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Effects of infection with maize streak virus, and cultivar, on yield and quality of maize forage, and on yield of grain

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Introduction Maize is a staple human food in Kenya and other East African countries. Due to intensification, smallholder dairy cattle feeding is increasingly based on maize forage, as thinnings and stover. Maize is therefore becoming both a food and feed crop. Maize streak disease, caused by maize streak virus (MSV) is increasing in prevalence. Economically, MSV disease is the most damaging disease of maize in Africa (Thottappilly *et al.* 1993), The disease reduces growth and yield of maize. In susceptible varieties, grain yield reductions may exceed 70% (Bosque-Perez *et al.* 1998). Losses due to MSV disease depend on many factors, including cultivar and growth stage at the time of infection (Van Rensburg 1981; Bjarnason 1986). MSV is erratic and most smallholder farmers have no access to insecticides such as Carbofuran to control *Cicadulina mbila* (leaf hopper) populations. Reliable control is by use of resistant cultivars. Resistant maize cultivars have been released in the past 30 years by IITA, CIMMYT and other national agricultural research systems in Africa. Although considerable research has been done on grain yield losses as a result of MSV disease, there is little information concerning effects on forage yield and quality. The present experiment, which is the first of a series, aimed to quantify the effects of time of MSV infection and cultivar on forage yield and quality.

Materials and methods The experiment was carried out at Muguga, Kenya at an altitude of 2095 m. Planting was during the short-rains growing season (October to December, 2001). However, 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. The experiment was a factorial in respect to time and cultivars but fertiliser levels were unbalanced. Three maize cultivars Hybrid 511, the local landrace (Gikuyu) and Muguga 1 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 Muguga 1 is a maize streak resistant variety bred by the Kenya Agricultural Research Institute. 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. 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_2O_5 without top dressing) and farmer rates (50% of recommended rate).

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 are shown in Tables 1 and 2. Infection with MSV reduced the yield of thinnings and grain, especially at 14 days; surprisingly yield of stover was not significantly affected. As expected, Muguga 1 was the cultivar least affected by MSV and consequently there was a significant MSV by cultivar interaction for yield of stover and grain. Grain yield of the susceptible cultivar, H 511, was much reduced by MSV. Ratio of leaf to stem in thinnings and stover differed between cultivars, with Gikuyu having a low leaf-content. Time of MSV infection did not significantly affect leaf to stem ratio, neither in thinnings nor in stover.

Discussion Findings from the present study demonstrate that MSV disease significantly reduces forage yields although this is a function of susceptibility/resistance levels of cultivars. In general, reductions in forage yield are directly related to the stage of infection; the earlier the infection, the greater the reductions Dry matter production of total thinnings and stover for the susceptible maize variety were substantially reduced while the resistant variety suffered minor reductions. The same trend was recorded for grain yields. This trend on grain yield agrees with findings by Bosque-Perez *et al.* (1998) who recorded a significant interaction between cultivar and age at challenge on plant weights and grain yield.

Table 1 Main effect means for dry matter yield (t/ha) of forage and grain, and quality of forage (leaf:stem ratio)

	MSV (days after germination)				Cultivar			s.e.d.		
	14	36	56	Control	Gikuyu	H 511	Muguga	MSV	Cultivar	Interaction
Thinnings (t/ha)	3.0	3.9	4.7	4.6	3.4	4.1	4.7	0.30***	0.26***	0.52
Stover (t/ha)	6.3	7.6	6.9	7.0	6.3	6.9	7.6	0.54	0.47**	0.93**
Grain (t/ha)	2.7	3.5	3.4	3.5	3.0	3.0	3.9	0.30**	0.26***	0.52**
Thinnings (L:S)	1.06	0.89	0.94	0.91	0.63	1.18	1.04	0.12	0.11***	0.21*
Stover (L:S)	1.01	0.97	0.94	0.97	0.85	0.99	1.08	0.09	0.08**	0.15

Table 2 Cultivar x time of MSV infection means for yield of forage and grain (t DM/ha)

MSV (days after germination)		14	36	56	Control
Thinnings	Gikuyu	2.5	2.7	4.1	4.3
	H 511	2.5	4.5	5.0	4.3
	Muguga 1	4.1	4.3	5.0	5.2
Stover	Gikuyu	5.8	5.8	7.0	6.7
	H 511	5.3	5.3	7.0	7.3
	Muguga 1	7.8	7.8	6.8	6.9
Grain	Gikuyu	2.9	2.8	3.1	3.0
	H 511	1.6	4.1	3.0	3.3
	Muguga 1	3.7	3.7	4.0	4.2

Farmers have been selecting for the local landrace, Gikuyu, over years in the MSV prone study area. Gikuyu sustained a large reduction in thinnings and stover yields. However it suffered the least reduction in grain yield and recorded the lowest leaf to stem ratio. This could be because Gikuyu matures much earlier than H 511. The present data show that large losses in forage and grain yield in the susceptible H 511cultivar could be expected if infection occurs within the first 6 weeks after germination.

Conclusions This preliminary study shows that cultivar and time of infection with MSV affect not only the yield of grain, but also the yield of maize forage as thinnings and stover. Forage quality (defined as leaf:stem ratio) is affected by cultivar, but (apparently) not by MSV. Further studies are in progress.

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