The impact of *Maize streak virus* disease on quality and yield of maize forage outputs of the maize-dairy production systems in central highlands of Kenya

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Justification Summary

Maize plays a critical role in food security in Eastern and Southern Africa, being the staple food for 24 million households in East and Southern Africa. Research priorities have therefore generally sought to optimise grain yields. Socio-economically it is, however, important not to ignore the value of the crop residue as forage, which has a value between one third and one half that of the grain (McIntire *et al.*, 1992). Moreover, for the smallholder farmers, maize stover is proportionately more important as a forage source than specific forage crops. In addition where land pressure is high, as in the densely populated areas of the Kenyan Central Highlands, farmers dense plant maize and feed thinnings to livestock, relay plant maize whenever there are rains and allow weeds to over grow beyond agronomic recommendations (Lukuyu *et al.*, 2000). The changes in farming practices may have serious implications in terms of pests and diseases. This study therefore recognised that, as maize-based crop-livestock systems intensify in densely-populated areas, the challenge is to ensure that maize production contributes more food for humans and more forage for ruminant livestock.

The rationale is that practices which increase the health and yield of maize will not only improve grain yields, but also the availability of forage and hence increase milk production, rural livelihoods and ultimately human nutrition. The objectives of the study were (i) reports the importance maize, pest and diseases on maize forage (ii) quantifies the effects of cultivar, time and level of infection on forage and grain yield, and (iii) quantifies the economic losses incurred as a result of MSVD.

Rapid rural appraisal

A rural rapid appraisal was carried out in Kiambu district of central Kenya during April and May 2001. Two interviews were conducted with ten farmer groups within the study area. They consisted of existing formal or informal groups in low or prone MSVD areas across different production zones. The production zones included coffee-dairy, tea-dairy, maize-dairy and horticulture-dairy. Maize was grown in all production zones.

Maize contributed 24% (6, 10 and 8% maize green thinnings, thinnings and stover respectively) of forage being second in importance to Napier (40%) of supplies (Figure 1, McLeod *et al.*, 2002). Farmers in Kiambu district of central Kenya identified *Maize streak virus* disease (MSVD) and maize stemborer as the main pests/diseases affecting forage and grain from maize (Figure 2, McLeod *et al.*, 2002). MSVD was also singled out by farmers as the disease they were least able to control (Figure 3 McLeod *et al.*, 2002). The impacts and especially the interaction of MSVD on forage and grain maize in these farming systems was, therefore, the focus of the experimental trials.

Experimental trials

The experiments were carried out at Muguga, Kenya at an altitude of 2095 m in the short rains season 2001 and long rains season 2002. Planting was during the short-rains growing season (October to December, 2001) and May to August 2002. In short rains season 2001, rainfall was insufficient and the crop was irrigated, once weekly, from four weeks post-emergence to maturity. Treatments, with 4 replicates, comprised 4 times of infection x 3 cultivars x 2 fertiliser levels, in a completely randomised block design. In long rains season 2002, 3 times of infection were compared. The experiment was a factorial in respect to time and cultivars but fertiliser levels were unbalanced. Three maize cultivars H511 (H614 in the long rains season), the local landrace (Gikuyu) and KH 521 were planted. The commercial hybrid is widely planted in medium-altitude areas of Kenya. The local landrace is selected and re-cycled by farmers while KH 521 is a maize streak resistant variety bred by the Kenya Agricultural Research Institute.

Figure 1: Total annual usage score for different forages in Kiambu, Kenya. (Source: McLeod *et al.,* 2002)

