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Studies on Potato Seed Tuber Degeneration in Karnataka

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ABSTRACT: Pathogen buildup in vegetative planting material which is drawn from within a crop population over multiple generations, termed as seed degeneration. The degeneration of potato is appeared to be either due to physiological causes or due to infection of tuber-borne viruses. To study the potato seed tuber degeneration an experiment was conducted under AICRP on Potato at Horticulture Research and Extension Centre, Hassan, Karnataka during *Rabi* season for three consecutive years from 2017 to 2019. An experiment was conducted by using Randomized Complete Block Design with four replications. In the study, treatment with previous seed produce with seed plot technique and previous seed produce without seed plot technique tubers were used. The variety Kufri Jyoti was adopted in the experiment as a ruling variety and agronomic practices were followed as per the package of practices of UHS, Bagalkot. An observation on per cent plant emergence, total tuber yield, per cent incidence of mosaic and Potato Leaf Roll Virus (PLRV) viral diseases at 50 and 65 days after planting were documented. The percentage of plant emergence was recorded maximum in previous seed produce with seed plot technique (88.98 %) as compared to without seed plot technique (85.77%). The lower percentage of mosaic (10.70) and PLRV (7.02) were noticed at 65 days after planting in the treatment of previous seed produce adopted with seed plot techniques. It was also registered highest tuber yield of 12.38 t/ha in the treatment of seed plot techniques compared without seed plot techniques (9.70 t/ha). Hence from the study, it was concluded that previous seed produce with seed plot techniques had lower incidence of viral diseases with higher tuber yield. To decrease the rate of degeneration use of seed tuber production system based on the seed plot technique can be considered as the primary management strategy tocounter on-farm seed degeneration.

Keywords: Seed degeneration, Mosaic, Potato Leaf Roll Virus, Yield, seed plot technique.

INTRODUCTION

In vegetative propagated crops, pathogens tend to accumulate if planting material is drawn from within a crop population over multiple generations, resulting in significant quality and yield losses. This problem, termed as seed degeneration. Potato, being vegetative propagated crop, is very prune to seed degeneration as several potato viruses accumulate to the seed tubers overtimes resulting into its reduced yield potential. It needs large quantity of healthy seed for its successful cultivation without losing productivity. Seed potato degeneration, the reduction in yield or quality caused by an accumulation of pathogens and pests in planting material due to successive cycles of vegetative propagation, has been a long-standing production challenge for potato growers around the world. Propagation of potato is done vegetative using seed tubers. This ensures uniformity of the crop in terms of growth and yield but resulting in degeneration of the crop due to virus infection. The rate of degeneration vary from variety to variety, place to place and from cropping season to cropping season. In a recent study by Van der Waals *et al*. (2013), the aphid population in specific agro-ecosystems in South Africa was predicted to increase by 2050. This in turn could increase outbreaks of Potato Virus Y and Potato Leaf Roll Virus epidemics. PLRV is one of the most prevalent viral

diseases of potato in India. All Indian potato varieties are susceptible to this virus. Yield loss normally ranges from 20 to 50% in India but in extreme cases may be as high as 50–80%, and infected plants produce only a few, small to medium tubers in severe secondary infections.

Virus replication and movement rates can be affected by climate change (Canto *et al*., 2009) and potato tuber infection is temperature sensitive, with increased susceptibility in warmer temperatures. Together with new and emerging tuber borne infections, these studies suggest that degeneration of potato is likely to become a greater challenge in the coming decades, with predicted increasing temperatures (Ghimire *et al*., 2016). The rate and expression of seed degeneration are directly and indirectly influenced by numerous environmental parameters and geographical characteristics that act not only on the host and pathogen and their interaction, but also modify vector dynamics (Thomas-Sharma *et al*., 2016).

In India, a conventional seed tuber production system based on the "seed plot technique (SPT)" has successfully been used for the last five decades. Since its introduction, the SPT revolutionized the indigenous quality seed production system in the subtropical plains of India by extending it from the hills to the plains. The seed plot technique practiced in India (whereas it starts out with certified virus free seed) is largely based on cultural practices to keep tuber seed healthy, growing during seasons and areas with low vector pressure coupled with IPM (Integrated Pest Management), rouging (negative selection), and dehaulming the seed crop before vectors reach a critical threshold limit. Insecticide application to prevent PLRV spread in seed potato crops is also routinely used where seed potato stocks are multiplied in more aphid vector prone areas. The use of certified seed is often recommended as the primary management strategy to counter on-farm seed degeneration (Kreuze *et al*., 2020). Over one cycle of multiplication, degeneration management by positive seed selection was found to be efficient in reducing virus diseases compared with the farmers' method of selection (Priegnitz *et al*., 2019).

