondor (66.65%) and Arsenal (61.65%) varieties, and the lowest from Vogue (33.35%) and Safari (21.65%) varieties. In fact, the emergence of Banso and Cipira out-performed some European varieties by 2-folds and 3 folds (figure 2).

3.2. Growth Parameters of Irish Potato

The plant height ranged from 25.0cm to 49.33cm, and differed significantly (F = 23.515, df = 5.12. *P* <.001), with the highest in Banso variety (49.33cm) followed by Cipira (48.33cm), Vogue (28.33cm), Arsenal (27cm) and Kondor (27.67cm) varieties, and the lowest in Safari (25cm) (Table 2). The LAI differed significantly (F = 7, df = 5, 12, *P* =.003) across the different potato varieties, with the highest in Kondor (28) variety, followed by Safari (16.33), Vogue (13.67), Banso (12.33) and Arsenal (12.67) varieties and the lowest in Cipira (11.07) (Table 2). The earliness to maturity ranged from 95 to 106 days and differed significantly (F = 113.680, df = 5, 12, *P* <.001) potato varieties, with the shortest duration to maturity recorded in the varieties in the Banso and Cipira (95 days) from Cameroon, while the longest duration to maturity occurred in the imported varieties with Safari (106 days) as the highest followed by Vogue (103 days) and 102 days for Arsenal and Kondor (Table 2).

The number of potato stems ranged from 2 to 8 and differed significantly (F = 30. 42, df = 5, 12, *P* <.001) across the different varieties, with the highest in Cipira (8) variety, followed by Banso (7), Arsenal (4), Vogue (3), and 2 stems for Safari and Kondor varieties (Table 2). The plant vigor ranged from 1 to 5 point-scale that differed significantly (F = 14.27 df = 5, 12, *P* < .001) across potatoes varieties, with the highest vigor (5) recorded in the Kondoh, Banso and Cipira varieties, followed by Vogue (3.3) and Arsenal (2.6), and 2 as the lowest in Safari (Figure 3).

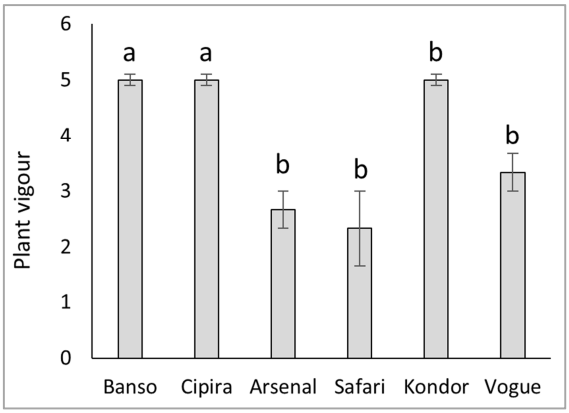

Figure 3. *Plant vigour of the different potato varieties. Mean bars with different letter are significantly different (P <.05, Tukey HSD).*

Table 2. *Growth parameters of Irish potato varieties cultivated in the highlands of Cameroon.*

Varieties	Plant height (cm)	LAI	Earliness (days)	Number of stems
Banso	49.33 ± 2.33a	12.33 ± 2.03b	95.0 ± 0.10c	7 ± 0.33a
Cipira	48.33 ± 1.90a	11.67 ± 0.33b	95.0 ± 0.10c	8 ± 0.88a
Arsenal	27.00 ± 1.50b	12.67 ± 0.33b	102.0 ± 0.20b	3 ± 0.33b
Safari	25.00 ± 4.00b	16.33 ± 3.89b	106.3 ± 0.3a	2 ± 0.23b
Kondor	27.67 ± 1.30b	28.00 ± 2.89a	102.0 ± 0.10b	2 ± 0.33b
Vogue	28.33 ± 1.80b	13.67 ± 2.19b	103.0 ± 1.00b	3 ± 0.33b

Means within a column with different letters are significantly different (*P* < 0.05, Tukey HSD).

