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Effect of Seedling Tuber Size and Depth of Planting on the Growth and Yield of Potato

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Abstract: The treatments comprised of four sizes of seedling tubers viz. 5.0, 7.5, 12.5 and 17.5 g derived from the TPS progeny HPS II/67 and four depths of planting viz. surface level, 2.5, 5.0 and 7.5 cm with their all possible combinations. Seedling tuber size significantly influenced the growth and yield of potato. Yield was found to increase with the increase in seedling tuber size and the maximum yield (39.34 t/ha) was obtained from the large seeds (17.5g). Depth of planting had no significant effect on the growth and yield of potato. The combined effect of seedling tuber size and planting depth revealed that the maximum yield per hectare (39.42 t/ha) was obtained from the large seedling tuber (17.5 g) with the planting depth of 5.0 cm. Economic analysis indicated that the best economic return was obtained from 17.5 g seedling tubers planted at a depth of 7.5 cm.

Key words: Tuber- size, depth, yield, potato

Introduction

Potato is one of the three leading staple food crops of the world next to wheat and rice. It ranks first among the vegetable crops grown in Bangladesh both in area and production (BBS, 1996). But the average yield of potato in Bangladesh is very low compared to that of the world. There are several reasons for low yield of potato in this country. Among these, both non-availability and higher price of seed potato are very important. In potato cultivation, seed potato alone may represent 40-70% of the total cost of production (Upadhya, 1995).The true potato seed (TPS) technology is considered to be complimentary to the traditional system of potato production in many countries of the world. Ahmad *et al*. (1987) reported that the use of TPS reduces about 50% of the total cost of production. It also helps to avoid many viral diseases and checks the rate of degeneration of seeds. With TPS, there are three alternative types of planting materials viz. I) TPS directly sown in the field for ware potato production; ii) TPS sown out on specially prepared seed beds to produce seedling tubers which are then stored and used for planting in the following year for the production of either edible or seed potatoes and iii) TPS sown on seed beds to produce seedlings, which are transplanted to the field about one month later to produce ware potatoes in the same year. According to Upadhya (1995), the second methods appears to be more suitable under Bangladesh conditions. Generally, the seedling tuber sizes vary form less than 1g to more than 50g, the majority being less than 10g (Islam *et al*., 1993). However, the yield of ware potato depends upon the size of seedling tubers used. Seedling tubers below 10g size can be successfully used for potato production as reported by Wiersema (1985). Devasabai (1982) obtained higher yields from 30-35g seedling tubers than 10-15g. Also in traditional method of potato production, seed sizes have been found to influence the yield and economic return of potato (Taleb *et al*., 1973; Smith, 1977). Again, depth of planting of seeds is another important consideration in the culture of potato. It also influence the growth and yield of potato (Kim *et al*., 1989). Although, information regarding seed size and depth of planting are available for conventional system of potato cultivation using seed potato as planting material. But the research on effect of seedling tuber sizes and depth of planting are scant. The present investigation was therefore, undertaken to study the effect of seedling tuber size and depth of planting on growth, yield and economic return of TPS variety HPS II/67 under the soil and climatic conditions of Bangladesh Agricultural University, Mymensingh.

Materials and Methods

The experiment was carried out during the period from October 1998 to march 1999, at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh. The soil of experimental area belongs to Brahmaputra alluvial tract having sandy loam texture. Seedling tubers of TPS progeny HPS-II/67 were used as experimental material. The TPS progeny HPS-II/67 is a hybrid of the parents MF-II and TPS-67 (Anonymous, 1992). The tuberlets were produced at the Horticulture Farm, Bangladesh Agricultural University from the true potato seeds. The treatments of the study consisted of four different sizes of seedling tubers (5.0, 7.5, 12.5 and 17.5g) and four depths of planting (surface level, 2.5, 5.0 and 7.5cm) with their possible combinations. The two-factor experiment was laid out in randomized complete block design with three replications. The size of unit plot was 2.4 x 3.0m^2. The distance maintained between the unit plots was 0.5m and between blocks was 1.0m. Border plants were planted around the experimental plot. The seedling tubers were planted on 25 November, 1998. For planting, furrows at a spacing of 60cm were dug with the help of a country plough. Within the row, the seedling tubers were spaced at a distance of 15cm. The crops received 10 tones of cowdung and 160-100-160-20 kg NPK and S per hectare in the form of Urea, TSP, MP and Gypsum, respectively. Irrigation, weeding, mulching, earthing-up and other intercultural operations were done as and when necessary. Harvesting of crop was done on March 3, 1999, i.e, 99 days after planting. Ten plants were randomly selected from each plot for recording the experimental data. Tubers collected from 10 sample plants in each plot were graded as seed and non-seed tubers by weight according to their diameter. In this study, 28-55mm diameter tubers were treated as seed tubers while below 28 and above 55mm diameter tubers were treated as non-seed tubers. The collected data was analyzed statistically and the differences between means were adjusted by DMRT.

