Research Article

Influence of plant spacing on productivity of true potato seed genotypes during nursery raising

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Abstract

To explore the appropriate plant spacing for true potato seed (TPS) in nursery, the present study was mainly conducted at Agriculture Research Institute, Tandojam, Pakistan located at 25.24, 46.00, 'N, 68.32, 12.00E during growing year 2009 and 2010. In this study seeds of three different true potato seed genotypes viz., TPS=9802, TPS=9804 and TPS=9805 were tested under three different plant spacing i.e. 2, 4, and 6 cm, respectively. Whereas, row to row distance was kept constant (25 cm). The results obtained from m² area showed maximum number of micro tubers (196.1), small tubers (42.15), medium tubers (26.56) and large tubers (7.57) when TPS-9804 was planted with 4 cm plant spacing. The maximum weight of micro tubers (1302 g), small tubers (480.3 g), medium tubers (340 g) and large tubers (468.5 g) were recorded also in TPS-9804 with same spacing. The overall results for tuber yield showed that TPS-9804 genotype planted with plant to plant distance of 4 cm recorded significantly maximum tuber yield (29.46 t ha⁻¹) as compared to rest of the genotypes, hence TPS-9804 genotype is recommended for raising of TPS nursery with plant to plant distance of 4 cm.

Key words: True Potato Seed (TPS); plant spacing; nursery; yield.

Introduction

Potato (*Solanum tuberosum* L.) is one of the most prevalent and nutritive vegetable [1]. It is the third most imperative non grain food crop in the world [2]. In some countries true potato seed (TPS) is used as planting material in a seed potato production scheme. The true potato seed for commercial potato production had been extensively used in China, Sri Lanka, Rwanda, Egypt, Philippine, India, Bangladesh and number of studies also undertaken in different parts of Ethiopia [3-

5]. In Pakistan this technology is in preliminary stages of implementation. The use of true potato seed (TPS) had many advantages over the use of seed tubers and attractive for small-scale farmers in developing countries [6]. Numerous reports indicated that plant spacing affects the mini-tuber production. As out of nine different spacing of directly sown true potato seed (TPS), the spacing 10 x 5 cm produced the highest yield (39.67 t ha⁻¹) while the lowest yield (24.17 t ha⁻¹) was obtained from 30 x 15

cm spacing, the maximum number of tubers were produced in the closer spacing [7]. Similarly the less yield for F and D grade tubers were recorded in wider spacing ($40 \times 15 \text{ cm}^{-2}$) when compared to 30×10 and $30 \times 15 \text{ cm}^{-2}$ [8]. Among different spacing of $25 \times 10 \text{ cm}$ with $40 \text{ seedlings m}^{-2}$ produced the highest tuber weight (2.9 kg m^{-2}) and population of $100 \text{ seedlings m}^{-2}$ gave the highest number of tubers (314 m^{-2}). Increasing plant population significantly increased tuber number but decreased the tuber weight, and eventually decreased crop yield [9]. The inter-row spacing at 10 cm produced significantly highest number and weight of $10\text{-}20 \text{ g}$, $20\text{-}40 \text{ g}$, and total tuberlets. The widest spacing of 30 cm was significantly superior for the number of compound leaves, and number and weight of $20\text{-}40 \text{ g}$ and $> 40 \text{ g}$ tuberlets. Similarly, intra-row spacing of 5 cm gave significantly higher number and weight of total and the other categories of tuberlets, except large sized compared to the wider spacing. On the other hand, wider intra-row spacing of 10 cm significantly enhanced the production of large sized ($> 40 \text{ g}$) tuberlets and the number of compound leaves [10]. Generally, small and medium size of tubers is considered as desirable size for seedling tubers. For the requisite size of tuber production, spacing of 25×4 and $15 \times 4 \text{ cm}$ were appropriate [11]. Keeping in view the above facts present study was carried out to determine the most suitable plant spacing for TPS nursery raising as farmers can obtain good earning by producing this valuable crop.

2. Materials and Methods

Three different true potato seed genotypes viz., TPS-9802, TPS-9804 and TPS-9805 were planted under three different plant spacing i.e. 2 , 4 , and 6 cm , respectively. The trial was laid out in randomized complete block design (RCBD) with four replications having a net bed size of 1 m^2 per treatment.

