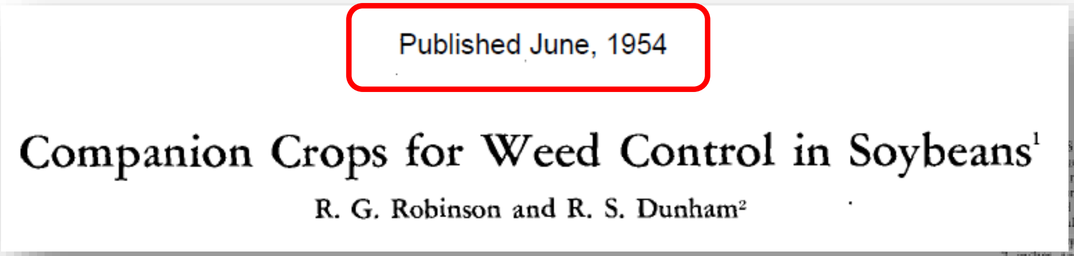
Mobiliser la compétition par des couverts : quelles pratiques pour limiter les adventices ?

Stéphane CORDEAU
INRA – UMR Agroécologie
stephane.cordeau@inra.fr
@scordeau_inra
Stéphane Cordeau Pro

Agroécologie Dijon
Unité de Recherche

INRA SCIENCE & IMPACT

Utiliser des plantes pour réguler des plantes
= vieux concept



Published June, 1954

Companion Crops for Weed Control in Soybeans[1]

R. G. Robinson and R. S. Dunham[2]

Published June, 1954

Companion Crops for Weed Control in Soybeans[1]

R. G. Robinson and R. S. Dunham[2]

...s are one of the major considerations in soybean ...ction. Because of weeds, soybeans are generally ...rows sufficiently far apart to permit cultivation ...r power. Because cultivation accentuates soil ...l organic matter losses, other methods of weed ...ld be more desirable.

...ybeans are sown with a grain drill in rows 6 or 7 inches apart, weed control is limited to human labor, herbicides, or tillage with the rotary hoe, spike-tooth harrow, or weeder. At present, herbicides are neither dependable nor entirely safe for weed control in soybeans. Successful use of the rotary hoe, harrow, or weeder is dependent on fairly uniform emergence of weeds, favorable weather and soil conditions, and a size differential between soybeans and weeds.

A new practice in soybean production—the use of companion crop competition for weed control—is presented in this paper. The use of weed-competitive crops sown with soybeans is relatively inexpensive; whereas chemical or tillage control methods require additional labor and a cash outlay for chemicals, machinery, and power. In addition to weed control, the new method eliminates cultivation of widely spaced rows and provides soil cover when the soybeans are small, thus reducing soil erosion and organic matter losses associated with normal production methods.

EXPERIMENTAL PROCEDURE

Two methods of using companion crops were tried: A—sown immediately after planting soybeans, and B—sown 18 days before planting soybeans.

Within method A, soybeans sown in non-cultivated rows 6 inches apart with and without companion crops were compared with soybeans planted in cultivated rows 40 inches apart with and without companion crops (figure 1). In addition, various companion crops and rates of sowing companion crops were compared.

Within method B, soybeans sown in non-cultivated rows 6 inches apart with companion crops were compared with soybeans planted in non-cultivated rows 40 inches apart with companion crops. In addition, various companion crops were compared.

In all trials, soybeans were inoculated. On non-cultivated plots, winter wheat, winter rye, or field pea companion crops were sown with a grain drill; alfalfa, red clover, timothy, bromegrass, or winter vetch companion crops were mixed with sand, and were broadcast and harrowed to cover the seed. On cultivated plots, companion crops were sown directly over the soybean row with a calibrated Planet Jr. garden planter.

Trials were conducted in 1952 and 1953 on Vermillion silt loam at Rosemount, Minn., and in 1953 on Storden silt loam at Westbrook, Minn.

Companion Crops Sown Immediately After Soybeans

On May 17, 1952, and May 26, 1953, at Rosemount, Ottawa Mandarin soybeans were sown with a grain drill at a rate of 2 bushels per acre in rows 6 inches apart and planted with a corn planter at a rate of 1½ bushels per acre in rows spaced 40 inches apart for cultivation. The companion crops were sown the same day in a second operation.

In 1952 the companion crops compared were winter wheat, winter rye, Ranger alfalfa, medium red clover, timothy, or bromegrass at sowing rates of 60, 56, 10, 10, 6, or 10 pounds per acre, respectively, in the non-cultivated soybeans and at rates of 20, 20, 4, 4, 3, or 4 pounds per acre, respectively in the cultivated rows 40 inches apart.

In 1953 the companion crops compared in the non-cultivated soybeans were winter wheat at 30, 60, or 90 pounds per acre, winter rye at 28, 56, or 84 pounds per acre, Chang field peas at 90 pounds per acre, or winter vetch at 30 pounds per acre. Companion crops compared in the cultivated soybean rows were winter wheat, winter rye, Chang field peas, winter vetch, alfalfa, or bromegrass at 30, 28, 45, 15, 8, or 4 pounds per acre, respectively.

Companion crop species and rates of sowing within companion crops were randomized and replicated three times. Companion crop plot size in the non-cultivated soybeans was 6 by 132 feet in 1952 and 12 by 66 feet in 1953. In the cultivated soybeans, companion crop plot size was 4 rows by 132 feet in 1952 and 3 or 4 rows by 66 feet in 1953. The most numerous weed species present were *Chenopodium album*, *Setaria viridis*, *S. lutescens*, *Amaranthus retroflexus*, and *Polygonum spp.* in 1952 and *Chenopodium album*, *Setaria viridis*, *S. lutescens*, and *Xanthium spp.* in 1953. Soybean yields were obtained both years. Weed control was measured by observations in 1952–53 and by weed plant yields at harvest time in 1953.