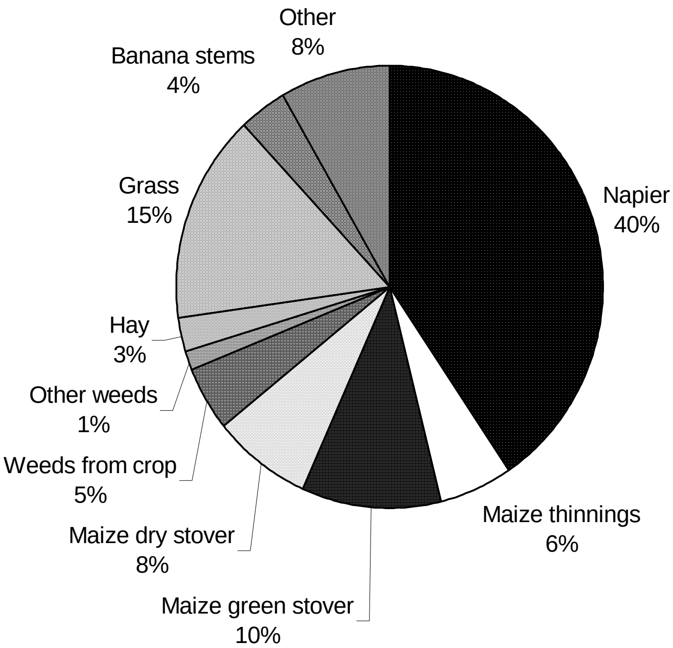


Figure 2: Farmers perceptions (0-no effect; 5=high impact) of pest and diseases on stover yields (Source: McLeod *et al.,* 2002)

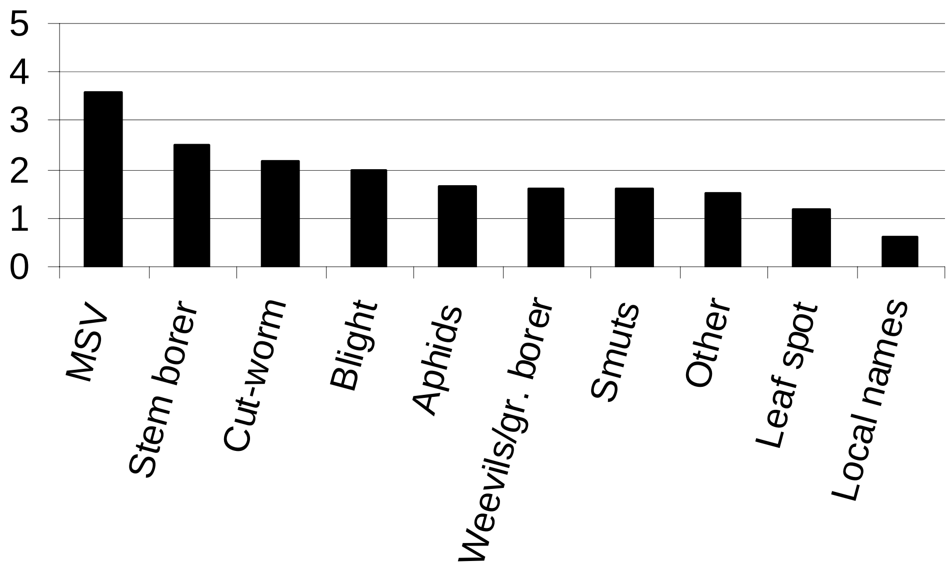
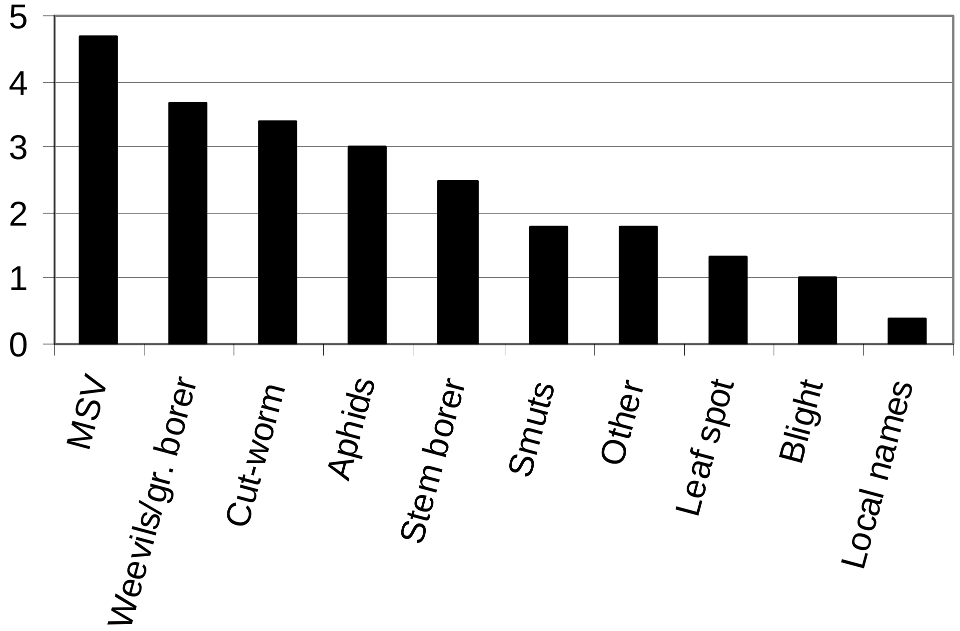


