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## RESEARCH ARTICLE

# PERFORMANCE OF SEEDLING TUBER DERIVED FROM TRUE POTATO SEEDAS INFLUENCED BY TUBER SIZE AND PLANT SPACING

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**ABSTRACT**

The experiment was conducted at Agronomy research field of Sher-e-Bangla Agricultural University, Dhaka, during 10 November 2012to 10 March 2013 to observe the response of seedling tuber weight and plant spacing on performance of potato. Four weight of seedling tubers *viz*., 40 ± 2, 30 ± 2, 20 ± 2 and 10 ± 2 g and three plant spacing *viz*., 60 cm × 25 cm, 60 cm × 20 cm and 60 cm × 15 cm were used as treatment and laid out in Randomized Complete Block Design (RCBD)with three replications. Results revealed that, plant height, stems hill$^{-1}$,and Leaf Area Index, Total Dry Matter plant$^{-1}$ and Total Dry Matter m$^{-2}$ and Crop Growth Rate increased with increasing seedling tuber weight. The highest tuber yield ha$^{-1}$ both gross and marketable was recorded in the tuber weight of 30 ± 2 g and the lowest from smaller seed tuber of 10 ± 2 g. The highest number of stems and leaves hill$^{-1}$, LAI, TDM plant$^{-1}$, tubers hill$^{-1}$, single tuber weight, tuber weight hill$^{-1}$, gross and marketable tuber yield ha$^{-1}$were observed in the wider spacing of 60 cm × 25 cm and the lowest from closer spacing of 60 cm × 15 cm. However, combindly the highest gross and marketable tuber yield was observed in the treatment combination of 40 ± 2 g seed tuber with the plant spacing of 60 cm × 25 cm. But economic point of view, the seedling tuber weight of 30 ± 2 g with plant spacing of 60 cm × 20 cm was more profitable than those of other treatment combinations.



## INTRODUCTION

Potato (*Solanum tuberosum*) is the 4th world crop after wheat, rice and maize. Bangladesh is the 7th potato production country in the world (FAOSTAT, 2012). In Bangladesh, it ranks 2nd after rice in production. The total area under potato crop, national average yield and total production in Bangladesh are 430446 hectares, 19.071 tons ha$^{-1}$ and 8205470 metric tons, respectively. Total production is increasing day by day as such consumption also rapidly increasing in Bangladesh (BBS, 2012).The yield of potato is very low in Bangladesh comparison to 40.16 tha$^{-1}$in USA, 42.1 tha$^{-1}$ in Denmark and 40.0 t ha$^{-}$ in UK (FAO, 2007), due to the use of low quality seed and use of sub-optimal production practices. Performance of potato can be increased by optimizing use of manure and fertilizer, planting time, spacing and use of optimal sized seed (Divis and Barta 2001). A good TPS progeny can produce 500 to 800 small tubers (called seedling tuber) in 1 square meter of land when planted at 10 cm × 10 cm spacing (TCRC, 2004). These seedling tubers can be planted as good quality seed tubers for ware potato production having higher yield potentiality when an optimum planting spacing is used (Wiersema, 1984). Research on seed tuber weight and plant spacing have been found to influence the yield and economic return (Bong Kyoon *et al.,* 2001; Conley *et al*., 2001; Malik *et al.,* 2002). But only a few studies have been done considering size of seedling tubers and plant spacing on the performance of potato in Bangladesh. Therefore, this experiment was undertaken to find out the principle purpose, response of seed tuber size and spacing on the growth, yield and economic return of potato.

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## MATERIALS AND METHODS

Experiment was carried out at Agronomy research field of Sher-e-Bangla Agricultural University, Dhaka, during 10 November 2009 to 10 March 2010, which was belonging to the Madhupur Tract (AEZ – 28). Four seedling size, viz., $T_1$ = 40 ± 2 g, $T_1$ = 30 ± 2 g, $T_3$ = 20 ± 2 g, $T_4$ = 10 ± 2 g and three spacing, viz., $S_1$ = 60cm×25cm, $S_2$ = 60cm×20cm, $S_3$ = 60cm×15cmwere used as treatment. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The planting material was the first generation TPS seedling tubers of BARITPS-1. The size of the unit plot was 2.5 m×2.0 m. Distances between block to block and plot to plot were 1.0 m and 0.50 m, respectively. Fertilizers were applied, viz. 320, 232, 285, 120, 10, 10 and 10000 kg ha$^{-1}$ for urea, TSP, MOP, gypsum, ZnO, boric acid and cowdung, respectively. Cowdung was applied 10 days before final land preparation.
Total amount of TSP, gypsum, ZnO, boric acid and half of urea and MOP were applied at basal dose during final land