After sowing, beds were covered with rice straw and watered early in the morning and late afternoon with hand sprinkler up to germination. After fifteen days of sowing straw cover was removed and irrigation water applied through channel. The recommended dose of fertilizer @ NPK $225+125+125 \text{ kg ha}^{-1}$ in the form of urea, single super phosphate (SSP) and sulphate of potash (SOP) were applied. The phosphatic and potash fertilizers were mixed with soil at seed bed preparation stage while nitrogenous fertilizer was applied in two split doses after 30 and 60 days of sowing. In addition to this all other cultural practices were completed according to the requirements of nursery. The vines were dehaulmed before 15 days of harvesting. The data for germination% at 45 days, number of micro tuber ($1\text{-}9 \text{ mm}$), small tuber ($10\text{-}19 \text{ mm}$), medium tuber ($20\text{-}39 \text{ mm}$) and large tuber ($> 40 \text{ mm}$), weight of tubers (g) $1\text{-}9$, $10\text{-}19$, $20\text{-}39$ and $> 40 \text{ g/m}^2$, total tubers/ m^2 and total tuber weight (g/m^2) were recorded. The collected data were then analyzed for Analysis of Variance (ANOVA). For mean discrimination Duncan's Multiple Range Test (DMRT) was applied on all the crop traits through MSTAT-C package [12].

3. Results

Results of the study showed greater number of micro tubers (183.3) at 4 cm plant spacing followed by 178.6 and 177.8 number of micro tuber in 6 and 2 cm plant spacing respectively. However, the maximum number of small (38.89), medium (21.20), large (6.40) and total (249.79 m^{-2}) tubers were obtained when plants were spaced at 4 cm . The 6 cm plant spacing ranked at 2^{nd} place by recording 178.6 micro, 36.05 small, 19.26 medium and 6.06 large tubers with total tubers of 239.9 m^{-2} . The results further showed that 2 cm plant spacing ranked at 3^{rd} place by recording 34.26 small, 16.82 medium and 5.53 large tubers with total

Table-1. Effect of plant spacing on different yield parameters of true potato seed genotypes.

True potato seed traits	SE	LSD (5%)	True potato seed plant spacing		
			2 cm	4 cm	6 cm
Tuber number (m ⁻²)					
Number of micro tubers	0.8185	2.286	177.8 b	183.3 a	178.6 b
Number of small tubers	0.09902	0.2766	34.26 c	38.89 a	36.05 b
Number of medium tubers	0.05000	0.1397	16.82 c	21.20 a	19.26 b
Number of large tubers	0.02141	0.05980	5.531 c	6.408 a	6.064 b
Total tuber number	1.584	4.424	234.41 c	249.79 a	239.9 b
Tuber weight (g m ⁻²)					
Weight of micro tubers	3.269	9.130	1154 c	1211 a	1172 b
Weight of small tubers	3.107	8.679	573.7 c	625.8 a	604.1 b
Weight of medium tubers	2.304	6.436	377.5 c	425.6 a	397.8 b
Weight of large tubers	2.208	6.168	321.3 c	360.7 a	352.6 b
Total tuber weight	21.68	60.57	2426 c	2623 a	2526 b
Tuber yield (t ha ⁻¹)	0.2172	0.6066	24.26 c	26.23 a	25.26 b

In each row, means followed by common letter are not significant different at 5% probability level.

Tuber grading: micro tuber (1-9 mm), small tuber (10-19 mm), medium tuber (20-39 mm) and large tuber (>40 mm).

tubers number of 234.41 m⁻². The higher weight of micro (1211 g), small (625.8 g), medium (425.6 g), large (360.7 g) tubers and maximum total tuber weight (2623 g m⁻²) was found when plants were spaced at 4 cm distance, whereas minimum 2426 g m⁻² total tuber weight was obtained in 2cm plant spacing. Thus, maximum tuber yield (26.23 t ha⁻¹) was recorded in 4 cm plant spacing. The minimum weight of micro 1154 g, small 573.7 g, medium 377.5 g and large 321.3 g tubers was observed in 2 cm plant spacing as shown in (Table 1).

