

DEGENERATION OF POTATO VARIETIES DUE TO VIRUS INCIDENCE IN NORTH GUJARAT

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ABSTRACT: The physiological causes and viral disease infections are the two main reasons for potato degeneration. The seed potato infected with viral diseases degenerate in the following successive generations therefore the investigation was carried out to evaluate the most popular potato varieties of Gujarat *i.e.* K. Badshah and K. Khyati against viruses (PLRV, mild mosaic & severe mosaic) and their subsequent degenerative effects on yield with comparison to fresh breeder seed. The three treatments *viz.*, T₁: Fresh breeder seed every year, T₂: Previous seed produce using seed plot technique, T₃: Previous seed produce without seed plot technique were evaluated. The studies were conducted for four consecutive years during *rabi* 2017-2021. The results revealed significantly higher per cent plant emergence at 40 DAP was recorded in T₁ (Fresh breeder seed every year) and T₂ (Previous seed produce using seed plot techniques) in all years as compared to T₃ (Previous seed produce without seed plot techniques). The per cent incidence of viral diseases at 75 DAP was recorded highest (mild mosaic:16.67 %, severe mosaic: 17.67 and PLRV 21.83 in last year) in T₃ *i.e.* Previous seed produce without seed plot techniques. Comparatively lower per cent incidence of viral diseases (mild mosaic:10.67 %, severe mosaic: 7.33 and PLRV 13.33 in last year) was recorded in T₂ *i.e.* Previous seed produce using seed plot techniques and the least incidence of viral diseases (Mild mosaic:1.83 %, Severe mosaic: 1.67 and PLRV 1.67 in last year) was recorded in T₁ *i.e.* Fresh breeder seed every year. The total tuber yield was higher in first two year in breeder as well as SPT raised seed. In Successive years the SPT raised seed tuber yield decrease. So, based on results it is concluded that seed producer can produce quality seed tuber from breeder seed up to three consecutive years by using "Seed Plot Technique".

KEYWORDS: Degeneration, potato, virus, PLRV, Mosaic, tuber yield

INTRODUCTION

Potato (*Solanum tuberosum*) is the third significantly valuable crop internationally and India is on second rank after china which produce 542.30. lakh tonnes (2021-22) potato annually. In the developing world the potato consumption reaches to tripling from 3.45 kg/capita year⁻¹ in 1962 to 25 kg/capita year⁻¹ in 2020 due to its per hectare production capacity, its significant nutritive value and great adaptability as vegetable purpose (fit with any other vegetables) and versatility in processing products (Faostat, 2021). Potato is known as hunger breaking crop as it has very short cropping period which fits easily in any cropping sequence. However, potato yield in developing countries is hindered by various factors, and one significant factor is seed degeneration which is mainly responsible for

low production in per hectare area. (Fuglie, 2007, Gildemacher *et al.*, 2009 and Cromme *et al.*, 2010)

Tubers are the most common method of potato propagation due to their ability to produce genetically identical clones of the parent plant. However, sexual propagation through true potato seed allows for the introduction of genetic diversity, which can be advantageous in breeding new potato varieties with improved traits. This is due to the fact that asexual propagules, such as seed tubers, are clonal and genetically identical, providing a favourable environment for pathogens to thrive and spread. On the other hand, sexual propagules like True Potato Seeds (TPS) exhibit genetic diversity, making it more difficult for pathogens to establish and proliferate. Whitehead (1930)

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elaborate degeneration as increase in viral diseases incidence and decrease the total tuber yield in subsequent potato generations. According to Struik and Wiersema, 1999 many soil borne pathogen or many vector borne pathogen become seedborne. Dung *et al.*, 2012 reported that the pathogen which cause degeneration are seedborne in nature, but not all significantly contribute to degeneration as they don't upsurge in incidence or severity over generations. Potato viruses, spreading systemically from parent to progeny tubers, are the primary cause of degeneration in potato plants. (Salazar, 1996; Solomon-Blackburn and Barker, 2001). According to Scholthof *et al.*, 2011 *Potato virus Y* (PVY), *Potato leafroll virus* (PLRV) and *Potato virus X* (PVX) are the most vital in potato production systems worldwide. Seed potato degeneration, caused by pathogens and pests in planting material, is a global production challenge for potato growers due to reduced yield and quality. (Sharma *et al.*, 2016). The rate of degeneration varies from variety to variety, place to place and from cropping season to cropping season.

