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Effect of aphids and virus diseases on yield of seed potatoes in Kenya

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Abstract Experiments were conducted at 2 sites to determine the relationship between aphid populations, virus incidence and yields on 4 potato varieties (*Solanum tuberosome*). These varieties were planted at Tigoni and Kabete during short rains, October 2001 – January, 2002) and long rains, (March to July, 2002). The experimental design was completly randomised block design with 3 replicates. Sampling was done every 2 weeks from crop emergence to maturity. Aphid populations were assessed based on a random collection of 15 leaf samples per plot and virus incidence was assessed basing on number of plants infested per plot. At harvest, season, yields were measured for each treatment and compared with the average scores of aphids and virus incidence over the season. A regression analysis of this data revealed that there was a significant decrease in yields with increase in virus incidence at both sites ($P<0.05$). Similarlly, there was a significant decrease in yield with increase in aphid populations at the Kabete site but not at the Tigoni site. Although no significant relationship between the aphid populations and virus incidence was observed at either Tigoni or Kabete, as the populations of aphids increased, the virus incidence also increased. It is therefore, necessary to control aphid populations to reduce virus spread in order to achieve optimal yields of seed and ware potato in Kenya.

Key Words: Aphids, pests and diseases, *Solanum tuberosum*, optimal yields

Introduction

Potato (*Solanum tuberosum* L)is the second most important food crop after maize (*Zea mays*) in Kenya (Ng'ang'a *et. al*., 1994; Anon., 2002). However the basic problem facing potato production in Kenya is low yields due to diseases and insect pests (Kinyae *et. al.,* 1994). The national average of 4.4 tons ha^{-1} is low compared to world average of 17tons/ ha in developed and 13 ha^{-1} in developing countries. It is possible to realize 40 ha^{-1} under research station conditions in Kenya (Lung'aho *et. al*., 1997). The low national average yield is mainly due to degeneration of the seeds as a direct consequence of a build up of viral, fungal and bacterial pathogens. Aphids and the potato tuber moth pests are increasingly becoming problematic. A solution to these pest and disease problems would result into increased certified seed and ware potato yields per unit area and an expansion of seed and ware potato acreage. Viruses and aphids are the key constraints to production of certified seed potatoes and constitute an important yield constraint. Viral infections mainly spread by aphids, greatly reduce potato yields. Efforts to address virus diseases and their aphid vectors are therefore needed if the anticipated benefits of farmer-based seed potato production are to be realized. Clearly, baseline information on the quantitative relationship between disease and pest incidence on potato yield, will be necessary in designing pest control startegies. Thus, the objective of this study was to determine the effect of aphid populations and virus incidence on yields of four potato varieties in Kenya.

Materials and methods

The experiments were carried out at 2 sites, the National Potato Research Centre (NPRC) Tigoni (altitude 2150 m.a.sl) and the University of Nairobi field station, Kabete (altitude 1953 m.a.s.l). Trials were planted during the short rains, (October 2001- January 2002) and long rains, (March - July 2002). The experiment was laid on a completely randomized block design (CRBD) in a split-split plot arrangement. Main plots were composed of 2 spraying treatments (sprayed or not sprayed), the subplots had 2 seed certification types (certified or not certified) while 4 varieties (Tigoni, Asante, Nyayo and Kerr's Pink) were in the sub-sub plots. This experiment was replicated 3 times (3 blocks). Each sub-subplot had 4 rows each with 10 hills (hence 40 plants per sub-subplot). Plants were spaced at 75 cm between the rows and 30 cm between the hills within each row. Each Sub-subplot was 3mx3m with 1m between the Subplots and 3m between the main plots and between the blocks (reps). Sampling was done every 2 weeks from crop emergence to maturity. Aphids were sampled from 15 leaves picked from the top, middle and bottom parts of 5 potato plants per sub-sub plot. Virus incidence was determined by counting the

number of plants showing virus symptoms in each plot. These were expressed as a proportion of the total plants in the plot to give virus disease incidence (%) in that plot. At the end of each season, data on yields was taken from the two middle rows of each treatment (sub-subplot). All data was subjected to analysis of variance (ANOVA) and regression analysis using the Genstat Statistical package.

Results and Discussion

Sprayed plots had significantly lower aphid populations than unsprayed plots ($p<0.05$) but there was no significant difference in virus incidence and yields between the sprayed and the unsprayed plots. Certified seed plots had significantly lower virus incidence than uncertified seed plots. However, there was no significant difference in aphid populations between the certified and the uncertified seed plots.

