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DEGENERATION OF POTATO SEED IN MEGHALAYA AND NAGALAND STATES IN NORTH-EASTERN HILLS OF INDIA

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ABSTRACT: Field experiments were conducted at CPRS, Shillong (Meghalaya) and Kohima (Nagaland), during 2008-11 to evaluate the rate of degeneration due to viral diseases in cvs. Kufri Jyoti and Kufri Giriraj. The first year harvest was carried forward along with the good quality seed to compare the yield loss in subsequent years. Incidence of Mild Mosaic, Severe Mosaic and Potato Leaf Roll was higher in ware crop as compared to quality seeds. The results revealed that seed stocks of cv. Kufri Jyoti can be maintained for more than 4 years and cv. Kufri Giriraj can be maintained for 3-4 years in both the states following the essentials of "Seed Plot Technique".

KEYWORDS: North-Eastern India, potato leaf roll, seed potato degeneration, severe mosaic.

INTRODUCTION

Potato, being a vegetative propagated crop, needs large quantity of healthy seed for its successful cultivation without losing productivity. Worldwide potato crop is infected by more than 36 viruses and viroid (Tiwari, 2012; Raigond, 2013). Studies on the cause of degeneration of seed potatoes in the country showed that the aphid, particularly *Myzus persicae* (Sulzer), is responsible for the spread of virus diseases in the fields. Conditions suited for seed potato production in hills are where summer temperatures are low and those exposed to wind currents. Vegetative propagation of the same stocks used year after year results in cumulative infiltration of pathogens, particularly the prevalent viruses which spread both through contact and aphid/ vectors (Khurana, 1999; Lakra, 2000; Lakra, 2010). Further infection of viruses has strong debilitating effect bringing down the yield potential of the infected plants/ crop. It has also been observed that loss in yield following virus infection is genotype/variety specific. The varieties react with different degrees of loss in tuber yield depending on the virus(es)/ stage of infection, and period of field exposure of the seed stocks (Khurana *et al*., 1998; Rahman *et al*., 2010; Motica *et al*., 2012). The degeneration and consequent losses in yield vary in different potato growing regions (Garg, 1987; Khurana and Singh, 1988; Khurana *et al*., 1998; Khurana, 1999; Singh *et al*., 2012).

Low productivity of potato in North-Eastern region of India is mainly due to non-availability of healthy seed material. Moreover, being vegetative propagated crop, 2.5 to 3 t seed is required for a hectare resulting in about 50% cost of cultivation (Rana *et al*., 2009; Rana *et al*., 2012). North-Eastern-Hill (NEH) region being situated far from the northern seed producing areas cannot afford to procure healthy potato seeds. Therefore farmers are compelled to use locally available degenerated seed stocks year after year which results into low yield. Production of quality seed locally

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by the growers is very much important option. Therefore the present study was under taken to identify suitable varieties which can withstand degeneration due to viruses in the region.

MATERIALS AND METHODS

Experiments were conducted at CPRS, Shillong (Meghalaya) and Kohima (Nagaland), during the years 2008-2011. Two popularly grown varieties *e.g*. Kufri Jyoti and Kufri Giriraj were used in the experiments. The trials were planted in RBD with four replications. The plot size was 3x2m with 60x20 cm inter and intra row distances. There were two treatments in the first year of the experiments, i) T_1: Ware crop with no aphid control (Farmers' practice; only fungicide sprays were given at 7-10 days intervals against late blight) and ii) T_2: crop grown as per seed plot technique[5]. Besides, additional treatments *i.e.* T_3 and T_4 planting of healthy potato seeds every year along with the application of systemic insecticides as in T_2. Data on per cent viral incidence of perceptible viral diseases *e.g.* Mild Mosaic (MM), Severe Mosaic (SM) and Potato Leaf Roll Virus (PLRV) symptoms were recorded thrice *i.e.* 50, 65 and 80 days after planting in the crop season based on visual symptoms. Virus incidences in the potato foliage and tuber sample at harvest from different treatments were detected through ELISA and presented in **Table 4**.