Seed potato degeneration is the build-up of diseases in potatoes over seasons, as a result of replanting tubers infected with viruses or other seed borne diseases. The degeneration of potato is appeared either due to physiological causes or due to infection of tuber-borne viruses specially PVY and PLRV. Infection by any one virus alone or some of them jointly would retard plant growth and reduce tuber yield in every generation. PVY and PLRV are the two tuber-borne viruses causing tremendous damage to the potato crop also caused degeneration on seed potato production. Therefore, proper selection depending on the conditions in which seed material is to be produced is of crucial importance to seed potato production. The limited data available related to the extent and variability of management component adoption, especially in scenarios where seed degeneration is a problem and it has become a challenge for model parameterization (Thomas-Sharma *et al*., 2017).

It has been recognized that the poor yield of potato is attributed due to use of virus infected seed potato infected by PVY and PLRV. Seed potato infected with PVY and PLRV seem to be degenerated following the successive generation (Sarker *et al*., 2018). It is an acute problem of seed potato production. So, it is highly important to evaluate the denegation behaviour of potato due to infection of PVY and PLRV. Therefore, the present study was undertaken for three consecutive years to detect the effect of PVY and PLRV on yield and resulting retardation in the rate of degeneration of potato during *Rabi* season under southern dry zone of Karnataka. Further, this paper aims to study the nature, causes and importance of potato seed degeneration which will further help in formulating a potato seed health strategy.

MATERIALS AND METHODS

An experiment was conducted for three consecutive years from 2017 to 2019 during *Rabi* season at Horticulture Research and Extension Centre, Hassan, Karnataka. A study was conducted by using Randomized Complete Block Design with four replications under storage. For seed degeneration studies, Kufri Jyoti tubers were planted at 60 cm × 20 cm spacing with soil application of recommended dose of fertilizers (75:75:100 kg NPK/ha) and FYM (25 t/ha) during *Kharif* season as per package of practices of UHS, Bagalkot.

Treatments:

T1 : Previous seed produce using seed plot techniques

T2 : Previous seed produce without seed plot techniques

Growth parameters:

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

$$\text{Plant emergence (\%)} = \frac{\text{Total no. of tubers germinated}}{\text{Total no. of tubers planted}} \times 100$$

Yield attributes:

Grade wise tuber yield (t/ha). Out of total tubers obtained in each plot, all tubers were sorted in to four different grades based on their weight as extra large-A grade (>76g), large- B grade (51-75g), medium-C grade (26-50g) and small-D grade (<25g) and transformed into tonnes per hectare.

Total tuber yield (t/ha)

Total tuber yield (t/ha) = A-grade + B-grade + C-grade + D-grade

Per cent incidence of Mosaic (%) and PLRV (%) at 50 and 65 days after planting

Per cent Disease Incidence (PDI) of Mosaic and PLRV was calculated by using the following formula.

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

Statistical analysis: A significance test was adopted by analysis of variance (ANOVA) for Complete Block Design. The ANOVA was carried out using the General Linear Model of the SAS procedure of version 9.1 (Anon., 2007). For factors showing significant effects, mean comparisons were made using the Duncan's Multiple Range Test (DMRT) at 5 per cent level of significance.

RESULTS AND DISCUSSION

Per cent plant emergence recorded for all three consecutive years from 2017 to 2019. Pooled data indicated that treatment T1: Previous seed produce using seed plot techniques recorded highest per cent plant emergence of 88.98 per cent and 84.13 per cent at 30 and 40 days after planting respectively, (Table 1). Grade wise tuber yields were recorded for three consecutive years and data indicated that treatment T1: Previous seed produce using seed plot techniques recorded highest marketable tuber yield with A-grade 2.13 t/ha and B-grade 5.34 t/ha. Whereas, treatment T2: Previous seed produce without seed plot techniques documented more number of C-grade (3.93 t/ha) and D-grade (1.67 t/ha) tuber yield. Over all, treatment T1: Previous seed produce using seed plot techniques recorded highest tuber yield of 12.38 t/ha as compared with T2: Previous seed produce without seed plot techniques registered of 9.70 t/ha (Table 2 and 3). Basu *et al*., (2003) and Singh *et al*., (2014) also reported that potato crop raised through seed plot technique gave lower incidence of viral diseases and higher tuber yield. Further Ali *et al*., (2013) found that vector transmitted viruses were prevalent only in ware crop but almost absent in crop raised with quality seeds.

