African Journal of Biotechnology Vol. 9(36), pp. 5852-5858, 6 September, 2010
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 ©2010 Academic Journals

Full Length Research Paper

Virus free seed potato production through sprout cutting technique under net-house

M. R. Karim[1], M. M. Hanafi[2], S. M. Shahidullah[2]*, A. H. M. A. Rahman[3], A. M. Akanda[3] and A. Khair[4]

[1]Bangladesh Agricultural Development Corporation (BADC), Dhaka, Bangladesh.
[2]Institute of Tropical Agriculture, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia.
[3]BSMR Agricultural University, Slana, Gazipur, Bangladesh.
[4]Department of Botany, Jahangirnagar University, Savar, Dhaka, Bangladesh.

Accepted 5 July, 2010

In order to evaluate the performance of sprout cutting for seed potato production against virus infection, a study was conducted at Bangladesh Agricultural Development Corporation (BADC) Foundation Seed Potato Production Farm, Domar, Nilphamary, Bangladesh in 2005 - 2006. Sprout cut seedlings were grown under three production practices viz. Net-house practice, BADC practice and farmers' practice. Sprout cutting technique was proved to be an effective method of seed potato production against potato virus Y (PVY) and potato leaf roll virus (PLRV). The incidence of PVY and PLRV was detected as nil in net-house practice. However, PVY and PLRV were prevalent in BADC practice and farmers' practice although, BADC practice performed better over farmers' practice. Yield of seed potato and non-seed tubers along with yield attributes were found to be higher in all the five varieties (Diamant, Baraka, Asterix, Raja and Provento) in net-house practice followed by BADC practice and farmers' practice. Among the varieties Diamant, Asterix and Raja seemed to be better in performance as compared to the others. In most of the cases net-house practice differed significantly (p = 0.05) with the others.

Key words: Potato virus Y, potato leaf roll virus, seed potato, sprout cutting.

INTRODUCTION

In comparison to other agricultural crops, the seed cost of potato cultivation is much higher. Bangladesh Agricultural Development Corporation (BADC) reported that the seed cost of potato is liable to 30 - 40% of total production cost (Anon, 2005). Bangladesh imported elite class (E-class) seed potatoes from Holland at the cost of above US $ 140.00 per quintal which engross large amount of foreign currency every year (Anon, 2008). The imported E-class basic seed potatoes are characterized as almost free from potato virus Y (PVY) and potato leaf roll virus (PLVR) (PLRV). The BADC produce foundation seed potatoes using the E-class seed imported from Holland. Certified seed potatoes are produced from these foundation seed potatoes through contract growers under the supervision of BADC experts. Certified seed potatoes are distributed to the farmers for potato cultivation throughout Bangladesh. Laboratory test (DAS-ELISA) of foundation and certified seed potatoes revealed that these classes may not be maintained properly in respect of PVY and PLRV infection in many cases. The quality seed that is, seed potato free from PVY and PLRV infection, its timely availability and the price are considered to be the most important factors of successful potato cultivation in Bangladesh. Very recently, BADC has been trying to produce virus free seed potato by using the sprout cutting of E-class seed potato for quick multiplication of higher amount of quality seed potatoes within a short period of time. After cutting the spouts, mother tubers are also used for the production of foundation and certified seed

*Corresponding author. E-mail: shahidullah4567@yahoo.com, shahidullah4567@gmail.com.

Abbreviations: BADC, Bangladesh Agricultural Development Corporation; **E-class,** elite class; **PVY,** potato virus Y; **PLRV,** potato leaf roll virus.

potatoes which is regarded as an additional advantage to produce PVY and PLRV free quality seed potatoes. So, the efforts might be highly beneficial to reduce the import dependency of expensive E-class basic seed potato from Holland. BADC claimed that sprout cutting is highly effective to produce virus free foundation seed potato without affecting the production capacity of the mother tubers (imported E-class seed potato). This effort might be highly sustainable for producing our own quality seed potatoes which ensures the supply of quality seed pota-toes to the farmers in proper time. This might contribute to reducing price and minimizing the shortage of seed potatoes for potato cultivation by the farmers. Moreover, the sprout cuttings obtained from E-class basic seed tubers has not yet been evaluated properly in respect of PVY and PLRV infection level; the two most devastating viruses in Bangladesh. With the above facts, this study was undertaken to evaluate the performance of sprout cutting of E-class basic seed potato in respect of different yield attributes as well as the yield of seed potatoes produced from sprout cutting under three different practices namely net-house practice, BADC practice and farmers' practice.

