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RESEARCH ARTICLE OPEN ACCESS

The Effect of Plant Spacing and Seed Size on The Number of Tubers Produced by a Potato Plant

[1]Prof. David Osiru, [2]Arinaitwe Innocent
[1]Supervisor, [2]The Principal researcher Master of Science in Agronomy, Bishop Stuart University, Mbarara

Abstract
Potato is one of the most valuable food crops and a mainstay in the diets of people in many parts of the world. It is one of the crops that play key roles as a source of food, income, and a raw material for factories in Uganda. This article mainly focuses on the effect of plant spacing and seed size on the number of tubers produced on the potato plant. Nakapot 1 variety of potatoes was used in this study. The experiment consisted of two factors. Plant density and seed size, the first factor involved three seed sizes; greater than 46mm, (S3) 35-45mm (S2) 20-34mm (S1) in diameter. Spacing was 75 by 40cm (P1) 75 by 30cm (P2) 75 by 25cm (P3). These were arranged in a Randomized Complete Block Design (RCBD) with three replications in each row that had three plots. Thus, there were 9 plots for each treatment. The study concluded that a spacing of 75 by 40cm planted with seeds of 46mm produces more tubers in number than other seed sizes planted at the given spacing above.

INTRODUCTION
Background of the Study

Potato *(Solanum tuberosum L.)* is one of the most grown crops in the world and in Uganda. (Alemayehu 2015).A number of players involved in the potato value chain that is from seed production to consumption have attained their livelihoods at different levels and this makes potato growing a significant source of income to a number of people, (Paul, 2008).

It contributes immensely to human nutrition, food security and used as a raw material for industries that produce chips, crisps and animal feeds. This makes it a source of income to those people involved directly and indirectly in its value chain, (Karim et al 2010).Potatoes contain high quality proteins and a substantial amount of essential vitamins, minerals and trace elements. They produce more edible energy and protein per unit area of land than any other crop (Paul, 2008).

It is the most important vegetable crop, currently rated as the fourth most important food crop in the world (Matto 2006, Dutches 2013). Uganda is the ninth largest producer of potato in Africa with an annual production of 327,300metric tons from the estimated 111,100 hectares in 2013 (FAOSTAT, 2014).

In Europe, potato is grown in countries like Ireland, United Kingdom, Germany, Poland and Netherlands. In North America, it is majorly grown in the United States and Canada. In South America it is grown in Peru and Bolivia, while in Africa, it's grown in Kenya, Rwanda, South Africa and Uganda. In Uganda, the major production areas are the highlands of south-western Uganda, comprising of Kabale, Rubanda, Rukiga, Kanungu and Kisoro districts which account for 60% of total national production. (FAOSTAT, 2014).The other potato producing areas are Kapchorwa, Sironko, Bulambuli and Bududa districts on the slopes of Mt Elgon in Eastern Uganda and Nebbi district in north-western Uganda. Potato cultivation has spread to non-traditional producing areas in Central Uganda, especially Mubende, Rakai and Masaka districts.

The yield and growth of potato is influenced by a number of factors, which include; Climate, potatoes prefer cooler temperatures (15-20^{o}c) during the day. Well drained soils with adequate nutrients and moisture to support good yields, relatively higher altitudes. Other factors majorly, seed size and spacing also affects yield, growth and development of potatoes (Barry *et al*. 1990; Arsenault *et al*., 2001).

However, the productivity and yield of potatoes have been as low as 7.5 tons per hectare against 30 tons per hectare which is the expected yield (Barry *et al*. 1990; Arsenault *et al*., 2001). This low production has been attributed to;

Low quality seed, most farmers (about 93%) use home saved seed from the previous season which is often of poor quality and affected by bacterial wilt disease. Therefore limited access to high quality and certified seed affects production.

Diseases and pests, Bacterial Wilt, viral diseases and pests, significantly impact negatively on the yield of potatoes. Bacterial Wilt affects 73% of ware potatoes and 50% of seed potatoes. (FAO 2010)

Among the factors that affect potato yield, plant population/spacing and seed size are probably the most important. Use of appropriate plant population/spacing and seed size ensures high yield of tubers. Unfortunately, some of the recommendations currently being used were determined more than 30 years ago. This is so despite the fact that many new varieties have been developed. Inappropriate planting density, affects both the quality and quantity of the yield. (FAO 2010) As plant density decreases, yield per plant increases but yield per unit area decreases because there are fewer number of plants grown in a given area, however as plant density increases yield per plant decreases due to competition for light, moisture, space and nutrients this might consequently result in reduction in the total yield per hectare/acre. While use of inappropriate seed size, has made farmers use very small or too big seeds which in turn affects yield.