3.3. Potato Yield

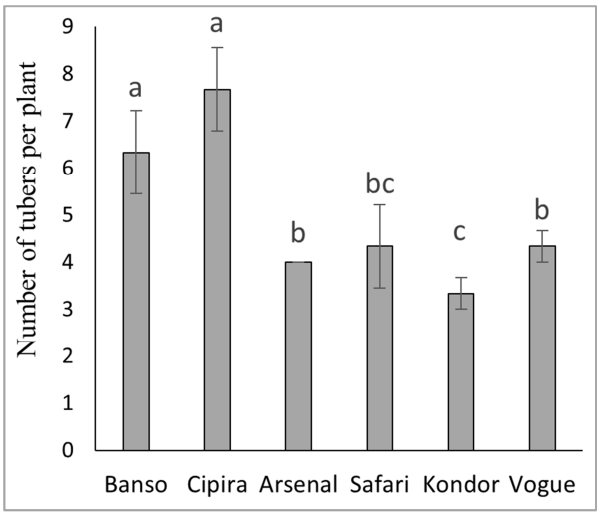

Figure 4. *Mean number of tubers from different potato varieties. Mean bars with the different letters are significantly different (P <.05, Tukey HSD).*

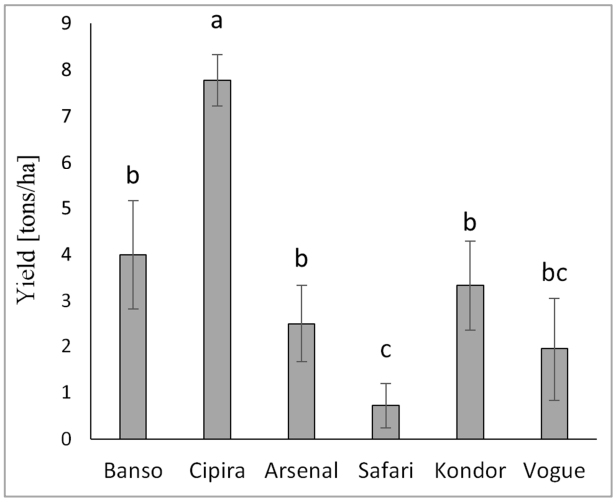

Figure 5. *Yield (t ha^{-1}) of different potato varieties. Mean bars with different letters are significantly different (P =.05, Tukey HSD).*

The number of potato tubers per plant ranged from 3 to 8 that differed significantly (F = 6.365, df = 5, 12, *P* =.044)

across potato varieties, with the highest in Cipira (8), followed by Banso (6), Arsenal, Safari and Vogue (4), and the lowest number of tubers in Kondor (3) (Figure 4). Potato yield ranged from 0.72 to 7.70 t ha^{-1} that differed significantly (F = 7.470, df = 5, 12, *P* =.002) across varieties with the highest in Cipira (7.70 tons/ha), followed by Banso (4.0 tons/ha), Kondor (3.33 tons/ha), Arsenal (2.50 tons/ha), Vogue (1.94 tons/ha), and the lowest of 0. 72 tons/ha in Safari (Figure 5).

3.4. Incidence of Late Blight, Viral Incidence, and Rotten Tubers

The incidence of potato late blight disease ranged from 30 to 87% and differed significantly (F = 4.245, df = 5, 12, *P* =.019) across potato varieties, with the highest incidence recorded on Vogue potato variety (87.0%), followed by Arsenal (65.0%), Kondor (64.67%), Safari (47.0%), Banso (37.0%), and with the lowest Cipira (30.0%).

The number of plants showing viral incidence on different potatoes varieties is represented on Table 3. There was a significant difference (F = 2.086, df = 5, 12, *P* =.048) in viral incidence on different potato variety. The viral incidence ranged from 0 to 1.33. The highest viral incidence (1.33) was recorded from Vogue potato variety. The lowest viral incidence (0) was recorded from Kondor, followed by 0.33, recorded from Safari (Table 3). The number of rotten tubers observed from different potatoes varieties are presented in Table 3. There was a significant difference (F = 1.725, df = 5, 12, *P* =.049) in the number of rotten tubers potato variety. The highest number of rotten tubers (2) was recorded from Kondor potato variety. There were no rotten tubers observed from Arsenal (Table 3).