MATERIALS AND METHODS

Materials and location of the experiment

The E-class seed potatoes used in the study were imported from Holland. The experiment was carried out at Domar BADC farm (26.10°N, 88.84°E) Nilphamari, Bangladesh during the period of November 2005 to March 2006. Five varieties viz. Diamant, Baraka, Asterix, Raja and Provento were grown in three different management practices viz. Net-house, BADC and farmers' practice. The experiment was laid out in a randomized complete block design (RCBD) with four replications.

Sprouting of the seed potato

The seed tubers were brought from Holland by ship at refrigerated condition within wooden cartons which took about a month to arrive at Chittagong sea port, Bangladesh. So, the seed potatoes within the cartons started to produce sprouts. After receiving, the seed potatoes were kept in dark condition in Domar farm by covering the cartons with gunny bags for 12 days. Then, the sprouts developed up to 8 - 12 cm in length within the period of time.

Cutting and preparation of sprouts for sowing

Every sprout was cut into three to five pieces with a sharp sterilized knife or blade. The cutting was done carefully so that every piece should contain one node. Then, the sprout cuttings were taken in plastic trays using the net-house and BADC practice sites, whereas the same were taken in a bamboo basket instead of plastic tray when the farmers' practice was use. The fungicides and rooting hormone were sprayed thoroughly on sprout cuttings to protect fungal infection and to enhance root formation.

Sowing of sprout cuttings

The sprout cuttings were planted on November 28, 2005 in the field of Domar Foundation seed potato production farm, Nilphamari for net-house and BADC practice. In the case of farmers' practice, the land was selected near vicinity to the BADC farm, Domar. The field was prepared and fertilized as per recommendation. To control the bacterial infestation, bleaching powder at 10 kg/ha was added to the soil during final land preparation. The cut sprouts were planted in furrows maintaining 60 × 15 cm spacing. The individual plot size was 6 × 6 m. The sprout cuttings were planted under the three different practices of net-house, BADC and farmers' practice.

Intercultural operations and harvesting

Intercultural operations including irrigation, haulm puling, harvesting and grading of seed tubers were carried out when necessary. Fungicides and insecticides were sprayed as per requirement.

Collection of data

Data were collected on the prevalence of virus infection, number of tubers per hill, total tuber yield, seed potato yield of different grades and yield of non-seed tubers.

Analysis of data

The data were analyzed with MSTATC program. The mean separation was done in Duncan's multiple range test (DMRT) at 5% level of significance. The graphs were prepared as and when necessary for proper interpretation of the data. The standard error (SE) values at 5% level of significance were used in the graphs when required.

RESULTS

Prevalence of potato virus y and potato leaf roll virus

The results on the prevalence of PVY and PLRV as well as the mixed infection of PVY and PLRV in five different varieties under three different practices are presented in Figure 1. In all the varieties, there was no infection of viruses under net-house practice. For BADC, practice the prevalence of PVY was found to be higher when compared to PLRV while the prevalence of PLRV was higher when compared to PVY in the case of farmers' practice. In the five varieties, Diamant, Baraka, Asterix, Raja and Provento, the prevalence of PVY was found to be 7.45, 6.38, 5.32, 6.91 and 6.85%, respectively, under BADC practice; while the prevalence of PLRV was detected as 5.59, 5.05, 4.26, 5.32 and 4.52% in Diamant, Baraka, Asterix, Raja and Provento, respectively, under BADC practice.