Interactive effect of plant spacing x genotypes on true potato seed traits

The statistical analysis of variances (ANOVA) showed that true potato seed traits were significantly affected by interactive effect of plant spacing x genotypes. The results showed maximum number of micro tubers (194.4) in TPS-9804 genotype planted at 4 cm plant spacing. However, the minimum number of micro tubers (170.3) were observed in TPS-9802 genotype at 2 cm plant spacing. The higher number of small tubers (40.54) was observed in TPS-9804 genotype when plants were spaced at 4 cm. The lower number of small tubers (33.98) were recorded when plants received 6 cm in

TPS-9802 genotype. The maximum number of medium tubers (23.96) were counted in 4 cm plant spacing in TPS-9804 genotype, whereas, minimum number of medium tubers (14.27) were recorded in TPS-9802 genotype where 2 cm plant spacing was maintained. The higher number of large tubers (7.13) were noted in TPS-9804 genotype sown at 4 cm plant spacing, while these tubers decreased (4.46) in TPS-9802 genotype at 2 cm plant spacing.

The overall results of the experiment showed that total tuber number was maximum (266.03) in TPS-9804 genotype when 4 cm plant to plant spacing was maintained. However, minimum (222.21) total tuber number was noted in TPS-9802 genotype seeds at close plant spacing of 2 cm (Table 2).

Results of the tuber weight (g) showed maximum weight of micro tubers (1290 g m⁻²) in TPS-9804 sown at 4 cm plant spacing, however, the minimum micro tuber weight (1106 g m⁻²) was observed in 2 cm plant spacing in TPS-9805 genotype. The greater weight of small tubers (676 g m⁻²) was observed in the interactive effect of 4 cm plant spacing and TPS-9804 genotype. The lower weight of small tubers (512.8 g m⁻²)

Table-2. Interactive effect of plant spacing x genotypes on true potato seed traits.

Plant spacing x genotypes		Tuber number (m ⁻²)					Tuber weight (g m ⁻²)					
		Number of micro (1-9 mm) tubers	Number of small (10-19 mm) tubers	Number of medium (20-39 mm) tubers	Number of large (> 40 mm) tubers	Total tuber number (m ⁻²)	Micro (1-9 g) tubers	Small tubers (10-19 g) tubers	Medium tubers (20-39 g) tubers	Large (> 40 g) tubers	Total tuber weight	Yield (t ha ⁻¹)
2 cm	TPS-9802	170.3 f	33.18 f	14.27 g	4.460 g	222.21 efg	1118 ef	512.8 f	360.0 e	302.6 f	2293 d-g	22.93 cde
	TPS-9804	175.2 de	38.14 c	19.58 e	5.849 e	238.76 c-g	1165 d	584.9 d	399.4 c	335.8 d	2485 c-f	24.85 cde
	TPS-9805	172.4 ef	33.35 f	16.43 f	5.491 f	227.67 def	1106 f	561.1 e	376.1 d	317.1 e	2360 def	23.60 cd
4 cm	TPS-9802	186.9 b	36.63 d	19.70 de	6.593 c	249.82 cd	1214 c	646.8 b	384.9 d	356.2 c	2601 c	26.01 c
	TPS-9804	194.4 a	40.54 a	23.96 a	7.131 a	266.03 a	1290 a	676.0 a	451.1 a	410.2 a	2827 a	28.27 a
	TPS-9805	186.5 b	38.76 b	21.43 b	6.823 b	253.51 b	1243 b	661.3ab	407.0 c	394.8 b	2706 b	27.06 b
6 cm	TPS-9802	176.2 cde	32.98 f	16.50 f	5.540 f	231.22 de	1131 e	561.5 e	387.5 d	305.2 f	2385 de	23.85 c
	TPS-9804	180.4 c	37.99 c	20.07 c	6.243 d	244.7 cde	1177 d	616.6 c	426.3 b	336.3 d	2556 cd	25.56 cd
	TPS-9805	176.9 cd	36.04 e	19.91 cd	5.879 e	241.7 c-f	1167 d	590.0 d	410.4 c	345.8 cd	2512 cde	25.12 cd
SE		1.418	0.1715	0.08660	0.03708	2.743	5.662	5.382	3.991	3.825	37.56	0.3762
LSD (5%)		3.960	0.4790	0.2419	0.1036	7.662	15.81	15.03	11.15	10.68	104.9	1.051

In each column, means followed by common letter are not significant different at 5% probability level.

