ISSN 0258-7122 (Print), 2408-8293 (Online)
Bangladesh J. Agril. Res. 46(3): 343-352, September 2021

QUALITY ASSESSMENT OF THE FARMER'S PRODUCED SEED POTATOES

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Abstract

The experiment was conducted at the research field and post graduate laboratory of Plant Pathology Department, Hajee Mohammad Danesh Science and Technology University, Dinajpur, during 2015 - 2016 to find out the performance of different source's seed potatoes and select suitable methods for improvement of farm saved seed potatoes. In the experiment, farm saved seed was compared with the certified seed, positive selection's seed, seed plot technique's (STP) seed Potato and Truthfully level seed potato as of BARI Alu-8(Cardinal). The maximum yield (27.72 t ha^{-1}) was recorded from positive selection's seed, which was similar to Certified and SPT seeds. The maximum plants of farmer's seed potatoes (≥ 8 %, 7.33 % and 4.17 %) were infected by PVY, PLRV and PMV, respectively. The seed potatoes of positive selection and seed plot technique were the best alternatives to supplement the certified seed.

Keywords: Positive selection, certified seeds, seed plot technique, seed potatoes.

Introduction

Potato (*Solanum tuberosum* L.) belonging to the family Solanaceae is an economically important crop of the world. It is also very popular in Bangladesh because of its high profit return. It gives remarkably high yield and produces more palatable energy per unit area and time than many other crops. The adaptation of potato cultivation in developing countries is increasing as food crop (Naik and Karihaloo, 2007). Potato is the 2nd most important food crop of Bangladesh next to rice; it is mainly used as a vegetable crop, auxiliary to the main food. It is also world leading crop that furnishes appreciable amount of vitamin-B and Vitamin-C as well as some minerals (Thomson and Kelly, 1997). In Bangladesh, total land area under potato crop in 2019-20 was 4,61,538 hectares compared to 4,23,887 hectares in 2009-10, which is 8.88% higher. Average yield rate of potato has been estimated 20.81 metric tons per hectare and total potato production has been estimated 9606 thousand metric tons at 2019-20 compared to 7930 thousand metric tons of the year 2009-10 which was 21.13 % higher (BBS, 2020). The seed rate of potato is very high which increases the total production cost, and it is counted as a major inhibitor to use the quality seeds by the growers. The major constraints in potato production have been identified as the unavailability of quality and healthy

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seed potatoes, difficulties in the production and distribution of disease free seeds, wide range of pest and diseases, inadequacy of cold storage facilities, etc. resulting in rotting and sprouting, and violent price fluctuation (Hoque and Sultana, 2012). So, it is essential to ensure quality seed potato within farmer's ability. Use of low quality seed is one of the main reasons for low yield of potato. Only 10% quality seed potato of the total requirement is being supplied by different government and other private organizations. The remaining 90% seed requirement is being mitigated by the farmers' retained seed which is usually of poor quality (Kabir and Haque 2012). On the other hand, improving the quality of seed potato is considered as a pathway to improve farmers potato yields and income (Getachew and Mela, 2000; Tindimubona *et al.,* 2000; Eshetu *et al.,* 2005; Hirpa *et al.,* 2010). For these reason, it is essential to increase the quality of farmer's own seed potato, which can directly decrease the yield gap between the farmers and potential yield. A large group of potato growers use their farm saved low quality seed tubers. Considering these the experiment was undertaken to find out the performance of different source's seed potatoes and select suitable methods for improving farm saved seed potatoes in Bangladesh.