At Westbrook, Blackhawk soybeans were planted May 15. They were sown with a grain drill at a rate of 2 bushels per acre in rows 6 inches apart. Check plots were planted with a corn planter at a rate of 1 bushel per acre in rows 40 inches apart for cultivation. Companion crops compared were winter wheat, winter rye, or First and Best field peas sown at rates per acre of 60, 56, or 90 pounds, respectively.

Companion crop species were randomized and replicated three times. Plot size was 12 by 44 feet in the non-cultivated soybeans and 4 rows by 44 feet in the cultivated soybeans. Weeds were not numerous and were mostly *Setaria viridis* and *S. lutescens*. Soybean yields were obtained. Weed control was measured by observations and stand estimates.

Companion Crops Sown 18 Days Before Soybeans

Early sowing of companion crops provides a vegetative cover before soybean planting time, possibly avoiding some erosion losses. Since the soybeans are sown or planted directly in the young companion crops with no seedbed preparation, it was

Fig. 1.—Left, soybeans and winter wheat. Right, cultivated rows 40 inches apart. June 30, 1953.

[1] Contribution from the Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, Minn. Paper No. 3113, Scientific Journal Series, Minn. Agr. Exp. Sta. Rec. for publication Feb. 10, 1954.

[2] Assistant Professor and Professor of Agronomy and Plant Genetics.

– Jour

Diversité d'arrangement spatio-temporel de la diversité cultivée

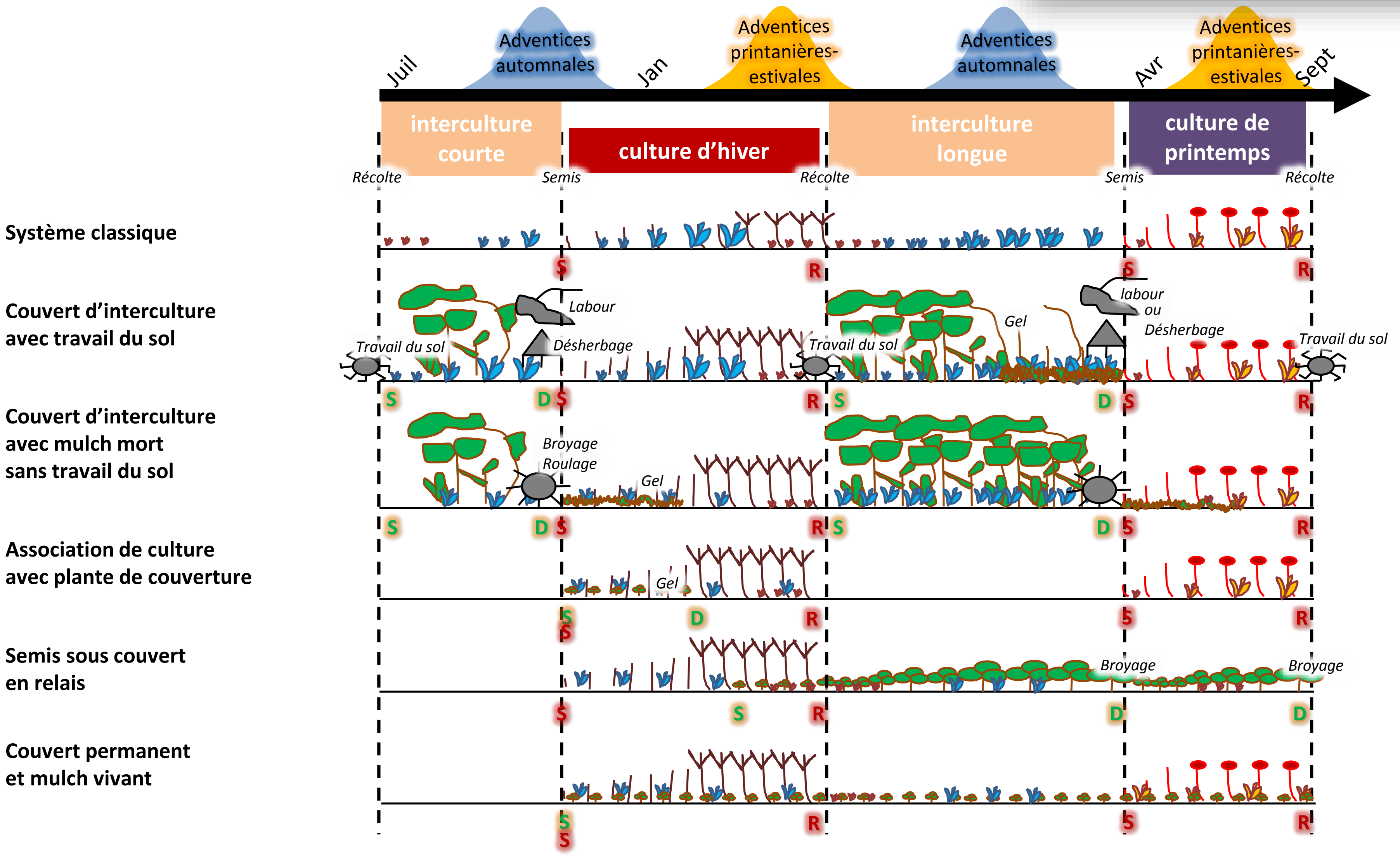

Agronomy for Sustainable Development (2018) 38:48
https://doi.org/10.1007/s13593-018-0525-3