The prevalence of PVY was found to vary from 5.32 to 7.45% while the prevalence of PLRV was found to vary from 4.26 to 5.59% depending on the varieties under BADC practice. In the case of mixed infection of PVY and PLRV, Diamant, Baraka, Asterix, Raja, and Provento, were found to had 1.33, 0.80, 0.27, 0.53 and 0.27%, respectively, under BADC practice; the range of mixed infection of two viruses were found to vary from 0.27 to 1.33% under BADC practice depending on varieties.

Based on the results of BADC practice, Asterix was

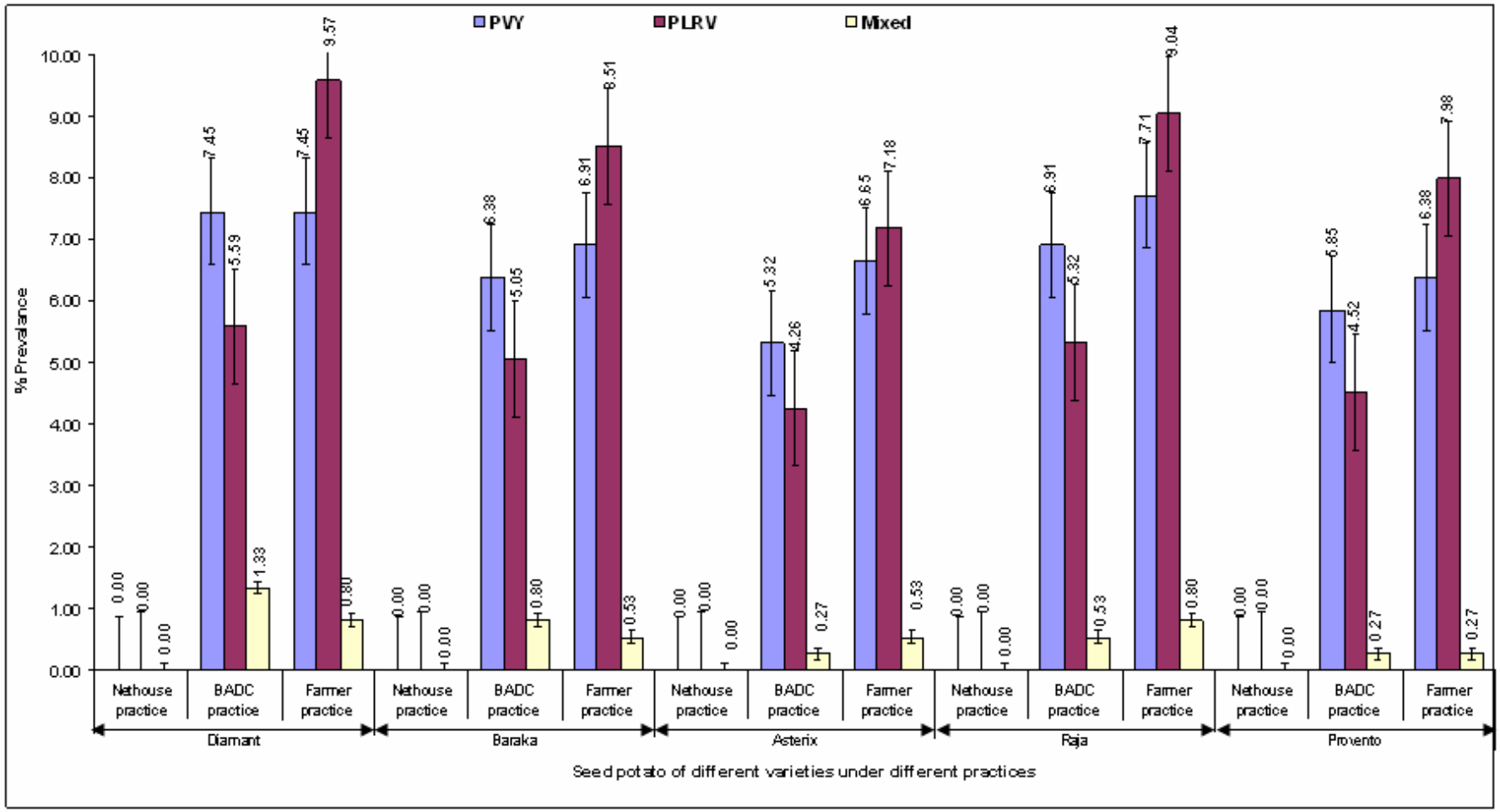

Figure 1. Prevalence of PVY, PLRV and mixed infection of PVY and PLRV on different seed potato varieties obtained from sprout cuttings under different practices.

found to be a better variety which was followed by Provento, Raja, Baraka and Diamant (Figure 1). In the case of farmers' practice, the prevalence of PVY was recorded as 7.45, 6.91, 6.85, 7.71 and 6.38% in Diamant, Baraka, Asterix, Raja and Provento, r espectively, (Figure 1). The prevalence of PLRV was found to be 9.57, 8.51, 7.18, 9.04 and 7.98% in Diamant, Baraka, Asterix Raja and Provento, respectively. There were 0.80, 0.53, 0.53, 0.80 and 0.27% mixed infection of PVY and PLRV in Diamant, Baraka, Asterix, Raja and Provento. The range of PVY infection was found to be 6.38 to 7.98% depending on the varieties, while the PLRV infection was in the range of 7.18 to 9.57%. The range of mixed infection of PVY and PLRV was varied from 0.27 to 0.80 depending on the varieties. Based on the prevalence of PVY and PLRV, Asterix was the best performing variety

Table 1. Number of tubers/hill of different potato varieties grown under different practices.

Varieties	Net-house Practice	BADC Practice	Farmers' Practice
Diamant	10.75 a	10.00 abc	9.00 bc
Baraka	10.00 abc	10.00 abc	8.75 c
Asterix	10.75 a	10.25 ab	8.75 c
Raja	9.75 abc	9.50 abc	9.25 bc
Provento	1075 a	9.75 abc	9.00 bc

Values within the same row and column with same letters are not significantly different at 5% level by DMRT.

Table 2. Yield of seed potato (kg/plot) of different to varieties grown under different practices.