Results and Discussion

Effect of seedling tuber size: The results indicated that the seedling tuber size significantly influence all the parameters under study (Table 1). The longest time required to complete 80% emergence of crop was taken from 5.0 g seedling tuber but was statistically identical with 7.5 g ones. Lowest but statistically identical time required to complete 80% emergence of crop was recorded from 17.5 g and 12.5 g seedling tubers. It might be due to the fact that large seedling tubers had more stored food materials with well developed sprouts than the small tubers, which led to the earlier emergence of the crop. Plant height significantly increased due to increase in seedling tuber size. Similar result was also reported by Rashid *et al.* (1990). It was possible due to larger seedling tubers with higher stored food materials, which enhanced early emergence of the crop and ultimately speed up the vegetative growth of plants. Seedling tuber size also significantly influenced the crop coverage at 70 DAP. Large seedling tubers gave maximum crop coverage at maximum vegetative growth stage. Sarker and Kabir (1989) obtained markedly maximum vegetative growth in terms of crop coverage with increase in the size of seedling tubers. The finding indicates that smaller seedling tubers need to be planted at a closer spacing in order to get a higher crop coverage. The number of main stem per hill also increased significantly with the increase in seed size. The highest number of stem per hill was produced by the largest seedling tuber size (17.5 g). The increased number of stems per hill obtained from the larger seedling tubers might be due to the higher number of potential eyes present per seedling tuber which led to the production of higher number of main stems per hill. These findings also support the results reported by Siddique *et al.* (1987). Size of seedling tuber significantly influenced the number of tubers produced per hill. The largest seedling tubers (17.5) produced on an average 9.31 tubers per hill which was significantly higher than those produced by 12.5 g and 7.5 g seedling tuber sizes. The small seedling tubers (5.0 g) produced the lowest number of tubers per hill (6.04). A similar trend was also observed for weight of tubers per hill. Likewise, the weight of tubers per hill obtained from 17.5 g, 12.5 g and 7.5 g seedling tubers size were found to be statistically identical and the lowest weight was recorded from 5.0 g seedling tuber size. The yield of tubers were also influenced significantly by the seedling tuber sizes used. An increase in seedling tuber size gradually increased the yield of tubers. It was primarily due to high food reserves in large seed tubers which ultimately contributed to produce high yield through increased vegetative growth of plants and development of tubers. In addition, the smaller seedling tubers produced a lower crop coverage which ultimately resulted in lower yield of tubers per unit area. The largest seedling tubers (17.5 g) produced the highest yield (39.34 t/ha) followed by 12.5g seedling size (34.51 t/ha) and the smallest seedling tubers (5.0 g) produced the lowest yield (21.69 t/ha). The similar findings were also reported by Siddique *et al.* (1987) and Kaidian *et al.* (1988).

Effect of depth of planting: It was observed from Table 1 that the different depth of planting had no significant effect on tuber yield and yield contributing characters except days required for 80% emergence, plant height and crop coverage. Deeper depth of planting tended to increase the days required for 80% emergence. Among the four depths of planting, 7.5 cm depth required the maximum days for emergence. On the other hand, the shortest time required to complete 80% emergence at surface planting. This might be due to the fact that in case of deep planting, the potato sprouts had to come across a long distance of the ground to emergence than the shallow planting. A similar trend was also observed for plant height at maximum vegetative growth stage. Plant height obtained from 7.5 cm depth of planting were found maximum and the lowest height was recorded from surface plating. The highest crop coverage percentage was observed at maximum depth of planting i.e. 7.5 cm while the lowest was at surface planting. Depth of planting had no significant effect on the number of main stem per hill. This indicates that, at least within the range of planting depth under report, the development of main stem depends on number of eyes in a seed piece. The number of main stems per hill ranged from 4.10 to 4.36 in different treatments. As regards tuber yield, 5.0 cm depth of planing was found to be the best (31.10 t/ha) although there was no significant difference between different planting depths. The results are in agreement with the findings of Singh (1985) and Kim *et al.* (1989), who reported that tuber yield did not differ significantly with different depths of planting.

