Agrotechnology
ISSN: 2168-9881

Ghimire et al., Agrotechnology 2016, 5:2
DOI: 10.4172/2168-9881.1000149

Research Article Open Access

Study on Degeneration of Potato Seed in Terai Region of Nepal

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Abstract

Field experiments were conducted in the experimental field of Regional Agriculture Research Station (RARS), Parwanipur, and Bara, Nepal. The objective of study was to evaluate the rate of degeneration due to viral diseases in Cardinal and Kufri Jyoti. The experimental plot design was Randomized Complete Block Design with 3 replication and 5 treatments considering each farmer as a replication. There were 10 treatment combinations consisting 2 varieties. DAS-ELISA was done to find out the degree of virus infection. Result showed a significant ($P<0.01$) effect of virus in yield loss of potato. Data of three different years were compared to find out the percentage loss due to damage cause by virus. Field observation was done for other insects and pest. The DAS ELISA results revealed that during third year the presence of PVM and PVY was highest in Cardinal under and Kufri Jyoti under control treatment condition respectively. Yield data of three different year showed that there is serious loss (27–46%) on an average in the subsequent year in the productivity of potato. To decrease the rate of degeneration insect proof net can be used which is cheaper and environment friendly resulting the satisfactory yield in the subsequent generation.

Keywords: Virus; Degeneration; Potato viruses; Small scale farmers

Introduction

Potato (*Solanum tuberosum*) is an important crop both in the hills and the terai of Nepal. 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 [1]. It needs large quantity of healthy seed for its successful cultivation without losing productivity [2]. 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 [3]. In developing countries like Nepal, small scale farmers do not have easy access to the quality seed leading to significant reductions in yield. Studies on the cause of degeneration of seed potatoes in the country showed that the aphid is responsible for the spread of virus diseases in the fields. 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 [4]. Major potato viruses, namely PLRV, PVS, PVX, PVY, PVA and PVM had been reported to infect potato crops in Nepal [1]. Infection by any one alone or some of them jointly would retard plant growth and reduce tuber yield [5]. Infection of viruses has devastating effect bringing down the yield potential of the infected plants. The varieties react with different degrees of loss in tuber yield depending on the virus stage of infection, and period of field exposure of the seed stocks [6,7].

Materials and Methods

Seed tubers of Cardinal and Kufri jyoti, a commonly cultivated potato variety in terai of Nepal, were used. The experiment was conducted in three consecutive crop seasons of 2070-71, 2071-72, 2072-73 at the experimental field of Regional Agriculture Research Station (RARS), Parwanipur, and Bara. The seed potato obtained from 2070-71 were planted in the subsequent year of 2071-72 and those obtained from that year were planted in 2072-73 [8,9].

Fertilizers were applied @ 100:100:60 kg/ha Urea, DAP, MOP as recommended by NARC (Nepal Agricultural Research Council). One half of urea and full dose of DAP and MOP were applied at the time of planting. Other half of urea was applied as side dressing after 35 days of planting when first earthling up was done. During land preparation, compost was applied at 20 t/ha. The seeds were planted in the field on second week of Mangsir and harvested in first week of Chaitra. During all the crop seasons of all three years, seed tubers were preserved in the cold storage. Whole tubers were planted maintaining 60 cm row to row and 25 cm seed to seed distances. The experiment was laid out following randomized complete block design (RCBD) with four replications. The unit plot size was 3 m×2.5 m. Intercultural operations, such as irrigation, weeding, mulching, and earthling up were done as and when necessary (Tables 1 and 2). The data were collected with following observation:

a. Emergence at 30 and 60 days after sowing

b. No. of stem per plant

c. Plant Height

d. Tuber yield per plot: For this data the total yield from a single plot was divided to three grades as under seed size; Seed size and Over seed size and the weight and number of each grade were recorded.

The samples were collected after 45 days of emergence for performing virus test and DAS-ELISA test was done. Virus incidences in the potato foliage from different treatments were detected through ELISA and presented in Figure 1.

