Directions for Management of Parasitic Weeds in Lowland Rice

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The most frequently encountered parasitic weeds in rain-fed and irrigated lowlands are *Striga aspera* and *Rhamphicarpa fistulosa*. *Striga aspera* is found in the relative dry floodplains and hydromorphic parts of inland valley slopes while *Rhamphicarpa fistulosa* can be found in the zone between hydromorphic slopes and the temporary to permanently inundated valley bottom (Rodenburg et al., 2010).

Striga parasitizes by infecting the host root and therefore part of the life-cycle is below-ground. As part of the host damage already occurs in the below-ground stages, management practice, in order to be effective and to prevent yield penalties, should try to target these species already at the most early life-cycle stages. Some herbicides with proven effectiveness against parasitic weeds exist. The herbicide 2,4-D was found to be effective against *S. asiatica* (Delassus, 1972) and *R. fistulosa* (Paré and Raynal Roques, 1992). However, 2,4-D has a low selectivity and requires multiple applications as it only affects parasitic weeds when they have emerged above-ground. In Nigeria rice seed treated with cinosulfuron (0.2-0.6 g l^{-1}) and prosulfuron (CG152005) (0.064 g l^{-1}) proved effective in delaying and reducing *S. hermonthica* infection (Adagba et al., 2002a) and could be used against the related *Striga aspera*. Carotenoid biosynthesis inhibiting herbicides such as fluridone, norfluarzon and clomazone: could be used to reduce strigolactone production (a host-derived biochemical stimulating *Striga* germination) and consequently germination of *Striga* spp. (Lopez-Raez et al., 2009). These relatively cheap and broadly available herbicides could already be effective at low concentrations (Lopez-Raez et al., 2009). They are however not likely to be effective against the facultative parasitic weed *R. fistulosa*, which is not dependent of germination stimulants.

For parasitic weed control, soil fertility enhancing technologies are key. The application of urea at three weeks after sowing helped reducing the number of *S. asiatica* infections in rice in Tanzania (Riches et al., 2005). Application of 90 to 120 kg N ha^{-1} proved an adequate method to delay and reduce *Striga* infection and ensure satisfactory crop yields in upland rice in Nigeria (Adagba et al., 2002b). It is highly likely that this will also reduce the related *Striga aspera* in floodplains. Improved N and P fertilization could indirectly reduce parasitic weed germination (Lopez-Raez et al., 2009) and slow down infection rate. Reduced infection time, in turn proved an important asset for host grain yields (van Ast and Bastiaans, 2006). Fertilizer applications also proved useful to reduce the number of *R. fistulosa* plants in a pot study with rice (Rodenburg et al., 2011) and to improve yields of rice grown in fields infested with *R. fistulosa* (Sikirou et al., 2002).

Parasitic weeds can also be controlled through the use of improved crop cultivars. A range of responses of cultivars of the two cultivated rice species (*O. sativa* L. and *O. glaberrima* Steudel) to different species of *Striga aspera* have been found but the number of known resistant and tolerant cultivars is still limited (Table 1). *O. sativa* cultivars IR47255-B-B-5-4, IR49255-B-B-5-2 and progenies from crosses with WAB928 were found resistant to *S. aspera* (Johnson et al., 2000). In general however cultivars of the African rice species (*O. glaberrima*) more frequently show *Striga* resistance than *O. sativa* genotypes (Riches et al., 1996; Johnson et al., 1997; 2000). The *O. glaberrima* cultivar CG14 showed resistance against *S. aspera*. Against *Rhamphicarpa fistulosa* the most tolerant cultivars identified so far are lowland NERICA-39 and -32, while popular variety Gambiaka, and lowland NERICA parents TOG5681, IR64 and NERICA-L-32 showed some level of resistance (Rodenburg et al., 2011).

Table 1. Rice varieties with resistance and/or tolerance against *Striga* spp. and *Rhamphicarpa fistulosa*.

