The influence of crop density and sowing delay on weed germination in winter wheat

Einfluss von Bestandesdichte und späterem Aussaatzeitpunkt auf die Unkrautkeimung in Winterweizen

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Abstract

Due to changes in agronomic practices and cropping systems such as the development of reduced soil tillage systems, monocropping; changing climate conditions that result in longer warmer periods in autumn and due to other factors such as herbicide resistance approaches for integrated weed management are needed. Crop competitiveness could be one of several measures of cultural weed control, which is an important factor in integrated weed control. Delayed sowing dates or higher crop seed rates could be an integrated tool for weed management, because higher crop plant densities generally are more competitive with weeds.

Two field trials were conducted to investigate the influence of winter wheat plant density and delay of sowing date at the Institute of Agriculture, LRCAF in conventional soil tillage system over the period of 2014 –-2016. Winter wheat var. 'Ada' was drilled at three different seeding rates (2, 4 and 8 million germinal seeds per hectare) at the regional recommended sowing date, three weeks later and six weeks later. Main weeds in winter wheat crops were annual dicotyledonous, common for the winter cereals stands in Lithuania such as *Thlaspi arvense*, *Viola arvensis*, *Galium aparine* and *Lamium purpureum*. Furthermore, volunteer oilseed rape and the annual monocotyledonous weed *Apera spica-venti* were presented in the field. Admittedly, meteorological conditions were favourable for cereals vegetation during the autumn.

In plots with the highest seeding rate weed biomass was significantly lower, however lodging problem, especially in early seeded plots occurred. The weed biomass in plots drilled at the end of September was significantly lower compared to early drilled plots. The lowest weed mass was recorded in plots with the latest sowing date, however a significant decrease in grain yield was recorded in these plots.

Keywords: Cultural weed control, sowing delay, sowing rate, winter wheat

Zusammenfassung

Aufgrund von Veränderungen in ackerbaulichen Anbauverfahren wie z.B. der Anwendung reduzierter Bodenbearbeitungsmaßnahmen und de m Anbau von Monokulturen, klimatischen Veränderungen, die zu längeren, wärmeren Perioden im Herbst führen können sowie aufgrund der Ausbreitung von Herbizidresistenz nimmt die Bedeutung von integrierten Lösungen zur Unkrautbekämpfung zu. Die Erhöhung der Konkurrenzkraft der Kulturpflanze ist eine von vielen ackerbaulichen Maßnahmen, die im Rahmen einer integrierten Unkrautbekämpfung angewendet werden können. Spätere Aussaattermine oder erhöhte Aussaatdichten können ebenso als effektive Maßnahmen angesehen werden, da dichtere Kultur-Pflanzenbestände generell eine höhere Konkurrenzkraft gegenüber den Unkräutern aufweisen können.

Zwei Feldversuche wurden in 2014-2016 am Institute of Agriculture, LRCAF, durchgeführt um den Einfluss von Bestandesdichte und späterem Aussaatzeitpunkt von Winterweizen in konventionellen Bodenbearbeitungssystemen zu untersuchen. Die Winterweizensorte 'Ada' wurden mit drei verschiedenen Bestandesdichten (2, 4 und 8 Millionen keimfähige Samen pro ha) und zu drei verschiedenen Aussaatzeitpunkten (regional empfohlener Aussaatzeitpunkt, drei Wochen später und sechs Wochen später) gedrillt. Die Hauptunkrautarten in den Versuchen waren einjährige zweikeimblättrige Arten, die typisch für Wintergetreide sind, wie *Thlaspi arvense*, *Viola arvensis*, *Galium aparine* und *Lamium purpureum*. Zudem traten Ausfallraps und einjährige einkeimblättrige Arten wie *Apera spica-venti* auf.

In den Parzellen mit den höchsten Bestandesdichten war das Unkrautaufkommen am niedrigsten. Allerdrings traten vor allem in Parzellen mit dem früheren Aussaatzeitpunkt Verschlämmungsprobleme auf. Bei späteren Aussaatterminen traten deutlich weniger Unkräuter auf als bei den früheren Aussaatzeitpunkten. Das geringste Unkrautaufkommen wurde in Parzellen mit dem spätesten Aussaatzeitpunkt beobachtet, allerdings war in diesen Parzellen auch der Ertrag des Winterweizens reduziert.

Stichwörter: Aussaatverspätung, Bestandesdichte, nicht-chemische Unkrautkontrolle, Winterweizen

Introduction

Measures of weed control need to be improved because of the increasing risk of herbicide resistance. Currently, cultural weed control methods therefore increase in importance. The main goal of cultural control methods is to reduce the competition imposed by weeds through the enhancement of crop competitive ability in order to improve the ability of the crop itself to suppress weeds (LEMERLE et al., 2001; MOHLER, 2001). This could be achieved through the use of competitive crop genotypes, transplants, and appropriate sowing pattern and fertilization strategy (BARBERI, 2002). The seeding rate of the crop is an important factor in determining the biomass production of weeds and most studies show a decreasing weed biomass at higher crop densities (BLACKSHAW, 1993; DOLL, 1997; AUSKALNIENĖ and AUSKALNIS, 2008). At relatively low crop densities, crop cover early in the growing season is low, resulting in a larger amount of resources available for the weeds, thus enabling them to establish and grow quickly (LEMERLE et al., 2001). No effects of crop density on crop biomass or yield were observed, when weeds were controlled with herbicides (KRISTENSEN et al., 2008). An increase from low to high density could result in 45% less weed biomass and the proportion of weed biomass on the total biomass differed between the weed species (OLSEN et al., 2005). The results of previous investigations also suggest that the relative size of the crop and weed plants when crop–weed competition becomes intense is critical in determining the effects of crop density and pattern on weed biomass. When the crop has an initial size advantage, increasing crop density can help suppress the weeds (OLSEN et al, 2006). When weed pressure is high, reduced weed biomass translates directly into yield (CHRISTENSEN, 1995; LEMERLE et al., 1996). On the other site, manipulating plant density is an effective practice to optimize tiller and main stem competition for light, water, and nutrition, therefore enhancing wheat grain yield and nitrogen use efficiency (CHEN and NEILL, 2006). One potential problem with increased sowing density is the risk of an increase in fungal pathogens, especially in row pattern (WEINER et al., 2001).