preparation. The rest 50% urea and MOP were side dressed in two equal splits at 25 and 45(Days after planting-DAP) during first and second earthing up. To protect the young seedlings from the attack of cut worm, soil was treatedwith Furadan 5G @ 15 kg ha$^{-1}$.The well sprouted seed tubers were planted on November 10, 2009, at a depth of 5to7 cm in furrow made 60 cm apart and seed tubers were covered with soil. Two weeding was done, 1st at two weeks after emergence and 2nd was done before 2nd top dressing of urea. Earthing up was done twice during growing period at 25 DAP and 45 DAP respectively. Irrigation was done three times at 25 DAP, 45 DAP and 65 DAP throughout the growing period in controlled way. Crop protection measures were taken as and when necessary. Ten sample plants were randomly selected from each plot and tagged separately for recording necessary data and then the whole plot was harvested at 90 DAP with the help of spade. The data were collected on plant height, stems hill $^{-1}$, leaves plant$^{-1}$, leaf area index, total dry matter, crop growth rate, relative growth rate, net assimilation rate, tuber hill$^{-1}$, single tuber weight, tuber yield. The collected data were analyzed statistically and means were adjusted by using the Duncan's Multiple Range Test.

## RESULTS AND DISCUSSION

Plant height was significantly influenced by seed tuber weight at (90 DAP) of potato (Table 1). Result showed that plant height increased with increasing tuber weight. The significantly tallest plant was recorded in tuber weight of 40 ± 2 g (54.7 cm at 90 DAP) followed by tuber weight of 30 ± 2 g(53.7 cm at 90 DAP) and lowest from 10 ± 2 g (38.5 cm at 90 DAP). The plant height was higher in larger tubers because of larger seedling tuber had huge stored food material that supported increased vegetative growth of the plants. This result supported by (Garg *et al*., 2000). Result showed that plant height increased with decreasing plant spacing (Table 1).

**Table 1. Effects of tuber weight and spacing on morpho-physiological characters of potato**

| Treatments | Plant height (cm) at 90 DAP | Stem hill$^{-1}$ at 90 DAP | Leaves hill$^{-1}$ at 90 DAP | LAI at 90 DAP |
|---|---|---|---|---|
| Tuber weight | | | | |
| $T_1$ | 54.7a | 5.05a | 63.2 a | 2.01 a |
| $T_2$ | 53.7a | 4.87a | 57.5 b | 1.87 a |
| $T_3$ | 47.8b | 3.05b | 41.6 c | 1.53 b |
| $T_4$ | 38.5 c | 1.82c | 33.4 d | 1.26 c |
| Significance | ** | ** | ** | ** |
| SE | .884 | .058 | 0.934 | 0.053 |
| Spacing | | | | |
| $S_1$ | 46.7 b | 3.84a | 54.5 a | 1.40 c |
| $S_2$ | 48.4 b | 3.17c | 49.6 b | 1.69 b |
| $S_3$ | 50.9 a | 3.30ab | 42.6 c | 1.91 a |
| Significance | ** | ** | ** | ** |
| SE | 0.765 | 0.050 | 0.809 | 9.57 |
| CV% | 5.45 | 4.91 | 5.73 | 0.046 |

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. ** indicate significant at 1% level of probability.$T_1$ = 40 ± 2 g, $T_1$ = 30 ± 2 g, $T_3$ = 20 ± 2 g, $T_4$ = 10 ± 2g and $S_1$ = 60cm×25cm, $S_2$ = 60cm×20cm, $S_3$ = 60cm×15cm.

