

Original Research Article

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Potato Seed Production Systems and Disease Prevalence in Major Potato Growing Regions in Kenya

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ABSTRACT

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Seed-borne diseases are a major problem in Kenya since many farmers have no access to certified seeds. The objective of the study was to study the influence of potato seed production systems on potato seed borne diseases. A survey was carried out in five major potato growing counties in various agro-ecological zones (AEZs). An open ended questionnaire was administered to 59 farmers to collect information on farming practices and disease parameters. Most of the farmers apart from Kiambu County use their own farm saved seeds, buy from the local market and from their neighbors. Some farmers renew seeds from reliable sources with Kiambu leading with about 80% followed by Nakuru (27.3%), Nyandarua (18.2%) and Meru (13.6%) respectively. Bacterial wilt disease and potato leaf roll were detected in all the counties. In case of bacterial wilt, the highest prevalence was in Nyeri County with a prevalence of 90.0%, followed by Meru and Nyandarua each with 81.8%. Most farmers' use poor quality seeds and due to small farm sizes they are unable to practice crop rotation leading to high prevalence's of bacterial wilt and potato leaf roll virus.

Introduction

Potato is an important crop in Kenya and it ranks fourth among the four major crops grown that include rice, wheat and maize (Hoffler, 2008; FAO, 2008). It provides high incomes for small scale farmers and it is a potential source of employment to many people both directly and indirectly (Mbaka *et al.*, 2013). Seed quality is affected by biological aspects such as the level of disease infection and physiological age of seed tuber. Tuber seeds planted continuously for several years show degeneration which is a result of viruses and virus-like organisms which accumulate in tubers. The major viruses

infesting potato and lowering potato seed quality are mainly potato leaf roll virus, potato virus Y, potato virus X, potato virus A and potato virus M (FAO, 2008). Bacterial wilt is a serious threat to tomato production due to limited strategies to control the disease effectively and farmers are abandoning cultivation of the crop due to the disease (Mbaka *et al.*, 2013).

To guarantee quality, seed should be free from bacteria, viruses and fungi which may lead to seed degeneration (FAO, 2010). Production of certified seed potato starts with

in-vitro plantlets from meristematic tissue in tissue culture laboratory. Plantlets are multiplied and after hardening, they are planted in sand media in greenhouses to produce mini-tuber seeds which are multiplied in the field for three generations to produce basic seed (Mbiyu *et al.*, 2012; Muthoni *et al.*, 2013). There has been lack of enough certified seeds to be supplied to farmers and this has forced farmers to plant seeds from their own farms and other sources. These poor quality seeds increase the rate of spread of seed-borne diseases such as bacterial wilt leading to high incidence and prevalence. Previous research indicates that bacterial wilt is found in all the potato growing areas of Kenya affecting 77% of potato farms followed by late blight (69%) (Peeters *et al.*, 2013; Kaguongo *et al.*, 2010).

Although crop rotation can reduce disease incidences, many farmers were not able to practice it due to the small farm sizes (Muthoni *et al.*, 2013). Cropping cycle using seeds from the same farms without renewing from reliable sources also contributes to the accumulation of seed-borne diseases namely bacterial wilt caused by *R. solanacearum* (Tahat *et al.*, 2010) and viral diseases such as PVY and PLRV which are the major potato diseases. Poor quality seeds reduce potato quality and yields (Gidemacher *et al.*, 2009).

Materials and Methods

The survey was conducted in the major potato growing counties in Kenya namely Nyeri, Nyandarua, Meru, Nakuru and Kiambu (Figure 1). The farms surveyed ranged in altitude from 2079 to 2617 meters above sea level (masl). The agro-ecological zones surveyed for the various counties were Meru-UH3 (wheat and barley zone), Nyandarua – UH3 (wheat-barley zone), Molo Elburgon – UH2 (pyrethrum – wheat zone), Nyeri-LH4 & LH3 (cattle-sheep zone) and Kiambu-LH3

(cattle-sheep zone) (Jaetzold *et al.*, 2007). In these counties, potato crop is grown for food consumption and commercial purposes.

