новые методы и результаты исследований ландшафтов в европе, центральной азии и сибири

монография в 5 томах

том IV оптимизация сельскохозяйственных ландшафтов

в содружестве с академией почвенного плодородия митчерлиха (митак), паулиненауз, германия

москва 2018

Коллектив авторов и редакторов под руководством В.Г. Сычёва (Москва), А.Х. Шеуджена (Краснодар), Ф. Ойленштайна (Мюнхеберг).

Главные редакторы: Лотар Мюллер (Лейбниц центр агроландшафтных исследований, Мюнхеберг, Германия) и Виктор Г. Сычёв (Всероссийский научно-исследовательский институт агрохимии им. Д.Н. Прянишникова, Москва, Россия)

Монография содержит информацию о самых современных методологиях и результатах в ландшафтных исследованиях. Она может быть использована в качестве руководства для исследователей, преподавателей, студентов и всех, кого интересует тема ландшафтной науки и смежных дисциплин. Монография является особо ценной информационной базой для лиц, принимающих решения на различных уровнях, от местных до международных органов по принятию решений. Приведенная в монографии информация представляет собой современный уровень ландшафтной науки в очень краткой форме.

Содержание глав дано в авторской редакции. Редакторы не несут ответственности в отношении опубликованных материалов.


Team of authors and editors under the guidance of: Viktor G. Sychev (Moscow), Askhad Kh. Sheudzhen (Krasnodar), Frank Eulenstein (Muencheberg)

Main editors: Lothar Mueller (Leibniz Centre for Agricultural Landscape Research, Muencheberg, Germany) and Viktor G. Sychev (All-Russian Research Institute of Agrochemistry named after D.N. Pryanishnikov», Moscow, Russia)

This monograph shall inform you about up to date methodologies and recent results in landscape research. It is intended as a guide for researchers, teachers, students, decision makers, stakeholders interested in the topic of landscape science and related disciplines. It provides information basis for decision makers at various levels, from local up to international decision bodies, representing the top level of landscape science in a very short form.

Authors are responsible for the content of their chapters. Neither the authors nor the editors can accept any legal responsibility for any errors or omissions that may be made. The editors make no warranty, express or implied, with respect to the material contained herein.

ISBN 978-5-9238-0246-7
ISBN 978-5-9238-0250-4 (Том 4)
DOI 10.25680/1479.2018.72.58.004

© ФГБНУ «ВНИИ агрохимии» 2018


Основная глава 12.4 Борьба с сорняками и вредителями
Main Chapter 12.4 Weed and Pest Control

CHAPTER IV/44: PRINCIPLES AND METHODS OF INTEGRATED WEED MANAGEMENT IN CROPPING SYSTEMS

Глава IV/44: Принципы и методы интегрированной защиты от сорных растений в системах земледелия

Arnd Verschwele

DOI 10.25680/2990.2018.76.68.309
Email: arnd.verschwele@julius.kuehn.de

Julius Kühn-Institut, Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Field Crops and Grassland, Messeweg 11/12, 38104 Braunschweig, Germany

ABSTRACT. During the last decades weeds in field crops have been predominantly controlled by herbicides, at least in developed countries. However, the weak diversity in cropping systems in combination with one-sided use of herbicides created problems like herbicide-resistant weeds. This worldwide increasing threat is still impaired by the continuous loss of registered herbicides. Consequently there is a strong need for more integrated weed management (IWM) focusing on preventive weed control. IWM is considered as a complex long-term approach by reducing weed emergence and reproduction. The key element of successful IWM is a diverse crop rotation, supported by site-specific primary soil tillage and stubble tillage. However, IWM is not fully accepted by farmers, mainly because the efficacy as well as the costs are hard to predict. Thus, more research and guidance are needed on decision support, weed thresholds and prediction models.
INTRODUCTION
In Europe and many other parts of the world arable weeds are predominantly controlled by herbicides. For the next future the consumption of herbicides and other pesticides as well is even proposed to increase especially in the developing countries [1]. Different specific herbicides can be applied in all major and many minor crops in order to enable a cost-efficient crop production. Because of these clear benefits field cropping has shifted to more intensive and monotonous systems. However, beside possible negative impacts for environment and human health there is also a high risk for the cropping systems when relying mainly on chemical short-term solutions. The same and repeated type of selection pressure by the same control method supports less sensitive weed species to spread. Furthermore, the number of herbicide resistant weed species is still increasing and herbicides with new mode of actions have not been introduced into the market. In addition, tougher registration and environmental regulations on herbicides have resulted in a loss of herbicides, particularly in Europe. The lack of novel herbicide chemistries being brought to market combined with the rapid increase in multiple resistance in weeds threatens crop production worldwide [2]. These factors are currently stimulating integrated weed management (IWM) in terms of new research efforts as well as the practical implementation. In addition, the Sustainable Use of Pesticides Directive (2009/128/EC), part of the EU Thematic Strategy for Pesticides, requires Integrated Pest Management (IPM) to be actively promoted. A key objective is to give greater priority to non-chemical methods of plant protection to reduce the impact of pesticides on human health and the environment [3].