RESULTS AND DISCUSSION

The experiments conducted at two different locations *viz.* CPRS, Shillong and Kohima, Nagaland representing major potato growing states in NEH, using predominant varieties of the region to study the rate of degeneration and to find out the optimum period up to which the seed stocks may be used without replacement and reduction in yield when potato seed is planted in the subsequent generations. The data on total viral incidence (%) of the three virus diseases like Mild Mosaic (MM), Severe Mosaic (SM) and Potato Leaf Roll Virus (PLRV) observed thrice at 50, 65 and 80 days after planting for both the varieties reveals a gradual increase in subsequent generations at both locations after crop was exposed to natural environment.

The results revealed that during third and fourth year of study in the ware crop average mosaic and leaf roll incidence was higher in cv. Kufri Giriraj (MM 26.0%, SM 18.0% and PLRV 24.3%) in Meghalaya as compared to cv. Kufri Jyoti (MM 15.6%, SM 14.5% and PLRV 17.9%), respectively (**Table 1**) as Kufri Jyoti reported tolerance to some viruses and have slow rate of degeneration (CPRI, 2011). The virus incidence was more in Meghalaya, may be, due to non-availability of virus-free seed, high frequency of the virus sources in and around the crop with early buildup and greater activity of aphid vectors, *M. persicae*, in the locality and crossing the critical level by middle of May. Amongst the two potato varieties included in the trial, the infection/ accumulation of common viruses was more in cv. Kufri Giriraj, this is due to its higher susceptibility to the common viruses (Khurana, 1999) while in Nagaland ware crop registered

[5]Application of systemic insecticide (Phorate 10G @15 kg/ ha) at the time of planting + two sprays with systemic insecticide, Imidacloprid @ 0.03 % conc. (3 ml / 10 l of water) at 15 days interval on the appearance of 1-2 aphids/ 100 leaves in the crop + fungicide spray (Curzate M-8 @ 3 g/ l of water alternating with Mancozeb @ 2.5 g/ l of water) against late blight 6-7 times starting from 100% plants emergence and later at 7-10 days intervals based on weather conditions and roguing out all the viral infected plants and varietal mixture to maintain the trueness to type of the variety, and haulms cutting when aphid population reaches initial level of 20 aphids per 100 compound leaves. In the subsequent years the trials were repeated wherein corresponding treatments were planted with seeds drawn from the previous treatments (2 tubers each from individually harvested plants/respective treatment plot, bulked and stored.

Table 1. Per cent plant emergence and virus incidence (average mean of four years) in seed degeneration trial (2008-11) at CPRS, Shillong, Meghalaya.

Treatments	Per cent plant emergence (DAP)		Per cent viral incidence (days after planting)									Yield (t/ha)
			Mild Mosaic			Severe Mosaic			Leaf Roll			
	50	**60**	**50**	**65**	**80**	**50**	**65**	**80**	**50**	**65**	**80**	
Kufri Jyoti												
T_1	69.3	82.5	3.1	9.1	**15.6**	0.0	5.4	**14.5**	0.0	10.1	**17.9**	**22.30**
T_2	76.0	84.0	4.2	7.7	**15.5**	0.0	4.2	**8.7**	0.6	2.8	**2.9**	**25.39**
T3	81.5	90.0	3.3	8.3	**13.9**	0.5	4.4	**6.3**	0.0	1.1	**1.3**	**26.06**
T4	90.0	98.5	1.5	8.1	**13.2**	0.0	3.0	**3.1**	0.0	1.0	**1.5**	**26.81**
CD (0.05)	5.8	6.5	0.51	1.21	0.73	0.33	0.73	0.87	NS	0.50	0.50	
Kufri Giriraj												
T_1	65.5	75.0	4.7	13.3	**26.0**	1.3	9.3	**18.0**	0.0	13.5	**24.3**	**17.57**
T_2	69.5	83.5	3.6	11.4	**15.5**	1.8	2.0	**2.2**	0.0	1.8	**2.1**	**22.11**
T_3	84.5	93.0	2.7	8.1	**13.4**	0.5	3.2	**3.4**	0.0	1.2	**2.9**	**21.91**
T_4	92.0	99.0	1.5	5.1	**9.6**	0.0	2.5	**3.1**	0.0	1.5	**2.1**	**24.71**
CD (0.05)	5.3	4.8	0.75	1.13	1.35	0.42	0.54	1.41	NS	0.91	0.98	