Results and Discussion

The field trials were conducted at RARS Parwanipur, representing major potato growing area, using predominant varieties (Cardinal

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Received September 17, 2016; **Accepted** October 13, 2016; **Published** October 10, 2016

Citation: Ghimire S, Pandey S, Gautam S (2016) Study on Degeneration of Potato Seed in Terai Region of Nepal. Agrotechnology 5: 149. doi: 10.4172/2168-9881.1000149

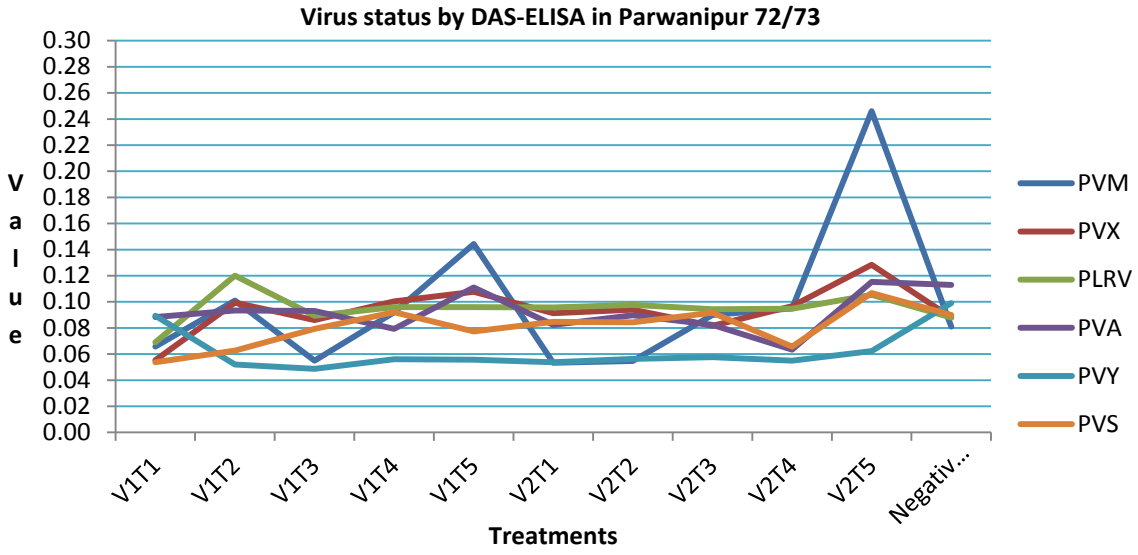

Figure 1: Graph showing the result by DAS-ELISA on status of virus.

SN	Treatments	Variety	Combination
1	Covered by insect proof net	V1: Kufri Jyoti	T1V1
		V2: Cardinal	T1V2
2	Only spraying of appropriate insecticides when aphid population reaches critical	V1: Kufri Jyoti	T2V1
		V2: Cardinal	T2V2
3	Only roughing of infected plant (negative selection)	V1: Kufri Jyoti	T3V1
		V2: Cardinal	T3V2
4	Spraying of appropriate insecticides and roughing of infected plant (2+3)	V1: Kufri Jyoti	T4V1
		V2: Cardinal	T4V2
5	Control	V1: Kufri Jyoti	T5V1
		V2: Cardinal	T5V5

Table 1: Treatment Combination.

Design	RCBD
Total Treatment combination	10
Number of replication	3
Area of individual plot	3 m × 2.5 m
Total plot area	3 × 2.5 × 10
Net experimental area	3 m × 2.5 m × 10 × 3

Table 2: Experimental Setup.

and Kufri Jyoti) 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 emergence after 30 and 60 days of sowing, uniformity, vigor, stem/plant, plant height, number of plant harvested, number and weight of under, seed and over size seed, incidence of disease and insects were observed.

The DAS ELISA results revealed that during third year the presence of PVM and PVY was higher in Cardinal under control treatment and in Kufri Jyoti under control condition respectively.

Regarding the percentage yield loss, result showed that the highest percentage loss in second year compared with the first year was highest in Kufri Jyoti (48.2%) in control condition followed by Cardinal (43.5%) in T2. Yield loss in the third year compared with second year was highest in Kufri Jyoti (43.85% & 43.5%) in control and T3 respectively. In both the years, the yield loss of Kufri Jyoti in the control condition is highest this might be because of high infestation by aphid and presence of viral disease along with other environmental factor. PLRV, PVX and PVY virus was detected in Kufri Jyoti with control treatment in both the year. Surprisingly the highest yield loss was noticed in T2 and T3 is subsequent year in case of Cardinal and PVX, PVY and PLRV virus was detected in DAS ELISA though insecticides were sprayed in T2 and roughing was done in T3. Yield loss in the control treatment was more in every subsequent year compared to other treatment; this might be because of controlled aphid and other insects.