Materials and Methods

The experiment was conducted at the research field and post graduate laboratory of Plant Pathology Division, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, during November 2015 to March 2016. Maximum temperature, minimum temperature, humidity (%) and total rainfall during the cropping period are presented in Fig. 1. Soil texture of the experiment field was clay loam to sandy loam having P^H of 6.25. The experiment was laid out in a Randomized Complete Block Design (RCBD) with 03 (three) replications. The unit plot size was 2.4 m × 4.0 m with 60 cm × 25 cm spacing. Treatments were as (i) Farmer's seed, (ii) Seeds of Positive selection, (iii) Certified seed, (iv) Seeds of seed plot technique and (v) Truthfully level seed of the most popular variety BARI Alu-8 (Cardinal). The farm saved seed potatoes was collected from farmer's stock who used certified seed. The seed potatoes of positive selection was collected directly from the farmer's (who used certified seed) fields by selecting healthy and vigorous vegetative mother plants at 65 days after planting. The seed potatoes of seed plot technique (SPT) was collected from a farmer's (who used certified seed) separately cultivated plot, situated at multi-locational trial (MLT) site of Ranigonj, On-farm Research Division (OFRD), Bangladesh Agricultural Research Institute (BARI), Dinajpur. The truthful level seed potato was collected from a local seed company (M N Agro & Traders, Thakorgong). The certified seed potatoes were collected from Bangladesh Agricultural Development Corporation (BADC), Thakorgong. The tillage operations were done for 4-5 times during 25 Oct to 03 November 2015. Fertilizers were applied @ N-P-K-S-Mg-Zn-B as of 90-20-90-10-5-2-0.5 $kgha^{-1}$ and compost of cowdung @ 5 t ha^{-1}. The rest half of N and half of K and full dose of other fertilizers were applied as basal dose before final land

preparation. The rest half of N and K was side-dressed at 35 DAP (FRG 2012). The well sprouted whole tubers were planted as per treatments on 4 November 2015. Planting was done at the depth of 5-7 cm at 25 cm × 60 cm spacing. After planting the tubers was covered with soil. Earthing up and weeding were done two times during growing period. The first earthing up was done after planting and the second earthing up was done at 35 DAP (Days after planting). Irrigation was provided thrice throughout the growing period at 10, 35 and 50 DAP. Dursban @ 5 ml per litre and Metasystox @ 1ml per litre was applied respectively to control cut worm and aphid. The fungicide Mencozeb @ 2.0 gm per liter were sprayed from 100% plant emergence and at 10 days interval as routine spray for seed potato production to keep the potato plants free from late blight infection. The crop was haulm pulled at 75 DAP. After 10 days the crop was harvested. The ten plants were harvested at the first time from each plot and then the rest of the plants were harvested with help of a country plough and spade. Care was taken to avoid injury in potatoes during harvesting. Emergence percentage was recorded by eye observation at 20 DAP and 30 DAP. The percent disease incidence of different diseases was recorded by observing the symptoms of diseases like Potato leaf roll virus (PLRV), Potato mosaic virus (PMV), Potato virus Y (PVY), Late blight (LB) of potato and Bacterial wilt, etc. For confirmation of viral diseases ELISA (enzyme-linked immunosorbent assay) test were done at Tuber Crop Research Centre, Bangladesh Agricultural Research Institute, Gazipur. The incidence of PLRV, PVY and PMV and bacterial wilt was assessed with the following formula-

$$\text{Percent disease incidence of plants} = \frac{\text{Number of plants infected by disease}}{\text{Total number of plants observed}} \times 100$$

The yield was recorded by calculation of weight of tubers per plot after harvest. Tubers were graded into four categories namely over size (> 55 mm), "B" grade (40-55 mm), "A" grade (28-40 mm) and small size (< 28 mm) tuber (Sarker *et al.*, 2018). Tuber number and weight per plant, seed tuber number and weight per plant were determined. The number of infected tubers by Common scab, *Rhizoctonia* canker and deformed tuber were counted. The disease incidence (%) was calculated according to the equations given below.

$$\text{Disease incidence (\%)} = \frac{\text{Total no. of infected tubers}}{\text{Total number of tubers}} \times 100$$

Percentage of deformed tuber were calculated using the following formula:

$$\text{Deformed tuber (\%)} = \frac{\text{Number of deformed tuber}}{\text{Number of total tuber}} \times 100$$

Data were subjected to statistical analysis to find out the levels of significance of the experimental results. The mean of all the treatments were calculated and analysis of variance was performed and the mean differences were adjudged by

Duncan's Multiple Range Test (DMRT) at 5% level of probability using MSTATC, the statistical computer package program (Russell, 1986).