In each surveyed county, farms were selected at random in the counties about 2-4km from each other. During the survey, bacterial wilt and potato leaf roll virus disease incidences were recorded per sampled farm. During the survey, a total of 59 farmers were interviewed and these included Nakuru (11), Nyandarwa (11), Meru (22), Nyeri (10) and Kiambu (5). Information was collected using an open ended questionnaire to allow individual farmer to express themselves and to be able to gather much responses on the potato seed production systems. The information covered included farmers' practices such as source of seeds, seed renewal, cropping cycle, area under potato production and disease prevalence. The collected data was recorded and analyzed using Statistical Package for Social Sciences (SPSS Inc. (2009). Visual assessment of the farms showing symptoms of bacterial wilt and potato leaf roll virus was done and disease severity and prevalence per sampled farm recorded.

Information on geographical positioning system (GPS) was collected namely elevation, longitude and latitude for mapping the position of the sites of survey using geographical information system (GIS). Samples were collected from farmers, certified seed and registered seed merchant systems, and taken to KEPHIS Laboratories at Muguga and analyzed for latent infection of bacterial wilt caused by *Ralstonia solanacearum* and viruses. Presence of bacterial wilt and viral diseases on the collected samples was achieved using both serology and conventional methods. Nitrocellulose membrane-ELISA (NCM-ELISA) was used for bacterial wilt screening while Double Antibody Sandwich-Enzyme Linked Immuno-Sorbent Assay (DAS-

ELISA) kit by Centre for International Potato (CIP) was used in the detection of viruses. Results were confirmed using FORSITE quick diagnostic kits from Central Laboratory U.K. for detection of bacterial wilt and viruses.

Results and Discussion

A total of fifty nine (59) farmers were interviewed and these comprised of 37.3% from Meru, Nakuru 18.6%, Nyandarua 18.6%, Nyeri 16.9% and Kiambu 8.5% The land allocated to potato production varied from 0.3 ha to 0.7 ha, with Nakuru having the highest acreage under potato production of 0.7 ha followed by Kiambu with 0.5 ha, Meru 0.4 ha, Nyandarua 0.3 ha and Nyeri-Kieni East with the lowest acreage of 0.3 ha.

Eighty percent (80%) of farmers in Kiambu County obtain clean potato seeds from KALRO Tigoni, (10.3%) farmers from Meru obtain potato seeds from Kisima Farm. Farmers from Nakuru, 20% source seed from Turi Farm and for Nyandarua 15% of the farmers' source seed from KALRO Njabi-ini. Farmers from the five counties also obtains high percentage of seeds from their own farms with Nyandarua leading with 69.2%, followed by Meru 65.5%, Nyeri 60%, Nakuru 46.7% and Kiambu 20%. Farmers also buy seeds from neighbours and market with Nyeri having 40%, Nakuru 33.3%, Meru 24.1% and Nyandarua 15.4%. There was a positive correlation between seed source and disease incidence with Kiambu and Nakuru having low bacterial wilt and potato leaf roll virus compared to the other counties. Seed source and incidence of BW and PLRV were either positively or negatively correlated. Where farmers were using certified seeds, there were fewer incidences of BW and PLRV. Where farmers were obtaining seeds from their own farms and neighbours there were high levels of BW and PLRV (Figures 2 and 3).

Some of the farmers interviewed renewed potato seed from reliable sources with Kiambu leading with 80% followed by Nakuru 27.3%, Nyandarua 18.2% and Meru 13.6%. In Nyeri Kieni -East 1.0 % of farmers renew seeds from reliable sources (Table 1). The study showed that 60% of the farmers interviewed did not renew the potato seed from reliable sources but used seeds from their own farms or purchased them from their neighbours. Use of uncertified planting seed increases seed borne diseases like BW and PLRV.