Table 3. *Incidence of late blight, viral attack and number of rotten tubers per plant of different potato varieties.*

Varieties	Late blight incidence (%)	Viral incidence (%)	Rotten tubers (%)
Banso	37.0 ± 8.54bc	6.52 ± 2.33bc	15.8 ± 2.67c
Cipira	30.0 ± 7.09c	2.22 ± 1.90c	13.0 ± 3.33c
Arsenal	65.0 ± 13.8ab	8.11 ± 1.50b	0 ± 0.0d
Safari	47.0 ± 14.79bc	7.69 ± 4.00b	23.1 ± 5.77b
Kondor	64.7 ± 7.31ab	0.0 ± 1.30d	60.0 ± 3.4a
Vogue	87.0 ± 6.656a	19.99 ± 1.80a	23.1 ± 5.67b

Means in the same with the same letter(s) are not significantly different (*P* =.05, Tukey HSD).

4. Discussion

In many developing countries, there is acute shortage of good quality seeds [26], and there is a paucity of knowledge of the varieties being cultivated across many sub-Saharan African (SSA) countries. The potential for increase potato production from adoptable varieties and improve agronomic practices is a quest for many governments and researchers in SSA [27]. Plant emergence of Banso and Cipira were almost 3-4 folds greater than those of Safari and Vogue. Among the many factors that can influence plant emergence such as the environmental and biotic stressors, the plant variety is a very important factor [28]. It is suggested that varieties developed for conventional farming conditions do not possess relevant traits for optimum performance under low-input settings [29], such as in the western highland of Cameroon. This could explain why local varieties exhibited higher emergence in the Western highlands of Cameroon than the European improved varieties.

The results revealed that the local varieties grew approximately twice as tall as the imported varieties. The trend is similar for the number of stems and plant vigour. The local varieties had more stems than the imported varieties. Similarly, they were more vigourous than the imported varieties. The observed increases in potato growth parameters of Banso and Sipira are supported by Wolf et al. [29].

The days to maturity (earliness) also varied across varieties. The days to maturity of Banso and Cipira were 95 (< 100 days). The days to maturity for the imported varieties were greater than 100 days. Banso and Cipira can be classified as 'early maturing' varieties according to [30], maturity categories. The other potato varieties can be classified as 'medium early maturing' varieties [31, 32], explaining the variations in days to maturity.

The variability observed in the present study is in accordance with that of [33] who reported substantial variability in growth parameters from different potato varieties. According to [34], there variabilities observed in the growth parameters may be caused by plant genetics and the quality of the planting material. Thus, the results in the present study are expected as genotypes normally differ in their phenotypes such as growth parameters.

Variations in yield and yield-related parameters from different potato varieties have been reported elsewhere [35]. According to Habtamu et al. [36], productivity of potatoes is highly influenced by genotype and environment. The imported varieties may have had low productivity because they were not adapted to the western highland of Cameroon, as compared to their environment of origin [37]. In Cameroon, yield of potatoes grown in monocropping commercial farms ranged from 7 to 20 t ha^{-1} [38]. Cipira and Banso are well suited for the Cameroonian condition, and that explains why Cipira performance as far as yield is concern was within the range reported by [38]. High performances have been reported for Banso too; Banso was the best performing variety in terms of tuber number and productivity in a six-potato varietal trial conducted in the monomodal rain-forest of Buea, Cameroon [39].