Varieties	Net-house Practice	BADC Practice	Farmers' Practice
Diamant	103.07 a	95.32 bcd	92.46 def
Baraka	101.20 a	94.43 cde	92.14 ef
Asterix	103.28 a	97.82 b	94.28 c-f
Raja	101.44 a	94.20 c-f	91.40 f
Provento	102.86 a	96.86 bc	93.00 def

Values within the same row and column with same letters are not significantly different at 5% level by DMRT.

against the two viruses which was followed by Provento, Baraka, Raja and Diamant in farmers' practice. Indeed the prevalence of PLRV was higher in all the varieties under farmers' practice as compared to PVY. The results once again proved that rigorous rouging and spraying systemic insecticides in BADC practice control the persistent PLRV virus more efficiently as compared to non-persistent PVY virus.

Number of tubers per hill

The results of the production of number of tubers/hill of five different varieties under three different practices are presented in Table 1. The variety, Diamant, produced higher number of tubers/hill which was statistically similar with BADC practice but differed from farmers' practice. There was no difference among the three different practices in the case of Baraka in respect to the number of tubers. The highest number of tubers was harvested in net-house practice in the case of Asterix which was statistically identical with BADC practice and both of them differed significantly with farmers' practice. Similar to Baraka, Raja did not differ significantly ($p = 0.05$) in producing number of tubers under three different practices. The Provento net-house and BADC practice seemed to be statistically identical while farmers' practice was statistically similar to BADC practice but differed with net-house practice. Irrespective of the five different potato varieties, net-house practice produced higher numbers of tubers which was followed by BADC practice and farmers' practice except in Baraka in which net-house and BADC practice produced similar number of tubers. In the case of production of numbers of tubers/hill the interactions among the three different practices and five different varieties was not found significant in most of the cases.