Generally, poor plant spacing/population and inappropriate seed size has made farmers experience low yields due to either too low or too high potato plant density. High seed rate increases production costs by 50% (FAOSTAT, 2014) and reduces yield by 25% (Forbes G 2012). High seed rate wastes seeds, requires much labor, increases fungal disease infestation therefore farmers are forced to buy expensive fungicides so as to cure these diseases. Disease infestation will definitely reduce yields if not controlled in time.

Low seed rate underutilizes the cultivated field and consequently reduces the total yield from a given acreage. Bulkiness and handling problems, large seeds increase packaging, handling and transport problems, small seeds make handling cheap and affordable. Determining the right seed size would solve the above problems. (FAOSTAT, 2014)

The above problems have affected potato production in greater Kabale area, a place that was very well known for potato production. This has affected people's livelihoods, made farmers food insecure, and reduced on the profit margin of a few farmers that have persisted in potato production. In Uganda, the above problems have affected agro industrialization, reduced government's revenue.

Uganda exports potato seed and ware to the neighboring countries of Rwanda, Burundi, Kenya among others. Any challenges that affect production equally affect the livelihoods of the neighboring countries.

From the above background, seed size and inappropriate plant population have greatly affected potato industry both locally and internationally and this makes this research very relevant since the results obtained will provide solutions to potato growing not only in Uganda but also in the whole world.

MATERIALS AND METHODOLOGY

Description of the study area

The study was conducted at Bishop Stuart University farm located at 1000 meters above sea level with a gentle slopping altitude that facilitates good drainage. The experiment was carried out from 20th September 2021 to 10th Jan 2022 and from 9th Jan to 15th June 2022. The area receives an average annual rainfall of 1,200mm with two rainy seasons, during the months of February-May and September-December. The average relative humidity of 80-90%, the soils are deep, fertile, well drained and dark in color, these characteristics make them suitable for potato growing. This site was selected because of its accessibility by both the researcher and the supervisors.

Experimental treatments and design

The experiment used two factors, Plant density and seed size. The plant spacing used was 75 by 40cm, (P1) 75 by 30cm, (P2) 75 by 25cm (P3) and the seed sizes used were; 46-55mm (S1) 35-45mm, (S2) 20-34mm, (S3) in diameter.
These treatment combinations were arranged in a randomized complete block design (RCBD) with three replications and thus there were 9 treatment combinations
A total of 27 plots were planted and a total of 54 plants were randomly selected for data collection.

3.3 Experimental procedures and cultural practices

The agronomic practices in season 1and 2 involved, primary tillage, secondary, making ridges planting, weeding, spraying, harvesting.
The experimental plots were cultivated to the depth of 15 to 20 cm. The land was leveled and ridges were made by a hand hoe basing on spacing between rows. The seed was treated with an insecticide, Malathion and pre-sprouted before planting. It was sourced from Kachwekano Zonal Agricultural Research Institute (ZARDI). The variety used was the medium maturing type which takes 90 days to reach physiological maturity.
Planting was done by selecting well sprouted seed tubers in each seed tuber size category according to the specified treatments for each variety. Weeding, cultivation and earthing-up and ridging were done at 30 days after planting to facilitate root, stolon as well as tuber growth and development. Ridomil MZ 63.5% WP at the rate of 2 Kg ha^{-1} and Mancozeb at the rate 3 Kg /hawere applied for late blight (EARO, 2019).

Description of experimental materials

The experiment was conducted using the new variety Nakapot 1, it was selected based on its adaptability, yielding potential, and preference of the producers and consumers.

Potato seed of different sizes was obtained and graded according to size in diameter. These sizes included: potato seeds above 46mm in diameter these are labeled as S3.
Seeds 35mm-45mm, these were labeled as S2 (control seed size used in the experiment)
While those seeds less than 34mm in diameter were labeled as S1.

Experimental Procedure

Number of tubers per plant
At harvesting time, the number of tubers from the three sampled plants of the two inner rows were harvested, counted and recorded. This was regardless of the size of the tubers. The average number of tubers per plant were then determined.

