PROMISING NAPIER (*PENNISETUM PURPUREUM* SCHUMACH) STUNTING DISEASE TOLERANT CLONES FOR DISSEMINATION TO SMALL HOLDER FARMERS IN KENYA

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ABSTRACT

Napier stunting disease is a major constraint in dairy production in Kenya. The disease causes stunted growth and reduction in biomass. A study was conducted whose objective was to screen for tolerant clones to stunting disease. Four hundred clones of Napier Grass *Pennisetum purpureum* schumach were collected from Bungoma, Mumias, Butere and Busia Districts in Western Kenya in 2008. The clones were then planted in unreplicated nursery at Alupe for pre-screening for tolerance to stunting disease. Out of four hundred clones one twenty disease free clones with diverse morphological characteristics were selected and planted in a complete randomized block design trial replicated three times for further screening. Eighty three clones without disease symptoms were planted in a screen house in a randomized block design replicated three times and were artificially challenged with the stunting disease using leafhoppers collected from the Napier grass fields in Alupe. Diseased Napier plants were then planted around the trial to serve as spreader rows. Harvesting of Napier was done at intervals of 8 weeks and data was collected on the incidence and severity of stunting disease using a scale of 1-4, where 1 was no symptoms and 4 was severe. Both fresh and dry matter yield data was collected for each plot and data analyzed using SAS. The clones were significantly different (P=0.05) from each other in terms of severity and incidence of stunting disease at every harvest. For the very susceptible clones stunting disease started appearing from the first harvest and the incidence increased with the second harvest. While for tolerant clones the disease symptoms started appearing at fourth harvest. Only 20 clones out of one hundred and twenty clones screened did not have any symptoms of stunting disease by the fourth harvest. Clones which were high yielding (More than 8tons/ha) and tolerant to stunt in both field and screen house trials were: MMS 3B9, BTR 3A1 and MM2A5 while clones which were tolerant to stunt and were also ranked high by both male and female farmers and researchers were: MMS3A5, BGM3A5 and BGM3A9. These clones could be screened further on farm and recommended to farmers.

Key Words: Napier Grass Clones, Disease incidence and severity, tolerant, farmer criteria

INTRODUCTION

Dairy farming is popular with smallholder farmers as it enables them to produce a number of readily marketable products to maximize their income. Kenya's strategy for economic recovery and revitalizing Agriculture (Republic of Kenya, 2004) emphasizes increasing employment and incomes for the poor. The smallholder dairy production and milk marketing are already contributing to these goals (SDP, 2004). Napier grass (*Pennisetum purpureum* schumach) is the major livestock feed for most farmers in Kenya and East Africa (Muyekho *et al*., 2003) and continues to be the major feed for the cut-and-carry zero grazing dairy systems in East Africa. Napier Grass constitutes between 40 to 80% of the forage for the smallholder dairy farms (Staal *et al.*, 1997). In Kenya alone, more than 0.3 million smallholder dairy producers (53%) rely on Napier grass as a major source of feed. Kenya's per capita milk consumption is to the tune of 85 liters per year adding up to 3.3 billion liters. The annual demand for milk is growing at a rate of 2-3 % precipitating a situation where demand could outdo supply if it doesn't grow at similar rate or more (Land o' lakes, 2008). Smut and stunt disease have been spreading in the region and are a major threat to the forage supply in the smallholder dairy sector (Orodho, 2006).

Napier grass head smut and Napier grass stunt disease are having a serious effect on smallholder

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dairy farmers in East Africa. Both diseases cause stunted growth in plants with low biomass that is unable to sustain the feed requirements of dairy cows (Jones, 2004). Farmers in Western and Central Kenya have been demanding for a solution to the severe losses that they suffer due to the effects of stunting disease (Boa *et al*., 2005). Although more restricted in its distribution, smut is causing a similar threat in the highlands of Kenya (Mwendia *et al*., 2006). While demand for smut resistant clones is high, Kakamega 1 which has been found to be resistant to smut is less productive than the best local variety Bana and is not fully satisfying the demands of local farmers in terms of biomass. Alternative high yielding resistant clones for both stunt and smut diseases are still required to meet the demand for livestock feeds in central and western Kenya. The objective of this study was to screen the Kenyan clones for tolerance to stunt and smut disease and select clones to recommend to farmers for use and breeders for further improvement.

MATERIALS AND METHODS

The trial was conducted in Alupe (Latitude 00 ^{0} 29'N, Longitude 34^{0} 08'E, Altitude 1189 m above sea level, Maximum mean temperature 29.0^{0} C and Minimum mean temperature 15.5^{0}C). Four hundred Napier grass clones collected from four districts (Bungoma, Mumias, Butere and Busia) in Western Kenya were planted at KARI Alupe in one acre unreplicated plot. Collections from each district were planted in a separate block. Each clone collected from one farmer was planted in one row and labeled with the farmers name, collectors name and Sub-location.