The "Seed Plot Technique (SPT)"-based conventional seed tuber production system has been used successfully in India for the past 50 years. After the development of SPT, SPT expands for indigenous quality seed production system from hills to plains in India. The seed plot techniques used in India is mainly based on agronomical practices such as to keep tuber seed disease free, planting the crop in area or in period when the sucking pest pressure is low with incorporation of IPM practices, rough out the virus infected or off type plants and cut the foliage on or before the vectors reaches on its ETL. When seed potato stocks are multiplied in more aphid vector-prone areas, insecticide application is also frequently used to stop the spreading of seed borne viral diseases from

seed potato crops. Certified seed is always recommended as the main management tactic to avoid farm degeneration (Kreuze *et al.*, 2020).

Poor potato yield is linked to using virus-infected seed potatoes infected with PVY and PLRV, leading to degeneration in successive generations. (Sarker *et al.*, 2018). To evaluate denegation behaviour of potato varieties affected by PVY and PLRV infection is the notable problem for seed potato production. A study conducted in several nations revealed that the severe economic impact of PVY on potatoes was as high as 30–40% in India, 16.5% in Ireland, 34% in Canada, 37% in Kenya, 40–44% in Poland and the USA, and almost 50% in China (Gray *et al.*, 2010; Wang *et al.*, 2011; Were *et al.*, 2013; Hasiow-Jaroszewska *et al.*, 2014; Hutton *et al.*, 2015; Jailani *et al.*, 2017).

The cost of cultivation of potato is very high. In potato cost of cultivation, the 40-45% cost behind the seed cost which is main factor for crop profitability. Now a days "Potato Seed Plot Technique" is used for quality potato seed production. By adopting "Potato Seed Plot Technique" producers can produce their own seed but the information on how many times producers can produce their own seed from breeder seed through "Potato Seed Plot Technique" is lacking. Therefore, the present study was commenced for four successive years to find out the impact of degenerative viruses on produce and effect of rate of degeneration on potato crop during *rabi* season under North Gujrat agro-climatic condition.

MATERIALS AND METHODS

The field study was carried out at Potato Research Station, S. D. Agricultural University, Deesa to evaluate the rate of degeneration of potato varieties due to virus incidence in north Gujarat for four

consecutive years from 2017-18 to 2020-21. Prior to experiment in the year 2016-17 (experiment conducted in one set) only the fresh breeder seed of two varieties *i.e.* K. Badshah and K. Khyati were raised by seed plot technique (SPT) and without using seed plot technique. From the first year onward, the experiment was conducted in two sets. In first set the seed production chain of two varieties *i.e.* Kufri Badshah and K. Khyati by using seed plot technique (SPT) and without using seed plot technique and the produce (seed produce through SPT and without SPT) were cold stored for next year use and process was continue in subsequent year (2016-17 to 2019-20). In the second set evaluation program of previous year seed produced seed was carried out and the process was continued in subsequent years (2017-18 to 2020-21). In evaluation program the experiment was laid out in a randomized block design with factorial concept by with two varieties *i.e.* Kufri Badshah and K. Khyati and three treatments *i.e.* T₁: Fresh breeder seed every year, T₂: Previous seed produced using seed plot technique, T₃: Previous seed produced without seed plot technique with 3.0 m × 2.0 m plot size and five replications. Planting was done at 50 cm row spacing and 20 cm plant-to-plant spacing in sandy loam soil, following recommended agronomic practices.

Seed plot technique:

- Planting in 1st calendar week of November.
- Place yellow sticky traps 60 per hectare at equidistance for mass trapping of white flies and aphids above canopy height.
- Three foliar sprays of label claim systemic insecticide (Imidacloprid 17.8 SL and Thaimethoxam 25 WG) at 15 days interval starting from 35-40 DAP.
- Cutting of haulm when aphids cross its critical level *i.e.*, 20 per 100 compound leaves.

Growth parameters:

Plant emergence (%) at 30 and 40 days after planting (DAP)

$$\text{Plant emergence (\%)} = \frac{\text{Total number of tuber germinated}}{\text{Total number of tubers planted}} \times 100$$

Yield attributes:

Out of total tubers obtained in each plot, all tubers were sorted in to four different grades based on their weight as I grade (>75 g. tuber), II grade (50-75 g. tuber), III grade (25-50 g. tuber) and IV grade (0-25 g. tuber) and transformed into tonnes per hectare.

Total tuber yield (t/ha): Total tuber yield was calculated by sum of all the grade *i.e.* I,II, III and IV grade.

Per cent incidence of Mosaic (Mild & severe) and PLRV were recorded at 45, 60 and 75 DAP.