The tallest plant was recorded at 60 cm ×15 cm plant spacing (50.9 cm at 90 DAP) followed by 60 cm ×20 cm plant spacing (48.4 cm at 90 DAP) and lowest from spacing of 60 cm ×25 cm (46.7 cm at 90 DAP). The taller plant in closer spacing might have resulted due to competition between plants for sunlight. These results supported by Bayorbor and Gumah (2007). In (Table 2) the highest plant height was recorded in the treatment combination of 40 ± 2 g tuber size with 60 cm × 15 cm plant spacing (57.8 cm at 90 DAP) and the lowest from 10 ± 2 g tuber with 60 cm × 25 cm spacing (37.2 cm at 90 DAP).

**Table 2. Interaction effects of tuber weight and spacing on morpho-physiological characters of potato**

| Interaction | Plant height (cm) at 90 DAP | Stem hill$^{-1}$ at 90 DAP | Leaves hill$^{-1}$ at 90 DAP | LAI at 90 DAP |
|---|---|---|---|---|
| $T_1×S_1$ | 52.0b-e | 5.47 a | 73.8 a | 1.69 cd |
| $T_1×S_2$ | 54.2 a-c | 5.20 a | 65.4 b | 2.07 ab |
| $T_1×S_3$ | 57.8 a | 4.47 b | 50.3 d | 2.26 a |
| $T_2×S_1$ | 50.9 c-f | 5.20 a | 61.3 bc | 1.60 d |
| $T_2×S_2$ | 54.0 a-d | 5.00 a | 59.1 c | 1.90 bc |
| $T_2×S_3$ | 56.2 a-b | 4.30 b | 52.0 d | 2.10 ab |
| $T_3×S_1$ | 46.7 f | 3.30 d | 45.1 e | 1.28 ef |
| $T_3×S_2$ | 47.5 e-f | 3.13 d | 40.4 ef | 1.53 de |
| $T_3×S_3$ | 49.2 d-f | 2.73 e | 39.4 f | 1.78 cd |
| $T_4×S_1$ | 37.2 g | 1.87 f | 37.7 fg | 1.02 f |
| $T_4×S_2$ | 38.0 g | 1.90 f | 33.6 g | 1.27ef |
| | 40.4 g | 1.69 f | 28.8 h | 1.50 de |
| Significance | * | * | ** | * |
| SE | 1.531 | .101 | 1.619 | 0.092 |
| CV% | 5.45 | 4.91 | 5.73 | 9.57 |

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.*; ** indicate significant at 5% and 1% level of probability, respectively. $T_1$ = 40 ± 2 g, $T_1$ = 30 ± 2 g, $T_3$ = 20 ± 2 g, $T_4$ = 10 ± 2 g and $S_1$ = 60cm×25cm, $S_2$ = 60cm×20cm, $S_3$ = 60cm×15cm.