Moreover, certified registered significantly higher yields than uncertified seed plots ($p<0.05$). There was no significant linear relationship between aphid populations and virus incidence at either Tigoni or Kabete sites ($P=0.05$). However, at both sites, as the populations of aphidsincreased, virus incidence also increased, but the relationship was not significant (Fig. 1 and 2).

There was no significant linear relationship ($P=0.05$) between aphid populations and yields at the Tigoni site (Fig.3). However there was a highly significant linear relationship ($P<0.001$) between aphid populations and yield (Fig. 4). At both sites, there was a highly significant linear relationship between the virus incidence and yield; as the virus incidence increased, the yields decreased significantly (Fig. 5 and 6).

The results indicated that spraying significantly reduced the aphid population in the potato crop. This concurs with earlier findings by Kariuki, (1999), which established that infestation of aphids and other insects was higher in unsprayed plot. Aphids are known to be the main vectors of potato virus diseases (Robertson, 1975; Raman, 1985). Our study has shown that by spraying the potato crop with appropriate aphid control pesticides, the aphid populations are significantly reduced. Nderitu (1983) established that both Oxydemeton methyl and dimethoate (foliar sprays) and disulfalton and carbofuran (soil insecticides) are effective in reducing aphid population in potato.

Consequently, there is a significant reduction in the transmission of virus diseases. Indeed, earlier findings indicated that insecticides use in control of aphids is an indirect control of potato viruses such as potato leaf roll virus (PLRV) and potato virus Y (PVY) (Woodford & Gordon, 1990). Radcliffe (1982) observed that insecticides applied in furrows at planting or side dressed at the time of emergence are more effective in suppressing aphid populations and also minimize virus spread in potato fields. PLRV is persistently transmitted and it is therefore, appropriate to use insecticides as a major component of its control (Hanafi, 2000). Other earlier findings have also reported that use of insecticides for aphid control has been accepted as an indirect means of PLRV management in potatoes (Till, 1971). But other reports have also indicated that although insecticides applied to the crop can prevent build up of colonizing aphids, they cannot kill immigrating alate aphids quickly enough to prevent the spread of non-persistently transmitted viruses from sources outside the crop (Difonzo *et al*., 1996). The presence of higher virus incidence on uncertified seed indicates that certified seed greatly reduces the virus incidence in the potato crop. This shows that aphid control, can be achieved by use of certified seed. Use of certified seed therefore plays a big role in preventing virus spread from seed, which would then be transmitted by aphids from infected plants to other healthy plants.

Results of the yield loss assessment between certified and uncertified potato seed showed that there was a significant reduction in the potato yields in the uncertified seed compared to the certified seed. This further shows that seed certification. Earlier reports have indicated that quality of seed potato tubers is the most important yield-determining factor and also a major constraint in many potato-growing developing countries (Struik & Wiersema, 1999).

Analysis of the relationship between the aphid populations, virus incidence and yields revealed that there was a significant reduction in yields with increase in virus incidence. There was also a significant decrease in potato yields with increase in aphid populations at the Kabete site, which is at a lower altitude than Tigoni site hence more active aphid activity in the transmission of the potato viruses. It has previously been reported that high altitude affects the activity of aphids due to limited flight (Bertschinger, 1992). In Tigoni, there was no significant difference in yields due to aphid populations hence it might not have been economical to spray ware potatoes for aphid control. These findings are consistent with the findings of the research at Lari area where it was found that it would be uneconomical to spray ware potatoes against aphids in that region since yields were not affected much by the presence of aphids (Kariuki, 1999). These findings are similar to that of Nderitu & Mueke (1986), who established that although some potato varieties, (Annet, Kerr's pink and Desiree) had a high number of aphids, they also had high yields. Its most likely that aphid populations were not high enough to affect the yields significantly. Fletcher *et al*., (2002) working with several varieties found that primary infection by PLRV from external sources had little effect on yields of cv. Desiree, Red Rascal and Shepody. However, since some farmers select planting material from their harvest, it is still advisable to spray both ware and seed potatoes in these areas to reduce incidences of latent virus disease infections, which would later be transmitted by the seed to the next crop. Though there was no significant relationship between the aphid populations and the virus incidence, it was clear from the graphs of regression analysis at both sites (Tigoni and Kabete) that, as the aphid population increased, the virus incidence also increased. This shows that, with late maturing cultivars, there is a possibility of a significant increase in the virus

Figure 1: Relationship between Aphid populations and Virus incidence on Potato at Tigoni during the short rains 2001 and the long rains 2002.