REVIEW ARTICLE

CrossMark

Biodiversity-based options for arable weed management. A review

Sandrine Petit[1] · Stéphane Cordeau[1] · Bruno Chauvel[1] · David Bohan[1] · Jean-Philippe Guillemin[1] · Christian Steinberg[1]



Petit et al., 2018 - ASD

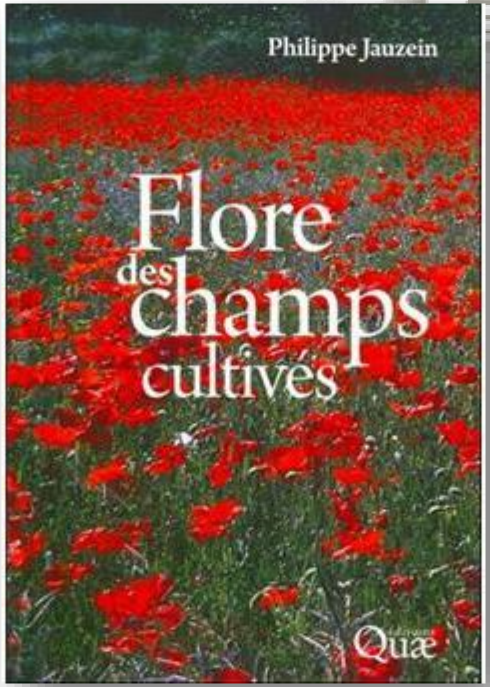
INRA SCIENCE & IMPACT

Grande diversité botanique et écologique

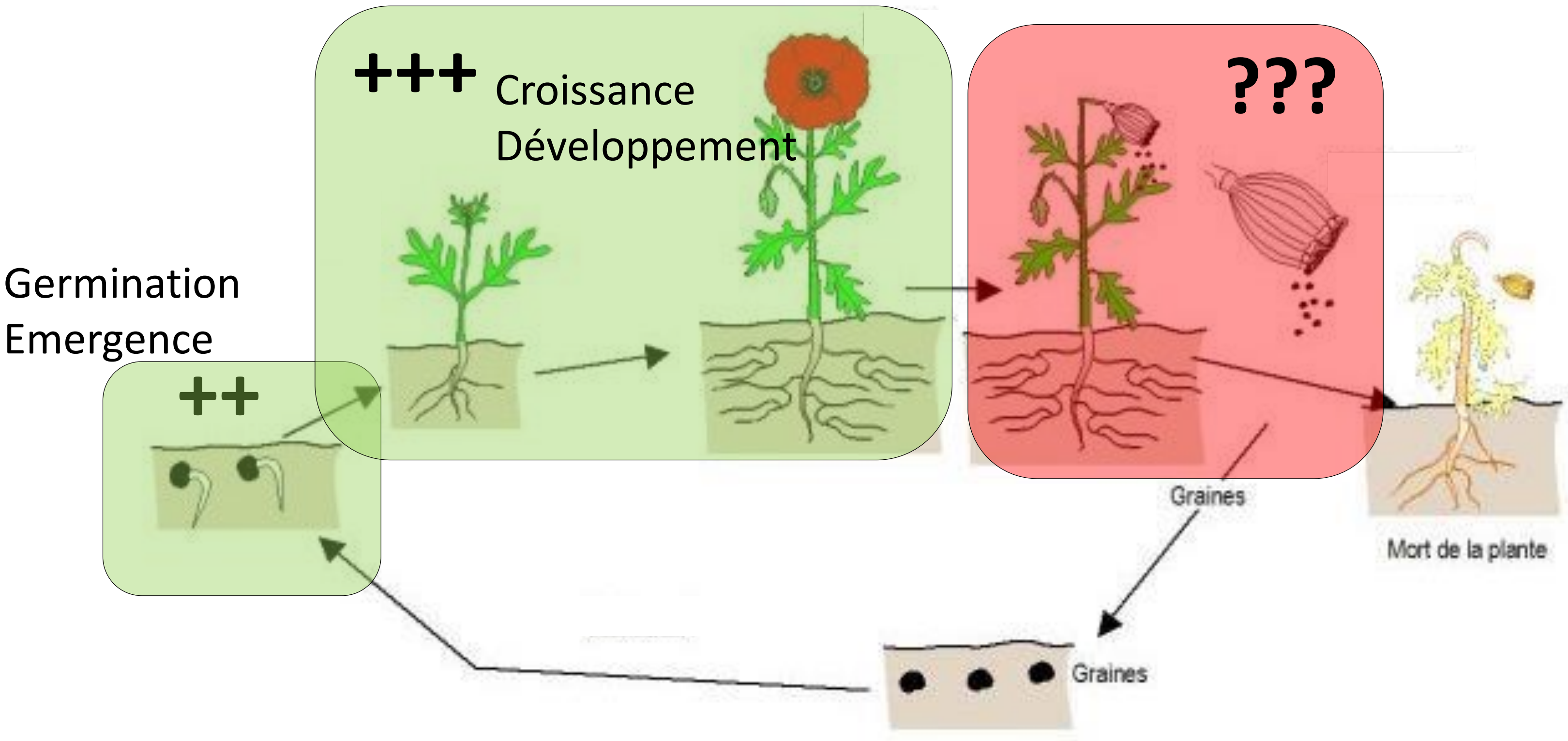
	Annuelles	Pluriannuelles	Vivaces	Total
Dicotylédones	91	12	28	131 (86%)
Monocotylédones	13	2	5	20 (13%)
Ptéridophytes	0	0	1	1 (1%)
Total (%)	104 (69%)	14 (9%)	34 (22%)	152

1200 espèces adventices des champs cultivées (Jauzein, 1995)

