Annals of Sri Lanka Department of Agriculture 2017. 19: 129 - 138

PERFORMANCE OF SEED TUBER PIECES OF POTATO AS PLANTING MATERIAL UNDER UP COUNTRY WET ZONE CONDITIONS

M.A.P. MAYAKADUWA, A.G.C. BABU, M.M. NUGALIYADDE, J. PETER, K.R.S.C.B. KAHAWANDALA, N.I.J.H. NISHSHANKA

Agriculture Research and Development Centre, Sita Eliya, Nuwara Eliya, Sri Lanka

ABSTRACT

Non availability of high quality seed potato at a reasonable price is one of the major limiting factors for increasing potato productivity in Sri Lanka. Potato seeds contribute about 60-75% to its total cost of production. Conversly, about 30% of seed tubers of large size are sold for consumption at a lower price. A study was carried out to investigate the possibility of using large seed potato pieces for to select the best size of cut tuber for planting during *Yala* seasons. Certified G_3 seeds of variety Granola produced in the USA were used in this experiment. Tubers of three weight classes of 120 g, standard seed size 60 g and 30 g were cut in to two pieces using disinfected knife. Whole tubers and tuber pieces of three weight classes were planted in a Randomized Complete Block Design (RCBD) with four replicates. The results showed that the size of the seed tubers influenced emergence and number of stems/liner/m. There was significantly higher emergence and stem number/m recorded in whole tubers of 60 g, 120 g and tuber pieces of 60 g where as the lowest was recorded with 15 g tuber pieces. Similarly, higher canopy height and diameter was recorded from whole tubers of 60 g, 120 g and tuber pieces of 60g during both *Yala* seasons tested. The highest marketable yield of potato of size >28 mm also was recorded from whole tubers of 60 g, 120 g and tuber pieces of 60 g in both seasons. It was found that the emergence, growth and yield decreased with decreasing size of seed tuber planted. Thus, it could be concluded that optimum size of seed tubers is either cut piece or whole tubers of 60 g.

Key words: Potato, Whole tubers, Tuber pieces, G_3 seeds

INTRODUCTION

The potato (*Solanum tuberosum* L.) is herbaceous, perennial tuberous crop of the family *Solanaceae*. It is the world's fourth largest food crop following rice, wheat and maize. In Sri Lanka, potato is grown mainly in

Nuwara Eliya and Badulla Districts during both *Maha* and *Yala* and in Jaffna and Kalpitiya only during the *Maha* season in less extent as a cash crop.

Obtaining of good quality seed is a critical decision faced by every potato grower. The physiological status of seed potatoes has a great impact on the emergence, number of stems per plant, number of tubers per stem, tuber-size distribution and tuber yield of the crop (Struik, 2007). Use of seeds that are both physiologically as well as physically healthy is very important. Seed size is one of the most important aspect in potato production due to their effect on seed cost, plant development, yield and vigour of the crop. Appropriate seed tuber size has very important implications on potato production (Gebremedhin *et al.,* 2008). Emergence, seedling vigour, subsequent plant growth, and final yield are affected by seed tuber size. Although all sizes of seed potatoes can grow into a crop, potato growers should only plant tubers range from 25-55 mm in diameter or 39-75 g in weight (Lung'aho *et al.*, 2007). Similarly, potato seeds should be homogenous and seeds of 28-55 mm can be used for potato production (Ermias, 2010). However, the optimum stem density for the maximum tuber yield markedly differed depending on size of seed tubers. Gulluoglu and Arioglu (2009) reported that the stem density increased with increasing seed size. On the other hand it was reported that the optimum seed piece sizes for planting was 50 - 64 g (Rykbost and Locke, 1999). However in Sri Lanka, recommended seed size for planting is about 28 - 55mm in diameter which is about 40 - 60 g in weight (Anon, 2014).