Tuber grading: micro tuber (1-9 mm), small tuber (10-19 mm), medium tuber (20-39 mm) and large tuber (>40 mm).

was recorded in TPS-9802 genotype sown at 2 cm plant spacing. The weight of medium tubers was recorded maximum (451.1 g m^{-2}) in TPS-9804 when 4 cm plant spacing was maintained. However, minimum weight of medium size tubers (360 g m^{-2}) was recorded in TPS-9802 genotype seeds at 2 cm plant spacing. The higher weight of large tubers (410.2 g m^{-2}) was recorded in TPS-9804 genotype where seeds were sown at 4 cm plant to plant spacing. The lower weight of large tubers (302.6 g m^{-2}) was obtained in TPS-9802 seeded at 2 cm plant spacing.

The overall results of the study showed that TPS-9804 genotype was better as compared to rest of genotypes for recording maximum weight of tuber yield (28.27 t ha^{-1}) when plant to plant distance was maintained at 4 cm. However, TPS-9802 genotype was not good enough in recording tuber yield (22.93 t ha^{-1}) at closer plant spacing of 2 cm (Table 2).

4. Discussion

In potato crop, plant density plays an important role on crop growth and productivity. An improper spacing may cause either too dense or too thin plant population resulting in the reduction of potato tuber yield. Optimum plant density ensures optimal growth of plants through efficient utilization of moisture, nutrients and light and crop covers the field early by promoting foliage growth and thus has an advantage over the low density crop in recording higher tuber bulking rate, which in turn help in producing greater tuber yield [13].

In this study densely populated plants ($25 \times 4 \text{ cm}$) recorded the maximum number and weight of micro, small, medium, large and total tuber yield t ha^{-1} . According to Khan et al. [14], highest yield of very small size tubers was obtained by planting tubers at close row and plant spacing. Whereas in our case planting of true potato seed with medium row spacing of 25 cm and plant to plant spacing of 4 cm proved better. This practice of sowing caused production of

healthier plants with better plant height having more number of leaves which ultimately helps in the maximum production rate of photosynthesis; a necessary component for obtaining higher organic yield. Malik [15] and Farooque [16] are also supportive of the above statement.

The positive effect of high plant density on total tuber number and weight appeared due to fast canopy cover resulting in more light interception and also due to suitable temperature for proper stolon development and tuber initiation. Due to favorable spacing seedling tubers gained more number and weight resultantly total tuber yield increased significantly. The higher number and weight of seedling tubers indicated the adoptability of TPS genotypes in Sindh. Mahmood [17], found the highest yield 52.62 t ha^{-1} in the combination of transplanting, double row, and $50 \times 5 \text{ cm}$ spacing. This is due to the compensation effect of plants per hectare than the wider spacing, which results higher yield of tuber per hectare. This result is also in support of the findings obtained by previous researchers [18-20]. Planting density strongly affect yield, both by number and by weight, and more tubers and yield per square meter are expected in higher planting densities Karafyllidis et al. [21]. These results are in agreement with the findings of Khourgami et al. [22] who observed significant effect on number of tubers m^{-2} in different true potato seed genotypes. Hasan [23] reported that total tuber yield, marketable tuber yield, plant height, number of main stem per plant, number and weight of tuber plant^{-1} , number and weight of tuber in size of smaller than 35 mm, between 35-55 mm and bigger than 55 mm. Comparison means of treatment showed that Sante, Almera, Banba and ATZIMBA $\times$ TPS-67-8 clone had the highest total and marketable tuber yield, weight of tuber per plant, and number and weight of tuber in size of 35-55 mm.

In the light of above study it can be concluded that narrow plant spacing (4 cm) for true potato seed TPS nursery raising is conducive for obtaining high value seedling tubers to be used for next year planting.

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