Date of establishment of a crop may be used as a measure to reduce weed infestation. By delaying sowing in autumn, growers can avoid the peak of flush of weeds and use the soil disturbances associated with seedbed preparation and planting to eliminate this flush (KOLB and GALLANT, 2012).

The aim of the present study was to investigate the influence of sowing delay and different sowing rates on weed number and grain yield of winter wheat.

Materials and Methods

The influence of sowing density and delaying of seeding date on weed suppression was investigated in winter wheat var. 'Ada' in field trials conducted at the Lithuanian Institute of Agriculture in 2015 and 2016 in Central Lithuania (55°23′50″N and 23°51′40″E). The soil at the experimental site was endocalcary-endohypogeyic cambisol (CM-p-w-can), neutrally acid light loam, rich in phosphorus and potassium. Seeding rates were adjusted for seed weights and germination rate to achieve a population density of 200, 400 or 800 plants per m^2. Three sowing dates were used, namely the regional recommended sowing date (1st decade of September), three weeks later and six weeks later. Split – plot design with three replications was used, where the main factor was the sowing date. Weed germination of species was assessed in late autumn by counting of emerged weed plants. Weed number was recorded in four places of 0.25 m^{-2}, in each plot of winter wheat in spring. Winter wheat was harvested at the end of July and grain yield was assessed for each plot.

Results

Main weeds in winter wheat were annual dicotyledonous such as *Thlaspi arvense* (THLAR), *Lamium purpureum* (LAMPU), *Viola arvensis* (VIOAR) *Galium aparine* (GALAP) and *Stellaria media* (STEME). *Apera spica-venti* (APESV) was recorded as a monocotyledonous weed species. Many weed species showed a different germination in autumn dependent on the seeding treatments (Tab. 1).

At the early sowing date, seeding rate had only a low impact on germination of almost all main weeds present in the experimental winter wheat field. With increasing seeding rate, the number of VIOAR and GALAP plants decreased significantly. More important for weed germination was the sowing time – in plots with a later sowing date, weed numbers in autumn were significantly lower, especially for LAMPU and VIOAR. No weeds germinated till the spring at in plots that received the latest sowing date.

Tab. 1 Germination of different weed species under the influence of seeding rate and sowing date.

***Tab. 1** Keimung verschiedener Unkrautarten in Abhängigkeit von Aussaatdichte und Aussaattermin.*

	Sowing date								
	Early sowing			3 weeks later			6 weeks later		
Weed	Sowing rate (mio seeds/ha)								
species	2	4	8	2	4	8	2	4	8
THLAR	7a	4a	3a	1b	0.3b	0.3b	0b	0b	0b
GALAP	57a	47ab	28b	41ab	36ab	41ab	0c	0c	0c
VIOAR	24a	18b	19b	6d	8d	4de	0e	0e	0e
LAMPU	14a	14a	12a	4c	6c	3c	0c	0c	0c

Different results were recorded for the number of *Apera spica-venti* (APESV) plants. No influence of sowing rate on plant density of APESV was observed. Large differences were recorded for plots with different drilling dates – sowing delay had a significant influence on APESV numbers. In plots with the latest sowing date, the number of APESV plants was 3 – 5 times lower compared to the early sowing (Fig. 1).

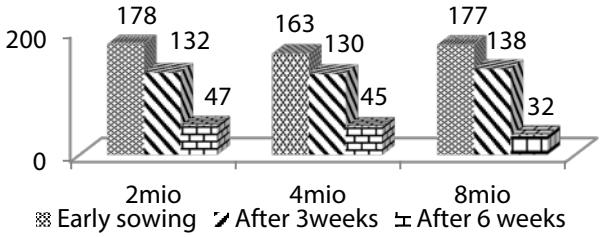

Fig. 1 Plant numbers/m^2 of APESV at different sowing time and winter wheat plant density.

***Abb. 1** Anzahl der APESV-Pflanzen/m2 zu verschiedenen Aussaatzeitpunkten und Aussaatdichten von Winterweizen.*

Sowing delay could be a possible management option for non-chemical weed control, however in plots with the latest sowing time, grain yield of winter wheat was significantly lower (Tab. 2).

Tab. 2 Grain yield of winter wheat in dependence of sowing time and seeding rate.

***Tab. 2** Kornertrag von Winterweizen in Abhängigkeit von Aussaatdichte und Aussaattermin.*

	Sowing date		
Sowing rate (wheat plants/ha)	Early	Three weeks later	Six weeks later
2 mio	5.6b	5.9ab	3.6c
4 mio	6.4ab	7.0a	4.3c
8 mio	6.5ab	7.1a	4.3c

A three-week delay of sowing date had no influence on grain yield of winter wheat compared to the early sowing date. In plots with high weed incidence it would be beneficial to sow winter wheat at the end of September.

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