Per cent disease incidence (PDI) of Mosaic and PLRV was carried out by using the following formula.

$$\text{PDI} = \frac{\text{Total number of virus infected plants}}{\text{Total number of plants observed}} \times 100$$

Statistical analysis:

The statistical analysis was carried out using the software OPSTAT developed by HAU, Hisar.

RESULTS AND DISCUSSION

Effect on emergence (2017-18, 2018-19, 2019-20 & 2020-21):

Significantly higher plant emergence at 40 DAP was recorded in T₁ (Fresh breeder seed every year) and T₂ (Previous seed produce using seed plot techniques) in three years as compared to T₃ (Previous seed produce without seed plot techniques) while there was non-significant difference in emergence between the two varieties. Shetty *et al.*,

(2021) studied on potato tuber degeneration in Karnataka and reported that the highest per cent plant germination of 88.98 per cent and 84.13 at 30 and 40 days after planting, respectively with previous seed produce using seed plot technique.

Effect incidence of viral diseases (2017-18, 2018-19, 2019-20 & 2020-21):

The incidence of mild mosaic, severe mosaic and PLRV at 75 DAP was noted significantly highest in T_3 *i.e.* Previous seed produce without seed plot technique (Mild mosaic- 6.50, 7.00, 15.50 & 16.67 per cent, Severe Mosaic- 4.50, 6.67, 15.33 & 17.67 per cent & PLRV- 6.00, 14.83, 21.50 & 21.83 per cent) in the year 2017-18, 2018-19, 2019-20 and 2020-21, respectively. Comparatively lower incidence was recorded in T_2 *i.e.* Previous seed produce using seed plot technique (Mild mosaic- 4.83, 4.83, 7.67 & 10.67 per cent, Severe mosaic- 2.63, 2.67, 5.83 & 7.33 per cent & PLRV- 4.00, 6.83, 10.66 & 13.33) in the year 2017-18, 2018-19, 2019-20 and 2020-21, respectively. The least mosaic incidence was recorded in T_1 *i.e.*, Fresh breeder seed every year (Mild mosaic- 3.67, 2.33, 2.50 & 1.83 per cent, Severe mosaic- 1.83, 1.50, 1.50 & 1.67 per cent & PLRV- 3.00, 4.83, 2.33 & 1.67) in the year 2017-18, 2018-19, 2019-20 and 2020-21, respectively (Table 1). The least incidence of viral disease (*i.e.* Severe Mosaic and PLRV) was noted in T_1 *i.e.* Fresh breeder seed every year and which was at par with T_2 *i.e.*, Previous seed produce using seed plot technique in the 2017-18 and 2018-19. In the subsequent years (2019-20 to 2020-21) the incidence of viral disease was increased in T_2 as compared to T_1 . The incidence of mild mosaic was found minimum in T_1 *i.e.*, Fresh breeder seed every year and which was at par with T_2 *i.e.* Previous seed produce using seed plot technique in the 2017-18. In the subsequent year, least incidence was recorded in T_1 and which was followed by T_2 and T_3 .

The disease incidence of viral diseases was found non-significant between the varieties *i.e.*, K. Badshah and K. Khyati. However, the minimum mild (9.11%) and severe mosaic (8.67%) virus was noted in K. Badshah variety as compared to K. Khyati (Mild Mosaic:10.33% and Severe mosaic: 9.11%) while minimum per cent PLRV was noted in K. Khyati (12.22%) as compared to K. Badshah (12.33%). (Table:2)

The interaction effect between various treatments and varieties had not exerted any significance influence on per cent incidence of viral diseases.

Tuber yield:

Significantly the highest total tuber yield was noted in treatment T_1 *i.e.*, Fresh breeder seed every year. Comparatively lower total tuber yield noted in T_2 *i.e.*, Previous seed produce using seed plot technique. The least total tuber yield was recorded in T_3 *i.e.* Previous seed produce without seed plot technique in the year 2017-18, 2018-19, 2019-20 as well as in 2020-21 in the both cultivars. Highest tuber yields 40.80, 52.75, 40.69, 47.93 t/ha was recorded in K. Khyati variety in the year 2017-18, 2018-19, 2019-20 and 2020-21 respectively as compared to K. Badshah variety (Table:3).