Description of symbols used

S1…….seed size less than 34 millimeters in diameter
S2……..seed size between 35-45 millimeters in diameter (control seed size used in the experiment
S3…….seed size between 46-55mm millimeters in diameter
P1 ……plant spacing of 75cm by 35cm (lowest plant population)
P2…….plant spacing of 75cm by 30 cm (control plant population used in the experiment)
P3…… plant spacing of 75cm by 25cm (highest plant population)
Each treatment had 9x3 = 27 plants randomly selected for data collection.

Results

Table a: Average number of tubers per plant (season 1)

	Spacing			
PP	S1	S2	S3	**PP means**
P1	8.16	10.3	21	**13.15**
P2	6	12.1	18.5	**12.2**
P3	2.16	8.5	13.1	**7.9**
Seed size. Means	**5.44**	**10.3**	**17.53**	

LSD to compare spacing= = 4.7
LSD to compare plant population = 4.7
LSD to compare interaction= 6.78
Average number of tubers produced per plant is given in the table above for season 1
P1 represents potato plants that were planted at a spacing of 40x75cm this enabled plants to produce more tubers.
Considering a Least Significant value of 4.7, S3 produced tubers which are more significant than S1 however they are not significantly different from S2
Bigger seeds (S3) produced more tubers than Medium S2 and Small seed sizes. Tuber production increased in the order of S3> S2 >S1
P1S3 produced the highest number of tubers compared to the rest of the treatment combinations while P3S1 produced the lowest number of potato tubers

Table b: Average number of tubers per plant (season 2)

	Spacing			
Plant population	S1	S2	S3	PP total
P1	9	11	24.5	14.83
P2	6.33	13.5	21.33	13.72
P3	10.66	12	22	13.08
SP means	8.66	12.16	22.61	43.43

LSD to compare plant spacing = 4.783
LSD to compare plant population = 4.783
LSD to compare interaction= 6.76
Bigger seeds (S3) produced more tubers (22.61) than medium (S2, 12.6) and small seeds (S1). S3 produced more tubers which are significantly different from S1 and S2. However the seeds produced by S1 are not significantly different from those of S2. The results from season 2 are similar to those in season 1.
P1, P2, P3 produced tubers which are almost equal in number. They are not significantly different from one another. But still, p1 has more tubers than P2 and P3
The interaction of the two factors did not have any significant effect on the number of tubers produced across all the seed sizes.

Tables a and b above show that there is no significant difference in the number of tubers produced by medium and small seeds. Whereas large seeds produced more number of tubers significantly different from small and medium seed sizes. These results agree with those of Zebenay 2018. Larger seeds have a relatively more number of 'eyes' and buds than smaller seeds. Eyes and buds on a potato seed increase the potential of the potato plant to produce more tubers. Larger seeds also have more stored energy and nutrients than smaller seeds. The stored energy and nutrients support tuber growth.
The results also agree with those of Tesfaye et al., 2011 who found out that tuber size is an important factor which contributes much to the number of tubers produced from a potato plant in that it produces vigorous sprouts, establishes a strong stand produces more roots per plant which support more tubers to grow.
Medium and small seeds, have limited stored energy which limits tuber production. They also have fewer eyes and buds that limit the potential to produce tubers Tesfaye et al., 2011
While different plant populations did not have any significant effect on the number of tubers produced, in both seasons, factors that favor the production of tubers are not affected by plant population.
The interaction of plant population and seed size did not produce tubers which are significantly different in both seasons.

Conclusion and recommendations

Varying seed sizes have a significant effect on the yield, growth and development of potatoes.
Large seed size produces tubers with a higher fresh weight, more in number and the overall yield per acre compared to medium and small.
This therefore implies that, with regard to the choice of the seed size to plant with intentions of producing

tubers, more number of tubers, and a higher yield per acre, it is recommended to plant large seeds at a spacing of 75 by 40 cm.

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REFERENCES

Adhikari, R.C. 2005.Performance of different size true potato seed seedling tubers at Khumaltar.Potato Research Program-NARC, Khumaltar-Lalitpur.*Nepal Agric. Res. J. Vol.* 6.

Aheisibwe AR, Barekye A, Namugga P, Byarugaba A (2015) Challenges and opportunities for quality seed potato availability and production in Uganda. Uganda J Agri Sci. 16: 149 – 159.