There was a negative correlation between seed renewal and disease incidence and this can be clearly seen in Nyeri county where most of the respondents did not renew seed. Regression analysis showed a negative correlation between increase in seed renewal with decrease in disease prevalence (Figures 4 and 5). Nyeri had bacterial wilt incidence of 90% and PLRV of 80% which is relatively high compared to other counties like Kiambu and Nakuru with PLRV of between 36.4% and 40%. Bacterial wilt disease incidence was relatively low between 60% and 64% in comparison with Nyeri.

Bacterial wilt disease was detected in all counties and the prevalence was highest at 90% in Nyeri followed by Meru with 82%, Nyandarua 82%, Nakuru 64% and Kiambu 60.0%. There was no significant difference in prevalence of bacterial wilt in the five counties. The study also showed that most of the farmers in Nyeri do not source seeds from reliable sources and therefore bacterial wilt prevalence was highest in the area. Bacterial wilt prevalence was lower in Kiambu County at 60% where 80% of farmers obtain seeds from reliable sources than in Nyeri 90%, Meru 82%, Nyandarua 82% and Nakuru 64% (Table 2). There was a significant correlation between clean seeds use and disease prevalence where bacterial wilt disease

decreased with increase in clean seed with correlation of $R^2=0.6529$ for BW and PLR value as $R^2=0.4251$.

Potato leaf roll virus was also observed in all the five counties and Nyandarua was leading with 90.9%, followed by Meru with 86.4%, Nyeri 80%, Kiambu 40% and Nakuru 36.4% but it was low in Nakuru and Kiambu compared to all the other counties. Farmers in Kiambu and Nakuru obtain 80% and 20% of potato seeds for planting from reliable sources, respectively and this may have contributed to low potato leaf roll incidence.

Potato is grown in all the counties that were surveyed and Meru was leading with 56% of respondents growing the crop, followed by Kiambu with 55%, Nakuru 50%, Nyeri 48% and Nyandarua 40%. Other crops widely grown are cabbages and maize, with Kiambu having 28% of respondents growing cabbages and 15% growing maize and beans. In Meru 12% respondents were growing cabbage and

carrot and 27% maize and beans while in Nakuru county, the crops grown were Maize + beans by 19% of respondents and rhodes grass grown by 14% of the respondents. Respondents in Nyandarua County also grew other crops besides potato and these are cabbages, oat and carrot while 38% of farmers in Nyeri grew maize and bean and 12% of the respondents were growing cabbages and carrot respectively (Table 3).

The most frequent crops sequences in the five counties surveyed in Kenya are two years' rotation. In Meru county, the rotation is for two years involving potato, maize + beans or cabbage and potato. In Nyandarua, farmers also practiced two years' rotation of potato, cabbage or carrot or pea and those surveyed in Nyeri did the same with potato, beans or maize, cabbage, potato. Farmers in Kiambu mainly planted potato, followed by cabbage, maize +beans and potato while at Nakuru they plant potato, maize + beans, rhodes grass and potato.

Table.1 Proportion of farmers who renew seed in the five counties

% Respondents	Counties				
	Kiambu	Meru	Nakuru	Nyandarua	Nyeri
Do not renew	20.0	86.4	72.7	81.8	99.0
Renew seed	80.0	13.6	27.3	18.2	1.0

Table.2 Percent disease prevalence for the counties

County	Bacterial wilt prevalence	PLRV prevalence
Kiambu	60.0	40.0
Nakuru	63.6	36.4
Meru	81.8	86.4
Nyandarua	81.8	90.9
Nyeri	90.0	80.0

Table.3 Crops grown in each of the five counties and the % age of respondents Growing each crop

	Kiambu	Meru	Nakuru	Nyandarua	Nyeri
Cabbage/carrot/pea	28.0	12.0	5.0	36.0	12
Maize+Beans/pea	5.0	10.0	19.0	10.0	28.0
Banana	10.0	17.0	0.0	0.0	10.0
Napier grass	1.5	3.0	5.0	0.0	2.0
Oat	0.0	0.0	0.0	14.0	0.0
Potato	55.0	56.0	50.0	40.0	47.0
Rhode grass	0.5	0.0	14.0	0.0	1.0
Wheat	0.0	2.0	7.0	0.0	0.0