highest virus incidence in Kufri Giriraj (MM 21.2%, SM 9.3% and PLRV 22.2%) as compared to cv. Kufri Jyoti (MM 19.3%, SM 16.61% and PLRV 12.8%).

In general virus incidence in the crop raised with healthy seeds (T4) was recorded very less but slightly higher in cv. Kufri Giriraj than cv. Kufri Jyoti at both the locations. Severe mosaic (SM) disease in cv. Kufri Jyoti ware crop was recorded many folds higher than the quality seeds at both the locations and cv. Kufri Giriraj registered higher in Nagaland as compared to Meghalaya (**Table 2**).

Amongst the four treatments (T_1 to T_4) in the trial, the highest yield, 30.15 and 26.35 t/ ha were recorded at CPRS, Shillong and 32.25 and 32.53 t/ ha at Kigwema village, Kohima, Nagaland using Kufri Jyoti and Kufri Giriraj, respectively, in the crop raised as suggested in "Seed Plot Technique" were followed against the virus-vectors. Whereas, yields in the crop raised by following farmers practices, after four continuous years of field exposure were 22.3 and 17.57 t/ ha, and 22.51 and 19.25 t/ ha, in cv. Kufri Jyoti and Kufri Giriraj respectively at CPRS, Shillong, Meghalaya and at Kigwema village (Kohima), Nagaland. The yields in cv. Kufri Jyoti was reduced to 22.3 from 27.48 t/ ha (18.85%) in the crop raised with ware potato seed in Meghalaya and it is slightly less than cv. Kufri Giriraj in which it was reduced to 17.57 t/ ha (30.41%) from 25.25 t/ ha (first year) after four consecutive years of field exposure. While in Nagaland comparatively higher yield reduction was recorded *i.e.* from 31.70 t/ha to 22.51 t/ ha (29.00%) in cv. Kufri Jyoti and in cv. Kufri Giriraj the yield reduction was slightly higher (38.55%) over yields in Meghalaya (**Table 3**). Our findings are in accordance with the earlier finding of Khurana and Singh (1988) that in the field trials conducted during 1978-82 in Shimla hills the degeneration in variety Kufri Jyoti due to PVX alone was 15.36 and 52% in first to third year of exposure. On the other hand, infection of PVY alone was only 3.6 and 11% in the seed exposed for three years. Further, it was also observed that the yield losses in

Table 2. Per cent plant emergence and virus incidence (average mean of four years) in seed degeneration trial (2008-11) at Kigwema village, Kohima, Nagaland.