Result revealed that stems hill$^{-1}$decreased with decreasing seed tuber weight (Table 1). The highest stems hill$^{-1}$ was observed in the tuber weight of 40 ± 2 g (5.05at 90 DAP) followed by tuber weight of 30 ± 2 g (4.87) with same statistical rank and the lowest from tuber weight of 10 ± 2 g (1.82). The increased of stems hill$^{-1}$ obtained from the large seed tuber might be due to the higher number of potential eyes present per tuber which led to production of higher stems hill$^{-1}$. The findings supported by Gulluoglu and Aroglu (2009). Result showed that stems hill$^{-1}$ increased with increasing plant spacing (Table 1). The highest stems hill$^{-1}$ (3.84) was recorded in 60 cm × 25 cm spacing which was statistically similar to 60 cm × 20 cm spacing (3.69) and the lowest from 60 cm × 15 cm spacing (3.17). Reduction in stem number in densely populated area might be due to increased number of plants per unit area. This increased number of plants per unit area exerted competition among plants for nutrients and light that caused a reduction in branch number. Results also reported by Yenagi *et al.* (2002) in potato. The highest stems hill$^{-1}$ was observed in 40 ± 2 g tuber weight with 60 cm × 25 cm spacing (5.47) followed by the treatment combination of 40 ± 2 g seed tuber and 60 cm × 20 cm spacing (5.2) and 30 ± 2 g seed tuber with 60 cm × 25 cm spacing (5.2) with same statistical rank and lowest from10 ± 2 g tuber with 60 cm × 15 cm spacing (1.69) (Table 2). Results revealed that leaves hill$^{-1}$ increased with increasing seed tuber weight. In (Table 1) the highest leaves hill$^{-1}$ was observed in 40 ± 2 g tuber (63.2 leaves hill$^{-1}$ at 90 DAP) followed by 30 ± 2 g seed tuber weight (57.5 hill$^{-1}$ at 90 DAP) and the lowest from 10 ± 2 g (33.4 hill$^{-1}$ at 90 DAP). Increased leaf number in larger tuber might be due to increased stems hill$^{-1}$. The results supported by Gulluoglu and Aroglu (2009) in potato. Results showed that leaf number increased with increasing plant spacing (Table 1). The highest leaves hill$^{-1}$ was recorded in 60 cm × 25 cm spacing (54.5 hill$^{-1}$ at 90 DAP) and the lowest from 60 cm × 15 cm (42.6 at 90 DAP). Leaf number was lower in closer spacing because of fewer stems hill$^{-1}$ than wider spacing. This results also supported by Cites *et al*. (2000). The highest leaves hill$^{-1}$ was observed in 40 ± 2 g tuber weight with 60 cm × 25 cm spacing (73.8 leaves hill$^{-1}$ at 90 DAP) and the lowest from 10 ± 2 g tuber with 60 cm × 15 cm spacing (28.8 leaves hill$^{-1}$ at 90 DAP). Results showed that LAI increased with increasing tuber size. In (Table 1), the highest LAI was observed in 40 ± 2 g tuber followed by 30 ± 2 g tuber at 90 DAP and lowest from 10 g size tuber at 90 DAP. The results supported by Verma *et al.* (2007) in potato. Result showed that LAI increased with decreasing plant spacing. In (Table 1) the highest LAI was observed in the spacing of 60 cm × 15 cm (1.91 at 90 DAP) and lowest60 cm × 25 cm spacing (1.40 at 90 DAP). The LAI was lower in closer spacing but reverse trend was observed in case of LAI might be due to larger plant population in closer spacing compared to wider spacing. The results supported by Ravichandran and Singh (2003). The highest LAI was observed in 40 ± 2 g tuber weight with 60 cm × 10 cm spacing (2.26 at 90 DAP) followed by tuber size of 40 ± 2 g with 60 cm × 20 cm spacing (2.07 at 90 DAP) and lowest from 10 ± 2 g tuber with 60 cm × 25 cm spacing (1.02 at 90 DAP).

Result showed that, total dry mass m$^{-2}$ increased with Increasing tuber weight. In (Table 3) the highest TDM m$^{-2}$ was recorded in tuber weight of 40 ± 2 g (1056.7 g m$^{-2}$ at 90 DAP) and lowest from 10 ± 2 g 470.8 g m$^{-2}$ at 90 DAP). The TDM was higher in larger tubers because of larger tuber seedling had huge stored food material that promoted increased vegetative growth of the plants. This results supported by (Garg *et al*., 2000). Result showed that total TDM m$^{-2}$ increased with increasing plant spacing.

**Table 3. Effects of tuber weight and spacing on morpho-physiological characters ofpotato**

| Treatments | TDM m$^{-2}$ (g) at 90 DAP | CGR(g m$^{-2}$d$^{-1}$ ) at 75-90 DAP | RGR(mg g$^{-1}$d$^{-1}$) at75-90 DAP | NAR(mg cm$^{-2}$d$^{-1}$ ) at 60-75 DAP |
|---|---|---|---|---|
| Tuber weight | | | | |
| $T_1$ | 1056.7 a | 11.12 b | 11.65 c | 109.0 a |
| $T_2$ | 1013.3 a | 9.55 c | 10.98 c | 115.7 a |
| $T_3$ | 789.6 c | 14.86 a | 21.85 a | 77.5 b |
| $T_4$ | 470.8 d | 7.65 d | 15.94 b | 75.6 b |
| Significance | ** | ** | ** | ** |
| Spacing | | | | |
| SE | 14.588 | 0.279 | 0.471 | 2.879 |
| $S_1$ | 720.6 c | 10.37 | 17.15 a | 95.2 |
| $S_2$ | 948.9 a | 11.14 | 14.17 b | 92.9 |
| $S_3$ | 941.1 b | 10.88 | 13.99 b | 95.2 |
| Significance | ** | NS | ** | NS |
| SE | 12.634 | 0.241 | 0.408 | 2.493 |
| CV% | 5.31 | 7.75 | 9.36 | 9.15 |

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. NS indicate non-significant;** indicate significant at 1% level of probability. $T_1$ = 40 ± 2 g, $T_1$ = 30 ± 2 g, $T_3$ = 20 ± 2 g, $T_4$ = 10 ± 2 g and $S_1$ = 60cm×25cm, $S_2$ = 60cm×20cm, $S_3$ = 60cm×15cm.

