Crop Protection 99 (2017) 93–107

Contents lists available at ScienceDirect

Crop Protection

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

Farmers' knowledge, use and preferences of parasitic weed management strategies in rain-fed rice production systems

Dennis E. Tippe [a, *], Jonne Rodenburg [b], Marc Schut [c, d], Aad van Ast [a], Juma Kayeke [e], Lammert Bastiaans [a, **]

[a] Centre for Crop Systems Analysis, Wageningen UR, P.O. Box 430, 6700 AK, Wageningen, The Netherlands
[b] Africa Rice Center (AfricaRice), 01 BP 4029, Abidjan 01, Côte d'Ivoire
[c] International Institute of Tropical Agriculture (IITA), P.O. Box 1269, Kigali, Rwanda
[d] Knowledge, Technology and Innovation, Wageningen UR, P.O. Box 8130, 6700 EW, Wageningen, The Netherlands
[e] Mikocheni Agricultural Research Institute (MARI), P.O. Box 6226, Dar es Salaam, Tanzania

ARTICLE INFO

Article history:
Received 7 December 2016
Received in revised form
30 April 2017
Accepted 3 May 2017

Keywords:
Oryza sativa
Witchweed
Striga asiatica
Rice vampireweed
Rhamphicarpa fistulosa
Participatory research

ABSTRACT

Rain-fed rice production in sub-Saharan Africa is often hampered by parasitic weeds. This study assessed farmers' awareness, use, preference and adoption criteria of parasitic weed management practices in rain-fed rice production environments in Tanzania. Surveys and workshops were organized in three affected rice growing areas in Morogoro-rural, Songea and Kyela district, supplemented with on-farm experiments in Kyela. In all districts, farmers were aware of the locally occurring parasitic weed species, *Rhamphicarpa fistulosa* (lowland) and *Striga asiatica* (upland), and they considered these weeds more problematic than non-parasitic weeds. Though they mostly practise hand weeding, farmers were aware of a wide range of control options. Local access, affordability, ease of implementation and control efficacy were considered important criteria for adoption, whereas trade-offs, like lack of preferred grain quality traits in resistant varieties, were mentioned as an important break on adoption. Based on informal discussions with farmers, altered sowing times, resistant rice varieties and soil amendments were marked as feasible control options and tested in a farmer-participatory manner in four years of experimentation in upland and lowland fields. In both types of fields, the contribution of soil amendment to parasitic weed suppression was not evident, but rice husk was marked as a suitable and cheap alternative to inorganic fertilizers. Control of *R. fistulosa* in lowlands was perceived to be best realized by early crop establishment, escaping major parasite damage due to the relatively slow early development of this weed species. The local variety Supa India, appreciated for its grain qualities and marketability, remained the preferred variety. For the control of *S. asiatica*, late planting was preferred, requiring a short-duration variety to minimize risk of drought stress during grain filling. The short-duration NERICA-10 was most preferred, as it combined a favourable short cycle length with resistance to *S. asiatica* and good grain appearance. Farmer participation in technology testing showed to be crucial in defining locally adapted and acceptable parasitic weed control strategies. Yet, it is argued that without lifting important constraints related to credit and input supply, it will be impossible to sustainably solve the parasitic weed problem in rain-fed rice.

1. Introduction

Rice is an increasingly important cereal commodity in many countries of sub-Saharan Africa (SSA) (Seck et al., 2012) due to growing populations and changes in consumer preferences (Balasubramanian et al., 2007). Domestic rice production lags behind consumption rates (Seck et al., 2012). This is in part due to suboptimal production, caused by a myriad of production constraints that are insufficiently addressed. Under rain-fed conditions, rice production is often hampered by poor soil fertility, drought, uncontrolled floods and weeds (Diagne et al., 2013). Parasitic

* Corresponding author.
** Corresponding author.
E-mail addresses: dennis.tippe@wur.nl (D.E. Tippe), lammert.bastiaans@wur.nl (L. Bastiaans).

http://dx.doi.org/10.1016/j.cropro.2017.05.007
0261-2194/

weeds, a sub-category of weeds, are becoming a more prominent threat to rain-fed rice production (N'Cho et al., 2014; Rodenburg et al., 2010). An important reason is that farmers, in order to increase production, expand rice production into areas where parasitic weeds naturally or historically occur (Rodenburg et al., 2011a). Rice cultivation provides favourable conditions for these weeds to reproduce and spread, and consequently they develop into serious problems in these rain-fed rice production systems (Ejeta, 2012).

Parasitic weeds are estimated to negatively affect 1.3 million ha of rain-fed rice fields in SSA, leading to production losses of nearly half a million tons of milled rice (worth US $200 million) per year (Rodenburg et al., 2016b). Among those weeds, *Striga asiatica* (L.) Kuntze and *Rhamphicarpa fistulosa* (Hochst.) Benth. are considered the most important species (Rodenburg et al., 2010). *Striga asiatica* is adapted to rain-fed upland rice systems. It is an obligate parasitic weed, meaning that it cannot complete its life cycle without a host plant (Parker, 2013). *Rhamphicarpa fistulosa* is an emerging problem in rain-fed lowland rice production systems (Ouédraogo et al., 1999; Rodenburg et al., 2011b). It is a facultative parasite, capable of completing its life cycle also in the absence of a host plant (Parker, 2013).