240 dans la flore de Mamarot et Rodriguez (Ed. 2013)



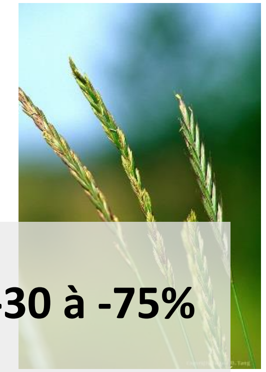
Cycle de vie
des adventices annuelles



Quelques rares exemples de gestion d'adventices vivaces

Weed Suppression by Annual Legume Cover Crops in No-Tillage Corn

John W. Fisk,* Oran B. Hesterman, Anil Shrestha, James J. Kells, Richard R. Harwood, John M. Squire, and Craig C. Sheaffer

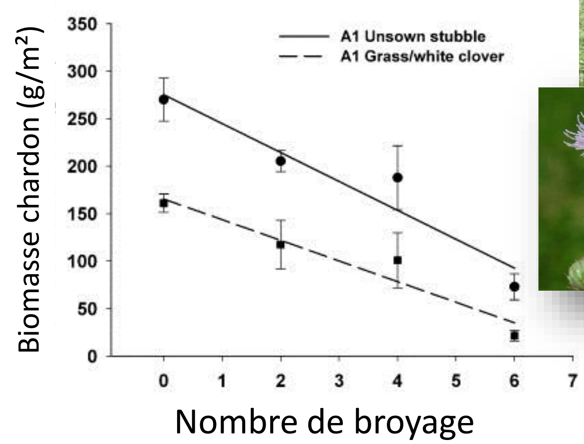


Dans le couvert ->
Densité : pas d'effet, Biomasse : -30 à -75%

Dans la culture suivante ->
pas d'effet

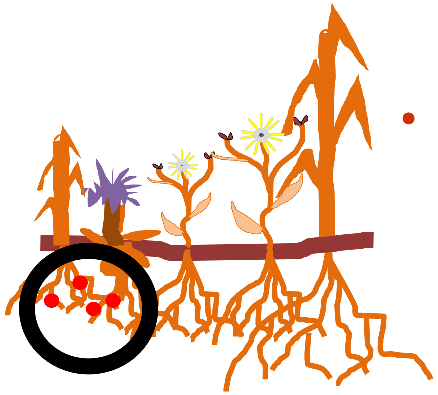
Mechanical and cultural strategies to control *Cirsium arvense* in organic arable cropping systems

E GRAGLIA, B MELANDER & R K JENSEN
Danish Institute of Agricultural Sciences, Department of Integrated Pest Management, Research Centre Flakkebjerg, DK-4200 Slagelse, Denmark



Processus de régulation biologique des adventices par des couverts

- **Compétition** pour des **ressources limitantes**
  - aérienne : lumière
  - souterraine : eau, nutriment



- **Allélopathie**
  – effet positif ou négatif de composants chimiques produits par des plantes, micro-organismes, virus ou champignons et qui ont une influence sur la croissance et le développement

Allelopathy for weed control in agricultural systems

Khawar Jabran [a,*], Gulshan Mahajan [b], Virender Sardana [b], Bhagirath S. Chauhan [c,*]

[a] Department of Plant Protection, Adnan Menderes University, Aydin, Turkey
[b] Punjab Agricultural University, Ludhiana, Punjab, India
[c] Queensland Alliance for Agriculture and Food Innovation (QAAFI), The University of Queensland, Toowoomba, Queensland, Australia

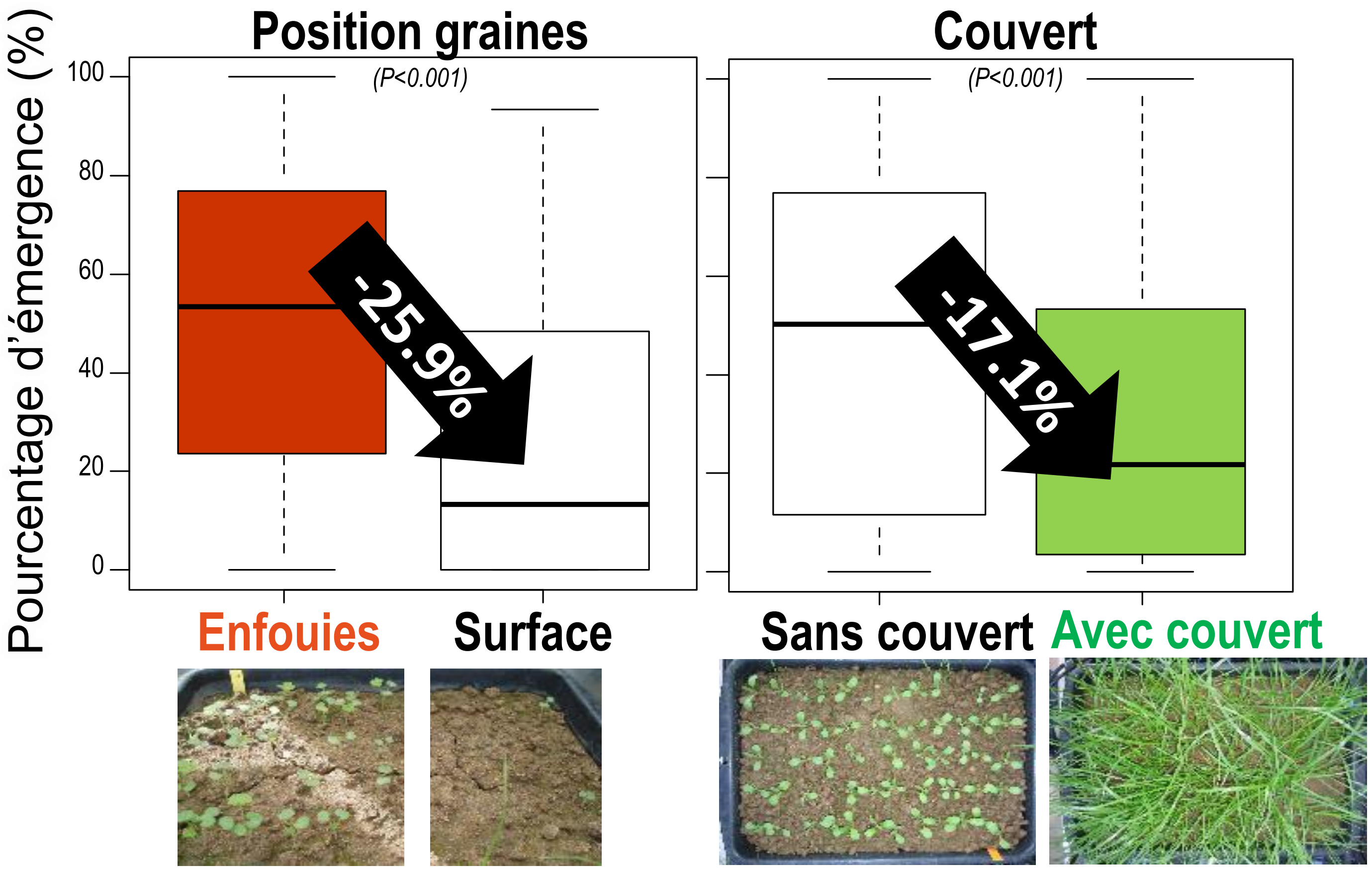
- **Cas particulier** : lutte contre les plantes parasites