In (Table 3) the highest TDM m$^{-2}$ was observed in 60 cm × 20 cm spacing (948.9 g m$^{-2}$ at 90 DAP) and lowest in wider spacing (720.6 g m$^{-2}$ at 90 DAP) because of plant density was lower in wider spacing than closer spacing. These results also supported by Bayorbor and Gumah (2007).The highest TDM m$^{-2}$ was observed in the treatment combination of larger tuber with closer spacing, 40 ± 2 g tuber with spacing of 60 cm × 15 cm (1157.0 g m$^{-2}$ at 90 DAP) and lowest from 20 ± 2 g tuber with spacing of 60 cm × 25 cm (389.8 g m$^{-2}$ at 90 DAP) in (Table 4). Results showed that at 60-75 DAP, the CGR increased with increasing tuber size. At 75-90 DAP, the highest CGR was observed in 20 ± 2 tuber (14.86 g m$^{-2}$ d$^{-1}$) and lowest from 10 ± 2 g tuber (7.65 g m-2 d$^{-1}$) in (Table 3).

The CGR was higher in larger tuber might be due to increased TDM plant$^{-1}$. This results supported by Divis and Barta (2001) in potato. The effect of plant spacing on CGR at 60-75 DAP was significant but at 75-90 DAP was non-significant (Table 3). The CGR was higher in closer spacing because of producing increased TDM m$^{-2}$. This results also supported by Ravichandran and Singh (2003). The highest CGR was recorded in the treatment combination of 30 ± 2g tuber size with 60 cm × 15 cm plant spacing (31.84 g m$^{-2}$ d$^{-1}$) and lowest from 10 ± 2 g tuber with 60 cm ×25 cm spacing (9.63 g m$^{-2}$ d$^{-1}$) in (Table 4). The effect of tuber size on relative growth rate (RGR) at 75-90 DAP was significant (Table 3). Result showed that the lowest RGR was observed in 20 ± 2 g tuber size at 60-75 DAP while at 75-90 DAP, the reverse trend was observed. The effect of plant spacing on RGR at 75-90 DAP was significant (Table 3). At 75-90 DAP, the RGR decreased with decreasing plant spacing in potato. The highest RGR was observed in wider spacing, 60 cm × 25 cm (17.15 mg g$^{-1}$ d$^{-1}$) and lowest from 60 cm × 15 cm (13.99 mg g$^{-1}$ d$^{-1}$). This results supported by Suman *et al.* (2003). RGR was significantly influenced at 75-90 DAP by the interaction effect of seed tuber size and plant spacing (Table 4). At 75-90 DAP, the highest RGR was recorded in the treatment combination of 20 ± 2 g tuber size with 60 cm × 20 cm spacing (23.56 mg g$^{-1}$ d$^{-1}$) and lowest from 30 ± 2 g tuber with 60 cm ×15 cm spacing (6.46 mg g$^{-1}$ d$^{-1}$).