Figure 2: Farmers perceptions (0-no effect; 5=high impact) of most difficult pest and diseases to control. (Source: McLeod *et al.,* 2002)



The variety has been tested through the national performance trial and cleared for seed production. Three times of infecting with MSV, 14, 36 or 56 days after germination, were compared (56 days post emergence was omitted in the long rains season 2002). Plots at harvest were treated as control. Two levels of fertiliser were applied at planting time: the local recommended rate (50 kg/ha of N and P_20_5 without top dressing) and farmer rates (assumed to be 50% recommended rate). In the long rains season 2002, the farmers' rates were reduced to (26.7 kg/ha of N and 10.4 P_20_5), to reflect farmer practice since the results from short rains did no show any clear fertiliser effects.

Plantings were at a spacing of 75 cm between rows and 30 cm within rows. Plants were infected artificially by attaching a vial with two infective leaf hoppers to the lowest leaf of each plant. Furadine, a systemic insecticide/nematicide, was applied to control (non-inoculation) plots to prevent infection by natural population leaf hoppers. Leaf hoppers were reared in insect-proof cages in glasshouses. Three days before the inoculation, adult leaf hoppers were transferred to insect proof cages containing MSV infected maize. A transmitting strain of leaf hoppers *Cicadulina mbila* was used throughout.
Four seeds were sown per hole and thinned to two healthy plants per hole 10 days after germination. Plots were intercropped with beans to simulate farmer practice. The beans (2 seeds/hole) were planted equidistant between maize rows and a spacing of 30 cm between plants.

To determine forage off-take as thinnings, plots were thinned to one plant per hole when at least 90% tasseling had occurred on both healthy (uninfected) and infected plots. The smaller of the two plants in each hole was thinned. One plant per hole was taken through to final harvest. DM yield and quality (leaf:stem) of forage, as thinnings and dry stover, were measured; grain yield was also measured.

Results

Results for the short rains season 2001 and 2002 are shown in Figure 3. Infection with MSV reduced the yield of thinnings, stover and grain ($p<0.001$), especially at 14 days. As expected, the MSVD resistant KH 521 was the cultivar least affected by MSVD and consequently there was a significant MSVD by cultivar interaction for yield of thinnings, stover and grain. Grain yield of the susceptible cultivar, H511, was much reduced by MSVD (data not shown). In long rains season 2002, there were no significant interactions between time of infection with MSV and cultivars. However, the effect of MSVD followed the same expected trend. Infection with MSVD significantly reduced both forage (thinning and stover yields) ($p<0.001$) and grain ($p<0.05$; data not shown). As observed in the short rains season 2001, the greatest reduction was at 14 days of infection. Farmers can make savings of up to Ksh 80,000/ha (£800/ha) by planting MSVD resistant cultivars Figure 4.