Non availability and high cost of good quality seed tubers are two major limiting factors for increasing productivity of potato in Sri Lanka. Potato seeds contribute 60-75% to the cost of production. In the seed production process, large size tubers, which accounts for about 30% of the total production is sold as consumption potato at a lower price. The large size tubers are cheaper, and quality of seeds is very high. Since seed tubers are sold on a weight basis, planting large tubers is usually expensive as more number of tubers are required to plant a unit area (Lung'aho *et al.*, 2007). Seed potatoes are therefore cut by some farmers to lower the cost of seed potatoes, or to increase the number of seed pieces in cases where sufficient seed from a specific variety is not available, without considering technical aspects.

Differences in variety characteristics determine the suitability for the cutting of seed potatoes. It includes rotting of some varieties compared to others, the number of eyes and the position of the eye, especially limited to the apical part of the tuber (Fienie, 2016). Beattie (2010) reported that potato plants are produced from a piece of a tuber that has been cut into pieces with at least one eye containing three buds.

In order to prevent wasting of good quality large size seeds as consumption potato, an experiment was carried out to study the possibility of cutting and planting of lager tubers of variety Granola under Up Country Wet zone conditions to select the best size cut tuber for planting during *Yala* seasons.

MATERIALS AND METHODS

Field experiments were conducted during two consecutive *Yala* seasons, which is the extensive potato growing season during 2013 and 2014 at Agricultural Research and Development Centre, Sita Eliya, Nuwara Eliya which is located in the Up Country Wet zone. This location is characterized by elevation of 1860 m amsl and temperature regime of 11 - 20.5 °C, and total rainfall of 504.7 mm during the *Yala* season. G_3 certified seeds of variety Granola produced in USA which was available at the time of experiment, were used in this experiment. Tubers of three weight classes of 120 g, standard seed size 60 g and 30 g were cut into two pieces using disinfected knife. Cutting knife was disinfected with 10% bleach solution for 10 minutes after every ten cuttings. Disinfected knife was dipped in distilled water for about one minute before use. Each cut piece weighed 60, 30 and 15g respectively. Cut surface was carefully inspected to make sure that they are free of seed born diseases. Cut tubers were cured under shade for four days for suberization to prevent soil-borne diseases from infecting the potato crop.

When cutting, care was taken to make sure that the each piece has at least one eye. Whole tubers of 120 g, 60 g, 30 g and cut tuber pieces of three weight classes 60 g, 30 g, and 15 g respectively, were planted at 60×25 cm in 4 ×2.5 m plots. The experiment was laid down in Randomized Complete

Block Design (RCBD) with four replicates. All agronomic practices were carried out according to the Department of Agriculture recommendations. Number of tubers emerged and stems/liner meter were recorded at 30 and 40 days after planting respectively. As growth parameters, canopy height and diameter were recorded on five randomly selected plants in each plot in every two weeks after planting. Each Plot was harvested separately 110 days after planting. Yield parameters, number of tubers and tuber fresh weight in size groups of 0 -28 mm, 28-55 mm, >55 mm in diameter and total marketable yield were recorded. Data analysis was done using SAS computer package. Mean separation was done using Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Results of 2013 *Yala* and 2014 *Yala* and showed that the size of the planting material significantly influenced the emergence and the number of stems/m. Higher emergence percentage was recorded in whole tubers of 60 g, 120 g and tuber pieces of 60 g where as the lowest emergence was recorded in 15 g tuber pieces. Among the different sizes of tubers planted, significantly the highest stem number/m was recorded from whole tubers of 60 g, 120 g and tuber pieces of 60 g during both seasons. However, from 15 g tuber pieces, the lowest number of stems/m was recorded (Table1).

It could be due to the fact that low level of stored food in smaller size whole tubers and tuber pieces. Sulthana (2001) also reported that the lowest number of stems emerged from small tubers was due to poor food reserves available in such tubers, even though number of eyes in each size was similar. In this experiment, higher number of main stems/m was recorded from whole tubers of 60 g, 120 g and tuber pieces of 60 g in 2013 *Yala* and 2014 *Yala* (Table 1). The number of stems/m increases as the size of the seed tuber increases. The number of sprouts, which grow per seed tuber, is principally determined by the size of the tuber and the temperature and duration of storage (Struik, 2007). However, it is reported that seed tubers having four to five strong sprouts are ideal for planting to achieve sufficient stems per hill (Beattie, 2010). Stem density influences the number and size of harvested

tubers (Harris, 1978). Therefore, when the stem density increases, number of tuber harvested also increased. Beattie (2010) reported that a higher seed yields were obtained at 25-30 stems m^2.