The high incidence of late blight and viral diseases observed for the imported European varieties could be related poor adaptation of the European varieties and different genotypes to environmental variations compared to the local potato. Habtamu et al. [36] posits that environment is one

critical factor which determine the phenotypic performances of potato. The presence of viruses on potato is not new in Cameroon as [40] reported high prevalence of viruses on some potato varieties in the Western highlands of Cameroon, but Banso and Cipira had low viral incidences. Cipira in particular was released in the early 1990s as a resistant and high yielding potato variety in Cameroon by the Institute of Agricultural Research for Development [38].

5. Conclusion

Significant variations were observed in the response of different Irish potato varieties in terms of growth, yield and disease parameters with the local varieties demonstrating greater performance than the imported European varieties. Banso and Cipira varieties were least affected by blight and viral diseases and they produced the highest yield, which demonstrates their adaptation to the local environment as compared to their European counterparts. Consequently, Banso and Cipira varieties are highly recommended for growers in the western highland regions of Cameroon, but they can resort to the European Kondor variety in case of scarcity or absence of the local variety two varieties. The findings of this study demonstrates that the choice of seed variety is not the major problem of Irish potato production but likely the unavailability of seeds in the local market which is forcing farmers to depend on poor performing imported seeds.

Authors Contribution

'Conceptualization, LET, TDA, LAV, NDK.; Methodology, LET, TDA, NDK.; Validation, LET, TDA, MES, CC, NDK.; Writing - Original Draft Preparation, LET, TDA, MES, CC, NDK.; Writing - Review & Editing, LET, TDA, MES, CC, NDK.; Supervision, LET, NDK.

Acknowledgments

We are grateful for the technical support we received from the agric-engineers in Bambili, Cameroon.

Conflicts of Interest

The authors declare no conflict of interest.

References

[1] Grun, P. (1990). The evaluation of cultivated potatoes. Economy Botany, Washington D. C 44 (3rd Supplement): 39-55.

[2] Gehan, A. E. (2013). Effect of organic, Nitrogen and Potassium fertilization treatments on growth, yield and chemical contents of two cultivars of potato (*Solanum tuberosum*). *Alexandria Science Exchange Journal*, 34 (4): 369-381.

[3] Naz, F., Ali, A., Iqbal, Z., Akhtar, N., Asghar, S., Ahmad, B. (2011). Effects of different levels of NPK fertilizers on the proximate composition of potato crop at Abbottabad. *Sarhad Journal of Agriculture*, 27 (3): 353-356.

[4] FAOSTAT (2022). FAO updates global potato statistics. https://www.potatonewstoday.com/2022/03/28/fao-updates-global-potato-statistics/ (Accessed: March 30, 2023).

[5] Rashid, M. M (1993). Potato cultivation. Shabjibijan. 1st Edition Bangla Academy. Dhaka Bangladesh, pp. 450-455.

[6] Tamm, L (2007). The current situation of organic potato production in Europe, Switzerland Research Institute of organic Agriculture, Switzerland.

[7] Fontem, D. A., Demo, P., Njualem, D. K (2004). Status of potato production, marketing and utilization in Cameroon; *In*. N. M. Mahanku, V. M. Mayong (eds), Advances in Root and Tuber crops Technology for Sustainable Food Security. Improved Nutrition, Wealth Creation and Environmenta Conservation in Africa, Proceedings, 9th ISTRC-AB Symposium, 1-5, Nov., Mombassa, Kenya, 2004, 18-25.

[8] KTHEISEN. (2016). https://research.cip.cgiar.org/confluence/display/wpa/Cameroon. International Potato Center: World potato Atlas. (Accessed: 25-05-2021).

[9] FAOSTAT, (2016). Production/Core Production Data. 2016.

[10] Njualem, D. K. (2010). Evaluation of potato (*Solanum tuberosum*) production and clonal screening for resistance to major disease and yield characterization in the Western Highlands of Cameroon. PhD Thesis, University of Dschang, Cameroon, 2010.

[11] Achiri, T. D., Tsegue, Z. S. M., Konje, S. C., Njualem, D. K. (2018). Effect of NPK fertilizer and animal manure on some biometric parameters of Irish potato *Solanum tuberosum* L. in Bougham, West Region Cameroon. *Asian Journal of Research in Crop Science*, 2 (1): 1-10.