The role of biological control in managing parasitic weeds

J. Sauerborn[a,*], D. Müller-Stöver[a], J. Hershenhorn[b]

[a] Department of Agroecology, Institute for Plant Production and Agroecology in the Tropics and Subtropics, University of Hohenheim, 70593 Stuttgart, Germany
[b] Section of Weed Research, Newe Ya'ar Research Center, ARO, P. O. Box 1021, Ramat Yishay 30095, Israel

1- Agir sur la germination-levée



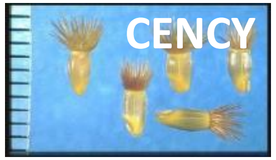
Cordeau et al., 2015 - AAB

1- Agir sur la germination-levée

mais variabilité de réponses des adventices annuelles

Lamier pourpre

Bleuet



Vulpin des champs

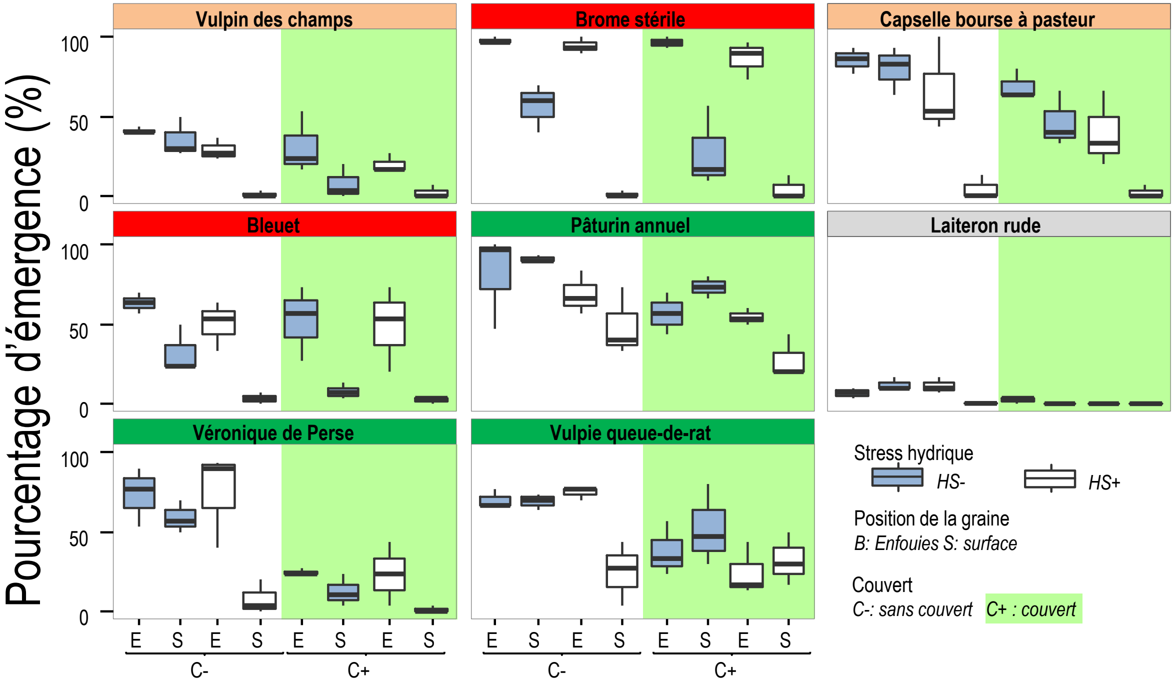
Paturin des champs

Pensée des champs

Laiteron rude

Ambroisie

Capselle



Cordeau et al., In 2018 - WBM

Géranium dissequé

Euphorbe réveil-matin

Brome stérile

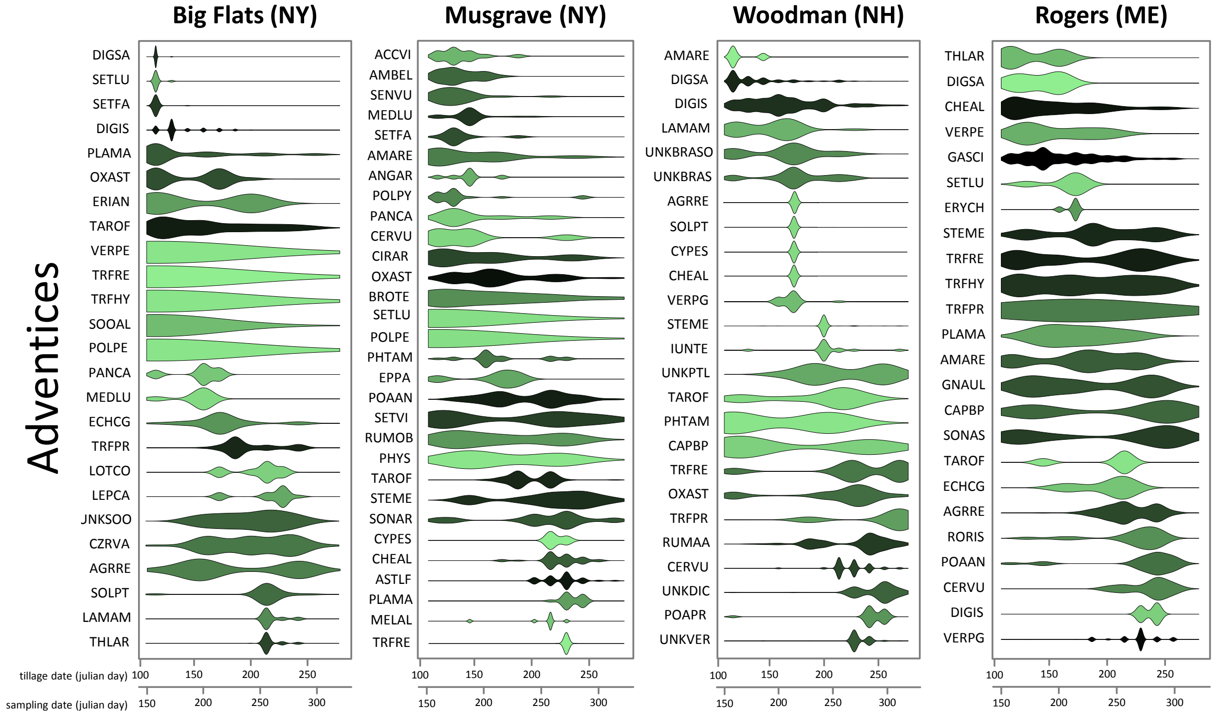
Vulpie queue de rat

Véronique de Perse

Mouron des champs

1- Agir sur la germination-levée

mais périodicité d'émergence des adventices



Cordeau et al., 2017 – AAB

Annals of Applied Biology ISSN 0003-4746

RESEARCH ARTICLE

How do weeds differ in their response to the timing of tillage? A study of 61 species across the northeastern United States

S. Cordeau[1,2], R.G. Smith[3], E.R. Gallandt[4], B. Brown[4], P. Salon[5], A. DiTommaso[2] & M.R. Ryan[2]

Positionner des couverts en fonction des périodes d'émergence des adventices
→ **quel est l'effet d'un couvert d'interculture dans une monoculture de maïs ?**
= Aucun, sur les mauvaises herbes du maïs

INRA SCIENCE & IMPACT

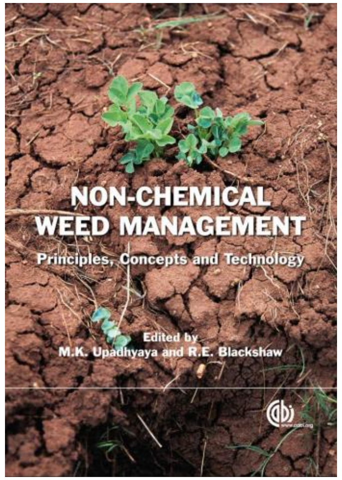
2- Agir sur la croissance (biomasse)