Seed potato yield per plot

Seed potato yield per plot was observed to be higher in all the five potato varieties in net-house practice which was followed by BADC practice and farmers' practice (Table 2). The significant interactions among the three practices and five potato varieties were observed. The seed yield of Diamant under net-house practice was significantly higher than BADC and farmers' practice. Baraka and Raja were found to follow the same trend as noted in Diamant. In case of Asterix the seed potato yield in net-house, BADC and farmers' practice were found to bediffer significantly among one another. The variety, Provento, followed the same trend as found in Asterix.

Non-seed yield of potato tubers

Significant interactions were found among the varieties and management packages in the production of non-seed potato tubers (Table 3). The highest yield of non-seed potato tubers (7.67 kg/plot) was recorded in farmers' practice which was statistically similar with BADC practice but these two differed significantly ($p = 0.05$) with net-house practice in the case of Diamant variety. The highest non-seed potato yield (7.59 kg/plot) in Baraka was obtained under BADC practice which was statistically similar with farmers' practice and these two practices differed significantly with the net-house practice (Table 3).

Table 3. Non-seed potato yield (kg/plot) of different potato varieties under different practices.

Varieties	Net-house Practice	BADC Practice	Farmers' Practice
Diamant	6.94 cd	7.49 abc	7.67 a
Baraka	6.81 d	7.59 a	7.49 abc
Asterix	6.97 bcd	7.55 ab	7.73 a
Raja	7.32 a-d	7.80 a	7.55 ab
Provento	7.28 a-d	7.55 ab	7.75 a

Values within the same row and column with same letters are not significantly different at 5% level by DMRT.

Table 4. Grade-wise percent yield of different potato varieties (average over 3 production practices).

Variety	Seed Potato Grade				
	Under (< 28 mm)	A (28 - 40 mm)	B (41 - 55 mm)	Over (> 55 mm)	Non-seed
Diamant	3.02 f (0.031)	20.23 c (0.205)	63.70 a (0.691)	5.98 e (0.060)	7.08 d (0.072)
Baraka	3.15 f (0.032)	20.65 c (0.208)	63.29 b (0.685)	5.82 e (0.058)	7.08 d (0.072)
Asterix	3.02 f (0.032)	20.48 c (0.207)	63.55 a (0.689)	5.94 e (0.059)	7.02 d (0.072)
Raja	3.08 f (0.031)	20.46 c (0.205)	63.43 b (0.684)	5.92 e (0.058)	7.12 d (0.075)
Provento	3.20 f (0.033)	20.60 c (0.208)	63.16 b (0.683)	5.87 e (0.058)	7.17 d (0.072)

Values within the same row and column with same letters are not significantly different at 5% level by DMRT. Values within parenthesis indicate arcsine transformed value.

The Asterix was found to follow the same trend as noted in Diamant. The rest two varieties, Raja and Provento, did not differ significantly among the three practices in producing non-seed potato although lowest non-seed yield was harvested in net-house practice in both the varieties.

Grade-wise yield percentage of seed potato and non-seed potato

Among the five varieties, Provento yielded the highest percentage (3.20%) of under sized potato which was followed by Baraka, Raja and Diamant and Asterix though there was no significant ($p = 0.05$) difference among the varieties (Table 4). The trend was almost similar over the varieties in the case of A-grade and B-grade of seed potatoes. However, in the case of A-grade, there was no statistical difference among the varieties while B-grade with the highest percentage (63.70%) was obtained in Diamant which seemed to be statistically similar with Asterix but differed with the others. In terms of over grade, there was no statistical difference among the varieties. However, Diamant produced the percentage (5.98%) which was followed by Asterix, Raja, Provento and Baraka. The highest yield of non-seed potato was obtained in Provento (7.17%) which was followed by Raja, Diamant and Baraka and Asterix. However, the five different potato varieties were found to be statistically similar in the case of non-seed tuber production.