Arsenault, W.J., D.A. LeBlanc, G.C.C. Tai and P. Boswall, 2001. Effects of nitrogen application and seed piece spacing on yield and tuber sizedistribution in eight potato cultivars *American J. Potato Res*., 78:301–309

Barnes, F.B., 1981. Potato. *Zimbabwe Agric. J*., 78: 111–116Baker, A.S., R. Ben Yehuda and U. Kafkafi, 1980. Effects of rate, sourceand distribution method of nitrogen fertilizer on seed potato production.*J. Agric. Sci. (Cambridge)*, 94: 745–747

Barry, P.B., T.S. Storsey and R. Hogan, 1990.Effect of plant population andset size on yield of the main crop potato variety Cara.*Irish J. Agric.Res*., 29: 49–60

Bereke, T.T. 1994. The utilization of true potato seed (TPS) as an alternative method of potato production. Ph.D. Thesis, School of Graduate Studies of Wageningen University, the Netherlands.

Berga, L., Gebremedihin, W., Teriessa, J. and Bereke-Tsehai, T. 1992. *Proceeding of 2nd national horticultural workshop of Ethiopia*, 1-3 December 1992. Potato agronomy research in Ethiopia in: Horticulture research and development in Ethiopia. Addis Ababa, Ethiopia.

Berga, L., Gebremedihin, W., Teriessa, J., Bereke- Tsehai, T. and Yaynu, H. 1992b.

Bohl, W.H. 2000. Seed piece size and spacing: effects on yield operating cost**,** Presented at the Idaho Potato Conference.

Bohl, W.H., Nolte. P., Kleinkopf, G.E., Thornton, M. K. 2000. Potato seed Management Seed Size and Age.

Bremmer, T. and M.A. Taha, 1966. Studies in potato agronomy: The effectsof variety, seed size and spacing on growth, development and yield. *Agric. Sci. J. (London)*, 66: 241–252

Bussan, A. J., Mitchell, P. D., Copas, M. E. and Drilias. M. J. 2007. Evaluation of the effect of density on potato yield and tuber size distribution.*Crop science*, 47: 2462-2472.

CIMMYT.1988. From agronomic data to farmers' recommendations: an economic training manual. Completely revised edition. Mexico, DF. 79p. CSA (Central Statistical Agency of Ethiopia).2013/14. Agricultural sample survey: Report on area and production of crops, Addis Ababa, Ethiopia, p 14. EARO (Ethiopian Agricultural Research Organization). 2004. Ethiopian agricultural research organization directory of released crop varieties and their recommended cultural practices, Addis Ababa, Ethiopia.

Endale, G. and Gebremedhin, W.G. 2001. Effects of Spatial Arrangement on Tuber Yields of Some Potato Cultivars. *African Crop Science Journal* 9(1): 67-76.

FAOSTAT (2014) Production statistics. Available at http://faostat.fao.org., (accessed 11 July 2016). Ferris GO, Crissman C, Ewell P, and Lemaga

B (2001) Uganda's Irish Potato Sector. pp: 6-37.

FAOSTAT. 2017. Food and Agriculture Organization of the United Nations, for a world without hunger. Rome, Italy. http://faostat.fao.org /site/567/.

Forbes G (2012) Using host resistance to manage potato late blight with particular reference to developing countries. Potato Res. 55: 205-216.

Garrett K, Nelson R, Mundt C, Chacon G, Jaramillo R, Forbes G (2001) The effects of host diversity and other management components on epidemics of potato late blight in the humid highland tropics. Phytopathology. 91: 993-1000.

Gebremedhin, W., Kassaye, N, Atsede, S., Abebe, C. and Berga, L. 2012. *Proceedings of the national workshop on seed potato tuber production and dissemination,* 12-14 March 2012. Participatory potato seed production: experiences from West and Southwest Shewa, and Gurage Zones. Seed potato tuber production and dissemination experiences, challenges and prospects.Bahir Dar, Ethiopia

Gildemacher, P., Demo, P., Kinyae, P., Wakahiu, M., Nyongesa, M. and Zschocke, T. 2007. Select the best positive selection to improve farmers saved seed potatoes trainers manual, Njoro, Kenya.
Gulluoglu, L. and Arıoglu, H. 2009. Effects of seed size and in row spacing on growth and yield of early potato in a Mediterranean-type environment in Turkey.*African Journal of Agricultural Research* .4 (5): 535-541.