Out of the four hundred clones, one twenty Napier clones which did not show disease symptoms were selected and were planted at KARI Alupe in November 2008 in a randomized complete block design replicated three times. Data collected from each plot included: Plant population, stunting disease incidence and severity, morphological characteristics and fresh and dry matter yields. Out of the one hundred and twenty clones eighty three clones which did not show any symptoms of the disease were planted in a screen house. The Napier was infested artificially by introducing field collected leafhoppers and spreader rows of diseased Napier as a source of inoculums. Scoring for disease incidence was started after the first harvest and was repeated every 6 weeks.

Protocols used to score for stunt involved examination of all plants in each plot for stunting disease symptoms just before harvesting and 2 weeks after harvesting. Stunt incidence was scored using scale 1-4 where: 1(Nil) – Plots with plants without disease symptoms, 2 (Mild) - Plots with few plants with symptoms (less than 25%), 3 (moderate) - Plots with many plants with symptoms (25-50%), 4 (severe) - most plants with symptoms (more than 6 infected plants/plot).

Disease severity was rated using scores 1-4, where: 1 (Nil) - had no symptoms, 2 (mild) - few tillers with symptoms (less than 25% of tillers), and 3 (Moderate) - many tillers with symptoms (25-50%) and 4 (Severe)-most tillers with symptoms (more than 50%). Data on stunting disease incidence and severity for different clones was analyzed using SAS

Researchers and farmers from Western Kenya ranked the Napier clones in the replicated trial using an agreed on criteria during a field day that was held at Alupe in September 2010.

RESULTS AND DISCUSSIONS

Napier stunting disease incidence and severity in the nursery and field trial

The clones were significantly different (P=0.05) from each other in terms of severity and incidence at every harvest (Table 1). At the first harvest most plots in the 3 replicates were not diseased, very few (less than 50) plots had disease incidence of 2 (Fig.1). The incidence increased significantly at harvest 4, with more than half of the plots scoring more than 2. In the observation nursery one hundred and ninety eight clones out of four hundred had disease incidence of score 2-3 at 4th harvest (Fig.1) while in the replicated trial only 20 clones out of one hundred and twenty clones screened did not have any symptoms of stunting disease at 4th harvest.

From the results the clones can be grouped into 5 major categories:

1) High yielding with dry matter yields ranging from 6 tons/ha to 10 tons/ ha tolerant clones were: BSA 1A2, Extra B3, BGM 1A1, Extra C3, BGM3B24, MMS1A10, BSA2B28 (Table 1).
2) Susceptible but high yielding clones with dry matter yields ranging from 8 tons/ha to 12 tons/ha and disease severity of between 2.0 and 2.7 were: BGM2B23, BGM3A10, MMS1A6 and BGM2A15 (Table 1).

Figure 1: Number of clones with similar disease incidence rating in the nursary at different harvests at Alupe,Western Kenya 2009/2010

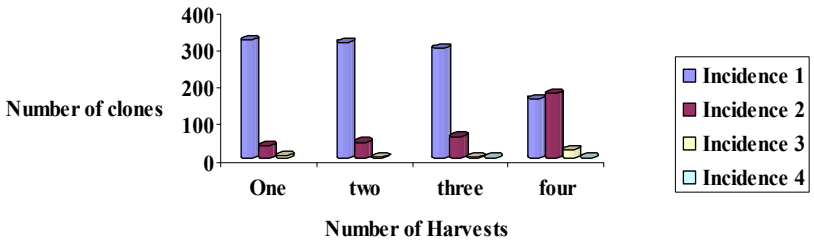

TABLE I -MEAN STUNTING DISEASE INCIDENCE, SEVERITY, YIELD AND MORPHOLOGICAL CHARACTERISTICS OF SELECTED NAPIER GRASS AT ALUPE IN 2009 AND 2010