Table 1. Effect of Whole tuber and seed piece size on emergence at 30 days after planting, and number of stems at 40 days after planting.

Size of Seed Tuber	Emergence %		Number of stems /m	
	2013 *Yala*	2014 *Yala*	2013 *Yala*	2014 *Yala*
WHOLE TUBER OF 120 G	100^{a}	100^{a}	14.0^{a}	14.5^{a}
WHOLE TUBER OF 60 G	100^{a}	99.37^{a}	13.75^{a}	14.0^{a}
WHOLE TUBER OF 30 G	100^{a}	98.75^{ab}	12.0^{bc}	12.5^{b}
TUBER PIECES OF 60 G	100^{a}	99.37^{a}	13.5^{a}	13.25^{a}
TUBER PIECES OF 30 G	97.5^{b}	98.12^{ab}	12.5^{b}	12.75^{b}
TUBER PIECES OF 15 G	95.0^{c}	96.87^{b}	11.5^{c}	11.5^{bc}
CV%	1.78	1.82	2.85	4.69

Note: Means having the same letters along each column are not significantly different at α =0.05.

Table 2 illustrates the canopy height and Canopy diameter at nine weeks after planting. Higher plant height was recorded in plants from whole tubers of 60 g, 120 g and tuber pieces of 60 g during both 2013 *Yala* and 2014 *Yala* seasons where as the minimum height was recorded in plants of tuber pieces of 15 g. The plants grown from whole tubers of 30 g and tuber pieces of 30 g had a lower plant height than that of 60 g tuber.

However canopy diameter was significantly higher in plants of 120 g whole tubers in both seasons. There was no difference in canopy height between plants from tuber pieces of 60 g and the 60 g whole tuber in both 2013 *Yala* and 2014 *Yala*. The growth parameters indicate that the plants of whole tubers of 60 g, 120 g and tuber pieces of 60 g had a greater vegetative growth in both *Yala* seasons.

Canopy height and diameter represents the haulm growth of the plant. The lowest haulm growth was recorded from tuber pieces of 15 g whereas whole tubers of 30 g and tuber pieces of 30g gave lower canopy height and canopy diameter in each tuber size groups than standard tuber size of 60g in both *Yala* seasons. Michael, *et al.*, (2012) reported that large size seed tubers, with their relatively larger food reserves, produced large plants which established faster and produced vigorous stems, which increases the efficiency of biomass partitioning to the tubers.

Table 2. Canopy height and Canopy diameter of different size seed tuber at 9 WAP.

Size of Seed Tuber	Canopy height at 9WAP (cm)		Canopy diameter at 9WAP (cm)	
	2013 *Yala*	**2014 *Yala***	**2013 *Yala***	**2014 *Yala***
WHOLE TUBER OF 120 G	42.62^{a}	41.75^{a}	58.25^{a}	57.8^{a}
WHOLE TUBER OF 60 G	41.26^{a}	41.75^{a}	55.26^{b}	54.45^{b}
WHOLE TUBER OF 30 G	35.25^{c}	34.87^{c}	49.5^{d}	48.6^{c}
TUBER PIECES OF 60 G	40.37^{a}	40.12^{a}	53.5^{b}	53.15^{b}
TUBER PIECES OF 30 G	38.25^{bc}	38.13^{b}	48.5^{d}	47.35^{c}
TUBER PIECES OF 15 G	32.62^{d}	33.62^{c}	46.25^{e}	44.6^{d}
CV%	1.86	2.93	1.68	1.74

Note: Means having same letters along the column are not significantly different at $\alpha = 0.05$
WAP - Weeks After Planting

There was no significant difference recorded in total mean tuber number in plants of whole tubers of 120 g, 60 g and tuber pieces of 60 g in both *Yala* seasons (Table 3). Data presented in Table 3 showed that the highest number of tubers of tuber size of 28 -55mm were recorded from seed tuber of size above 30 g. The lowest mean tuber number was recorded when planted 15 g sizes of cut seed tubers during 2013 *Yala*.

