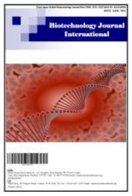

Biotechnology Journal International

24(2): 30-34, 2020; Article no.BJI.55306
ISSN: 2456-7051
(Past name: British Biotechnology Journal, Past ISSN: 2231–2927, NLM ID: 101616695)

Effect of Tuber Size and Intra-row Spacing on Yield and Quality of Potato (*Solanum tuberosum* L.)

Dawinder[1], Gurbax Singh[1], Amanpreet Singh[1*] and Jagjot Singh[1]

[1]Department of Agriculture, Khalsa College, Amritsar, India.

Authors' contributions

This work was carried out in collaboration among all authors. Author Dawinder designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AS and GS managed the analyses of the study. Author JS managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJI/2020/v24i230100
Editor(s):
(1) Antar El-Banna, Kafrelsheikh University, Egypt.
Reviewers:
(1) Rentapalli Balaji, Acharya N. G. Ranga Agricultural University, India.
(2) Jayath P. Kirthisinghe, University of Peradeniya, Sri Lanka.
Complete Peer review History: http://www.sdiarticle4.com/review-history/55306

Original Research Article

Received 08 January 2020
Accepted 12 March 2020
Published 16 April 2020

ABSTRACT

A study was conducted to determine the effect of tuber size and intra row spacing on potato (*Solanum tuberosum* L.) yield and subsequent growth in the 2017 production season. The experiment was laid out in a 3x4 combination arranged in a split-plot design with three replications (three levels of tuber size: 20-30 mm, 30-40 mm and 40-50 mm and four levels of intra row spacing's: 8, 12, 16 and 20 cm). For the optimum emergence and successful growth of potato tubers for processable yield, a size of 40-50 mm and spacing of 20 cm between plants, respectively were identified as the best treatments to be used in the study area.

Keywords: Potato; yield; tuber size; spacing; quality.

1. INTRODUCTION

Potato is used for a variety of purposes, and not only as a vegetable for cooking at home. Worldwide, only fifty percent of fresh potatoes are consumed and while rest are processed into other food product ingredients such as potato chips, sliced, French fries and for the production of starch and alcohol. The space used between crests and plants for the production of seed

**Corresponding author: E-mail: nandgharia@gmail.com;*

potatoes and tubers was one of the most important among the extent of the limitations that contribute to the low potato yield, especially in northern-western parts of the country. Plant spacing affects the cost of seeds, plant development, and yield and crop quality. In practice, the space between the potato plants is manipulated by the number and size of the tubers planted. Of course, this increased total yield, but decreased the percentage of large potato tubers that will be produced. The possibility of ensuring a high yield largely depends on the maintenance of an optimal number of plants per unit area and their spatial arrangement in the field. This, therefore, requires establishing an optimal combination of seed size and planting distance.

2. MATERIALS AND METHODS

The experiment was conducted in a split-plot design at Khalsa College Amritsar during the Rabi seasons of 2017. The soil was sandy loam in texture with organic carbon (0.71%), medium in available phosphorus (17.5 kg/ha) and potassium (330 kg/ha). These seed tubers having similar physiological age were planted at three tuber sizes, viz. 20-30 mm (T_1); 30-40 mm (T_2) and 40-50 mm (T_3) , representing the intra-row (plant to plant) spacing 8 cm (S_1), 12 cm (S_2), 16 cm (S_3) and 20 cm (S_4) respectively. Statistical analysis of the data recorded was done as per split-plot design using EDA 1.1 software developed by PAU, Ludhiana.

2.1 Weather during Crop Season

The meteorological mean monthly data for Amritsar city during the crop season of the year 2017-18 has been presented in Table 1. The maximum temperature ranged between 19.2ºC and 34.5ºC while minimum temperature ranged between 3.2° and 20.9ºC. Maximum temperature 34.5°C was recorded from the 7th-13th day of October and minimum temperature 3.2ºC from the 6th-12th day of January. Maximum relative humidity 85.7% was recorded from the 11th-17th day of November and a minimum of 65.4% from the 2nd-8th day of December. Maximum wind speed 4.6 km per hr was recorded from the 16th-22nd day of December and minimum wind speed 1.2 km per hour was recorded from 25th November to 1st December. The maximum rainfall (2.03 mm) was recorded in January.

3. RESULTS AND DISCUSSION

3.1 Tuber Dry Matter Content (%)

Tuber dry matter is an important quality parameter that determines the yield of fried products, oil uptake and energy consumption for frying. Tuber dry matter content more than 20 percent is acceptable for processing. The data regarding dry matter was recorded at harvest and is illustrated in Table 2. Tuber dry matter content was found to be non-significant.