Treatments	Per cent plant emergence (DAP)		Per cent viral incidence (days after planting)									Yield (t/ha)
			Mild Mosaic			Severe Mosaic			Leaf Roll			
	50	**60**	**50**	**65**	**80**	**50**	**65**	**80**	**50**	**65**	**80**	
Kufri Jyoti												
T_1	73.0	67.5	3.1	8.6	**19.3**	1.1	7.6	**16.6**	0.0	11.1	**12.8**	**22.51**
T_2	89.2	97.5	0.0	2.1	**2.7**	0.1	0.5	**1.5**	0.0	2.1	**7.2**	**27.99**
T_3	94.0	97.5	0.0	1.6	**1.6**	0.0	0.5	**1.6**	0.0	0.5	**1.1**	**27.62**
T_4	95.0	99.5	0.5	1.5	**1.7**	0.0	0.0	**0.5**	0.0	0.0	**1.0**	**28.19**
CD (0.05)	8.14	5.1	0.69	0.90	0.96	0.47	0.62	0.78	NS	0.57	0.72	
Kufri Giriraj												
T_1	81.5	96.7	7.2	10.8	**21.2**	0.5	4.6	**9.3**	0.5	3.6	**22.2**	**19.25**
T_2	83.5	94.0	5.3	5.3	**17.5**	0.5	1.1	**7.4**	0.0	1.6	**12.2**	**27.85**
T_3	87.0	97.0	3.1	6.2	**11.8**	1.1	1.5	**3.6**	0.5	2.1	**10.8**	**27.40**
T_4	80.0	96.5	2.1	5.7	**10.9**	0.0	0.5	**1.5**	0.0	1.1	**3.1**	**30.38**
CD (0.05)	16.85	4.7	1.13	0.66	1.59	0.33	0.70	0.96	0.39	0.74	1.26	

T_1-Ware crop (from Ist year basic seed), T_2- 3rd year improved practice, T_3- 2nd year improved practice, T_4- basic seed improved practice

Table 3. Per cent yield reduction over the years (2008-11) at CPRS, Shillong, Meghalaya and Kigwema village, Kohima, Nagaland.

Variety: Kufri Jyoti Location: CPRS, Shillong, Meghalaya							Per cent yield reduction over the years		
Treatments	Yield (t/ha)								
	Ist yr	IInd yr	IIIrd yr	IVth yr	CD (0.05)	CV (%)	IInd	IIIrd	IVth
T_1	27.48	26.65	24.28	22.30	4.1	10.17	3.02	11.64	18.85
T_2	27.15	27.67	26.44	25.39	NS	9.7	NS	2.61	6.48
T_3		30.15	27.21	26.06	3.06	6.35		9.75	13.56
T_4			27.60	26.81	NS	10.56			3.21
Variety: Kufri Giriraj Location: CPRS, Shillong, Meghalaya Per cent yield reduction over the years									
T_1	25.25	24.37	23.41	17.57	2.45	6.81	3.48	7.29	30.41
T_2	24.31	23.96	23.94	22.11	NS	9.06	1.43	1.52	9.05
T_3		25.33	24.69	21.91	NS	7.45		2.52	13.18
T_4			26.35	24.71	NS	7.23			6.2
Variety: Kufri Jyoti Location: Kohima, Nagaland Per cent yield reduction over the years									
T_1	31.70	30.33	25.23	22.51	2.72	4.32	4.32	20.41	29.00
T_2	32.25	29.91	30.72	27.99	NS	7.26	7.25	-	13.21
T_3		30.72	30.24	27.62	NS	12.52		-	10.00
T_4			31.77	28.19	NS	6.22			11.27
Variety: Kufri Giriraj Location: Kohima, Nagaland Per cent yield reduction over the years									
T_1	31.33	28.25	21.78	19.25	3.35	8.34	9.83	30.48	38.55
T_2	32.53	30.98	28.35	27.85	2.59	5.42	4.76	12.85	14.39
T_3		29.75	28.37	27.40	NS	4.29		4.64	7.86
T_4			30.63	30.38	NS	3.36			NS

T_1-Ware crop (from Ist year basic seed), T_2- 3rd year improved practice, T_3- 2nd year improved practice, T_4- basic seed improved practice

the three varieties including Kufri Jyoti, due to current year infection of PVX and PVY varied between 11 to 17% and 36 to 48%, respectively. In the second year due to PVX and PVY infections yields were 17 to 24% and 40 to 58% less. In our trials reasons of higher yields in Nagaland probably due to the crop raised in the virgin field reclaimed under *'Jhum'* cultivation. The results lend support to earlier recommendations where hills have been said to be suitable for producing healthy seed potatoes (CPRI, 1999; Ali *et al*., 2013). As the main crop gets enough time to tuberize and bulk before the aphid population crosses the critical level. There was significant difference in yields at both the locations between crops raised with quality seeds and with ware potato crop after four years of exposure to field conditions, which clearly indicates that crop productivity under present conditions of both the varieties can be maintained only for three to four years if the essentials of Seed Plot Technique are adopted.

