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PROGRAMME

EX ANTE EVALUATION OF CROPPING SYSTEMS FOR WEED-MEDIATED PESTS AND ENVIRONMENTAL BENEFITS WITH SIMULATION-BASED INDICATORS

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Introduction

Integrated crop protection tolerates residual weed floras if they are not harmful for crop production. These weeds can host harmful crop pests, among which parasitic plants such as broomrape (*Phelipanche ramosa*). They can also contribute to reduce soil erosion as well as nitrate and pesticide leaching. To evaluate these weed impacts of management practices *ex ante,* we developed indicators for the weed dynamics model FLORSYS (Colbach *et al*., 2014) and then used the model to predict weed-mediated broomrape risk and environmental benefits in cropping systems from five French regions.

Materials and Methods

FLORSYS is a virtual field on which cropping systems can be tested. It predicts indicators of weed impact on biodiversity and production (Mézière *et al*., 2014). Here, several new indicators were developed (Table 1). For instance, for the potential weed contribution to reduce soil erosion, the potential rain interception by weeds is calculated each dayby summing the relative light interception (as a proxy for rain interception) for each plant p of each weed species w: $Iweed_d = \sum_w \sum_p Light\ interception_{wpd}$. The daily interception $Icrop_d$ by crop plants is calculated on the same principle. For a given cropping season, the indicator value *Ierosion* is the sum of days from crop harvest *h* to harvest *h+1* with $Iweed_d > 0.1$ and $Icrop_d < 0.2$.
Then, 246 arable cropping systems from five French regions (Aquitaine Burgundy, Lorraine, Paris Basin, Poitou-Charentes) were simulated over 27 years and repeated 10 times with randomly chosen regional weather series.

Results and Discussion

Antagonisms and synergies between weed-impact indicated were analysed with Pearson correlation coefficients (Table 1). For instance, weed-mediated broomrape was positively correlated to weed-based food offer for bees and carabids, and, to a lesser degree, to vegetal biodiversity, field infestation and weed-mediated environmental benefits. Then, regression trees were used to quantify the effect of cultural practices on weed-impact indicators (Fig. 1).

Conclusions

There tended to be an antagonism between weed-mediated environmental benefits and biodiversity on one hand, weed-mediated pests and harmfulness on the other hand. Additional analyses and simulations will be necessary to design innovative cropping systems that reconcile high weed benefits with low harmfulness.

Table 1. Examples of antagonism (in bold) and synergy between weed benefits and harmfulness. Pearson correlation coefficients between weed-impact indicator values of 246 cropping systems averaged over 27 simulated years

New Weed-Impact Indicators	Vegetal **Biodiversity**: Species Richness	Weed-Based **Food Offer** For			Weed **Harmfulness**: Field Infestation	Weed-Mediated **Pest**: Broomrape	Weed-Mediated **Environmental Benefits**	
		Birds	Carabids	Bees			Erosion Protection	Reduced Pesticide Leaching
Broomrape Risk	**0.55**	-0.02	**0.64**	**0.82**	0.45	1.00	**0.49**	**0.45**
Erosion Protection	0.50	**-0.15**	0.37	0.64	**0.20**	**0.49**	1.00	0.45
Reduced Pesticide Leaching	0.56	0.07	0.48	0.62	**0.61**	**0.45**	0.45	1.00

$ All coefficients were significant at P=0.001

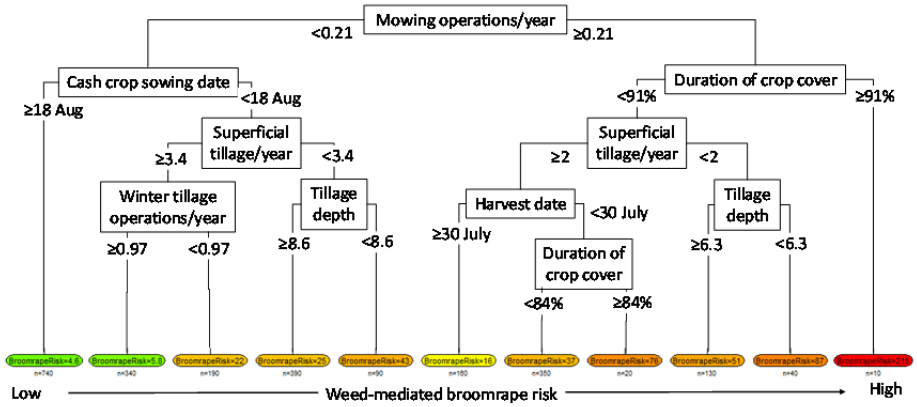

Figure 1. Identification of combinations of cultural practices that affect weed-mediated broomrape risk. Regression tree of indicator values of 246 cropping systems averaged over 27 simulated years.

Acknowledgements

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References

Colbach N. – Biju-Duval L. – Gardarin A. – Granger S. – Guyot S.H.M. – Mézière D. – Munier-Jolain N.M. – Petit S.: 2014. The role of models for multicriteria evaluation and multiobjective design of cropping systems for managing weeds. *Weed Research,* **54**:541–555.

Mézière D. – Petit S. – Granger S. – Biju-Duval L. – Colbach N.: 2015. Developing a set of simulation-based indicators to assess harmfulness and contribution to biodiversity of weed communities in cropping systems. *Ecological Indicators,* **48**:157–170.