In comparison among three production practices, farmers' practice produced the highest number of under grade seed potato (3.78%) which was followed by BADC and net-house practice (Table 5). For under grade seed potato, three different practices differed significantly ($p = 0.05$) among one another. The trend was found to be similar in the case of A-grade and non-seed potato. For B-grade, the net-house practice produced the highest percentage of seed potato (65.63%) which was followed by BADC and farmers' practice and the practices differed significantly among one another. The trend was exactly similar for over grade seed potato. The interactions were found to be significant (Table 4 and 5).

Total yield of potato tubers

The potato variety, Diamant, produced the highest yield (30.56 t/ha) which differed significantly ($p = 0.05$) with the BADC and farmers' practice although the BADC and

Table 5. Grade-wise percent yield of seed potato grown under different practices (average over five varieties).

Practices	Seed Potato Grade				
	Under (< 28 mm)	A (28 - 40 mm)	B (41 - 55 mm)	Over (> 55 mm)	Non-seed
Net-house	2.19 n (0.022)	18.68 f (0.189)	65.63 a (0.714)	7.12 h (0.071)	6.38 i (0.065)
BADC	3.31 m (0.032)	21.07 e (0.213)	62.89 b (0.679)	5.43 j (0.055)	7.30 h (0.073)
Farmers'	3.78 l (0.040)	21.70 d (0.218)	61.75 c (0.667)	5.16 k (0.050)	7.61 g (0.078)

Values within the same row and column with same letters are not significantly different at 5% level by DMRT. Values within parenthesis indicate arcsine transformed value.

Table 6. Total tuber yield of different potato varieties grown under different practices.

Varieties	Yield /ha (ton) *		
	Net-house Practice	BADC Practice	Farmers' Practice
Diamant	30.56 a	28.56 cde	27.81 ef
Baraka	30.00 ab	28.34 def	27.67 f
Asterix	30.63 a	29.30 bc	28.33 def
Raja	30.21 a	28.33 def	27.49 f
Provento	30.59 a	29.00 cd	27.99 ef

Values within the same row and column with same letters are not significantly different at 5% level by DMRT.

farmers' practice were found to be statistically similar between each other. The trend was similar for Baraka and Raja. Three different practices differed statistically among one another in the case of Asterix and Provento; however, in both varieties, the highest yields (30.63 and 30.59 t/ha) were harvested under net-house condition. The significant ($p = 0.05$) interactions were found in this regard (Table 6).

DISCUSSION

The results of the study demonstrated that the effect of PVY and PLRV infection on potato was found to be highly prominent in respect to the reduction of yield contributing characters and yield of potato. In all cases, net-house practice was found to be the best in comparison to BADC and farmers' practice. In almost all yield contributing characteristics and yield, net-house practice differed significantly ($p = 0.05$) as compared to BADC and farmers' practice which reflected in the direct effect of infection of PVY and PLRV. Moreover, the non-seed yield was found to be higher in farmers' practice and BADC practice as compared to net-house practice. The phenolmenon was similar with under-grade tubers. Also, though not highly prominent, the individual potato variety respond differently to PVY and PLRV infection which was reflected in their performance in respect of growth and yield. Levy and Marco (1982) reported the alteration of cellular component in potato tuber due to infection of PVY and PLRV which ultimately affected the growth and yield of potato. Sreenivasulu et al. (1989) reported that the effect of virus infection caused severe alteration of the cellular components as well as disruption of physiology like photosynthesis, transpiration, respiration etc. of the infected plants which reasonably explained the effect of PVY and PLRV on growth and yield of potato. Hooker (1981) observed that the potato plant with secondary infection of PVY were dwarfed while PLRV infect plants were often noticeably stunted and rigid. Growth reductions are common phenomena in PVY and PLRV infected plants in potato field as reported by Rashid et al. (1986). It seemed that the total number of tubers in different potato varieties and production of small grade (< 28 mm) and non-seed grade seed potatoes were largely dependant on the infection of PVY and PLRV (Anon, 1990, 1993). The field loss due to PVY and PLRV depends on potato varieties, environment, length of time from infection, disease severity and partial tolerance of the potato varieties which ranges from 40 - 83% and 40 - 50% respectively, (Bokx and van der Want, 1987; Khurana and Singh, 1986; Robertson, 1978; Singh and Khurama, 1980). When symptoms of PVY and PLRV are severe, the loss of tuber yield of individual plants may go even up

