Field Crops Research 225 (2018) 163–169

Contents lists available at ScienceDirect

Field Crops Research

journal homepage: www.elsevier.com/locate/fcr

Genotypic response of brachiaria (*Urochloa* spp.) to spider mite (*Oligonychus trichardti*) (Acari: Tetranychidae) and adaptability to different environments

Duncan Cheruiyot[a,b,*], Charles A.O. Midega[a], Edward A. Ueckermann[b], Johnnie Van den Berg[b], John A. Pickett[c], Zeyaur R. Khan[a]

[a] *International Centre of Insect Physiology and Ecology (icipe), P.O. Box 30772-00100, Nairobi, Kenya*
[b] *Unit for Environmental Sciences and Management, North-West University, Potchefstroom 2520, South Africa*
[c] *School of Chemistry, Cardiff University, Cardiff, CF10 3AT, Wales, United Kingdom*

ARTICLE INFO

Keywords:
Adaptability
Biomass yield
Damage
Host resistance
Multi-locations

ABSTRACT

Grasses in the genus *Urochloa*, commonly known as brachiaria, are grown as forage crops in sub-Saharan Africa, with some genotypes being used in management of insect pests. However, spider mite, *Oligonychus trichardti* Meyer (Acari: Tetranychidae), has recently been reported as its major pest in the region. We evaluated 18 brachiaria genotypes to identify sources of resistance to *O. trichardti*, and to determine their adaptability to different environments in western Kenya. Response to artificial infestation with *O. trichardti* was evaluated under controlled conditions in a screenhouse while adaptability to different environments and field resistance to mites was evaluated in three locations for two cropping seasons in 2016 and 2017 under farmers' conditions. The parameters evaluated as indicators of resistance to pest damage included leaf damage, chlorophyll content reduction, plant height, leaf area, number of tillers and shoot biomass. Rainfall played a role in reducing mite infestation and increasing biomass yield of the genotypes. Significant correlations between parameters were only observed between leaf damage and yield (r = -0.50), and leaf damage and chlorophyll loss (r = 0.85). The cultivar superiority index (Pi) ranked Xaraes, Piata, ILRI 12991 and ILRI 13810 as reliable genotypes that combined moderate resistance to the mite ($Pi \leq 48.0$) and high biomass yield ($Pi \leq 8.0$). Since this is the first documentation of interactions between *O. trichardti* and different brachiaria genotypes, we propose these genotypes as potential candidates for improved forage yields in areas prone to *O. trichardti* infestation in Africa.

1. Introduction

Urochloa genotypes (Poaceae, commonly referred to as brachiaria) are common forage crops native to Africa (Renvoize et al., 1996), and are extensively grown in tropical Latin America, Africa and south Asia (Hare et al., 2015; Phaikaew et al., 1997). There are over 100 species in this genus but only a few, such as *Urochloa brizantha* (A. Rich.) Stapf (palisade grass), *U. ruziziensis* (R. Germ. & C.M. Evrad) (ruzi grass), *U. decumbens* Stapf (signal grass), and *U. humidicola* (Rendle) Schweick (koronivia grass), have been commercially exploited as forage crops (Miles et al., 2004). In addition to its use as a pasture crop, *U. brizantha* cv. Mulato II, has been adopted in combination with greenleaf desmodium, *Desmodium intortum* (Mill.) Urb., in a climate-smart push-pull strategy for management of cereal stemborers, including *Chilo partellus* (Swinhoe) (Lepidoptera: Crambidae), the main pests of maize, *Zea mays* L., in eastern Africa (Khan et al., 2016; Pickett et al., 2014). The technology involves intercropping maize with drought tolerant greenleaf desmodium, and planting Mulato II as a trap crop around this intercrop (Midega et al., 2015a, 2015b). Greenleaf desmodium emits semiochemicals that are repugnant to the moths (push) while Mulato II emits attractive volatile organic compounds (pull). The pest is thus repelled from the maize crop and is subsequently attracted to the trap plant using a stimulo-deterrent strategy (Khan et al., 2014; Midega et al., 2011; Miller and Cowles, 1990). Additionally, brachiaria exhibits highly sophisticated responses to *C. partellus* herbivory that involves multitrophic interactions with some of its natural enemies (Bruce et al., 2010). The climate-adapted push-pull strategy thus effectively reduce infestations of stemborers, and in combination with other benefits such as suppression of the parasitic *Striga* weed, *Striga hermonthica* (Del.) Benth and improvements in soil fertility, result in significant increases in crop yields (Khan et al., 2016, 2014a; Midega et al., 2015b; Pickett et al., 2014). The benefits of brachiaria as trap plant for *C. partellus* and forage crop are however limited by biotic and abiotic challenges associated with climate change.