Table 1: Per cent plant emergence at 30 and 40 days after sowing.

Treatment	Plant emergence (%) 2017		Plant emergence (%) 2018		Plant emergence (%) 2019		Plant emergence (%) Pooled	
	30 DAP	40 DAP	30 DAS	40 DAP	30 DAP	40 DAP	30 DAP	40 DAP
T1	87.20	81.60	91.50	87.35	88.24	83.45	88.98	84.13
T2	86.60	78.40	88.20	81.15	82.50	79.60	85.77	79.72

Table 2: Marketable tuber yield (t/ha).

Marketable tuber yield (t/ha)											
A- Grade >75g				B-Grade 51-75g				C-grade 26-50 g			
2017	2018	2019	Pooled	2017	2018	2019	Pooled	2017	2018	2019	Pooled
2.80	1.85	1.75	2.13	5.75	5.12	5.15	5.34	3.40	3.56	3.28	3.41
1.05	1.15	0.85	1.02	2.10	2.00	3.60	2.57	4.20	4.19	3.40	3.93

Table 3: Un-marketable and Total tuber yield (t/ha).

D-grade 0-25g				Total tuber yield (t/ha)			
2017	2018	2019	Pooled	2017	2018	2019	Pooled
1.35	1.02	2.10	1.49	13.30	11.55	12.28	12.38
2.15	1.15	1.70	1.67	9.50	9.59	10.00	9.70

Similarly, treatment T1: Previous seed produce using seed plot techniques registered lowest per cent of Mosaic (10.70 and 16.42) and PLRV (7.02 and 11.33) at 50 and 65 days after planting respectively, (Table 4 and 5). Results are in accordance with the findings of Ghimire *et al*. (2016). They found linear relationship among the yield and the degree of virus infection. PLRV and PVX viruses perpetuate in the seed stock and cause degeneration of varieties if necessary management measures are not adopted. Among the two viruses, PVY was reported to be more damaging compared to PLRV (Rahman *et al*., (2010). Degeneration of potatoes is marked by stunting and curling and overall chlorosis of plants or at least the foliage. It is responsible for rather small sized tubers and poor yields Singh *et al*., (2012).

A combined approach for degeneration control adjusted to the local socio-economical and climatic context, as suggested by (Thomas-Sharma *et al.*, 2016), may be the best way to go in developing countries where sophisticated seed production schemes are not currently a viable option. In addition, an improved understanding of farmers' motivations to use (or not use) planting material from formal sector sources is one step towards better designed interventions for the improved quality seed tuber production (Almekinders *et al*., 2019).

Table 4: Per cent incidence of Mosaic (%) at 50 and 65 days after planting.

Treatment	Mosaic (%)							
	2017		2018		2019		Pooled	
	50 DAS	65 DAS	50 DAS	65 DAS	50 DAS	65 DAS	50 DAS	65 DAS
T1	12.00	16.00	11.60	20.50	8.50	12.75	10.70	16.42
T2	18.00	32.00	15.70	25.00	11.25	19.50	14.98	25.50

Table 5: Per cent incidence of PLRV (%) at 50 and 65 days after planting.

Treatment	Potato Leaf Roll Virus (%)							
	2017		2018		2019		Pooled	
	50 DAP	65 DAP	50 DAP	65 DAP	50 DAP	65 DAP	50 DAP	65 DAP
T1	7.00	12.00	8.50	14.00	5.55	8.00	7.02	11.33
T2	14.00	17.00	10.00	18.25	9.45	14.40	11.15	16.55

CONCLUSION

In the study, lower percentage mosaic (10.70) and potato leaf roll virus of 7.02 per cent incidence were observed in the treatment with previous seed produce using seed plot techniques at 50 days after planting and it was also documented highest tuber yield of 12.38 t/ha. The results indicates in each generation potato seed tuber yield under gone degeneration losses at the range of 2.68 t/ha and 21.64 per cent. Hence, it is concluded that, tubers used from previous seed produce following seed plot techniques observed lower incidence of mosaic and PLRV with higher yield during *Rabi* season under Southern Dry Zone of Karnataka. Over all, use of seed plot technique for the production of potato tubers was found beneficial as it reduced the rate of degeneration. Further, incorporation of hi-tech seed production systems coupled with advanced virus detection techniques may help in fulfilling the very large demand of quality seed potatoes in the state.

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Conflict of Interest. Nil.

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