Table 3. Effect of Whole tuber and seed piece size on tuber size distribution.

Size of Seed Tuber	Number of tubers ($6m^2$)							
	2013 *Yala*			2014 *Yala*			2013 *Yala*	2014 *Yala*
	<28mm	28-55mm	>55mm	<28mm	28-55mm	>55mm	Total	
WHOLE TUBER OF 120 G	32.4^{a}	144.0^{ab}	23.5^{a}	99.0^{a}	138.75^{a}	11.5^{a}	208.5^{ab}	240.65^{a}
WHOLE TUBER OF 60 G	33.5^{ab}	163.25^{ab}	19.75^{ab}	86.75^{ab}	132.5^{abc}	11.0^{a}	216.5^{a}	230.25^{a}
WHOLE TUBER OF 30 G	23.25^{bc}	159.0^{ab}	13.75^{bc}	63.0^{cd}	109.75^{cd}	9.5^{ab}	196.0^{ab}	182.25^{b}
TUBER PIECES OF 60 G	25.25^{abc}	173.0^{a}	18.75^{ab}	74.5^{bc}	136.5^{ab}	13.5^{a}	217.0^{a}	224.5^{a}
TUBER PIECES OF 30 G	23.0^{bc}	152^{ab}	15.75^{bc}	54.25^{cd}	114.0^{bcd}	7.5^{b}	190.75^{b}	175.75^{b}
TUBER PIECES OF 15 G	14.25^{c}	131.25^{b}	11.75^{c}	50.25^{d}	93.0^{d}	7.75^{b}	157.25^{c}	151.0^{c}
CV%	16.39	13.06	12.65	10.70	13.52	14.40	8.2	10.80

Note: Means having same letters under each column are not significantly different at $\alpha = 0.05$

In potato production, the tuber size distribution is an important determinant of price and economically important size of tuber is larger than 28mm. Results showed that the whole seed tubers of 60 g, 120 g and tuber pieces of 60 g gave economically higher tuber yields during both seasons. However, the highest number of tubers of size 28-55mm was recorded only from seed sizes above 60 g during 2014 *Yala*. On the other hand, during both seasons the highest number of >55mm tubers were recorded from seed tuber size above 60 g irrespective of cutting. The lowest mean tuber number was recorded from tuber pieces of 15 g where as whole tubers of 30 g and tuber pieces of 30 g gave lower mean tuber numbers in each tuber size groups than standard tuber size of 60g in both 2013 *Yala* and 2014 *Yala*.

The total yield of six different sizes of seed tubers is shown in Table 4. The yield data during both *Yala* seasons showed that, seed tuber size higher than 60 g gave a higher yield than that of 30 g and 15 g seed tubers. Although 15 g tuber pieces gave the lowest yields in both 2013 *Yala* and 2014 *Yala*, yield of seed tubers of 30 g was higher than 15 g seed tubers. The results of the experiments showed that, with the decreasing size of the seed tubers, irrespective of cutting, the total yield decreased. Seed tuber size significantly affected the tuber yield. Gulluoglu and Arioglu (2009) reported that tuber yields per hectare consistently increased with increasing seed size. Bigger seed potato tubers exhibited greater overall resource use efficiency of allocation of metabolites (Michael, *et al.*, 2012).

Table 4. Effect of Whole tuber and seed piece size on total yield.