HARC (Holetta agricultural research center) 2004.Holetta research centre annual report, Holetta, Ethiopia.

Harnet, A., Derbew, B. and Gebremedhin, W. 2014. Effects of inter and intra row spacing on seed tuber yield and yield components of potato (*Solanumtubersoum*L.) at OflaWoreda, Northern Ethiopia. *Afr.J.Plant SCI.* 8(6):285-290.

Hassan panah D, Gurbanov E, Gadimov A, Shahriari R (2008) Determination of yield stability in advanced potato cultivars as affected by water deficit and potassium humate in Ardabil region, Iran. Pak J Biol Sci. 11: 1354-1359.

Hijmans RJ (2001) Global distribution of the potato crop.*Potato Research* 78: 403-412.

Islam, M.S., Moonmoon, S., Islam, M.Z., Waliullah, H. and Hossain, M.S. 2012.Studies on seed size and spacing for optimum yield of potato in northern region of Bangladesh.*Bangladesh J. Prog. Sci. & Tech.* 10(1): 113-116.

Joshi A, Witcombe JR (1996) Farmer participatory crop improvement. II. Participatory varietal selection, a case study in India. ExpAgr. 32: 461-477.

Kaguongo W, Ng'ang'a N, Muthoka N, Muthami F, Maingi G (2010) Seed potato subsector master plan for Kenya(2009-2014). Seed potato study sponsored by GTZ-PSDA, USAID, CIP and Government of Kenya. Ministry of Agriculture, Kenya.

Kakuhenzire R, Hakiza JJ, Mateeka B, Lemaga B, Salazar L, Olanya, M (2000) Incidence and importance of potato viruses in south-western Uganda. African Potato Association Conference Proceedings. 5: 285–290.

Kakuhenzire R, Kimoone G, Wagoire WW, Gildemacher P, Lemaga B, Adipala E, Mateeka B (2007) Adapting fungicide spraying regimes to potato late blight host resistance in Uganda. African Crop Science Conference Proceedings. 8: 801-807).

Khalafalla, A.M. 2001.Effect of Plant density and seed size on growth and yield of *Solanum*potato in Khartoum State, Sudan. *African Crop Science Journal* .9 (1): 77-82.

Kinyua Z, Smith J, Lung'aho C, Olanya M, Priou S (2001) On-farm successes and challenges of producing bacterial wilt-free tubers in seed plots in Kenya. ACJS 9: 279-285.

Lacha G., Nigussie, D. and Firew M. 2012.*Proceedings of the national workshop on seed potato tuber pand dissemination,* 12-14 March 2012.Seed system analysis of potato in GuragheHighlands.Seed potato tuber production and dissemination experiences, challenges and prospects.Bahir Dar, Ethiopia

Lemaga B (2001) Integrated control of potato bacterial wilt in Kabale district, South Western Uganda. *In* Scientist and Farmer.Partners in Research for the 21st Century, Program Report.1999-2000. pp. 129-141.

Low J (1997) Potato in southwest Uganda: threats to sustainable production. Afr Crop Sci J. 5: 395-412.

Michael t. Masarirambi1, farai c. Mandisodza†, arnold b. Mashingaidze and evisonbhebheinternational journal of agriculture & biology issn Print: 1560–8530; ISSN Online: 18149596 11–579/AWB/2012/14–4–545–549 http://www.fspublishers.org

Muhinyuza JB, Shimelis H, Melis R, Sibiya J, NzarambaMN(2012) Participatory assessment of potato production constraints and trait preferences in potato cultivar development in Rwanda. Int J Develop Sust. 1: 358-380.

Adane, A., Meuwissen, M.P.M., Tesfaye, A., Lommen, W.J.M., Lansink, A.O., Tsegaye, A. and Struik, P.C. 2010.Analysis of seed potato systems in Ethiopia. *Am. J. Pot Res*, 87:537-552.

Proceeding of 2nd national horticultural workshop of Ethiopia, 1-3 December 1992 Potato improvement research in Ethiopia in: Horticulture research and development in Ethiopia. Addis Ababa, Ethiopia.

ZebenayDagne, NigussieDechassa and Wassu MohammedEthiopian Institute of Agriculture Research (EIAR), Holetta Research Centre, PO Box 2003, Addis Ababa, Ethiopia