[12] Bishaw, Z., Atilaw, A. (2016). Enhancing agricultural sector development in Ethiopia: The role of research and seed sector. *Ethiopian Journal of Agricultural Sciences*, 27: 101-130.

[13] Abebe, G., Alemu, A. (2017). Role of improved seeds towards improving livelihood and food security at Ethiopia. *International Journal of Research-Granthaalayah*, 5 (2): 338–356.

[14] Zewdie, B., Van Gastel, A. (2008). ICARDA's seed-delivery approach in less favorable areas through village-based seed enterprises: Conceptual and organizational issues. *Journal of New Seeds*, 9 (1): 68-88.

[15] Sperling, L., McGuire, S. (2010). Understanding and strengthening informal seed markets. *Experimental Agriculture*, 46 (2): 119-136.

[16] Meselu, Y. K. (2019). A review on the seed sector of Ethiopia: Prospects and challenges of faba bean seed supply. South Asian Journal of Development Research, 1 (1): 44–54.

[17] Baoua, I., Amadou, L., Margam, V., Murdock, L. (2012). Comparative evaluation of six storage methods for postharvest preservation of cowpea grain. *Journal of Stored Products Research*, 49: 171-175.

[18] Mbeboh, M. N., Youmbi, E., Mala, W. A., Manga, G. A., Ngwa, A. F., Badjel Badjel, S. M., Ngosong, C. (2020). Comparative evaluation of six different storage materials for long-term preservation of huckleberry (*Solanum scabrum*) seeds. *International Journal of Sustainable Agricultural Research*, 7: 3-38.

[19] Lyon, A., Tracy, W., Colley, M., Culbert, P., Mazourek, M., Myers, J., Zystro, J., Silva, E. M. (2019). Adaptability analysis in a participatory variety trial of organic vegetable crops. *Renewable Agriculture and Food Systems*, 35 (3): 296 - 312. https://doi.org/10.1017/S1742170518000583.

[20] European Cultivated Potato ECP. (2020a). The European cultivated potato database – *Arsenal*. https://www.europotato.org/varieties/view/Arsenal-P. (Accessed: August 4, 2020)

[21] European Cultivated Potato ECP. (2011). The European cultivated potato database – *Kondor*. https://www.europotato.org/varieties/view/Kondor-E. (Accessed: December 20, 2020)

[22] European Cultivated Potato ECP. (2020b). The European cultivated potato database – *Safari*. https://www.europotato.org/varieties/view/Safari-P. (Accessed: August 4, 2020)

[23] VOGUE (2015). Potato Variety Information. https://www.potatopro.com/potato-varieties/vogue (Accessed: December 20, 2020).

[24] Amanullah K. H., Marwat, K. B., Shah, P. (2009). Nitrogen levels and its time of application influence leaf area, height and biomass of maize planted at low and high density. *Pakistan Journal of Botany*, 41: 761–768.

[25] Achiri, T. D., Ngone, A. M., Nuigho, K. B., Nsobinenyui, D., Nkuh, A. A., Njualem, D. K. (2021). Spatial orientations of common bean influence the activities and population dynamics of bean stem maggot (*Ophiomyia phaseoli*) and bean foliage beetle (*Ootheca mutabilis*). *Fundamental and Applied Agriculture*, 6 (2): 183-192. https://doi.org/10.5455/faa.71183.

[26] Demo, P., Akoroda, M. O., Njualem, D. K. (2001). A model for rational determination of prices of seed potato (Solanum tuberosum L.) tubes of different size grades using agronomic data. Proceeding of the Eighth Triennial Symposium of the International Society for Tropical Root Crops Africa Branch. Ibadan, Nigeria.