The observation was done on emergence, stem/plant and plant yield. In first and second year the emergence was highest in V1T2 and in the third year in V2T4. And lowest emergence was on V1T1, V2T2 and V2T1 in first, second and third year, respectively. Result on number of stems per plant was highest in V1T4 in the first year and V1T1 in the second and third year. Less number of stem per plant was in V2T4 in first and second year and V2T3 in the third year. Plant height was found higher in V1T1 in first and second year and V1T4 in the third year. Plant with lowest height was observed in V1T2 in first and second year and V2T5 in the third year (Figure 2).

Yield Loss vs. Virus Incidence

While performing ANOVA for finding the effect of virus on yield loss, the result revealed that it is highly significant ($p>0.01$). The result of this experiment showed that yield and the degree of virus infection have the linear relationship and fits the function ($y=26.424+72.23x$) with value of r^2 to be 0.1143. The result showed the less percentage yield loss in the plot having insect proof net that might be because of fewer aphids inside the very plot however some loss may be due to other environmental and genetic factors. Loss in production of tuber yield varies from 27% to 46% so it emphasizes the need for farmers to use the clean seed which is the main input for increasing productivity (Figure 3) (Table 3).

Conclusion

Results indicate that the yield reduction was 26–46% in treatment T4 and T5, respectively in Kufri Jyoti and 27.5 to 42.4%

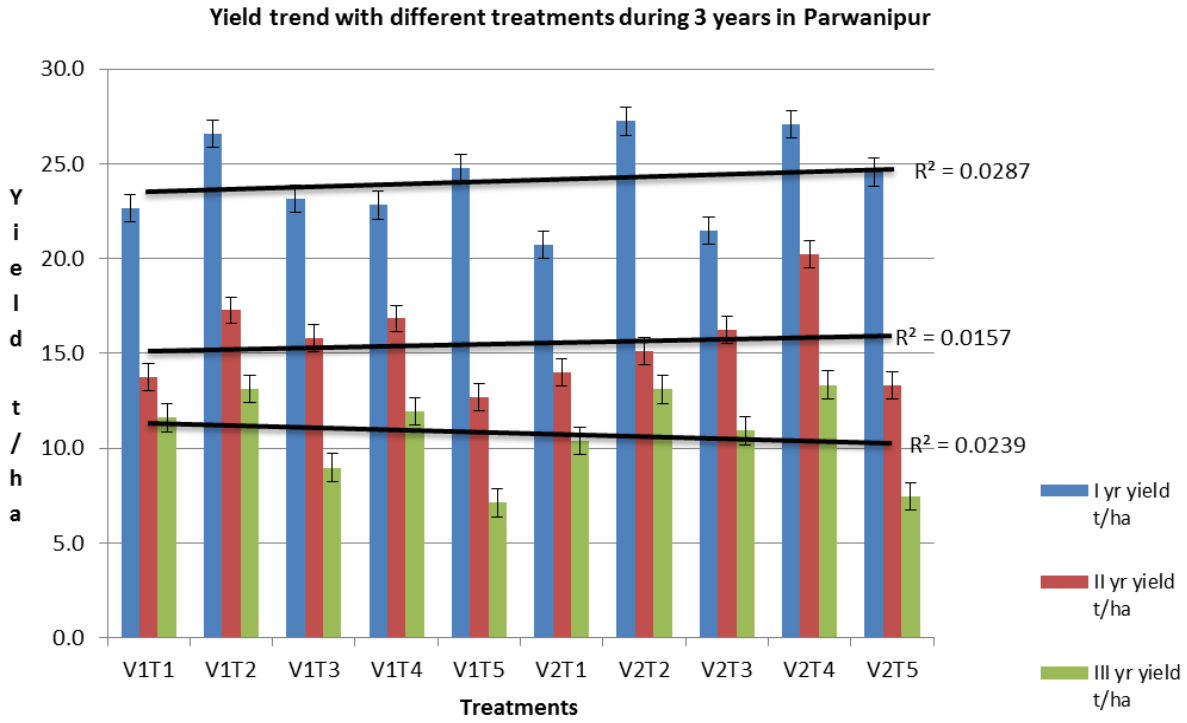

Figure 2: Graph showing the trend of productivity with different treatments.