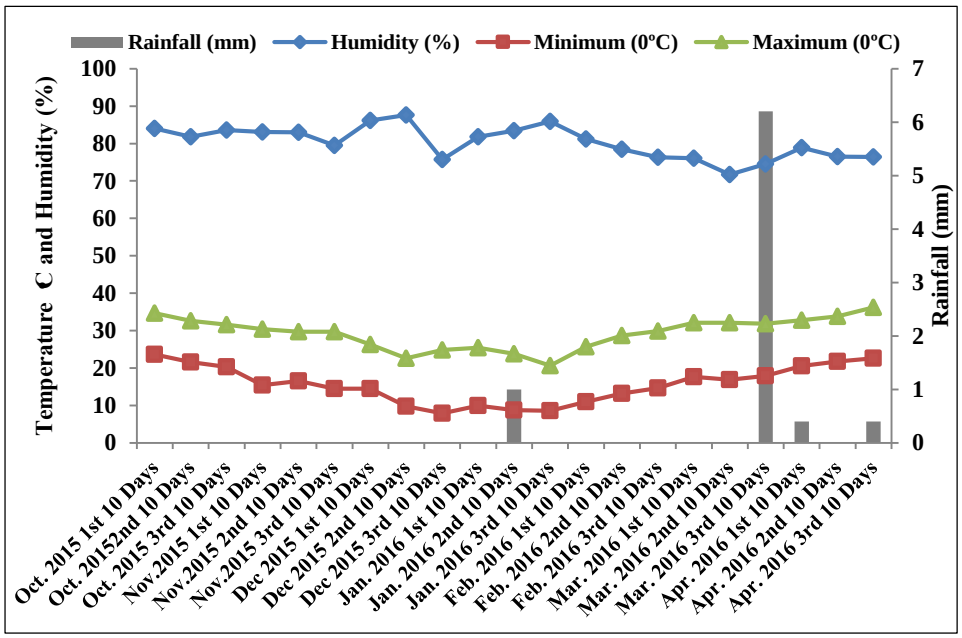

Fig. 1. Ten days average maximum temperature, minimum temperature, humidity and rainfall during the cropping period of 15-16 at HSTU, Dinajpur.

Results and Discussions

The quality of farmer's seed potato is most remarkable and noticeable subjected to low cost quality seed potato production.

Emergence of seed potato

The maximum emergence percentage of potato was remarkably influenced by the quality of seed which is directly related with the source of seeds. The maximum emergence percentage (98.96) at 20 days after planting (DAP) was recorded from positive selection's seeds which was statistically similar to the certified seed and seeds of seed plot techniques (SPT) and the minimum emergence percentage (89.38) was recorded from farmer's seed (Table 1). The emergences of positive selection's seed potatoes were faster than others. The result was supported by the findings of Okeyo *et al.,* (2018), where they stated that positive selection was a good management strategy to manage the seed borne viruses of potato.

Plant population at haulm pulling time

The healthy potato plants can survive more time in the field than the diseased ones. The highest plant (98.96%) at haulm pulling time was recorded from positive

selection's seeds. The lowest plant (85.82%) recorded from Farmer's seed (Table 1). Good quality seed tuber has the potentiality to good field performance. The result was corroborated with the findings of Okeyo *et al.,* (2018) and Gildemacher *et al.,* (2007**),** where they stated that positive selection seed potatoes were better than normal seed tubers.

Tuber number per plant

The tuber number per plant is very important for yield and quality of seed potato. The significant variation was also observed in tuber number per plant among the different sources of seed potatoes. The maximum tuber number (8.24) per plant was recorded from positive selection's seed potatoes, which was statistically similar with the certified seed and seed plot technique's seed potato. The minimum tuber number (5.96) per plant was counted from the truthfully labelled seed tuber which was statistically similar with farmer's own seed potato (Table 1). The seed potatoes of positive selection produced maximum tuber number per plant might be due to good vegetative growth and low disease susceptibility then other source's seed potato. The result was supported by the findings of Okeyo *et al.,* (2018). Where they stated that the field of positive selected seed potato had low visual virus incidences, higher number of tubers per hill and yield (t ha^{-1}) and low virus incidences of PVS (47%), PVY (0.0%), PLRV (0.0%) and PVM (0.0%), tested by ELISA from the plots of positive selection's seed potato.