THE PRINCIPLES OF INTEGRATED WEED MANAGEMENT (IWM)
Worldwide there are many definitions on IWM e.g. IPM (Integrated Pest Management) but the basic principles and targets are very similar. In contrast to the short-term herbicide approach the IWM system is based on a toolbox of preventive and direct control methods of weed control to provide the crop with an advantage over weeds. IWM is focusing on the weed seed bank rather than the weed abundance in the field. The successful combination of applicable methods will favor crop competitiveness but also limit emergence, growth and seed production of weeds. Furthermore, a high diversification of all preventive and direct control measures reduces selection pressure and avoids serious situations with problem weeds. The following figure shows the weed life cycle and the impact points of IWM (Fig. 1).
Depletion of the weed seed bank and reduction of weed competition by
1. increasing seed degradation (soil tillage)
2. increasing fatal germination (soil tillage, false seedbed)
3. decreasing active germination (crop rotation, false seedbed)
4. decreasing initial weed density (false seedbed, delayed sowing, direct control)
5. decreasing weed growth and competition (crop rotation, cultivar choice, direct control)
6. decreasing reproduction (competitive crops, direct control)

A comprehensive review on the principles and tools of IWM including preventive methods, crop rotation, crop competitiveness and other has been provided by [4].

For legislative purposes, general principles of integrated pest management are listed in Annex III of Directive 2009/128/EC, for full text please refer to [5]:

1. The prevention and/or suppression of harmful organisms should be achieved or supported among other options especially by: crop rotation, use of adequate cultivation techniques (e.g. stale seedbed technique, sowing dates and densities, under-sowing, conservation tillage),
2. Harmful organisms must be monitored by adequate methods and tools, where available.
3. Based on the results of the monitoring the professional user has to decide whether and when to apply plant protection measures. Robust and scientifically sound threshold values are essential components for decision making,
4. Sustainable biological, physical and other non-chemical methods must be preferred to chemical methods if they provide satisfactory pest control.
5. The pesticides applied shall be as specific as possible for the target and shall have the least side effects on human health, non-target organisms and the environment.
6. The professional user should keep the use of pesticides and other forms of intervention to levels that are necessary …
7. Where the risk of resistance against a plant protection measure is known and where the level of harmful organisms requires repeated application of pesticides to the crops, available anti-resistance strategies should be applied to maintain the effectiveness of the products. …
8. Based on the records on the use of pesticides and on the monitoring of harmful organisms the professional user should check the success of the applied plant protection measures.

Only four of these eight principles are related to non-chemical methods. The other principles are defining the standards for pesticide applications in compliance with IPM e.g. IWM. For a more clear view on IWM we should therefore distinguish between “true integrated weed management” and “integrated herbicide management” [6]. Integrated herbicide management defines the best herbicide performance in
order to avoid herbicide resistance. These are for example the application of at least two modes of action or the use of tank mixes. In the following we focus on “true IWM”.