Discussion

In the highly densely populated areas of central highlands of Kenya, maize is not only an important source of grain but also fodder (Lukuyu, 2000; McLeod *et al.,* 2002)). As shown from the rapid appraisal results, farmers perceive MSVD is the most important and difficult diseases to control. However, the most commonly planted cultivars in the study area are the MSVD susceptible H511, H513 and H614 cultivars (McLeod *et al.*, 2002). This may be due to the fact that farmers are unaware of the new cultivars that are resistant to MSVD and also due to the non availability of the seed in local stores. Hence, farmers resort to planting the cultivars they know which happen to be prone to MSVD. The advantage of the MSVD resistant cultivars is that they reduce the effect of MSVD (Bosque Perez *et al.,* 1998).

There is a devastating effect of early infection (14 days) with MSVD, which significantly reduces forage yields. The reduction in yield especially with early MSVD infections may be as a result of chlorosis and stunting that characterise the symptoms of MSVD.). This results in reduced photosynthesis and increased respiration, leading to a reduction in leaf length and plant height (McClean, 1947). The dry matter production of total thinnings and stover for the susceptible maize varieties (H511 and H614) were substantially reduced while the resistant varieties (KH 521 and PAN 67) suffered minor reductions in all seasons tested. This may be partly because resistant cultivars are more difficult to infect than susceptible ones i.e. symptom development is inhibited (Asanzi *et al.,* 1994). Gross margin analysis showed that farmers loss up to Ksh 28,000/ha (£800/ha) due to effects of early infection when they plant MSVD susceptible cultivars.

Conclusions

(i) Early infection with MSVD had a devastating effect on maize forage
(ii) Resistant cultivars alleviated forage and grain yields losses as a result of early infection with MSVD
(iii) Farmers make losses of up to Ksh 28,000/ha (£800/ha) by planting MSVD susceptible cultivars

Acknowledgement

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Figure 3 - The effect of time of infection and cultivar on thinning and stover yield