**Table 4. Interaction effects of tuber weight and spacing on morpho-physiological characters of potato**

| Interaction | TDM m$^{-2}$(g) at 90 DAP | CGR (g m$^{-2}$d$^{-1}$ )at 75-90 DAP | RGR (mg g$^{-1}$d$^{-1}$) at75-90 DAP | NAR(mg cm$^{-2}$d$^{-1}$ ) at 60-75 DAP |
|---|---|---|---|---|
| $T_1×S_1$ | 933.1 cd | 11.65 cd | 13.82 c | 110.0 a |
| $T_1×S_2$ | 1080.0b | 11.76 cd | 11.89 cd | 105.0 a |
| $T_1×S_3$ | 1157.0 a | 9.97 e | 9.23 e | 112.0a |
| $T_2×S_1$ | 937.2 cd | 13.12 c | 16.79 b | 115.0a |
| $T_2×S_2$ | 1113.0 ab | 8.94 ef | 9.68 de | 116.0 a |
| $T_2×S_3$ | 1035.7 b | 6.59 g | 6.46 f | 116.0 a |
| $T_3×S_1$ | 619.3 f | 10.3 de | 19.13 b | 81.10 b |
| $T_3×S_2$ | 810.0 e | 16.08 b | 23.56 a | 74.50 b |
| $T_3×S_3$ | 939.4 cd | 18.19 a | 22.87 a | 76.90b |
| $T_4×S_1$ | 389.8 g | 6.41 g | 18.87 b | 74.80b |
| $T_4×S_2$ | 449.5 g | 7.77 fg | 11.54c-e | 76.00 b |
| $T_4×S_3$ | 573.1 f | 8.78 ef | 17.40 b | 76.00 b |
| Significance | * | ** | ** | * |
| SE | 25.268 | 0.483 | 0.816 | 4.987 |
| CV% | 5.31 | 7.75 | 9.36 | 9.15 |

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. *; ** indicate significant at 5 % and 1% level of probability, respectively. $T_1$ = 40 ± 2 g, $T_1$ = 30 ± 2g, $T_3$ = 20 ± 2 g, $T_4$ = 10 ± 2 g and $S_1$ = 60cm×25cm, $S_2$ = 60cm×20cm, $S_3$ = 60cm×15cm.

There was a significant variation in net assimilation rate (NAR) at 60-75 DAP due to seed tuber weight (Table 3). Result showed that NAR increased with increasing tuber size till tuber weight of 30 ± 2 g. The highest NAR was recorded in tuber size of 30 ± 2 g (115.7 mg $cm^{-2}d^{-1}$) followed by tuber weight of 40 ± 2 (109.0 mg $cm^{-2}$ $d^{-1}$) with same statistical rank and lowest from 10 ± 2 g (75.6 mg $cm^{-2}$ $d^{-1}$) that was statistically similar to tuber size of 20 g (77.5 mg $cm^{-2}$ $d^{-1}$). This results supported by (Garg *et al*., 2000).The effect of plant spacing on NAR was non-significant (Table 3). These results disagrees with that of Bayorbor and Gumah (2007) who reported that plant spacing had significant effect on NAR of potato. In (Table 4) the higher NAR was recorded in the treatment combination of 30 ± 2 g tuber weight with 60 cm × 25 cm plant spacing (116.0 mg $cm^{-2}$ $d^{-1}$) and lowest from 20 ± 2 g tuber with 60 cm × 20 cm spacing (74.50 mg $cm^{-2}$ $d^{-1}$) .Result revealed that the number tubers $hill^{-1}$ increased with increasing tuber weight till 30 ± 2 g tuber and thereafter further increase tuber weight did not increase tubers $hill^{-1}$ in (Table 5). The highest production of tubers $hill^{-1}$ was observed in the tuber weight of 30 ± 2 g (8.07) that was statistically similar to tuber weight of 40 ± 2 g (7.70 $hill^{-1}$) and lowest from 10 ± 2 g (6.46). Reduction inthe tubers $hill^{-1}$ under smaller weight seed tuber might be due to lesser stems $hill^{-1}$ (Table 1). This results supported by (Rashid, 1987).

**Table 5. Effects of tuber weight and spacing on yield attributes and yield of potato**

| Treatments | Tubers $hill^{-1}$ (no.) | Single tuber weight (g) | Tuber weight $hill^{-1}$ (g) | Tuber yield (t $ha^{-1}$) |
|---|---|---|---|---|
| Tuber weight | | | | |
| $T_1$ | 7.70 ab | 52.03 a | 304.1 a | 26.47 a |
| $T_2$ | 8.07 a | 52.13 a | 317.2 a | 27.27 a |
| $T_3$ | 7.30b | 45.29 b | 248.5 b | 22.33 b |
| $T_4$ | 6.46 c | 30.13 c | 146.0 c | 16.33 c |
| F-test | ** | ** | ** | ** |
| SE | 0.145 | 1.069 | 7.955 | 0.606 |
| Spacing | | | | |
| $S_1$ | 7.85 a | 48.70 a | 293.8 a | 23.18 ab |
| $S_2$ | 7.57 a | 44.75 b | 258.9 b | 23.92 a |
| $S_3$ | 6.73 b | 41.24 c | 209.0 c | 22.20 b |
| F-test | ** | ** | ** | * |
| SE | 0.125 | 0.926 | 6.889 | 0.524 |
| CV% | 5.89 | 7.15 | 9.40 | 7.87 |

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.*; ** indicate significant at 5% and 1% level of probability, respectively. $T_1$ = 40 ± 2 g, $T_1$ = 30 ± 2 g, $T_3$ = 20 ± 2 g, $T_4$ = 10 ± 2 g and $S_1$ = 60 cm×25 cm, $S_2$ = 60 cm×20 cm, $S_3$ = 60 cm×15 cm.