DISCUSSION

The results shows that the minimum viral disease (Mosaic & PLRV) incidence was noted in breeder seed as well as SPT raised seed in initial first two years. The results were corroborating the finding of Basu *et al.*, (2003) and Singh *et al.*, (2014). They concluded that SPT-raised potato crops had higher tuber yields and a lower incidence of viral diseases. Further Ali *et al.*, (2013) discovered that crops raised with high-quality seed production program hardly ever had any

Table 1. Per cent emergence at 30 and 40 DAP (2017-18, 2018-19, 2019-20 and 2020-21).

Year	Treatment	% Emergence at 30 DAP				% Emergence at 40 DAP			
		T ₁	T ₂	T ₃	Mean	T ₁	T ₂	T ₃	Mean
2017-18	K. Badshah	81.93	88.67	83.67	84.76	91.43	95.33	90.00	92.26
	K. Khyati	80.67	86.33	83.00	83.33	94.00	92.67	89.33	92.00
	Means	81.30	87.50	83.33		92.72	94.00	89.67	
		CD (0.05)		S.Ed. (±)		CD (0.05)		S.Ed. (±)	
	Variety	NS		0.97		NS		0.68	
	Treatment	2.50		1.19		1.75		0.83	
	Variety × Treatment	NS		1.68		2.48		1.18	
2018-19	K. Badshah	80.67	87.67	73.33	80.56	91.00	92.33	79.00	87.45
	K. Khyati	83.33	89.33	75.67	82.78	90.00	93.00	78.00	87.00
	Means	82.00	88.50	74.50		90.50	92.67	78.50	
		CD (0.05)		S.Ed. (±)		CD (0.05)		S.Ed. (±)	
	Variety	NS		1.86		NS		1.79	
	Treatment	4.79		2.28		4.61		2.20	
	Variety × Treatment	NS		3.22		NS		3.11	
2019-20	K. Badshah	83.33	91.00	81.33	85.22	91.000	94.000	84.332	89.777
	K. Khyati	88.33	91.33	85.00	88.22	92.666	94.334	87.334	91.445
	Means	85.83	91.17	83.17		91.833	94.167	85.833	
		CD (0.05)		S.Ed. (±)		CD (0.05)		S.Ed. (±)	
	Variety	NS		2.10		NS		1.92	
	Treatment	5.41		2.57		4.94		2.35	
	Variety × Treatment	NS		3.64		NS		3.33	
2020-21	K. Badshah	87.00	89.66	86.00	87.55	91.00	91.33	89.34	90.56
	K. Khyati	85.00	90.33	87.66	87.67	90.67	92.00	90.00	90.89
	Means	86.00	89.99	86.83		90.83	91.67	89.67	
		CD (0.05)		S.Ed. (±)		CD (0.05)		S.Ed. (±)	
	Variety	NS		1.20		NS		1.13	
	Treatment	3.09		1.47		NS		1.38	
	V × T	NS		2.08		NS		1.96	

vector-transmitted viruses, while ware crops ("Seed Plot Technique" not followed) were the only ones to have them in abundance.

The results are also conformity with the findings of Singh *et al.*, (2014). They reported potato growers of North Gujarat are advised to maintain their seed stocks of cvs. K. Badshah, K. Pushkar and K. Surya up to three consecutive years adopting seed plot technique for maintaining assured quality

seed and yield potential which also gives assurance against introduction of other tuber borne diseases like common scab, black scurf, brown rot etc. Shetty *et al.*, (2021) also noted at 65 days after planting, that the treatment of previous seed products using the seed plot technique resulted in a lower percentage of mosaic and PLRV and higher tuber yield as compared to ware crop (seed plot techniques not used).

Table 2. Per cent incidence of Mild & Severe Mosaic and PLRV at 75 DAP (2017-18, 2018-19, 2019-20 and 2020-21).