Interaction effect: Now, turning to the combined effect of seedling tuber size and depth of planting demonstrated a gradual increase in the number and yield of tubers per hill with increase in seed size under different planting depth (Table 2). But yield of tubers on unit area basis was considered, the highest seed size (17.5 g) planted at a depth of 5.0 cm was found to give the highest yield of tubers (39.42 t/ha) followed by the same seed size planted at depth of 2.5 cm (39.41 t/ha). However, there was no significant difference among the treatment combinations, where 17.5 g seedling tubers were planted at the surface, 2.5, 5.0 and 7.5 cm depth, respectively. The lowest yield (20.34 t/ha) was recorded when the smallest seed (5.0 cm) was planted at a depth of 7.5 cm. Again, the extent of vegetative growth expressed in terms of plant and crop coverage was closely associated with tuber yield.

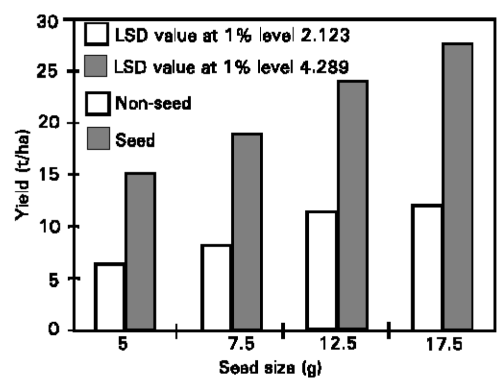

Fig. 1: Main effect of seedling tuber size on production of seed and non-seed tuber

Yield of seed and non- seed tubers: The main effect of seedling tuber size on the production of seed and non- seed tubers have been presented in Fig. 1. There was significant variation among different seedling tuber size in production of seed tubers. The highest amount of seed tubers (27.36 t/ha) was obtained from seedling tuber size of 17.5 g, but the seedling size of 17.5 g and 12.5 g were statistically identical in respect of this character. The lowest amount of seed tubers were obtained from 5.0 g seedling tuber. A similar trend was

Table 1: Effects of seedling tuber size and depth of planting on growth and yield of potato

Treatments	Days required for 80% emergence	Plant height (cm) at 70 DAP	Crop coverage (%) at 70 DAP	No. of main stems/hill	No. of tubers/hill	Wt. of tubers/ hill (g)	Wt. of tubers/plot (kg)	Yield of tubers /ha (t)
Seedling tuber size (g)								
5.0	9.33a	36.76d	54.58d	3.58d	6.04c	200.83b	15.62d	21.69d
7.5	8.83a	42.98c	67.52c	4.02c	7.02bc	238.13ab	19.55c	27.16c
12.5	8.08b	49.42b	72.98b	4.51b	7.62b	253.33ab	24.85b	34.51b
17.5	7.83b	55.29a	90.00a	4.95a	9.31a	309.00a	28.32a	39.34a
Depth of planting (cm)								
Surface	6.67d	44.30c	71.01c	4.18	7.89	241.25	21.81	30.29
2.5	7.25c	45.73b	71.14bc	4.27	7.78	253.13	22.11	30.11
5.0	9.17b	46.48b	71.42ab	4.25	7.12	255.88	22.39	31.10
7.5	11.00a	47.93a	71.52a	4.36	7.20	251.04	22.03	30.59

Means bearing the same letter(s) in a column do not differ significantly at 5% level of probability.

Table 2: Combined effects of seedling tuber size and depth of planting on growth and yield of potato

Treatments		Days required for 80% Emergence	Plant height (cm) at 70 DAP	Crop coverage (%) at 70 DAP	No. of main stems/hill	No. of tubers /hill	Wt. of tuber/ hill (g)	Wt. of tuber/ plot (kg)	Yield of tubers/ ha	Yield of seed tuber/ ha (t)	Yield of non-seed tubers/ha (t)
Seed size (g)	Depth of Planting (cm)										
5.0	surface	7.33f	36.33gh	54.42e	3.43g	7.13bcde	179.17b	15.91e	22.10e	14.73f	7.36de
	2.5	8.33e	38.33g	54.39e	3.63fg	6.17cde	193.33ab	16.09e	22.35e	16.56def	5.79e
	5.0	10.00cd	37.30gh	54.84e	3.47g	5.37e	226.67ab	15.83e	21.98e	15.48ef	6.49de
	7.5	11.67a	35.07h	54.67e	3.77efg	5.50de	204.17ab	14.64f	20.34f	13.79f	6.54de
7.5	surface	7.00fg	41.87f	67.08d	4.13de	6.73bcde	243.33ab	20.35c	28.27c	19.53cdef	8.73bcde
	2.5	7.33f	43.40ef	67.16d	4.13de	7.03bcde	252.50ab	19.37d	26.90d	18.90cdef	7.99cde
	5.0	9.67d	43.03ef	67.77c	3.93ef	6.97bcde	211.67ab	19.25d	26.73d	19.69cdef	5.98de
	7.5	11.33ab	43.60ef	68.08c	3.87ef	7.33bcde	245.00ab	19.24d	26.72d	16.55def	9.16bcde
12.5	surface	6.33gh	45.67de	72.82b	4.43cd	7.63bcde	286.67ab	25.01b	34.73b	22.61bcd	12.12ab
	2.5	6.67fgh	46.77d	72.93b	4.47bcd	8.13abc	271.67ab	24.60b	34.16b	24.45bc	9.71bc
	5.0	8.67e	50.50c	73.04b	4.47bcd	7.27bcde	201.67ab	24.65b	34.24b	22.94cde	11.30bc
	7.5	10.67bc	54.73b	73013b	4.67bc	7.43bcde	253.33ab	25.14b	34.91b	22.93cde	11.97ab
17.5	surface	6.00h	53.33b	89.71a	4.70bc	10.07a	303.33ab	28.30a	39.31a	24.03cde	15.27a
	2.5	6.67fgh	54.40b	90.08a	4.83ab	9.77a	306.00ab	28.37a	39.41a	27.28ab	12.12ab
	5.0	8.33e	55.10b	90.03a	5.13a	8.87ab	325.00a	28.38a	39.42a	28.12ab	11.28bc
	7.5	10.33cd	58.33a	90.18a	5.13a	8.53ab	301.67ab	28.22a	39.20a	30.01a	9.18bcde