Fig.1 Map showing areas where the study was carried out

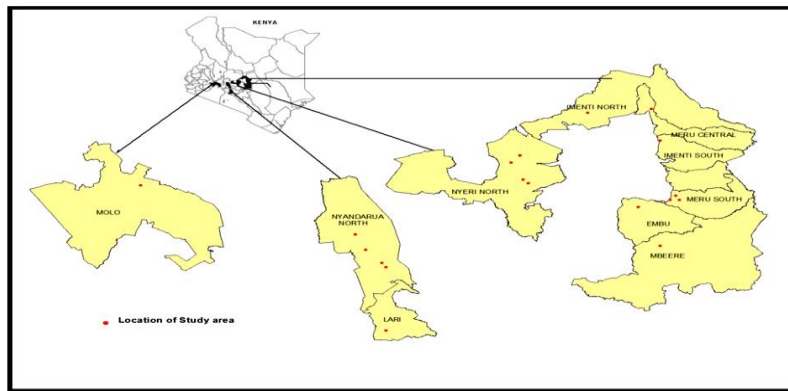
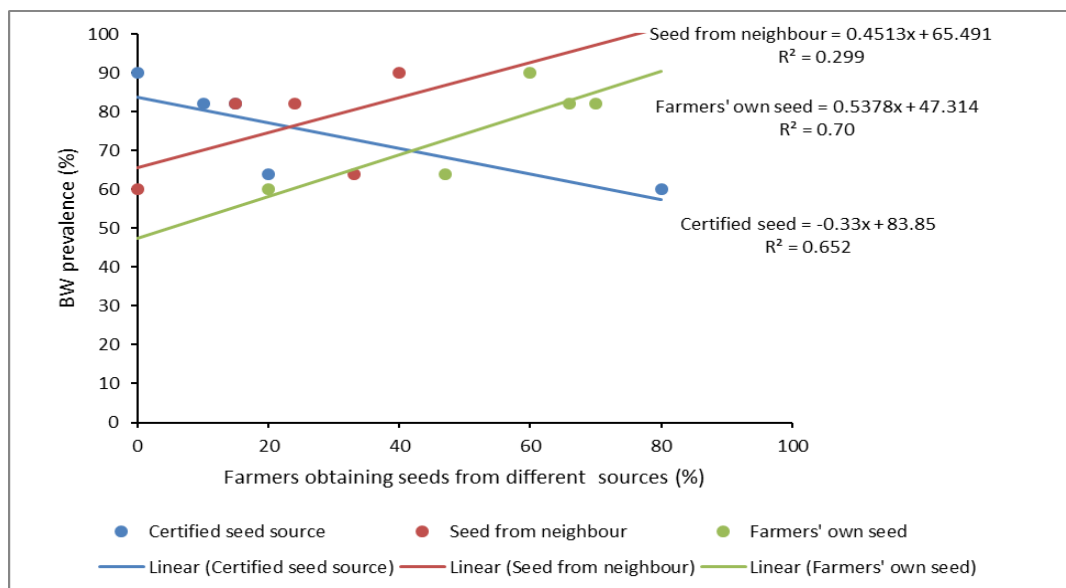
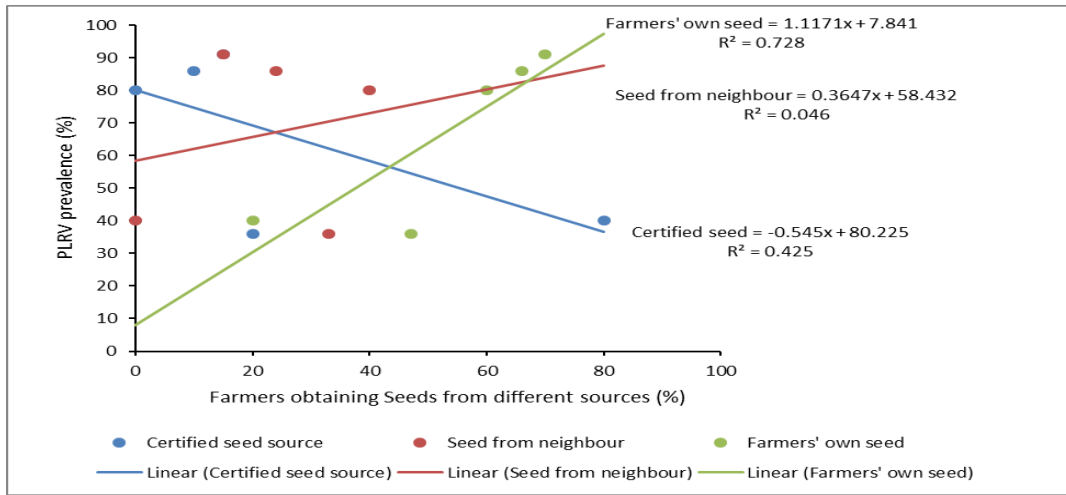