[27] Achiri, T. D., Nkuh, A. A., Nsobinenyui, D. and Njualem., D. K. (2020). Heterogeneous nutrient sources exhibit varying associations of vegetative and reproductive parameters of Irish potato (*Solanum tuberosoum*, L). *International Journal of Plant and Soil Science*, 32 (3): 1-12. https://doi.org/10.9734/IJPSS/2020/v3230253.

[28] van Bueren, L. E. T., Jones, S. S., Tamm, L., Murphy, K. M., Myers, J. R., Leifert, C., Messmer, M. M. (2010). The need to breed crop varieties suitable for organic farming, using wheat, tomato and broccoli as examples: a review. Journal of Life Sciences, https://doi.org/10.1016/j.njas.2010.04.001.

[29] Wolf, M. S., Baresel, J. P., Desclaux, D., Goldringer, I., Hoad, S. (2008). Developments in breeding cereals for organic agriculture. *Euphytica*, 163, https://doi.org/10.1007/s10681-008-9690-9.

[30] Mihovilovich, E., Carli, C., De Mendiburu, F., Hualla, V., Bonierbale, M. (2014) Tuber bulking maturity assessment of elite and advanced potato clones protocol. Lima, Peru: International Potato Center. 43 pp.

[31] Kolech, S., De Jong, W., Perry, K., Halseth, D., Mengistu, F. (2017). Participatory Variety Selection: A Tool to Understand Farmers' Potato Variety Selection Criteria. *Open Agriculture*, 2 (1): 453–63.

[32] Tessema, L., Mohammed, W., Abebe, T. (2020). Evaluation of Potato (*Solanum tuberosum* L.) Varieties for Yield and Some Agronomic Traits. *Open Agriculture,* 5: 63-74 https://doi.org/10.1515/opag-2020-0006

[33] Zerihun, K. (2016). Morpho-Physiologic Evaluation of Potato (*Solanum tuberosum* L.). Msc. Thesis, Haramaya University, Haramaya, Ethiopia.

[34] Eaton, T. E., Azad, A. K., Kabir, H. and Siddiq, A. B., (2017). Evaluation of Six Modern Varieties of Potatoes for Yield, Plant Growth Parameters and Resistance to Insects and Diseases. *Agricultural Science*, 8 (11): 1315–26.

[35] Seifu, F., Betewulign, E. (2017). Evaluation of Potato (*Solanum tuberosum* L.) Varieties for Yield Attributes. *Journal of Biology, Agriculture and Healthcare*, 7 (21): 15–22.

[36] Habtamu, G., Wassu, M., Beneberu, S. (2016). Evaluation of Potato (*Solanum tuberosum* L.) Varieties for Yield and Yield Components in Eastern Ethiopia. *Journal of Biology, Agriculture and Healthcare*, 6 (5): 146–54.

[37] Masarirambi, M. T., Mandisodza, F. C., Mashingaidze, A. B., Bhebhe, E. (2012). Influence of plant population and seed tuber size on growth and yield components of potato (Solanum tuberosum). *International Journal of Agricultural Biology*, 14: 545–9.

[38] Njualem, D. K., Demo, P., Mendoza, H. A., Koi, J. T., Nana, F. S. (2001). Reaction of 22 potato (Solanum tuberosum) genotypes to wilt in CDeameroon, Paper presented at the 8th Triennial Symposium of the International Society for Tropical Root Crops Africa Branch, held on the 12-16 Nov. in Ibadan, Nigeria. 2001a.

[39] Kerla, L. H. (2018). Comparative growth and yield of six potato (*Solanum tuberosum* L.) varieties in Buea, a monomodal rainforest site. Msc Thesis, University of Buea, Cameroon.

[40] Delolo, D. C. T., Achiangia, N. P., Chofong, N. G., Mbulli, A. I., Anoumaa, M., Sama, L. F. Fonku, T. (2021). Prevalence of potato viruses on potato (*Solanum tuberosum* L.) grown in the Western highland of Cameroon. *Journal of Agriculture and Food Research*, 5: https://doi.org/10.1016/j.jafr.2021.100192.