Viral incidence from the degeneration trial fields were ascertained by visual counts of virus infected plants (**Tables 1 and 2**) and also by collecting potato leaves at random from ten potato plants from each location and tested them through ELISA in the laboratory (**Table 4**). Tubers collected from each treatment/replication from both the varieties at the time of harvesting were kept in poly-house to facilitate early sprouting. On the initiation of sprouting the sprouts were taken from each sample and subjected to ELISA testing. The post-harvest ELISA results from degeneration trials conducted at Shillong and Nagaland revealed that contact virus *i.e.* PVS was most prevalent at both the locations and in both the varieties, while it was not so in case of PVX. Vector transmitted viruses were prevalent only in ware crop but almost absent in crop raised with quality seeds at both locations and both the varieties**,** while variety Kufri Giriraj was found more prone to viruses (**Table 5**).

Table 4. Principal potato viruses detected through ELISA in NE-states (2008-11).

Virus	Meghalaya				Nagaland			
	2008	2009	2010	2011	2008	2009	2010	2011
PVX	√	√	√	√	√	√	√	√
PVS	X	√	√	√	√	√	√	√
PVY	X	X	√	√	X	X	√	√
PVA	X	X	√	√	X	X	√	X
PVM	X	X	X	X	X	√	√	√
PLRV	X	X	√	√	X	X	X	√

Table 5. Post-harvest ELISA results of degeneration trials at Meghalaya and Nagaland (2008-11).

Virus	Meghalaya (Kufri Jyoti)				Meghalaya (Kufri Giriraj)				Nagaland (Kufri Jyoti)				Nagaland (Kufri Giriraj)			
	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
PVX	√	X	X	X	√	√	√	√	√	√	X	X	X	√	√	√
PVS	√	√	√	X	X	√	√	√	√	√	√	√	√	√	√	√
PVY	√	X	X	X	√	X	X	X	√	X	X	X	√	√	X	X
PVA	X	X	X	X	X	X	X	X	X	X	X	X	X	√	X	X
PVM	X	X	X	X	X	X	X	X	X	√	X	X	X	X	X	X
PLRV	X	X	X	X	√	X	X	X	√	X	X	X	√	√	X	X

Note: 6 tubers tested/replicate/treatment

CONCLUSIONS

Results indicate that the yield reduction in the crop raised with farmer practice was 18.85% (from 27.48 to 22.3 t/ ha) and 29.00% (from 31.70 to 22.51 t/ ha) in cv. Kufri Jyoti and 30.41% (from 25.25 to 17.57 t/ ha) and 38.55% (from 31.33 to 19.25 t/ ha) in cv. Kufri Giriraj in Meghalaya and Nagaland states respectively as farmers do not treat ware potato crop with any pesticide, hence the vector population as well as the virus incidence remain high. Further, in our trials crop yields were higher in treatments where crops were raised with quality seed *i.e.* 30.15 and 32.25 t/ ha in cv. Kufri Jyoti and 25.25 and 31.33 t/ ha in cv. Kufri Giriraj in Meghalaya and Nagaland states, respectively. It gave an indication that the crop productivity can be raised 2-3 folds higher than present average, if good quality seed socks are made available to the farmers at their door step. The findings also revealed that vector transmitted viruses like PVY, PVM, PVA and PLRV are prevalent at lower altitudes due to high vector pressure while contact viruses *i.e.* PVX & PVS are in abundance at all the sites, mainly due to the fact that farmers in the absence of availability of quality seed bound to use same seed stocks year after year. The studies are relevant for identifying locations with low aphid pressure for minimum degeneration of seed stocks for multiplying seed potato crops in the respective NE states.

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