Short season 2001 | **Long season 2002**

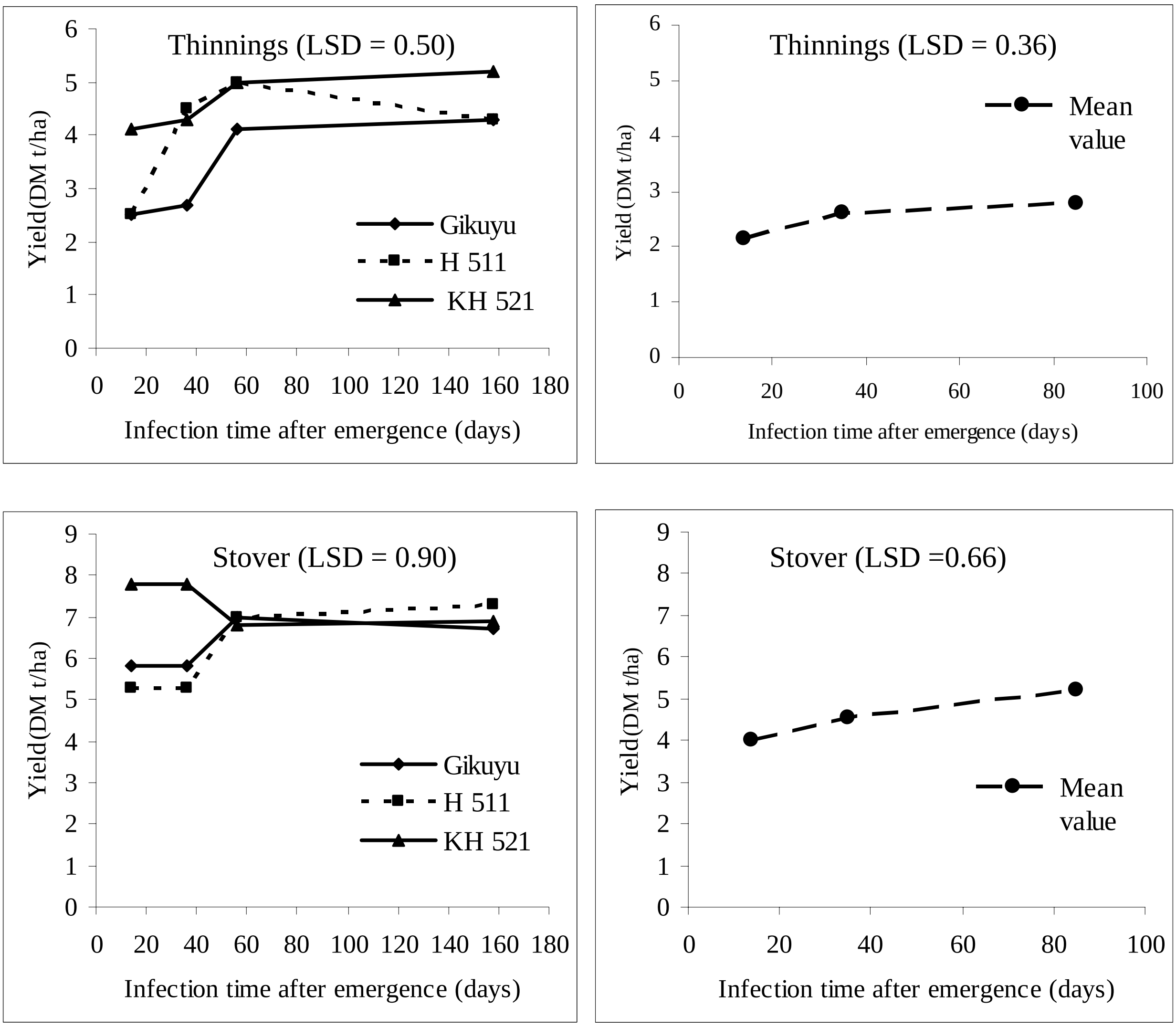
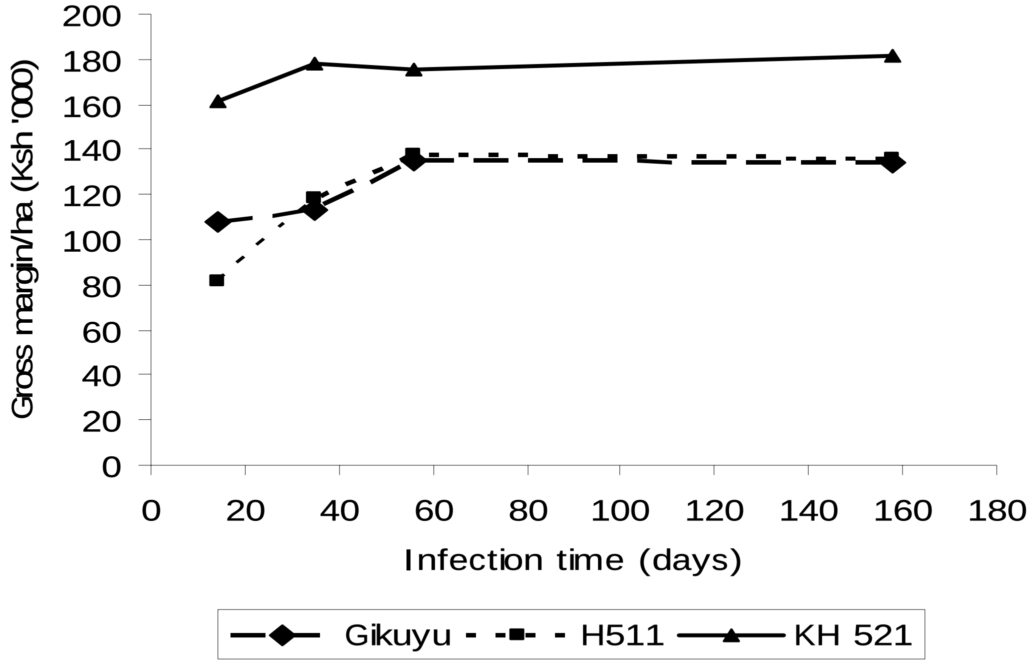


Figure 4: The effect of cultivar and MSVD on gross margins



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