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Original article

Effects of planting times and plant densities of top-shoot cuttings on multiplication of breeder seed potato

Md. Abdullah Al Mamun,[a] Abdullah Al-Mahmud,[b,*] Mohammad Zakaria,[c] M. Mofazzal Hossain,[c] Md. Tofazzal Hossain[d]

[a] Department of Agriculture Extension, Gangachara, Rangpur, Bangladesh
[b] Tuber Crops Research Sub-Centre, Bangladesh Agricultural Research Institute, Sheujgari, Bogra 5800, Bangladesh
[c] Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur, Bangladesh
[d] Department of Crop Botany, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur, Bangladesh

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ABSTRACT

Top-shoot cuttings were planted with the whole tuber (as a control) at different dates using three spacings at the Horticultural Research Farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University to evaluate the performance of top-shoots as planting material and to determine the optimum time of planting and the optimum spacing for top-shoot cuttings as planting material for breeder seed production. The survival of top shoot cuttings was more than 97.8% irrespective of the planting time and plant spacing. Significant variations were found among the treatment combinations for plant height at 45 and 60 days after planting (DAP), foliage coverage at 45 and 60 DAP, number of branches per plant, number of tubers per plant, individual tuber weight, tuber yields per plant and per hectare yield. The highest mean yield (46.57 t/ha) was produced by whole tubers planted on 10 November with 50 × 10 cm spacing which was similar to whole tubers planted on 1 November with 50 × 10 cm spacing. On the other hand, plants from top-shoot cuttings yielded 34.82 t/ha in T_3S_2 followed by T_1S_1 (33.34 t/ha), T_3S_3 (30.70 t/ha). The total yield of potato increased 122.8% from a single, early crop due to taking two repeated cuttings compared with 89.6% from a single late crop. Early planting of top-shoot cuttings with closer spacing (50 × 10 cm and 50 × 15 cm) is recommended for the multiplication of breeder seed potato.

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Introduction

Potato (*Solanum tuberosum* L.) is the most important food crop following wheat and rice in the world (Camire et al., 2009). In Bangladesh, it ranks first among vegetables with an area, production and average yield of 0.46 million ha, 8.33 million t and 18.10 t/ha, respectively (Hortex Newsletter, 2011). Increased yields from potato cultivation mostly depend on the availability of sufficient quantities of good quality seed potatoes and the annual seed potato requirement of the country is about 0.60 million t (Bangladesh Agriculture Development Corporation, 2012). Out of the total requirement, the Bangladesh Agriculture Development Corporation (BADC) supplied only 18,899 t (3.16%) in 2010–2011 that was used by the farmers as replacement stock (Bangladesh Agriculture Development Corporation, 2012). Seed tuber is the most important planting material used in the country (Sarath et al., 2001). Potato can be grown from several types of propagating material including sprout cutting (Hossain et al., 1999) top-shoot cutting or stem segments with at least one bud in true potato seed (Hossain, 1995). In Bangladesh, as there is a scarcity in production and supply of quality seed potatoes, there is scope for the rapid multiplication of seed potatoes by using top-shoot cuttings as planting material instead of the whole tuber. It has been reported that early-planted, top-shoot cuttings produced more tubers per plant with a greater mean tuber weight than from late planting (Hossain, 1993, 1997). However, top-shoot cuttings are not being used by the farmers for table potato production. Farmers can take top-shoot cuttings from the plants grown at medium to high elevations and can use them as propagating material for cultivating potato on lower land, thus reducing the seed cost. This method

* Corresponding author.
E-mail address: Mahmud.tcrc@live.com (A. Al-Mahmud).

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could be expanded to provide farmers with appropriate production technology.

Potato is grown during winter (from middle of November to middle of February) as a cash crop all over Bangladesh and the length of the growing period is relatively short at around 90 d (Rashid et al., 1986). During the crop growth period, low temperatures after planting as well as during the early growth stages and high temperatures during the tuber bulking stage significantly reduce the growth and yield of potato, respectively, because the winter duration (end of November to end of January) is very short in Bangladesh (Rashid, 1999). Winter lasts longer in northern Bangladesh and this is an advantage in producing potatoes (Rashid et al., 1986). Consequently, the application of proper management practices to enhance vigorous early growth is very important in achieving a higher tuber yield of potato under these environmental conditions. Optimizing the plant density is one of the most important goals of potato production, because it affects the seed cost, plant development, yield and quality of the crop (Bussan et al., 2007). In practice, plant density in the potato crop is manipulated through the number and size of the seed tubers planted (Allen and Wurr, 1992). Therefore, many studies have been conducted to establish the optimal combination of seed size and planting distance for a certain environment (Sultana and Siddique, 1991; Negi et al., 1995; Creamer et al., 1999; Hoque, 2001; Bussan et al., 2007). These authors have reported that in general, larger seed and closer spacing up to a certain limit increase the yield of tubers per unit area. The yield increased with a decrease in spacing from 25 to 20 cm in the rows and 55 cm between rows (Banarjee et al., 1988). However, the optimal planting density differed depending on the environmental conditions and cultivars. Farmers in Bangladesh generally plant cut tubers with one or two eyes at closer densities and the plant density varies from location to location. However, the Tuber Crops Research Centre (TCRC) of Bangladesh Agricultural Research Institute (BARI) recommends planting at 60 × 25 cm for whole tuber planting (Hussain et al., 2006). On the other hand, planting large seed tubers is advantageous under certain circumstances such as unfavorable soil and weather conditions at planting, if the growing season is short (Beukema and Zaag, 1990). Thus the current experiment was designed to evaluate the performance of top-shoot cuttings planted under different plant spacing at different times on the yield of potato. The objectives were: 1) to evaluate the performance of top-shoot cuttings as planting material in seed potato production and 2) to determine the optimal planting time with the optimal spacing of top-shoot cuttings for potato production.