Figure 2: Relationship between Aphid populations and Virus incidence on Potato at Kabete during the short rains 2001 and the long rains 2002.

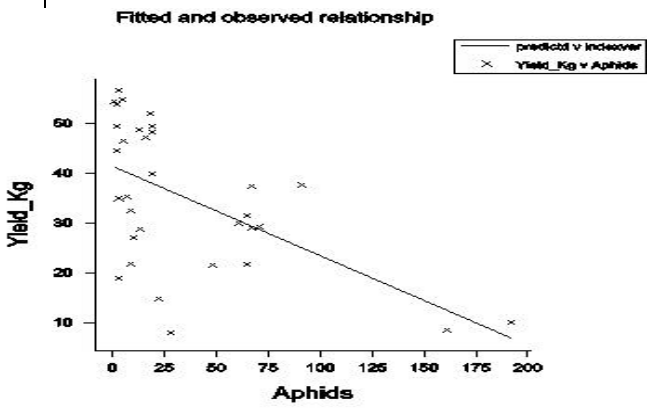

Figure 3: Relationship between Potato Aphids populations and the Yields of potatoes at Tigoni during the short rains 2001 and the long rains 2002.

Figure 4: Relationship between Potato Aphids populations and the Yields of potatoes at Kabete during the short rains 2001 and the long rains 2002.

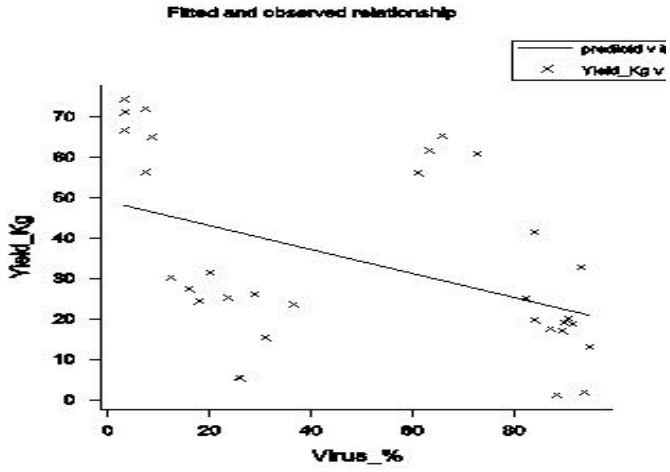

Figure 5: Relationship between Potato Virus incidence and the Yields of Potatoes at Tigoni during the short rains 2001 and the long rains 2002

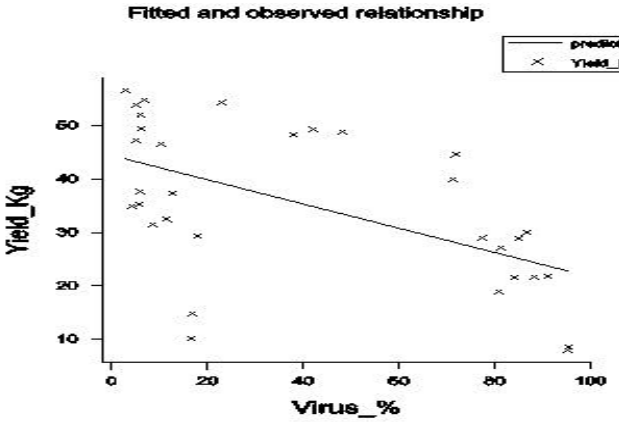

Figure 6: Relationship between Potato Virus incidence and the Yields of Potatoes at Kabete during the short rains 2001 and the long rains 2002.

incidence with increase in aphid activity. This would then lead to a significant decrease in the potato yields due to the increased virus incidence. Aphids cause direct injury to potato and also transmit viral diseases that reduce yields by as much as 80% (Goffinet, 1982). However, most damage by aphids is caused by transmitting viruses than by feeding on the plants (Raman, 1985). Control of the aphids to reduce the virus disease spread is therefore necessary if virus free potato seed production is to be maintained. Use of certified seed also significantly reduces the virus incidence on potato and leads to higher potato yields.

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