Table 4.1. Suppression of weeds that are growing at the same time as a live cover crop during summer or winter periods.

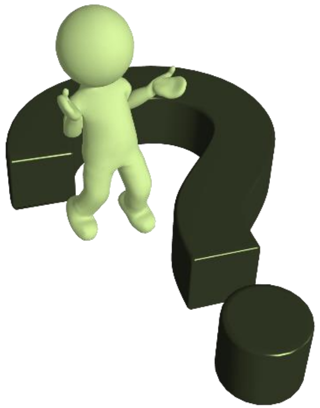
Period of growth	Location	Cover crop	Percentage weed biomass reduction[a]	Reference
Summer fallow	Nigeria	Velvetbean	85 (83–87)	Akobundu *et al.* (2000)
	Brazil savanna	Jack bean	72	Favero *et al.* (2001)
		Black mucuna	96	
		Lablab, pigeonpea	35 (22–48)	
	North Carolina, USA	Cowpea, sesbania, trailing soybean, buckwheat	85	Creamer and Baldwin (2000)
		Soybean, lablab	48	
		Sorghum-sudangrass, millet spp.	94	
	Maryland, USA	Hairy vetch	58 (52–70)	Teasdale and Daughtry (1993)
	Japan	Hairy vetch	66	Araki and Ito (1999)
		Wheat	39	
	Alberta, Canada	Yellow sweetclover	91 (77–99)	Blackshaw *et al.* (2001)
	Alberta, Canada	Berseem clover	58 (51–70)	Ross *et al.* (2001)
		Alsike, balansa, crimson, Persian, red, white clover	35 (9–56)	
		Rye	64 (31–89)	
Summer intercrop	Brazil (southern)	Black mucuna, smooth rattlebox	97 (95–99)	Skora Neto (1993)
		Jack bean, pigeonpea	83 (71–90)	
		Cowpea	39 (29–48)	
	Mississippi, USA	Hairy vetch	79	Reddy and Koger (2004)
	New York, USA	Rye	61 (37–76)	Brainard and Bellinder (2004)
	Norway	Subterranean, white clover	48 (45–51)	Brandsaeter *et al.* (1998)
Winter-surviving annuals	Oregon, USA	Rye	97 (94–99)	Peachey *et al.* (2004)
		Oats	89 (81–96)	
		Barley	89 (78–99)	
	Italy	Rye	83 (54–99)	Barbari and Mazzoncini (2001)
		Subterranean, crimson clover	32 (0–67)	
Winter-killed annuals	New York, USA	Oilseed radish, mustard	94 (81–99)	Stivers-Young (1998)
		Oats	71 (19–95)	
	Michigan, USA	Annual medics, berseem clover	54 (18–88)	Fisk *et al.* (2001)
	Illinois, USA	Mustard	93	Grimmer and Masiunas (2004)
		Barley	94	
		Oats	76	