to 90% (Jones and Peters, 1982). The common viruses like PVY and PLRV singly reduced yield up to 60 - 75% (Gupta et al., 1985). Salzar (1989) reported that the potential yield losses might reach up to 90% with severe infection of PVY and PLRV in potato. The infection of PVY and PLRV in potato caused severe effect on plant growth and yield of potato (Venhocks, 1965; Watson, 1956). It was observed that PVY infected plants produced more under-sized small tubers as compared to PLRV (Sanger et al., 1994). The results of our experiments are in agreement with the previous workers mentioned earlier. However, the sprout cutting is a new approach to produce seed potato.

REFERENCES

Anon (1990). Annual Report for 1989-90. Tuber Crops Research Centre (TCRC), Bangladesh Agricultural Research Institute, Joydebpur, Gazipur.

Anon (1993). Annual Report for 1992-93. Tuber Crops Research Sub centre, Agricultural Research Station, Bangladesh Agricultural Research Institute, Bogra.

Anon (2005). Cultivation registers of Domar Foundation Seed Potato Production Farm for 2004-05 production years, Bangladesh Agricultural Development Corporation (BADC), Domar, Nilphamari.

Anon (2008). Cultivation registers of Domar Foundation Seed Potato Production Farm for 2007-08 production years, Bangladesh Agricultural Development Corporation (BADC), Domar, Nilphamari.

De Bokx JA, Van Der Want (1987). Viruses of potatoes and seed potato production. 2nd edn. Pudoc, Wageningcn. p. 259.

Gupta BM, Sing BP, Varma HN, Shrivastava KM (1985). Perspective in Plant Virology. Printer House India 1: 1-132.

Jones RAC, Peters D (1982). Potato leaf roll virus. In: Compendium of potato diseases (Hooker WJ Ed.). APS, St. Paul. USA. pp. 68-78.

Khurana SMP, Singh MN (1986). Viral and Mycoplasma diseases of potato. Rev. Trop. Plant Pathol. 3: 123-184.

Levy D, Marco S (1982). The quality of seed tubers in the Golien Heights for the spring season in Israel. Potato Res. 25(1): 107-1597.

Rashid MM, Khan AL, Ali MS (1986). Seed Potato Production (*In Bengali*). Tuber Crops Research Centre, BARI, Joydebpur, Gazipur, Bangladesh. p. 156.

Robertson DG (1978). The effect of virus diseases on the yield of potatoes. Proc. of the second Regional symposium on potato production South-East Asia and the Pacific. 5-6 Feb. held at LosBanos, Laguna. Philippines, p. 21.

Salzar LF (1989). A worldwide problem: Potato virus disease control. CIP circular. p. 17.

Sanger RBS, Agrawal HO, Nagaich BB (1994). Studies on extent of primary infection of PVX and PVY among tubers of potatoes. Indian J. Virol. 10(1): 22-32.

Singh MN, Khurana SMP (1980). Isolation and identification of virus strains and studies on losses in commercial varieties. Ann. Sci. Rept. CPR). Simla, India, pp. 88-89.

Sreenivasulu P, Naidu RA, Nayudu MV (1989). Physiology of virus infected plants. South Asian Publishers, New Delhi, India, p. 164.

Venhocks JL (1965). Photosynthesis and carbohydrate metabolism of healthy and leaf rol1 diseases potato plants. Thesis, Wageningen (Netherlands). Communication, 43: 1-89.

Watson DJ (1956). Leaf growth in relation to crop yield. *In*: The growth of leaves, proc. 3rd Easter Sch. Agric. Sci. Univ. Notl. pp. 178-191.