In (Table 5), result showed that tuber number $hill^{-1}$ increased with increasing plant spacing. The highest tubers $hill^{-1}$ (7.85) was recorded in 60 cm × 25 cm spacing which was statistically similar to 60 cm × 20 cm spacing (7.57) and lowest from 60 cm × 15 cm spacing (6.73). Reduction in tuber number in densely populated area might be due to increased number of plants per unit area. These results also reported by Yenagi *et al.* (2002) in potato. In (Table 6) the highest tubers $hill^{-1}$ was observed in 30 ± 2 g tuber weight with 60 cm × 25 cm spacing (8.60) and lowest from 10 ± 2 g tuber with 60 cm × 15 cm spacing (6.40). In (Table 5) result revealed that single tuber weight increased with increasing seed tuber weight till 30 ± 2 g seed tuber followed by no increment was observed. The higher single tuber weight was observed in 30 ± 2 g and 40 ± 2 g seed tuber with being the highest in 30 ± 2 g seed tuber (52.13 g) and lowest from 10 ± 2 g (30.13 g). These results reported by Bong Kyoon *et al*. (2001). Results showed that single tuber weight decreased with decreasing plant spacing in (Table 5). The largest tuber was observed in wider spacing, 60 cm × 25 cm (48.70 g) followed by the plant spacing of 60 cm × 20 cm (44.75 g) and lowest from 60 cm × 15 cm (41.24 g).The larger tuber in wider spacing was probably due to less competition among the plants for space, light, water and nutrients which were facilitated to faster growth and development of tuber thereby increase tuber size in wider spacing as compared to closer spacing. These results supported by Ghosh *et al*. (2002).

**Table 6. Interaction effects of tuber weight and spacing onyield attributes and yield of potato**

| Interaction | Tubers $hill^{-1}$ (no.) | Single tuber weight (g) | Tuber weight $hill^{-1}$ (g) | Tuber yield (t $ha^{-1}$) |
|---|---|---|---|---|
| $T_1 \times S_1$ | 8.60 a | 60.20 a | 388.3 a | 29.0 a |
| $T_1 \times S_2$ | 8.00 ab | 50.10 b-d | 300.6 c | 27.30 ab |
| $T_1 \times S_3$ | 6.50 e | 45.80 de | 223.3 e | 23.00 c |
| $T_2 \times S_1$ | 8.70 a | 55.00 ab | 328.9 ab | 28.00 ab |
| $T_2 \times S_2$ | 8.50 a | 53.50 bc | 341.1 b | 28.20 ab |
| $T_2 \times S_3$ | 7.00c-e | 47.90 c-e | 251.5 de | 25.60 bc |
| $T_3 \times S_1$ | 7.60 bc | 48.60 cd | 277.0 cd | 20.90 d |
| $T_3 \times S_2$ | 7.30b-d | 45.00 de | 246.4 de | 23.50 cd |
| $T_3 \times S_3$ | 7.00 c-e | 42.27 e | 222.1 e | 22.60 cd |
| $T_4 \times S_1$ | 6.50 de | 31.00 f | 151.1 f | 14.70 e |
| $T_4 \times S_2$ | 6.48 de | 30.40 f | 147.7 f | 16.70 e |
| $T_4 \times S_3$ | 6.40 e | 29.00 f | 139.2 f | 17.60 e |
| F-test | ** | * | ** | ** |
| SE | 0.251 | 0.852 | 13.778 | 1.049 |
| CV% | 5.89 | 7.15 | 9.40 | 7.87 |

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. *; ** indicate significant at 5% and 1% level of probability, respectively. $T_1$ = 40 ± 2 g, $T_1$ = 30 ± 2 g, $T_3$ = 20 ± 2 g, $T_4$ = 10 ± 2 g and $S_1$ = 60cm×25cm, $S_2$ = 60cm×20cm, $S_3$ = 60cm×15cm.