Du potentiel :
Une réduction
de la biomasse adventice ✓

Variable selon
les mélanges,
les adventices,
les ressources ✘



Niveau d'intensité de compétition pour les ressources



Dépend

- de la densité des individus
  - effet de la densité de semis des couverts

Piloter son couvert pour maximiser la biomasse

Date de semis x Densité de semis x date destruction

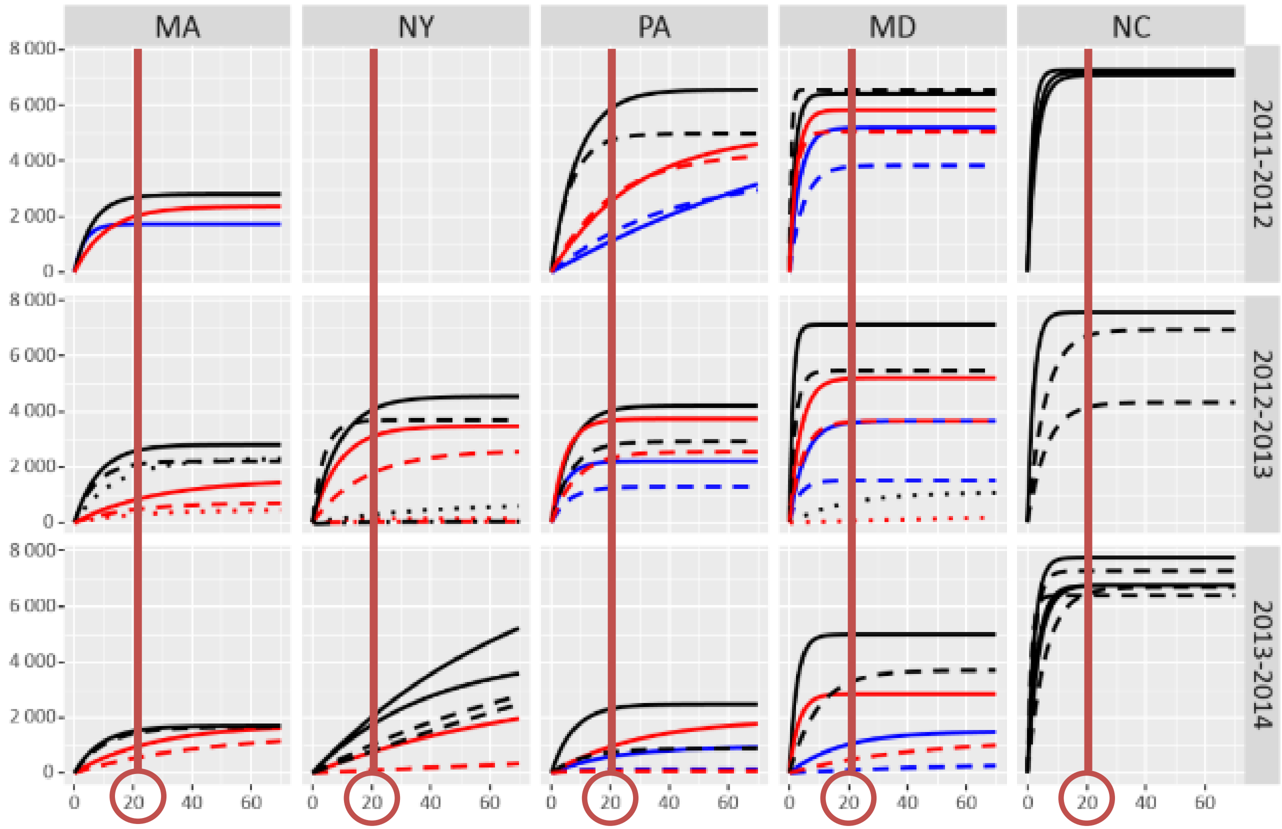
Published online July 12, 2017
CROP ECONOMICS, PRODUCTION & MANAGEMENT

Hairy Vetch Biomass across the Eastern United States: Effects of Latitude, Seeding Rate and Date, and Termination Timing

Steven B. Mirsky,* Victoria J. Ackroyd, Stephane Cordeau, William S. Curran, Masoud Hashemi, S. Chris Reberg-Horton, Matthew R. Ryan, and John T. Spargo

Gradient nord-est au sud-est

Biomasse sèche (kg/ha)