Rice species	Genotype	*S. aspera*	*R. fistulosa*
O. glaberrima	ACC102196	R/T	
	Makassa	R/T	
	IG10	R/T	
	M27	R/T	
	T2	R/T	
	CG14	R	
Interspecific[2]	WAB951-1	R	
	NERICA-L-39		T
	NERICA-L-32		R/T
O. sativa	IR49255-B-B-5-2	R	
	IR47255-B-B-5-4	R	
	WAB928-22	R	
	WAB935-5	R	
	WAB937-1	R	
	T1	Su	
	IAC165	Su	
	Gambiaka		R

Adapted from Rodenburg et al. (2010)

Other potentially effective control strategies could be the use of crop rotations, intercropping or improved fallows in particular with N-fixing legumes or trap crops (e.g. cow pea, pigeon pea). The additional crop could contribute to the control of the parasitic weed through competition (mainly for light) or by causing suicidal germination. The latter is only a useful mechanism against *Striga* spp. requiring host root signals for germination. Out-shading, is useful for all parasitic weeds and deemed particularly suitable to control *R. fistulosa* as its seeds require sunlight to germinate (Ouédraogo et al., 1999). Intercropping is however less compatible with lowland rice production systems due to the limited number of species that can thrive under permanent or intermediate flooded conditions.

References

Adagba, M.A., Lagoke, S.T.O., Singh, B.N., Ndahi, W.B., 2002a. Potential of cinosulfuron and CGA152005 seed treatment for control of *Striga hermonthica* in upland rice. *Acta Agronomica Hungarica,* 50(1)**:**7-18.

Adagba, M.A., Lagoke, T.O., Usman, A., 2002b. Management of Striga hermonthica (Del.) Benth in upland rice: influence of upland rice varieties and rates of nitrogen fertilizer. *Nigerian Agricultural Journal,* 33**:**119-127.

Delassus, M., 1972. Methods of controlling *Striga* spp. *Agronomie Tropicale,* 27(2)**:**249-254.

Lopez-Raez, J.A., Matusova, R., Cardoso, C., Jamil, M., Charnikhova, T., Kohlen, W., Ruyter-Spira, C., Verstappen, F., Bouwmeester, H., 2009. Strigolactones: ecological significance and use as a target for parasitic plant control. *Pest Management Science,* 65(5)**:**471-477.

Ouédraogo, O., Neumann, U., Raynal Roques, A., Sallé, G., Tuquet, C., Dembélé, B., 1999. New insights concerning the ecology and the biology of *Rhamphicarpa fistulosa* (Scrophulariaceae). *Weed Research,* 39(2)**:**159-169.

Paré, J., Raynal Roques, A., 1992. The genus Striga (Scrophulariaceae): Taxonomy, geographical distribution: Embryological results in Striga hermonthica (Del.). Benth. Scourge of food crops in Tropical Africa with special reference to the action of herbicide on seed development. *Acta Biologica Cracoviensia Series Botanica,* 35(0)**:**25-35.

Riches, C.R., Mbwaga, A.M., Mbapila, J., Ahmed, G.J.U., 2005. Improved weed management delivers increased productivity and farm incomes from rice in Bangladesh and Tanzania. *Aspects of Applied Biology,* 75**:**127-138.

Rodenburg, J., Riches, C.R., Kayeke, J.M., 2010. Addressing current and future problems of parasitic weeds in rice. *Crop Protection,* 29(3)**:**210-221.

Rodenburg, J., Zossou-Kouderin, N., Gbèhounou, G., Ahanchede, A., Touré, A., Kyalo, G., Kiepe, P., 2011. *Rhamphicarpa fistulosa*, a parasitic weed threatening rain-fed lowland rice production in sub-Saharan Africa - A case study from Benin. *Crop Protection,* 30(10)**:**1306-1314.

Sikirou, R., Gbehounou, G., Zannou, A., Bouraima, Y., Year. Comportement variétal du riz fume a l'engrais minéral face au parasitisme de *Rhamphicarpa fistulosa*: lutte intégrée et efficacité économique. In. Actes de l'Atelier Scientifique 1, Dassa, Bénin, 2002/12/18.

van Ast, A., Bastiaans, L., 2006. The role of infection time in the differential response of sorghum cultivars to *Striga hermonthica* infection. *Weed Research,* 46(3)**:**264-274.