The highest single tuber weight was recorded from 60 cm × 25 cm plant spacing with 40 ± 2 g seed tuber (60.20 g) followed by the treatment combination of 60 cm × 25 cm plant spacing with 30 ± 2 g seed tuber (55.0 g) and lowest from 60 cm × 15 cm plant spacing with 10 g seed tuber (29.0 g) in (Table 6). Result revealed that tuber weight $hill^{-1}$ increased with increasing seed tuber weight upto 30 ± 2 g seed tuber followed by decline trend in (Table 5). The higher tuber weight $hill^{-1}$ was observed in 30 ± 2 and 40 ± 2 g seed tuber with being the highest in 30 ± 2 g seed tuber (317.2 g $hill^{-1}$) and lowest10 ± 2 g (146.0 g $hill^{-1}$).The lesser tuber weight in smaller size seed tuber might be due to fewer tubers $hill^{-1}$ and smaller weight tuber. This results supported by (Gregoriou, 2000). Results showed that tuber weight decreased with decreasing plant spacing in (Table 5). The highest tuber weight $hill^{-1}$ was observed in wider spacing, 60 cm × 25 cm (293.8 g $hill^{-1}$) followed by the plant spacing of 60 cm × 20 cm (258.9 g $hill^{-1}$) and lowest from 60 cm × 15 cm (209.0 g $hill^{-1}$). The higher tuber yield $hill^{-1}$ in wider spacing was probably due to higher number of tubers $hill^{-1}$ and larger tuber. This results supported by (Ghosh *et al*., 2002). In (Table 6), the highest tuber weight $hill^{-1}$ was recorded in the treatment combination of 60 cm × 25 cm plant spacing with 40 ± 2 g seed tuber (388.3 g $hill^{-1}$) followed by the treatment combination of 60 cm × 25 cm plant spacing with 30 ± 2 g seed tuber (328.9 g $hill^{-1}$) and lowest from 60 cm × 15 cm plant spacing with 10 ± 2 g seed tuber (139.2 g $hill^{-1}$). Result revealed that gross tuber yield increased with increasing seed tuber weight upto 25 ± 2 g seed tuber. The highest gross tuber yield was observed in the seed tuber weight of 30 ± 2 g (27.27 t $ha^{-1}$) followed by the seed tuber weight of 40 ± 2 g (26.47 t $ha^{-1}$) with same statistical rank and lowest from 10 ± 2 g (16.33 t $ha^{-1}$) in (Table 5). The gross tuber yield was lower in smaller weight seed tuber because of producing minimum tuber weight $hill^{-1}$.This results supported by (Gregoriou, 2000). The effect of plant spacing on gross tuber yield in potato was significant (Table 5). The highest gross tuber yield was observed in the plant spacing of 60 cm × 20 cm (23.92 t $ha^{-1}$) that was identical to the plant spacing of 60 cm × 25 cm (23.18 t $ha^{-1}$) and lowest 60 cm × 15 cm (22.20 t $ha^{-1}$). Lower tuber yield per plant as well as per unit area under densely populated condition was might be due to lesser amount of assimilate produced by the plants through lesser photosynthetic area $plant^{-1}$ and competition of nutrients uptake by the plants. This results supported by (Ghosh *et al*., 2002). The highest gross tuber yield $ha^{-1}$ was recorded from 60 cm × 25 cm plant spacing with 40 ± 2 g seed tuber (29.10 t $ha^{-1}$) followed by 60 cm × 20 cm plant spacing with 30 ± 2 g seed tuber (28.20 t $ha^{-1}$) and lowest from 60 cm × 25 cm plant spacing with 10 ± 2 g seed tuber (14.70 t $ha^{-1}$).

**Conclusion**

Potato growth and yield mostly influenced by many production factors, among these seed tuber weight and spacing is most important. From this study, it may concluded that, different seed tuber weight and spacing influence the seedling tuber performance as a whole, but from economic point of view, the seedling tuber weight of 30 ± 2 g with plant spacing of 60 cm × 20 cm was more profitable than those of other treatment combinations.

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