---

[*] Corresponding author at: International Centre of Insect Physiology and Ecology (*icipe*), P.O. Box 30772-00100, Nairobi, Kenya.
E-mail address: dcheruiyot@icipe.org (D. Cheruiyot).

https://doi.org/10.1016/j.fcr.2018.06.011
Received 6 May 2018; Received in revised form 22 June 2018; Accepted 24 June 2018

Tetranychid mites are responsible for significant yield losses in many economically important crops. The most common species of spider mites in Kenya are *Tetranychus evansi* Baker and Pritchard, *Tetranychus urticae* Koch which attack solanaceous crops such as tomato (*Solanum lycopersicum* L.), aubergine (*S. melongena* L.), potato (*S. tuberosum* L.) and tobacco (*Nicotiana tabacum* L.) while rapidly expanding its host and geographic range (Boubou et al., 2010; Ferragut et al., 2013; Toroitich 2011; Tsagkarakou et al., 2007). Depending on the species, spider mites have a wide range of alternate hosts including wild grasses and broad-leafed plants (Meyer, 1987) where they can survive and infest the next crop. There is also a possibility of the mites surviving on remaining parts of cut stems, and plant residues in the field. Under extreme conditions, they diapause in the soil (Wilson, 1995). Phytophagous mites feed by piercing the leaf surface with their stylets and sucking out the cell contents (Tomczyk and Kropczynska, 1985), concomitantly reducing chlorophyll content and net photosynthetic rates of leaves (Park and Lee, 2005). In sub-Saharan Africa, spider mites have recently been observed in brachiaria grasses and were reported as the main pest of these grasses (Maass et al., 2015; Njarui et al., 2016). In this region, crop losses of up to 90% as a result of the mite damage have been documented (Saunyama and Knapp, 2004). Damage caused by the tetranychid mites on this forage crop is expected to increase in response to increasing climate change effects such as increasing temperatures and drought.

Pesticides are one of the control methods against these mites (Toroitich et al., 2014). However, their use, especially in small farming systems, have been linked to human health implications and adverse environmental impacts which are often ascribed to their incorrect and inappropriate use, a common scenario in Africa (Azandémè-Hounmalon et al., 2015; Mbakaya et al., 1994; Ngowi et al., 2007; Van den Berg and Nur, 1998). Application of pesticides onto non-cash crops is also not a common practise in Africa (Orr and Ritchie, 2004; Van den Berg and Nur, 1998). Application of pesticides on grasses that are used as forage and in an eco-friendly management strategy for stalk borers, would therefore defy the general aims of integrated pest management (IPM) and specifically the push-pull strategy (Khan et al., 2016). Significant suppression of mite populations has been achieved through biological control approaches including the use of natural enemies such as *Phytoseiulus longipes* Evans (Bugeme et al., 2015; Ferrero et al., 2011, 2007). There is much interest in host-plant resistance as a management strategy since it is also compatible with other IPM strategies.

Host plant resistance to insect pests is influenced by the environmental conditions which further complicates testing and selection of superior genotypes. According to Eberhart and Russell (1966), a desirable genotype is one which has the highest yield over a broad range of environments. This principle is important in achieving good crop yields across an array of environments (Faris et al., 1979). Further, the cultivar superiority index (*Pi*) (Lin and Binns, 1988) has been employed to evaluate genotypes for such adaptability to different environments. Regression analyses also serve as a useful tool for measuring genotypic stability of resistance traits under conditions of varying biotic/abiotic stresses (Finlay and Wilkinson, 1963). Although the spider mite is known to be an important constraint to brachiaria cultivation, especially in sub-Saharan Africa, no study of interactions between *O. trichardti* and different brachiaria genotypes have been documented. Therefore, the present study was undertaken to identify potential sources of resistance to *O. trichardti* among brachiaria genotypes and to select candidate genotypes that are resistant to the mite and adaptable across different environments.