Table 1. Status of different sources seed potatoes on plant population and tubers per plant

Treatments	Emergence 20 DAP (%)	Emergence 30 DAP(%)	Plants at Haulm pulling (%)	Number of tubers /plant
Farmer's seed	89.38	97	85.42	6.18
Positive selection's seeds	98.96	100	98.96	8.24
Certified seed	95.83	100	98.96	8.22
Seeds of SPT	96.67	100	97.92	7.46
TLS	90.62	99	95.83	5.96
$LSD_{0.05}$	4.69	NS	3.17	1.14
CV (%)	2.64	1.57	1.76	8.39

Performances of different sources of seed potatoes on grading of tubers and yield

Significant differences were observed in different sources of seed potatoes regarding weight of different sized tuber per plant and yield (Table-2). The maximum weight of "A" grade seed tubers were observed from the seeds of SPT which was similar to certified and positive selection's seeds. But the maximum

weight of "B" grade (257.26 g) tubers were observed from the positive selection's seed potato and the minimum weight (198.54 g) from farmer's seed. The maximum weight (70.31 g) of over sized tubers were measured from farmer's seed, which was similar to positive selection's seeds. The maximum weight of tuber per plant was measured in positive selection's seeds which were similar to certified and seeds of SPT and the minimum weight (329.48 g) was recorded in farmer's seed. The maximum yield (27.72 t ha^{-1}) was recorded from positive selection's seeds which was similar to certified and seeds of SPT and the minimum weight (21.97 t ha^{-1}) was observed in farmer's seed (Table 2). The positive selection's might maximize tuber weight per plant and increase yield. The result were supported by the findings of Okeyo *et al.,* (2018), Gildemacher *et al.,* (2011) and Anonymous 2012. Where it was stated that positive selection plots had low visual virus incidences, high number of tubers per hill and increase average yield.

Table 2. Status of different sources of seed potatoes regarding grades of tubers and yield

Treatment	Weight of tuber per plant (g)					Yield (t ha^{-1})
	<28 mm	28-40 mm	40-55 mm	>55 mm	total	
Farmer's Seed	13.13	47.50	198.54	70.31	329.48	21.97
Positive Selection's Seed	17.60	76.04	257.26	64.86	415.77	27.72
Certified Seed	16.25	77.34	250.49	38.59	382.68	25.51
Seeds of SPT	17.42	91.77	229.58	45.21	383.98	25.60
TLS	9.90	54.27	207.29	62.92	334.37	22.29
$LSD_{0.05}$	NS	16.34	22.05	18.31	34.41	2.29
CV (%)	22.44	12.51	5.12	17.24	4.95	4.95

Status of different source's seed potatoes on viral diseases

The field performance of different seed sources on viral diseases like potato virus Y (PVY) potato leaf role virus (PLRV) and potato mosaic virus (PMV) are shown in Fig. 2. The maximum plants (more than 9%) were infected by PVY in Farmer's seed. The minimum plants (2.1%) were infected by PVY in positive selection seed or certified seed (2.1%). Considering PLRV infected plant, severely infection was observed in TLS (8.3 %) and farmer's seeds (7.3%). the minimum number of PLRV infected plants were counted from positive selection seed or certified seed or TLS seeds. The similar trend was also recorded in PMV infected plant, where the maximum (5.2 %) infection was observed in farmer's seeds. The minimum (1.0%) PMV infected plants were recorded from certified seed. The healthy seed potato collecting from seed plot technique or positive selection was comparatively disease free and alternate option for different virus management. These results were supported by Anonymous 2012, Okeyo *et. al*., (2018), Thomas-Sharma *et al.,* (2016), and Schulte-Geldermann *et al.,* (2012), where they stated that different

viral diseases of potato were managed through use of positive selection seed, or SPT seed or certified seed.