Size of Seed Tuber	Total Yield (t/ha)	
	2013 *Yala*	**2014 *Yala***
WHOLE TUBER OF 120 G	30.15^{a}	24.08^{a}
WHOLE TUBER OF 60 G	27.64^{ab}	23.39^{a}
WHOLE TUBER OF 30 G	22.92^{c}	17.94^{b}
TUBER PIECES OF 60 G	27.61^{ab}	23.02^{a}
TUBER PIECES OF 30 G	24.75^{bc}	17.42^{b}
TUBER PIECES OF 15 G	18.23^{d}	15.5^{c}
CV%	8.93	12.78

Note: Means having same letters under each column are not significantly different at $\alpha = 0.05$

Table 5 shows the cost comparison of big and small seed potatoes. Price of 50 kg of large tubers (120 g), which is sold as ware potato, ranges between Rs. 4,000.00-5,000.00 where as 60 g size seed tubers are sold at 9,000.00. When 50 kg of 120 g is cut, an equal number in 50 kg of 60 g whole seed can be obtained for the cost of Rs 4250.00 - Rs. 5,250.00. Hence a farmer can save Rs. 4,750.00-3,750.00 per 50 kg of seeds by cutting larger tubers to optimum size of 60g cut pieces.

Table 5. Cost comparison of 120g, 60g whole seed tubers and 60g cut pieces of Seed Potato

Description	Number of tubers in Seed Size of		
	120g whole tuber	60g cut pieces	60g whole tuber
Number of tubers in 50 kg	416	832	833
Cost of seed (Local) (Rs)	4,000.00-5,000.00	4,000.00-5,000.00	9,000.00
Cost of cutting (Rs)	-	250.00	-
Total (local) (Rs.)	4,000.00-5,000.00	4,250.00-5,250.00	9,000.00

There was no difference in growth and development and yield of potato when planted either 60 g or 120 g seed tuber. However, there was an advantage of planting 60 g cut tuber as far as cost of seed is concerned.

CONCLUSIONS

This study concludes that optimum size of seed tubers for planting is either cut piece or whole tubers of 60 g. Therefore, large tubers can be cut in to appropriate size of 60 g pieces to obtain optimum growth characters and good yield which in turn lead to reduce the cost of cultivation.

REFERENCES

Anon. 2014. European Cultivate Potato Database. http://www.euro-potato.org. (Accessed on 2017/05/12.)

Beattie, B.M. 2010. The Effects of Seed Production Practices on the Productivity of the Succeeding ware Potato Crop. University of Tasmania. 2 (31): 114-119.

Ermias, A. 2010. Healthy potato seed production guideline for the Amhara region, Bahirdar, Ethiopia.

Fienie,N. 2016. The Cutting of Seed potatoes. http://www.potatoes.co.za. (Accessed on 2017/04/12)

Gebremedihen, W., Endale, G., Berga, L. and Tesfaye, A. 2008. Root and tuber crops. Ethiopian institute of agriculture research, Addis Ababa, Ethiopia.

Güllüoglu, L and H Arioglu. 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.

Harris, P.M. 1978. The potato crop. Department of Agriculture and Horticulture, Reading University, London, UK.

Lung'aho, C., B. Lemaga, M. Nyongesa, P. Gildermacher, P. Kinyale, P. Demo and J. Kabira, 2007. Commercial seed potato production in eastern and central Africa. Kenya Agricultural Institute, Kenya. pp 140.

Michael,T.M.A., C.M Farai, B.M Arnold, and B. Evison. 2012. Influence of plant population and Seed Tuber Size on Growth and Yield Components of Potato *(Solanum tuberosm).* International Journal of Agriculture and Biology. ISSN Print: 1560–8530. pp 545-549.

Rykbost, K.A and K.A. Locke. 1999. Effect of seed piece size on performance of three potato varieties in the Klamath Basin of Oregon. American Potato Journal. 76 : 75-72.

Struik, P.C. 2007. Physiological age of seed tubers. https://www.researchgate.net. (Accessed on 2013/03/22)

Sultana, N., M.S. Bari, and M.G Rabbani. 2001. Effect of Seedling Tuber Size and Depth of Planting on the Growth and Yield of Potato. Pakistan Journal of Biological Sciences 4(10):1205-1208.