Clone	Stunt Disease Incidence (Score 1-5)	Stunt Disease Severity Score 1-5)	Yield DM tons/ha	Leaf-stem ratio	Node hairiness	Serrateness	Tiller No.
MMS 2B 26	1.33	1.33	6.734	1.057	1.367	2.667	20.533
BSA 1B 19	1	1	2.329	1.310	1.400	2.000	8.167
BSA 2A 3	1.67	1.67	6.501	0.866	1.345	1.655	13.931
BANA	1.67	1.67	6.641	3.090	2.000	1.667	18.800
EXTRA B 3	1	1	6.142	1.047	1.933	2.333	19.267
BGM 3B 27	1	1	1.770	21.059	0.667	2.000	10.200
BSA 3A 10	2	2.67	9.710	1.570	1.000	1.333	16.000
EXTRA C 3	1	1	7.640	1.529	1.000	1.333	21.533
MMS 3B 9**	1.33	1.33	12.758	1.523	1.333	1.333	18.333
BSA 2B 22	1	1	4.175	1.757	1.667	1.667	15.300
BGM 3A 5**	1.33	1.33	8.085	1.077	1.033	1.667	22.667
BGM 2A 12	2.33	3	3.528	8.586	1.367	1.667	15.800
BTR 3A 1**	1.33	1.33	12.434	1.511	1.033	1.333	28.333
BGM 1B 28**	1.67	1.67	10.946	1.290	1.000	1.333	26.867
BGM 3B 24	1	1	4.384	1.139	1.333	1.333	13.067
MMS 3B 32**	1.33	1.33	10.062	1.584	1.000	1.333	23.133
BGM 1A 1	1	1	7.532	2.142	0.667	2.333	22.133
BSA 1A 2	1	1	5.738	1.282	1.667	2.667	19.567
BGM 2B 23	2	2.33	6.617	1.132	1.333	2.667	20.333
MMS 1A 6	1.67	2.33	4.491	3.980	1.633	1.667	12.567
MMS 1B 17	1.33	1.67	6.470	1.178	1.533	2.000	15.400
MEAN	1.110	1.138	6.124	2.465	1.178	2.014	17.37
S.E	0.186	0.2469	1.156	1.029	0.074	0.095	2.38
CV%	29.0389	37.000	51.429	2.045	34.46	25.91	55.13
LSD	0.523	0.693	6.770	2.886	0.409	0.270	6.620

**Clones which are high yielding and tolerant to stunting disease
**Clones ranked high by both Farmers and Researchers

3) Moderately tolerant and high yielding with dry matter yields ranging from 8tons /ha to11 tons/ha and stunting disease incidence and severity score ranging between 1.3 and 2.7 were: BSA1B32, MMS3B9, BSA3A10 and BSA3B30 (Table1).
4) Low yielding disease tolerant with dry matter yields ranging between 0.5 tons/ha and 5.5 tons/ha and no disease symptoms such as: BSA1A4, BSA1B19, BTR2B29, BSA3B27, MMS3B27, BSA3B20, BTR3A6, BGM3B27 (Table1).
5) Low yielding with dry matter yields ranging between 2.0 tons and 5.5 tons/ha and disease incidence and severity between 2.0 and 4 were: BGM2A12, BGM 2B17, MMS3B26, MMS2A14, MM1B30, MM1A4 and BTR1A5 (Table 1).

Disease incidence and severity in relation to morphological characteristics of the clones

In terms of key morphological characteristics like hairiness and Serrateness (which hampers the handling during weeding, harvesting and feeding); most of the stunt disease tolerant clones are hairy while the susceptible ones are less hairy e.g BGM2A12 and MMS3B26, ExtraA3, MMS1A1. High yielding clones with moderate tolerance and less hairiness included MM2A5 and BTR1B18.

Screen house trial

Disease incidence was higher in the field trials when compared with the screen house trial probably because the species diversity of the disease vectors was higher in the field and the environmental conditions more suitable for survivorship. The clones which showed tolerance to stunting disease in both field and screen house trials and were also high yielding were: BGM3A5, BGM 3A9, MM3A5, MM3B9, MM3B9, MM2A5 and BTR 3A1.

Ranking of Clones by Farmers and Researchers

Three clones which were ranked best by the female and male farmers and researchers included: MMS3A5, BGM3A5 and BGM3A9. The common criteria used to select the clones were: Disease tolerance, broad leaves, many tillers, high yields, not hairy (smooth), growth vigor, bulkiness, dark green color and high protein content.

CONCLUSIONS AND RECOMMENDATIONS

Out of one hundred and twenty Napier clones, 41 of them showed some tolerance to Napier Stunting disease after the 3rd harvest and reduced to 20 tolerant clones after 4th harvest. Out of the 41 Napier clones that showed tolerance, 28 had Dry Matter (DM) yields that were either equivalent to or more than the control (Bana). In terms of key morphological characteristics like hairiness and Serrateness (which hampers the handling during weeding, harvesting and feeding), the clones that showed tolerance compared very closely with Bana in terms of limited number of hairiness on the leaf and limited number of Serrateness in the leaf edge. The tolerant clones with desirable characteristics should be evaluated in different sites under high stunting disease pressure to a certain their tolerance or resistance to the disease and promote them for on-farm production. This should be followed by bio-contained studies where they are subjected to equal disease inoculums and measurement of presence or absence of phytoplasma to determine their resistance levels. Same studies should be carried out on low yielding resistant ones for breeding purposes.

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