Status of different source's seed potato of bacterial wilt and black scarf

The maximum plants were infected by wilt at 60 DAP in farmer's seed (3.13%), the minimum plants are infected in the field of certified (0.00%) and seeds of SPT (0.00%). On the other hand, the maximum plants were infected by Black scarf **(***Rhizoctonia* canker) in the plot of farmer's seed (3.13%), the minimum plants infected by Black scarf **(***Rhizoctonia* canker) both in the field of positive selection seed (0.00%) (Fig 3). Positive selection decrease seed borne diseases of potato. These result were supported by Gildemacher *et al.*, (2011), Anonymous 2012 and Hossain *et al.*, (2010) they found that incidence of virus or bacteria in potato field were very low in the field of healthy and clean mother seed potato and positive selection can reduce bacterial wilt.

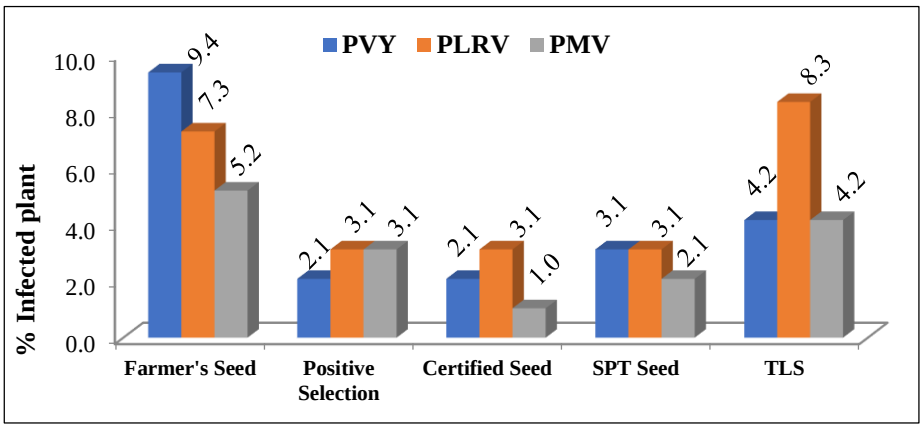

Fig. 2. Status of different sources of seed potatoes regarding viral diseases.

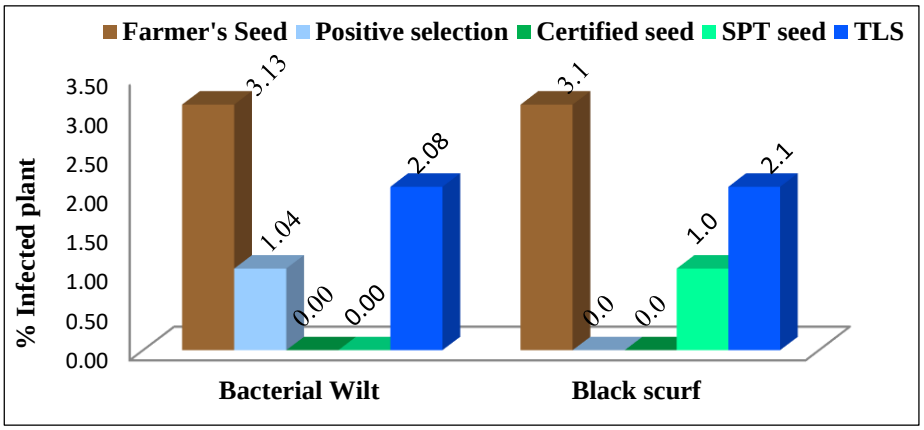

Fig. 3. Status of different sources of seed potatoes regarding bacterial wilt and black scurf.