2. Materials and methods

2.1. Experimental plants

Table 1
Brachiaria genotypes that were evaluated over two cropping seasons in three locations in Kenya.

Entry	Source	Accession no.	Genotype	Variety name
1	CIAT	606	*Urochloa decumbens*	Basilisk
2	CIAT	1752	*U. ruziziensis x U. decumbens x U. brizantha.*	Cayman
3	CIAT	6294	*U. brizantha*	Marandu
4	CIAT	16125	*U. brizantha*	Piata
5	CIAT	26110	*U. brizantha*	Xaraes
6	CIAT	36087	*U. ruziziensis x U. decumbens x U. brizantha*	Mulato II
7	ILRI	11553	*U. brizantha*	–
8	ILRI	13648	*U. brizantha*	–
9	ILRI	12991	*U. brizantha*	–
10	ILRI	12995	*U. brizantha*	–
11	ILRI	13344	*U. brizantha*	–
12	ILRI	13368	*U. brizantha*	–
13	CIAT	679	*U. humidicola*	–
14	ILRI	13497	*U. brizantha*	–
15	ILRI	13810	*U. brizantha*	–
16	ILRI	13545	*U. brizantha*	–
17	ILRI	14807	*U. brizantha*	–
18	CIAT	36061	*U. brizantha x U. ruziziensis*	Mulato

Seeds of brachiaria cultivars used in this study were sourced from International Center for Tropical Agriculture (CIAT), Cali, Columbia and the International Livestock Research Institute (ILRI), Ethiopia. The accessions were grown in an on-station nursery at the International Center of Insect Physiology and Ecology - Thomas Odhiambo Campus (ITOC), Mbita Point (0°25́ S, 34°12́ E; 1200 m above sea level) in Kenya for preliminary observation and selection based on agronomic performance.

The 18 genotypes that were evaluated in this study are listed in Table 1. A commercial and locally adapted hybrid, Mulato II, was included as a check. The latter variety is preferred by smallholder farmers in sub-Sahara African as an animal fodder (Khan et al., 2014). Additionally, Mulato II plays a major role in the 'push-pull' habitat management strategy due to its phytochemical properties that make it highly attractive to stemborer oviposition (Midega et al., 2015a, 2011). Mulato II was however observed to be highly susceptible to spider mites especially in hot and drier ecologies (Maass et al., 2015). Spider mite samples were collected from a susceptible genotype Mulato II grown in field experiments in ITOC-Mbita, Siaya and Homabay. The samples were identified as *Oligonychus trichardti* Meyer at the Arachnology unit-Agricultural Research Council, South Africa.

2.2. Screenhouse experiments

Susceptibility of brachiaria genotypes to *O. trichardti* was evaluated by artificially infesting the plants in an insect-proof screenhouse under natural conditions (25 °C, 65% r.h., and L12:D12)

at ITOC. Propagules were planted individually in plastic pots (22 cm in diameter, 21 cm high) filled with soil and placed on 30 cm high benches covered with metal mesh. One plant was grown per pot. Phosphorus was applied at planting at 12 kg$^{-\mathrm{ha}}$ P as di-ammonium phosphate (DAP), while nitrogen was applied at 16.2 kg$^{-\mathrm{ha}}$ N in the form of calcium ammonium nitrate (CAN), two weeks later. The arrangement followed a complete randomized design (CRD) with three replicates. Plants were grown following standard agronomic practices and artificially infested with mites two weeks after planting. Mites were obtained from the susceptible brachiaria variety Mulato II maintained in an on-station nursery at ITOC.

Infestation with *O. trichardti* was done by placing two fully infested leaves of Mulato II on the adaxial surface of the experimental plants. One on a youngest fully expanded and the other on second young fully expanded leaf of the plant. The damage on leaves was visually estimated 14 days after infestation using a modification of a rating score used by Hussey and Parr (1963), as described by Murungi et al. (2014).