Materials and methods

Top-shoot cuttings were evaluated, as planting material, under different planting times and spacings for rapid multiplication of potato at Bangabandhu Sheikh Muijubur Rahman Agricultural University during winter 2011. Top-shoot cuttings of the standard potato variety Diamant were used in the experiment. The breeder seed tuber was collected from TCRC, BARI, Joydebpur. Whole tubers were used as the control. The experiment was laid out in a randomized complete block design with two factors (planting time and spacing) and three replications. The plot size was 1.50 × 1.20 m. Planting times were: T_1 = whole tuber planting on 1 November (Control1), T_2 = whole tuber planting on 1 November; T_3 = first cutting (from T_2) planted on 25 November; T_4 = second cutting (from T_2) planted on 5 December; T_5 = whole tuber planted on 10 November (Control2); T_6 = whole tuber planted on 10 November; T_7 = first cutting (from T_6) planted on 5 December and T_8 = second cutting (from T_6) planted on 15 December. Three spacings—S_1 (50 × 10 cm), S_2 (50 × 15 cm) and S_3 (50 × 20 cm)—were used for each treatment. The seed tubers were kept in a well-ventilated room and allowed to sprout under light (at night) to obtain healthy, green sprouts prior to planting. It required 8–10 d for sprouting. The sprouted tubers were planted on 1 November (T_1 and T_2) and 10 November (T_5 and T_6). T_1 and T_5 were treated as controls for producing normal crops. T_2 and T_6 were used as sources of top-shoot cuttings. The first top-shoot cuttings with at least two nodes were taken from T_2 at 25 days after planting (DAP) and were used as planting material for T_3. Second cuttings were taken from T_2 at 10 d after first cutting and were used as planting material for T_4. Cuttings were taken using a slant cut with a sharp blade and the cut end was immersed in water immediately. Then, the shoot cuttings were planted in the main plot after being treated with rooting hormone (napthalene acetic acid at 16 parts per million). Before planting the shoot cuttings in the experimental plots, the plots were irrigated properly so that when the cut portion was in contact with the soil it could absorb moisture. Similarly, top-shoot cuttings were taken from T_6 and were used as planting material for T_7 and T_8 on 5 December and 15 December, respectively. Full doses of cow dung (10 t/ha), triple superphosphate (220 kg/ha), muriate of potatsh (270 kg/ha), gypsum (120 kg/ha), boric acid (6 kg/ha) and a half dose of urea (175 kg/ha) were applied at final land preparation. The remaining half dose of urea (175 kg/ha) was applied as top dressing at 30 DAP followed by earthing-up and light irrigation. The ridge method was used for whole tuber planting (T_1, T_2, T_5 and T_6 treatments). Healthy cuttings were used as top-shoot cuttings and were planted in a well-watered flat bed. After establishment of the shoot cuttings, a ridge was made by earthing-up the sides. Intercultural operations such as weeding and earthing-up were done manually. After spading the soil between the rows, weeds were removed. Earthing-up was done twice during the growing period. The first earthing-up was done at 30 DAP when the plants had attained a height of about 15–20 cm from the base; the second was 20 d after the first earthing-up. Before the first earthing-up, urea was applied. Irrigation was applied five times. The first irrigation was applied at 2 wk after planting, the second just after earthing-up (30 DAP), the third at 45 DAP, the fourth at 60 DAP and the last at 75 DAP. During land preparation, Furadan 5G (10 kg/ha) was applied basally during land preparation and Malathion (0.2%) was sprayed in two installments at 45 and 60 DAP to control insects. The crops were also sprayed with Dithane-M 45 (0.2%) and Secure (0.1%) alternately five times (at 30, 40, 50, 60 and 70 DAP, respectively) to prevent late blight infection of potato (Dey et al., 2010). Haulm pulling was done at 80 DAP in every treatment. Hardening of tubers and setting up of the skin of tubers were allowed for 10 d under the soil; thereafter the crop was harvested at 90 DAP. During the growing period, the maximum and minimum temperature was recorded and the results are presented in Table 1. Data on different plant and yield contributing characters were recorded and were analyzed statistically using the computer package MSTATC (developed by the Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI, USA). Significance between treatments and interactions was tested using Duncan's multiple range test at the $p < 0.05$ level.

Results and discussion

Plant survival

The planting time and plant density of top-shoot cuttings had no significant effect on plant survival. The survival of top-shoot cuttings was more than 97.8% irrespective of the planting time and plant density while for whole tubers, survival was 100%. There were no significant interaction effects on plant survival (Table 2). The higher survival percentage might have been due to the use of the

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