THE METHODS OF INTEGRATED WEED MANAGEMENT (IWM)
A. Cultural Methods

Crop rotation:
Undeniable, a diverse crop rotation is the key element for prevention of weed growth. A crop sequence should optimize the use of resources and also limit the abundance of crop-specific pests and diseases. It is well known, that crops need specific cultivation breaks, for example winter wheat and maize (1 year), oilseed rape (3 years), potatoes and peas (4 years). Following this simple rule, crops are able to develop a high competitiveness. Furthermore, an alternating of spring and winter crops enables emergence only of those weed species which are adapted to the seasonal timing of the crop.

Some crops like winter cereals, winter oilseed rape, and especially forage crops are important for IWM as they are very suitable to suppress weeds. Furthermore, intercropping can be used to compete with weeds as far as sowing and growing conditions are favorably. Intercrops like *Sinapis alba*, *Lolium multiflorum* or *Secale cereale* require sufficient soil moisture and precipitation for a dense and competitive crop canopy. Otherwise the periods between harvest and sowing of the subsequent crop should be used for soil tillage.

Soil tillage:
Any kind of soil disturbance has a decreasing effect on the weed seed bank because it stimulates the degradation of weed seeds. Also it is often followed by higher emergence rate of weeds which can be destroyed by a second soil cultivation (before and while preparing the seedbed for the subsequent crop). This so called false seedbed or stale seedbed technique reduces the seed bank: After a seedbed has been prepared, a second operation follows 10-14 days after the first one in which emerged weeds will be killed. Conversion tillage is well known for its reducing effect on weed growth and dispersal. By plowing weed seeds are removed in deeper soil layers where they are unable to emerge and buried until they die. For agronomical and environmental reasons conversion tillage has more and more replaced by non-conversion and even minimum tillage. In these cases a successful IWM requires a much more diverse crop rotation. However, practical experiences have shown that especially perennial weed species like *Cirsium arvense*, *Elymus repens* or *Sonchus arvensis* are hard to control under conditions of reduced soil tillage.

Crop competitiveness and cultivar choice:
Almost all agronomical measures like soil tillage, fertilizing and sowing are aiming to a high yield going along with a competitive crop stand. However, in terms of IWM some methods are of major importance, e.g. cultivar choice: For winter wheat and other cereals it could be demonstrated that cultivars differ significantly in their ability to compete with weeds. In some countries this trait is yearly published in official cultivar lists so that farmers can consider it for their choice of cultivars.

Delayed sowing of winter crops:
In general, the emergence rates of weeds decline later in the season because of unfavorable growing conditions (temperature and day length). Thus, delayed crop sowing in autumn can be used as IWM tool by providing advantages to the crop over the weeds. For Maritime European conditions seeding later than mid of October is dedicated to reduce initial weed infestation in winter wheat. For spring crops a delayed
sowing cannot be recommended unless it is applied in combination with the false seed bed technique and at extremely high weed infestation.

B. Physical Control
During the last decades mechanical weeding has been replaced by broadcast applications of herbicides in conventional cropping systems. However, recently hoeing and harrowing equipment have significantly been improved by technical innovations like the GPS technology. Additionally, online digital image analysis is able to detect crop rows or even single crop plants which relieve the machine driver. Thus, an automated weeding results in higher efficacy and area treatment. Today there is a wide range of different machines and uses offered on the market. Flaming and other thermal weed control measures have been developed for practical use but except for some minor crops they have almost no relevance in field crops.

C. Other Methods
Allelopathic effects have been investigated at many plant species. Crops like sunflower and rye are able to inhibit emergence, growth and reproduction of weeds actively by releasing biochemicals. Although this biological phenomenon has been often demonstrated in the glasshouse practical uses of allelopathic plants under field conditions are difficult to implement.