Throughout rain-fed rice fields in SSA, parasitic weed invasions not only result in severe crop losses, but frequently drive farmers to abandon their fields (Houngbedji et al., 2014; N'Cho et al., 2014). Most of the rice producers in SSA are resource-poor farmers with little access to external inputs. This limits their options for parasitic weed management, which in turn poses a threat to their food security and income generation (N'Cho et al., 2014).

With some exceptions (e.g. Riches et al., 2005), relatively few research efforts focussed on parasitic weeds in rain-fed rice in SSA (Schut et al., 2015a,b). Most research on parasitic weeds focused on two dominant staple crops, i.e. maize and sorghum. For these crops, a number of control options have been suggested, such as the use of fertilizers, cereal-legume intercropping, use of resistant and tolerant varieties and modifications in sowing methods (Hearne, 2009). Technologies developed for one crop or one parasitic weed species are, however, not necessarily effective or suitable for another crop or weed species. Moreover, despite all research and development efforts regarding parasitic weed problems in maize and sorghum, relatively few parasitic weed management strategies have been adopted by farmers (Mrema et al., 2017; Schut et al., 2015a). In this context, Norton et al. (1999) pointed out that early involvement and participation of farmers in research priority setting and development is key to the adoption of the new strategies that ultimately derive from such efforts. Where technology transfer is characterized by a top-down approach, critical factors for acceptance of a new technology might easily be overlooked. Farmers who have experience with parasitic weeds in their fields are likely to be a valuable source of information, particularly if the aim is to develop and disseminate acceptable and affordable control strategies. Attempts to explore and utilize such farmer's knowledge in the context of parasitic weeds have, however, hardly been undertaken in the past (Rodenburg et al., 2015b).

The objectives of this study were therefore to assess farmer's awareness on parasitic weeds in different rain-fed rice environments, to take stock of their current control practices, their knowledge on alternative control strategies and to identify their reasons for adoption or non-adoption of strategies or technologies. A further aim was to define management strategies against parasitic weeds in rice that are applicable for resource-poor farmers.

2. Materials and methods

2.1. Study sites

Surveys and workshops were conducted in Mbeya, Ruvuma and Morogoro. These regions were selected because of their importance to Tanzania in terms of rice-production and because parasitic weeds are reported to cause problems in rice (e.g. Kayeke et al., 2010). Mbeya and Ruvuma are located in the Southern highlands, while Morogoro region is located in the Eastern highlands. The study specifically concentrated on the districts of Kyela (09°25′S 35°41′E) in Mbeya, Songea (10°41′S 35°39′E) in Ruvuma and Morogoro-rural (06°54′S 37°54′E) in Morogoro. The two districts in the Southern Highlands are characterized by a unimodal annual rainfall regime, with a rainy season between November and May. Annual rainfall ranges from 2000 to 2300 mm in Kyela, and from 900 to 1300 mm in Songea. Morogoro-rural district is characterized by a bimodal annual rainfall regime, with the main rainy season between March and June, and annual rainfall ranging from 1000 to 2000 mm. The rice farmers surveyed for this study in Morogoro-rural district encountered *S. asiatica*, whereas the farmers surveyed in Songea district dealt with *R. fistulosa* infestations. In farmers' fields in Kyela district, both parasitic weed species are found and this location was therefore chosen for the field trials where various locally accessible control strategies were tested.

2.2. Surveys

In all three districts, surveys were conducted from January to April, 2012 to explore farmers' awareness, knowledge and experience with parasitic weeds in rain-fed rice production systems. Following a Participatory Rural Appraisal (PRA) approach (Cavestro, 2003), questionnaires were administered by researchers, following group discussions that involved experienced individual rice farmers. In addition, visual observations by walking around the fields were done to appreciate incidences of both parasitic weed species. In Kyela district, farmers from Mbako, Kilasilo, Itope and Ibungu villages participated (95 farmers), in Morogoro-rural farmers from Kibangile and Kiswila villages were involved (40 farmers), while in Songea district Chabuluma, Namanditi, Wambati, Lilambo and Ruhuwiko villages were represented (18 farmers). These villages were selected purposefully based on the presence of parasitic weed species. Instead of entire households, individual farmers were targeted, because, according to local traditions, members of the same household own individual plots at different sites under their own management and responsibility. Farmers were selected randomly from selected villages. This facilitated farmers with different experiences and knowledge to express their perceptions. Interviews were held in Kiswahili, a language well understood by both the enumerators and the farmers in all locations. Empirical data were captured through questionnaires and group discussions. During the interviews, information was collected on: (i) Farmer's profile e.g. age and occupation (ii) Crop production e.g. priority crops, rice farm size, production methods, inputs and constraints and (iii) Farmers knowledge of parasitic weeds, current parasitic weed management strategies and factors determining the choice of a strategy.

2.3. Workshops

As a follow up on the surveys, five farmer participatory workshops were organised in the same three districts involving largely