Means bearing the same letter(s) in a column do not differ significantly at 5% level of probability.

Table 3: Effect of seedling tuber size and depth of planting on economic analysis of potato production

Treatments		Seed rate (Kg/ha)	Total cost of production (Tk/ha)	Gross return (Tk/ha)	Net return (Tk/ha)	Benefit cost ratio (BCR)
Seed size (g)	Depth of planting (cm)					
5.0	Surface	555	71953	106780	34827	1.48
	2.5	555	71953	113835	41882	1.58
	5.0	555	71953	109105	37152	1.52
	7.5	555	71953	99090	27137	1.38
7.5	Surface	833	77239	139005	61766	1.80
	2.5	833	77239	133375	56136	1.73
	5.0	833	77239	135590	58351	1.76
	7.5	833	77239	122200	44961	1.58
12.5	Surface	1388	87789	165960	78171	1.89
	2.5	1388	87789	17975	83186	1.95
	5.0	1388	87789	145790	58001	1.66
	7.5	1388	87789	167513	79724	1.91
17.5	Surface	1944	98359	182355	83996	1.85
	2.5	1944	98359	193980	95621	1.97
	5.0	1944	98359	196920	98561	2.00
	7.5	1944	98359	203010	104651	2.06

* Sale of seed potato @ Tk. 6.00/kg, and non-seed potato @ Tk. 2.50/kg.

also observed for the yield of non - seed tubers. An increase in seedling tuber size gradually increased the yield of non-seed tubers. Seedling tuber size 17.5 g gave the highest amount of non-seed tubers (11.9 t/ha). However, there was no statistical difference between the seedling tuber size of 12.5 g and 17.5 g. Depth of planting had no significant effect on the yield of seed and non-seed tubers. Again, the combined effect of seedling tuber size and depth of planting for seed and non-seed tubers was found to be significant (Table 2). The highest yield of seed tubers (30.01t/ha) was found when 17.5 g seedling tuber was planted at 7.5 cm depth of planting. But there was no significant difference among the treatment combinations where 17.5 g seedling tuber was planted at the depth of 2.5 cm, 5.0 cm and 7.5 cm, respectively. On the other hand, the lowest yield of seed tubers (13.79 t/ha) was recorded when 5.0 g seedling tuber was planted at 7.5 cm depth of planting, though it was statistically identical with the treatments where 5.0 g seedling tuber was planted at surface, 2.5 cm, 5.0 cm and 7.5 cm depth, respectively. The higher yield of non- seed tuber was recorded from 17.5 g seedling tubers using surface planting and that of lower with 5.0 g seedling tuber size at 2.5 cm depth of planting.

Economic analysis: It has been noticed that the cost of production increased with the increase in seed size (Table 3). But the highest net return (1,04,651 Tk/ha) was obtained by the combination of the largest seed (17.5 g) and 7.5 cm depth of planting which was followed by the combination of 17.5 g seed and 5.0 cm depth. The lowest net return of 27,137 Tk/ha was found in the combination of 5.0 g seed and 7.5 cm depth. The benefit cost ratio was also found to be the lowest in above stated treatment combinations. Although, the cost of production was higher due to use of large seed but their planting gave higher yield of seed tubers. So, the net return was increased. However, from economic point of view it can be concluded that seedling tuber sizes of 17.5 g were the best planting material and gave higher economic benefit, when planted at 7.5 cm depth.

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