Densité de semis (kg/ha)

date de semis

- D1
- D2
- D3
- D4

date de destruction

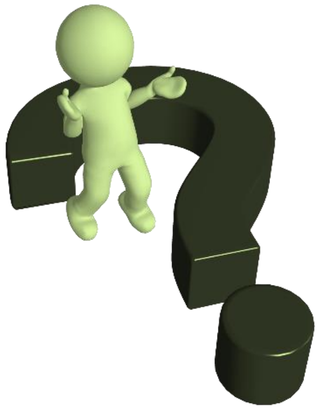
- précoce
- intermédiaire
- 50% floraison

Vesce velue

20 kg/ha = dose recommandée traditionnellement

Mirsky et al., 2017 – Agronomy Journal

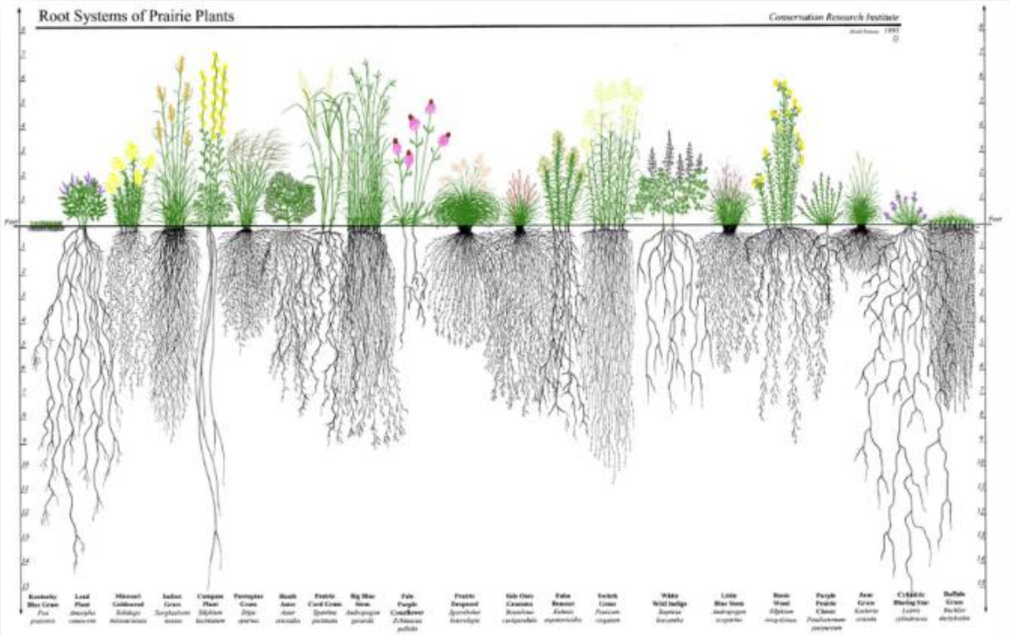
Niveau d'intensité de compétition pour les ressources



Dépend

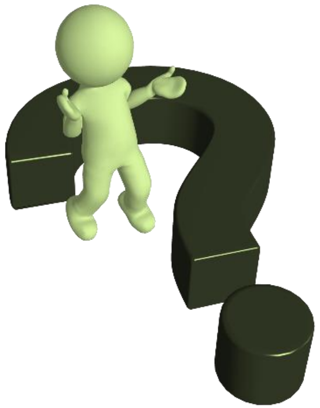
- de la densité des individus
  - effet de la densité de semis des couverts
- de la diversité des espèces
  - vitesse de croissance précoce
  - aptitude des espèces à prélever les ressources

Faut-il maximiser la diversité cultivée ?



Pour le seul service de compétition vis-à-vis des adventices : NON !

Niveau d’intensité de compétition pour les ressources



Dépend

- de la densité des individus
  - effet de la densité de semis des couverts
- de la diversité des espèces
  - vitesse de croissance précoce
  - aptitude des espèces à prélever les ressources
- de leur durée de co-occurrence entre couvert et adventice

A méditer … #1

Les couverts d'interculture
doivent être considérées
comme des cultures intermédiaires

> besoin criant de recenser les besoins des agriculteurs pour améliorer l'offre d'espèces et de variétés

Renewable Agriculture and Food Systems: 32(4); 376–385 doi:10.1017/S1742170516000338

Organic and conventional farmers differ in their perspectives on cover crop use and breeding

Sandra Wayman[1], Lisa Kissing Kucek[2], Steven B. Mirsky[3], Victoria Ackroyd[3], Stéphane Cordeau[1,4] and Matthew R. Ryan[1*]

A méditer … #2

Les cultures intermédiaires

doivent être évaluées

au plus proche des conditions de leurs usages

- ❑ **Capacité à se développer en conditions limitantes**
  - **azote (post récolte)**
  - **eau (été)**
- ❑ **Aptitude à l'association**
  - **en pure ✓**
  - **en mélange ??**
- ❑ **Aptitude à concurrencer des adventices**
  - **en situation enherbée**

GEVES
Expertise & Performance
Groupe d'Étude et de contrôle des Variétés Et des Semences

Protocole d'Expérimentation

Plantes de Services

Essais de Valeur Agronomique Technologique et Environnementale

A méditer … #3

× Le travail du sol est un filtre plus sélectif des communautés adventices que les couverts

✓ L'effet des couverts est plus visible (nécessaire, important, …) en non-travail du sol

× Couvert n'est pas une méthode de substitution au désherbage

✓ mais est un réel levier agro-écologique et bio-logique

➔ approche systémique (rotation)

Stéphane CORDEAU

stephane.cordeau@inra.fr

INRA – UMR Agroécologie

scordeau_inra

Stéphane Cordeau Pro