Table 1. Weekly mean meteorological data recorded during the crop season (October 2017 - January 2018)

Months	Date	Week	Mean temperature (^{0}C)	Maximum temperature (^{0}C)	Minimum temperature (^{0}C)	Relative humidity (%)	Wind speed (km per hr)	Rainfall (mm)
October	7-13	41	27.1	34.5	20.9	75.1	2.7	0
	14-20	42	25.4	34.3	18.5	71.8	3	0
	21-27	43	23	32.6	16.2	73	2.3	0
	28-3	44	20.5	28.4	14.8	82.4	1.3	0
November	4-10	45	18.1	26.6	12.5	85.4	1.3	0.43
	11-17	46	16.3	24.5	11.2	85.7	3.4	0
	18-24	47	14.7	24.2	7.5	71.3	3	0
	25-1	48	15	25.5	7.1	67.3	1.2	0
December	2-8	49	13.7	24.0	5.8	65.4	3	1.56
	9-15	50	12.4	19.2	7.1	82.9	3.6	0
	15-22	51	13.6	22.7	5.7	69.4	4.6	0
	23-29	52	11.9	21.4	5.3	81.4	1.6	0
January	30-5	1	10.5	19.2	4.6	81.4	1.3	0
	6-12	2	11.5	20.3	3.2	72.9	3.3	0
	13-19	2	12.6	22.1	4.2	73.3	3.8	2.03
	20-26	4	11.4	20.3	4.8	83.4	2.7	0

Table 2. Effect of tuber seed-size and spacing on quality and yield attributes of potato

Treatments	Tuber dry matter content (%)	Reducing sugars (mg per 100 g FW)	Sucrose content (mg per 100 g FW)	Chip color score	Chip recovery (%)	dry matter accumulation	Processable yield (q per ha)	Non processable yield (q per ha)
Tuber size								
20-30 mm	21.1	24.45	127.98	2.96	33.81	13.1	118.2	81.3
30-40 mm	22.0	24.98	127.46	2.95	33.77	15.4	164.0	94.9
40-50 mm	22.9	25.46	128.45	2.87	34.79	17.8	195.9	98.6
CD (p=0.05)	NS	NS	NS	NS	1.15	2.60	9.5	NS
Intra-row spacing								
60 × 8 cm	21.7	24.09	127.71	2.84	33.54	11.9	132.3	140.6
60 × 12 cm	21.8	24.71	128.01	2.93	33.55	13.4	144.1	122.5
60 × 16 cm	22.1	25.01	128.05	2.95	33.77	15.6	153.8	87.8
60 × 20 cm	22.5	25.05	128.09	3.00	34.31	17.1	163.3	75.5
CD (p=0.05)	NS	NS	NS	NS	NS	1.39	7.4	23.2

3.2 Reducing Sugars and Sucrose (mg per 100 g Fresh Weight)

Low reducing sugars are preferable for good processing quality and sucrose content in tuber is an important quality parameter because it may also participate as a substrate for reducing sugars after undergoing heat-induced hydrolysis during frying and can affect chip color respectively.

The perusal of data in Table 2 showed reducing sugars and sucrose varied non significantly due to different tuber sizes. All these treatments were no significant towards each other. Among Intra row spacing, all the treatments of plant spacing were found to be non-significant.

3.3 Chip Color

The color of fried chips is the most important visual character which determines the suitability of potatoes for processing. Chips having dark colors are unacceptable to consumers due to poor aesthetic appeal and bitter taste. Chip color score up to 3 is considered highly acceptable. The data in Table 2 further examined that there was no significant variation in chip color score among tuber sizes. Similarly, spacing treatments were also showed no significant difference in chip color score towards each other. Chip color score was observed to be in the order of S_4 (3), S_3 (2.95) S_2 (2.93) and S_1 (2.84).

3.4 Chip Recovery (%)

Chip recovery is a good index of final fried products. Chip recovery varied significantly under the different tuber sizes. Maximum chip recovery was recorded in T_3 tuber size (34.79%) followed by T_2 (33.77%) and T_1 (32.81%). It was also observed that among plant spacing treatment, Chip recovery was found to be non-significant.

3.5 Processable Tuber Yield (40-75 mm)

Among tuber size effect, the data presented in the Table 2 explained that the maximum tuber yield of 195.9 q per ha was recorded in the treatment with tuber size 40-50 mm (T_3) whereas minimum tuber yield was recorded with tuber size 20-30 mm (T_1) (118.2 q per ha). However, tuber size 40-50 mm was significantly differing with tuber size 30-40 mm (T_2) and 20-30 mm (T_1). Percent increase in T_3 and T_2 was 65.7 and 38.7 over T_1 respectively. It was primarily due to high food reserves in large seed tubers which ultimately contributed to produce high yield through increase vegetative growth of plants and rapid development of tubers. This result is supported by several authors [1,2,3]. Similar results have been reported by several authors [4,5].