Year	Treatment	Mild mosaic 75 DAP				Severe mosaic 75 DAP				PLRV 75 DAP			
		T ₁	T ₂	T ₃	Mean	T ₁	T ₂	T ₃	Mean	T ₁	T ₂	T ₃	Mean
2017-18	K. Badshah	3.67	4.67	6.67	5.00	1.33	2.27	4.33	2.65	2.33	3.67	5.00	3.67
	K. Khyati	3.67	5.00	6.33	5.00	2.33	3.00	4.67	3.33	3.67	4.33	7.00	5.00
	Means	3.67	4.83	6.50		1.83	2.63	4.50		3.00	4.00	6.00	
		CD (0.05)		S.Ed. (±)		CD (0.05)		S.Ed. (±)		CD (0.05)		S.Ed. (±)	
	Variety	NS		0.52		NS		0.42		1.32		0.63	
	Treatment	1.34		0.64		1.07		0.51		1.61		0.77	
	Variety × Treatment	NS		0.90		NS		0.72		NS		1.09	
2018-19	K. Badshah	3.00	5.00	7.00	5.00	1.33	2.00	6.33	3.22	3.33	6.33	17.67	9.11
	K. Khyati	1.67	4.67	7.00	4.44	1.67	3.33	7.00	4.00	6.33	7.33	12.00	8.56
	Means	2.33	4.83	7.00		1.50	2.67	6.67		4.83	6.83	14.83	
		CD (0.05)		S.Ed. (±)		CD (0.05)		S.Ed. (±)		CD (0.05)		S.Ed. (±)	
	Variety	NS		0.75		NS		0.77		NS		0.93	
	Treatment	1.93		0.92		1.98		0.94		2.40		1.14	
	Variety × Treatment	NS		1.30		NS		1.33		3.39		1.62	
2019-20	K. Badshah	2.67	7.33	14.00	8.00	1.67	5.33	16.33	7.78	2.00	10.00	23.66	11.89
	K. Khyati	2.33	8.00	17.00	9.11	1.33	6.33	14.33	7.33	2.67	11.33	19.33	11.11
	Means	2.50	7.67	15.50		1.50	5.83	15.33		2.33	10.66	21.50	
		CD (0.05)		S.Ed. (±)		CD (0.05)		S.Ed. (±)		CD (0.05)		S.Ed. (±)	
	Variety	NS		0.94		NS		0.72		NS		0.97	
	Treatment	2.43		1.15		1.85		0.88		2.49		1.18	
	Variety × Treatment	NS		1.64		NS		1.25		NS		1.68	
2020-21	K. Badshah	2.00	10.33	15.00	9.11	1.33	6.67	18.00	8.67	1.33	13.33	22.33	12.33
	K. Khyati	1.67	11.00	18.33	10.33	2.00	8.00	17.33	9.11	2.00	13.33	21.33	12.22
	Means	1.83	10.67	16.67		1.67	7.33	17.67		1.67	13.33	21.83	
		CD (0.05)		S.Ed. (±)		CD (0.05)		S.Ed. (±)		CD (0.05)		S.Ed. (±)	
	Variety	NS		0.83		NS		0.86		NS		0.83	
	Treatment	2.13		1.01		2.22		1.05		2.13		1.01	
	Variety × Treatment	NS		1.44		NS		1.49		NS		1.44	

Table 3. Total tuber yield (t/ha) for the year 2017-18, 2018-19, 2019-20 and 2020-21.

Treatment	Total tuber yield (t/ha)															
	2017-18				2018-19				2019-20				2020-21			
	T ₁	T ₂	T ₃	Mean	T ₁	T ₂	T ₃	Mean	T ₁	T ₂	T ₃	Mean	T ₁	T ₂	T ₃	Mean
K. Badshah	45.29	38.36	29.16	37.61	56.63	52.62	22.38	44.87	45.68	38.17	12.62	32.15	53.40	32.31	21.65	35.79
K. Khyati	48.55	40.70	33.15	40.80	68.31	62.02	27.94	52.75	50.70	40.69	30.69	40.69	66.00	42.11	35.68	47.93
Mean	46.92	39.53	31.16		62.47	57.37	25.16		48.19	39.42	21.65		59.70	37.21	28.66	
	CD (0.05)		S.Ed. (±)		CD (0.05)		S.Ed. (±)		CD (0.05)		S.Ed. (±)		CD (0.05)		S.Ed. (±)	
V	2.23		1.06		5.94		2.83		2.86		1.36		4.21		2.01	
T	2.74		1.30		7.27		3.46		3.51		1.67		5.16		2.46	
VXT	NS		1.84		NS		4.89		4.96		2.36		NS		3.47	

CONCLUSION

The winter is very short in North Gujarat as compared to other Northern states of India. The aphid population is major concern for quality seed potato production. The seed producer must have to adopt “Seed Plot Technique” for quality seed production under North Gujarat condition. Based on degeneration study of potato varieties result revealed that the incidence of viral diseases increasing slowly up to three consecutive years then after the incidence increasing fast in the seed which produce through seed plot technique as compared to breeder seed. So, it is concluded that seed producer can produce quality seed tuber from breeder seed up to three consecutive years by adopting “Seed Plot Technique”.

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CONFLICT OF INTEREST

All authors declare no conflict of interest with this article.

ETHICAL STATEMENT

This article does not contain any studies with human participants or animals performed by any of the authors

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