Fig.2 Correlation between bacterial wilt prevalence and farmers obtaining potato seeds from different sources



Key: BW Bacterial wilt

Fig.3 Correlation between potato leaf roll virus prevalence and farmers obtaining potato seeds from different sources



Key: PLRV Potato leaf roll virus

Fig.4 Correlation between bacterial wilt prevalence and number of farmers renewing seeds

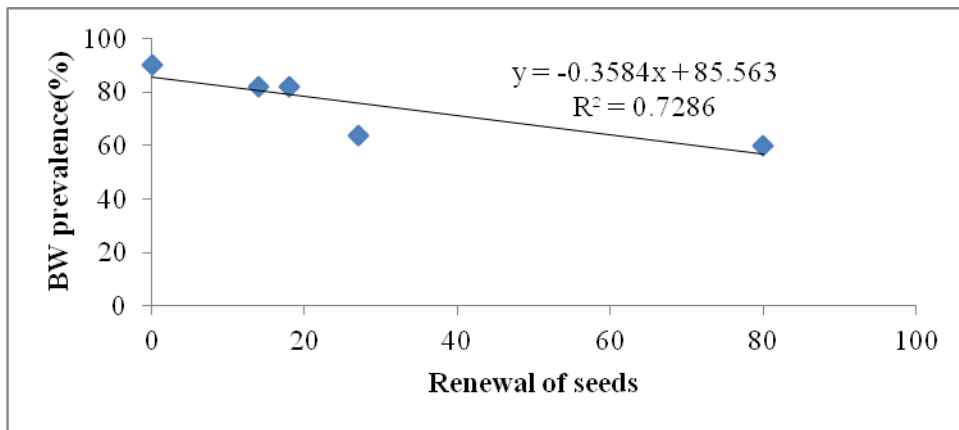
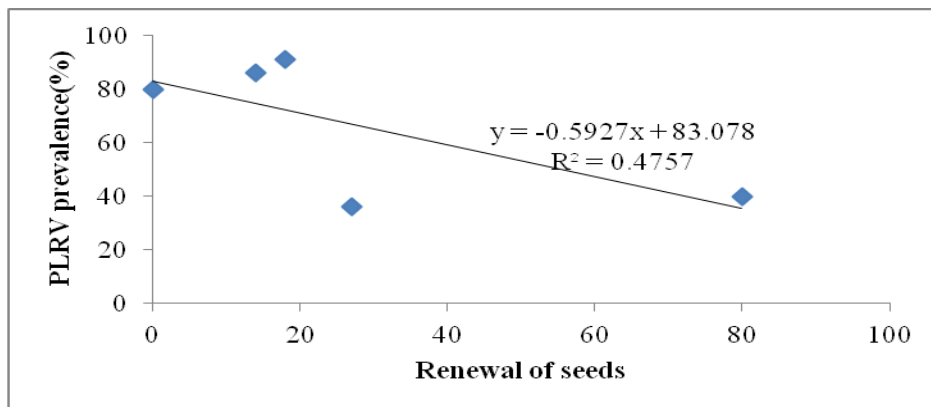