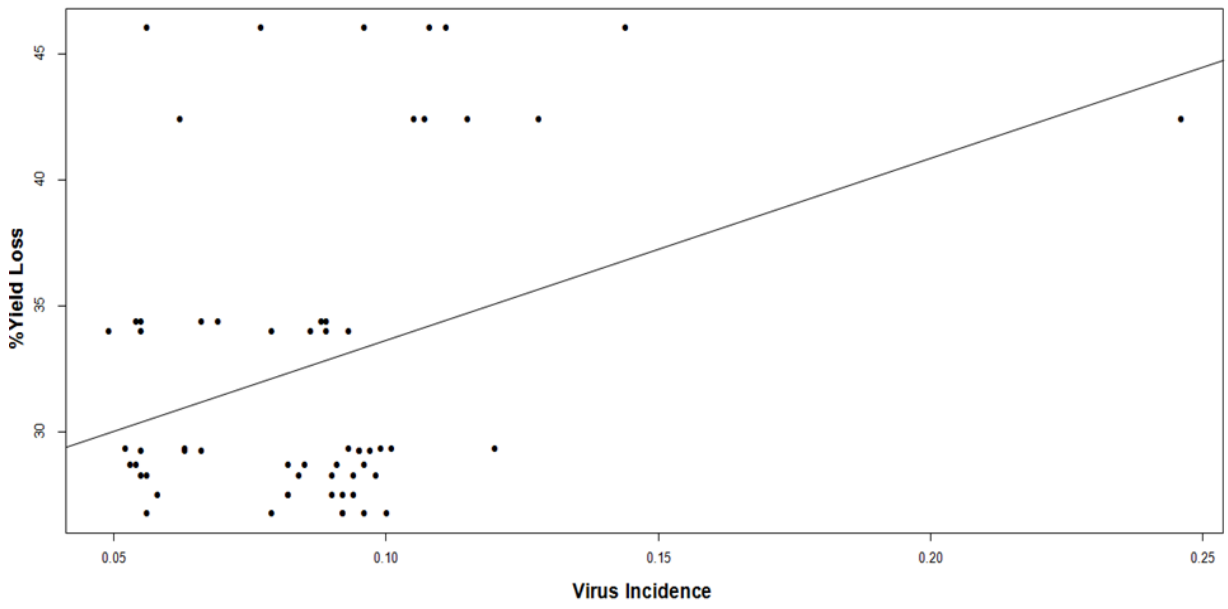

Figure 3: Yield loss % of potato vs. virus incidence.

in treatment T3 and T5 in Cardinal, respectively. PLRV, PVX and PVA virus was detected in Kufri Jyoti with control treatment in both the year and PVX and PLRV virus was detected in Cardinal with treatment T2 and T3 while testing through DAS ELISA. Crop yield was higher in treated plot compared to control in both variety giving the highest yield by Kufri Jyoti 16.6 t/ha under T4 and 13.1 t/ha under T2 in second and 3rd year, respectively. And in case of Cardinal yield was higher in 20.2 under T4 and 13.1 under T2 in second and 3rd year, respectively. It gave an indication that the crop productivity can be raised 2-3 times higher than present average, if good quality seed socks are made available to the farmers at their door step. To decrease the rate of degeneration insect proof net can be used which is cheaper and environment friendly resulting the satisfactory yield in the subsequent generation.

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Response: YL
                  Df  Sum Sq    Mean Sq    F value    Pr(>F)
VI                 1   272.94    272.939    7.4863 0.008237 **
Residuals         58   2114.58   36.458
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Coefficients:
                    Estimate Std. Error  t value  Pr(>|t|)
(Intercept)          26.424      2.408    10.975   8.82e-16 ***
Virus Incidence      72.236      26.401    2.736    0.00824 **
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 6.038 on 58 degrees of freedom
Multiple R-squared: 0.1143,     Adjusted R-squared: 0.09905
F-statistic: 7.486 on 1 and 58 DF,  p-value: 0.008237
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Table 3: Analysis of Variance.

Acknowledgement

I would like to express my special thanks to the entire National Potato Research Program family.

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