PRACTICAL RELEVANCE AND FUTURE
In practice IWM is often covered by Good Agricultural Practice. For example the choice of a crop and a variety which is best adapted to the site will result in high weed suppression by the crop. This is in line with the farmer’s interest in achieving a high yield. In many situations the farmer has to weigh up between weed and crop effects. During those complex decision processes normally the long-term negative weed effects will be underestimated, especially because they cannot be exactly predicted. In unfavorable cases more efforts for IWM by the farmer do not automatically result in a lower herbicide input. Furthermore, economic effects of IWM are also hard to predict since they cannot be calculated as a net-return per year. These are clear obstacles for a better acceptance of IWM: It is not (yet) possible to evaluate the control effect of the complex IWM toolbox on weeds.
In general, the following barriers for a higher acceptance of IWM have been identified: a perception of a higher risk to management, a lack of economic incentive, and a lack of support from the crop-protection industry. In order to overcome these barriers, more research and guidance are needed on decision support, weed thresholds and prediction models [7]. Farmers often consider more IWM when they already have serious problems with a specific weed. However, at this stage it is much too late in having success with preventive control methods. Therefore it is absolutely necessary to provide farmers with adequate guidance and support in the field. Public or private advisory organizations should support farmers in effective and early implementation of IWM. Due to the increasing limitations for herbicide options in field crops we can expect a broader application of IWM - at least for some easy-to-use and inexpensive tools. Much progress in developing alternative weed management techniques, and the integration of these techniques into real IWM systems, has been made [6]. Recent technical innovation as for example machines for automated mechanical weeding and weeding robots will also improve IWM in the coming future [8].

CONCLUSIONS
1. During the recent decades cropping systems have been developed towards systems with low diversity - based on the permanent and one-sided use of pesticides.
2. Herbicide resistance will be the strongest agronomic impeller for IWM in the next future. This trend will be followed by a continuous loss of registered herbicides.
3. Technical innovations like automated mechanical weeding can support a broader practical implementation of IWM.
4. Sustainable crop production requires a high diversity on preventive and direct tools of crop protection.
5. Farmers have to understand weed management as a complex and long-term strategy.

REFERENCES
Chapter IV/45: INFLUENCE OF LONG-TERM APPLICATION OF MINERAL FERTILIZERS ON THE FUNGISTASIS OF SOUTHERN CHERNOZEMS IN THE SYSTEM OF LANDSCAPE-ADAPTED AGRICULTURE

Глава IV/45: Влияние многолетнего применения минеральных удобрений на фунгистазис южных черноземов при адаптивно-ландшафтной системе земледелия

Galina N. Churkina*, Irina V. Rukavitsina, Kairat K. Kunanbayev, Dana Yerpasheva

DOI 10.25680/5398.2018.72.20.310

*Email: galina_churkina@mail.ru

LLP “Scientific and Production Centre of Grain Farming named after A.I. Barayev”, Nauchnyi village, Kazakhstan

ABSTRACT. In order to determine the effect of mineral fertilizers on the biological soil activity, the change in the total number of soil micromycetes was studied depending on the application of different types and doses of mineral fertilizers when cultivating continuous wheat by No-till technology in the southern carbonate chernozems of Northern Kazakhstan. It has been found that the use of mineral fertilizers activated the fungistasis processes in the system of landscape- adapted farming, against the background of prolonged fallow less cultivation of wheat, which resulted in an increase of soil fungi. Fungi compose 0.1-0.2% of the total microbocenosis in soils of southern chernozem. The most common are representatives of the genus Penicillium, Trichoderma and somewhat fewer - the genera Mucor, Aspergillus, Fusarium. The introduction of ammonium nitrate increases the amount of fungi biomass that in turn help to supply plants with nitrogen and phosphorus, thus contributing to soil fertility increase, when cultivating wheat after rape seed using zero (No-till) technology.

Резюме. С целью определения влияния минеральных удобрений на биологическую активность почвы, изучалось изменение общей численности почвенных микромицетов в зависимости от применения различных видов и доз минеральных удобрений при возделывании бессменной пшеницы по ну-тилл технологии на южных карбонатных черноземах Северного Казахстана. Установлено, что использование минеральных удобрений в адаптивно-ландшафтной системе земледелия активизировало процессы фунгистазиса, на фоне длительного беспарового возделывания пшеницы увеличилось количество почвенных грибов. В почвах южного чернозема грибы составляют 0,1-0,2% от общей численности микробоценоза. Наиболее распространены представители рода Penicillium, Trichoderma несколько меньше – родов Mucor, Aspergillus, Fusarium. При нулевой технологии возделывания пшеницы по рапсу внесение аммиачной селитры увеличивает количество биомассы грибов, которые помогают потреблению азота и фосфора растениями, чем способствуют повышению плодородия почвы.