Status of different sources of seed potatoes on tuber diseases and marketable potato

Potato tubers, from the seeds of different sources were infected significantly by *Rhizoctonia* canker and common scab. The highest infected tuber (1.00%) of *Rhizoctonia* canker were found in the field of TLS which was similar with farmer's seed. The lowest infected tuber (0.00%) were found in the field of certified seeds. Considering the common scab, the maximum (2.01%) infected tuber recorded from farmer's seed, which was similar with TLS (1.56%). In case of deformed or physiological disorder tuber, largest amount (7.36%) was counted in farmer's seeds. The lowest amount (1.55%) of deformed tubers was found in positive selection seed, which was similar with the tubers of certified or SPT seeds (Table 3). The quality of mother seed potato is related to produce marketable potato. The results was also supported by Anonymous (2012), where it was reported that incidence bacterial diseases and common scab were very low in seed plot techniques compared to farmer's practice.

Table 3. Status of different sources seed potatoes on tuber diseases and marketable Potato

Treatments	Infected tuber (%) (wt. basis)		Deformed tuber (%) (wt. basis)	Non-marketable Tuber (%) (wt. basis)	Marketable Potato (%) (wt. basis)
	Rhizoctonia Canker	Common Scab			
Farmer's Seed	1.00	2.01	7.36	14.22	85.78
Positive Selection's Seeds	0.39	0.91	1.55	4.02	95.98
Certified Seed	0.00	0.77	1.68	3.36	96.64
Seeds of SPT	0.42	0.42	1.81	3.62	96.38
TLS	1.39	1.56	6.65	12.54	87.46
$LSD_{0.05}$	0.56	1.37	2.70	5.97	5.97
CV (%)	46.73	53.59	37.65	42.01	3.43

Farmer's seeds were infected with different diseases. So, the maximum (14.22%) tubers were nonmarketable and minimum (85.78%) tubers were marketable. On the other hand, the minimum non marketable (3.36%) tubers and maximum marketable (96.64%) tubers produced by certified seeds which was similar to positive selection or SPT seed potatoes.

Economic analysis

Benefit-cost analysis of potato production from different sources seed potatoes are presented in Table 4. The highest gross return (266056.6 $Tkha^{-1}$), net return (144056.6 $Tkha^{-1}$) and benefit cost ratio (2.2) was recorded from positive selection's seeds. But, closest benefit cost ratio (2.1) was recorded in seeds of seed plot technique. The lowest gross return (73958.66 $Tkha^{-1}$) was calculated in farmer's seed potatoes.

Table 4. Partial benefit cost ratio of potato production from different sources of seed potatoes

Treatments	Yield (t ha^{-1})	Marketable yield (t ha^{-1})	Gross return (Tk ha^{-1})	Cost (Tk ha^{-1})	Net return (Tk ha^{-1})	BCR
Farmer's seed	21.97	18.85	188458.7	114500	73958.6	1.6
Positive selection's seeds	27.72	26.61	266056.6	122000	144056.6	2.2
Certified seed	25.51	24.65	246528.6	137000	109528.6	1.8
Seeds of SPT	25.60	24.67	246732.8	117500	129232.8	2.1
TLS	22.29	19.49	194948.3	129500	65448.34	1.5

Here, certified seed potato = 35.00 Tk kg^{-1}, TLS= 30.00 Tk kg^{-1}, Positive Selection's seed potato= 25.00 Tk kg^{-1}, Farmer's Seed potato = 20.00 Tk kg^{-1}, Seed potatoes of SPT= 22.00 Tk $kg^{-1}$and Ware Potato = 10.00 Tk kg^{-1}, Urea 16 Tk kg^{-1}, TSP 22 Tk kg^{-1}, MoP 15 Tk kg^{-1}, Gypsum 25 Tk kg^{-1}, $ZnSO_4$ 220 Tk kg^{-1}, Boric Acid 420 Tk kg^{-1}, Labour 400 Tk Day^{-1} $Person^{-1}$ and Land rent 15,000 Tk $season^{-1}$ ha^{-1}.

Conclusion

From the aforementioned results and discussions, it can be concluded that the tuber yield was higher from the positive selection's or seed plot technique's or certified seed potato. The disease development was lower in positive selection's or seed plot technique's or certified seed potatoes. Moreover, considering the gross return and benefit-cost ratio, the seed potato of positive selection or seed plot technique are the best alternatives to supplement the certified seed. Potato farmers can now choose to either buy commercial seed potatoes or practice positive selection or seed plot technique (SPT).

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