Fig.5 Correlation between potato leaf roll virus prevalence and number of farmers who renew seeds



In Meru county where cropping cycle involves potato rotated with maize or cabbage, BW prevalence was 81.8% and PLRV was 86.4%. In Nyandarua BW was high up to 90.0% and PLRV was 90.9%. In Nyeri where crop rotation is between potato and maize or beans, BW incidence was 90.0% and PLRV incidence was 80.0%.

The study revealed that bacterial wilt was distributed in all the five counties surveyed with a higher prevalence being reported in the high altitude areas. The prevalence of bacterial wilt was lower in Kimbu and Nakuru compared to Nyandarua and Meru which have higher altitude than other counties. This was not expected because these counties lie within high altitude areas (Jaetzold Schmidt, 2007). Strains of *R. solanacearum* have been reported in many parts of the world and it affects over 200 plant species in over 50 families (Champoiseau and Momol, 2009).

The findings showed that farmers obtain seed which are of poor quality from their own farms and neighbours and continue planting them year after year without renewing them from reliable sources and this contributes highly to the problem of bacterial wilt and viruses. In the past, research reported incidence of bacterial wilt at altitudes of 2942 masl which was contributed by factors like source of seeds (Ateka, *et al.*, 2001). Comparatively, Meru County produced more potatoes than the other four counties surveyed with 56% respondents growing the crop. The average farm size under potato production ranged from 0.3 to 0.7 ha for the counties surveyed with Nakuru leading followed by Meru and Kiambu. It is clear that the sizes of the farms in the areas surveyed are relatively small (less than a hectare) and farmers were not able to practice long period of crop. The problem of small farm sizes has been limiting long crop rotation (Lutaladio *et al.*, 1995). Farmers were also replanting poor quality

potato seeds in the same farm and this increased disease incidence and prevalence. This agrees with report by FAO (2008) which indicates that use of low quality seeds in Sub-Saharan Africa contributes to the low average yields.

Most respondents (69%) obtained seeds from their own farms and Nyandarua led with 69% while others obtained seeds from neighbours. Nyeri county had the highest percentage of farmers who obtained seed potato from neighbours. Renewal of seeds was done by a few farmers except Kiambu farmers who obtained clean seed potato from KARLO. Own farm seed potatoes are usually of poor quality and planted continuously for several years, they show degeneration of tubers which is a result of viruses and virus-like organisms that accumulate in them (FAO, 2010).

Farmers who used seeds from their own farms had very high prevalence of bacterial wilt and viruses. Farmers in Nyandarua county used their own seed (69.3%). These results show that most farmers in the surveyed region do not renew seed and this explains the high incidence and prevalence of bacterial wilt and viral diseases. Due to lack of certified seed potatoes for planting farmers plant poor quality seeds from their own farms and this increases seed-borne diseases leading to high incidences and prevalence of BW and PLRV. Previous research indicates that *Ralstonia solanacearum* is a wide spread pathogen and 77% of potato farms in Kenya are affected by the disease (Muthoni *et al.*, 2013; Peeters *et al.*, 2013).

Rotation sequences also play a role in disease prevalence and it can be seen that in Nakuru where potato is rotated with rhodes grass, maize, and other none related crops, PLRV was low. Previous research shows that planting potato crop from the same farm without rotation with none host crop leads to

poor quality seed potato due to degeneration of tubers caused by viral diseases (FAO, 2010). It was noted that even where rotation was done with non- host crop, the incidence and prevalence of bacterial wilt and potato leaf roll was high and this was due to replanting diseased potato seeds from the same farms. Most farmers could not meet the rotation sequence recommended because the farm sizes are small.

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