In the case of Intra row spacing, the given data showed that S_4 (60×20 cm) plant spacing recorded maximum yield of 163.3 q per ha and minimum yield (132.4 q per ha) was recorded in plant spacing of S_1 (60×8 cm). Percent increase in S_4, S_3, and S_2 was 23.4, 16.2 and 8.91 over S_1 respectively. The highest processable yield in S_4 might be due to the minimum competition in wider Intra row spacing. [6] also reported wider Intra row spacing gives more processable yield due to minimum competition among plants. Like our studies [7] also reported that under wider intra-row spacing mean tuber weight increased, whereas, total tuber yield decreased by 12% when intrarow spacing was increased. Hence, they absorb sufficiently available resources and intercept more light. Similar results have been reported by Kushwah and Singh [8,9].

3.6 Non-processable Tuber (<40 and >75 mm)

The data presented in Table 2 showed that maximum non-processable yield 98.6 q per ha was found with tuber size of T_3 (40-50 mm) the minimum non-processable yield 81.3 q per ha was obtained in tuber size of T_1. The data was found to be non-significant.

Among intra row spacing, maximum non-processable yield 140.6 q per ha was found in closer plant spacing S_1 (60 × 8 cm) and minimum at S_4 (60 × 20 cm). This might be due to the available amount of assimilated produced by the plants through increase photosynthetic area per plants and less competition of nutrients uptake by the plants and resulting in more processable yield at wider spacing. These results are also confirmed by Yenagi et al. [10,11].

3.7 Plant Dry Matter Accumulation (g per Plant) at Harvest

Plant dry matter is a reliable index determining the growth and development of a plant. The data presented in Table 2 illustrated that tuber size had a significant effect on haulm dry matter accumulation. The higher haulm dry matter accumulation (g per plant) was recorded under T_3 (17.8 g). The highest haulm dry matter accumulation (g per plant) was found in S_4 (17.1 g) among intra-row spacing.

4. CONCLUSION

Potato seedlings require wide spacing for better processable yield as well as for most of the growth variables. However, indefinite decreases in spacing between plants result in further change in the processing yield of potato tubers. Therefore, for proper yield and growth of potato for both seed and ware according to this research a seed-tuber size of 40-50 mm and intra row spacing of 20 cm can be considered as the best combinations of seed-size and spacing for potato processable yield in Lady Rosetta variety of potato. No effect on quality attributes observed under these agronomic manipulations.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Verma V, Varshney SK, Singh B, Kumar A effect of seedling tuberlet size on seed potato yield of tps varieties in calcareous soils of North Bihar. Ann. Biol. 2007;23: 137-139.
2. Bayorbor TB, Gumah Y, Effects of seed tuber weight and spacing on the yield of Frafra potato *(Solenostemon rotundifolius)*. Ghana J. Hort. 2007;6:41-48.
3. Gulluoglu L, Aroglu H. Effects of seed size and row spacing on growth and yield of early potato in a Mediterranean-type environment in Turkey. African J. Agric. Res. 2009;4:535-541.
4. Khurana SC, Pandita ML, Srivastava VK. Effect of seed size and seed rate on potato yield. J. Indian Potato Assoc. 1991;18:167-68.
5. Kadian MS, Patel PK, Thakur KC, Upadhyay MD. Comparative yield potential of seedlings and seedling tuberlets from true potato seed in Deesa (Gujarat). J. Indian Potato Assoc. 1988;15:115-18.
6. Getachew T, Belew D, Tulu S. Combined effect of plant spacing and time of earthing up on tuber quality parameters of potato (*Solanum tuberosum* L.) at Degem District, North Showa Zone of Oromia Regional State. Asian J. of Crop Sci. 2012;1-9.
7. Zebarth BJ, Arsenault WJ, Sanderson JB. Effect of seed piece spacing and nitrogen fertilization on tuber yield, yield components and nitrogen use efficiency parameters to two potato cultivars. Am J Potato Res. 2006;83:289-96.
8. Kushwah VS, Singh SP. Effect of intra-row spacing and date of haulm cutting on production of seed size tubers in potato. Potato J. 2008;35:88-90.
9. Kushwah VS, Singh SP. (Effect of intra-row spacing and date of haulm cutting on production of small size tubers. Potato J. 2008;35:88–90.
10. Zamil MF, Rahman MM, Rabbani MG, Khatun T. Combined effect of nitrogen and plant spacing on the growth and yield of potato with economic performance. Bangladesh Research Publication Journal. 2010;3(1):062–70.
11. Yenagi BS, Meli SS, Angadi SS. Effect of row spacing, planting date and nitrogen level on tuber grade, yield, and economics of potato. Karnataka J. of Agri. Sci. 2004; 17:220-223.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/55306