PRECROP EFFECTS OF GRASS SEED STANDS ON THE YIELD OF SUCCEEDING CROPS

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ABSTRACT

Depending on grass species, number of harvest years, location and fertilizer input grass seed cropping leaves varying quantities of organic residues in the soil. When grasses are part of a crop rotation, soil-physical properties will be improved, and positive effects on the yield formation of successors can be expected. In three different experiments run between 1990 and 1995 the precrop effects of six grass species (one or two seed cropping years) were studied for their influence on the yielding of various successors. A highly differentiated water supply in spring 1993 and 1994 enabled an exact assessment of the precrop effects by the grasses, mainly for succeeding wheat.

KEYWORDS

Grass seed cropping, number of harvest years, precrop effects, successor crops, yield effects

INTRODUCTION

Perennial grasses are reported to leave in the soil more organic matter than cereal crops or annual main crops when being part of a crop rotation (Simon, 1993; Schäfer, 1994). For this reason, grass seed crops are recommended as suitable predecessors for root crops and also for rape. In this connection attention is drawn to the necessity of shallow soil tillage and sward destruction still in summer in order to induce the rotting of plant residues already prior to the winter furrow. Such measures can decisively influence the precrop effects of grass seed populations, apart from influences by weather factors. The root dry matter (including harvest residues) left in the soil varies considerably depending on crop species, number of harvest years, location and fertilization and amounts to 2.5 to 5.0 t•ha $^{-1}$ (Renius et al., 1992). However, the N content and also the P and K quantities in the root dry matter are rather low according to studies on Italian ryegrass by Berendonk (1989). Grass seed cropping as part of a crop sequence is said to have also a positive phytosanitary effect on the succeeding crop (Bockmann, 1962; Pansegrau and Simon, 1994). The present paper discusses the crop rotation effects of annually and biennially utilized seed grasses on the yield of various successor crops.

METHODS

The field trials were run from 1990 to 1995 in the experimental station of Halle university in Seehausen near Leipzig (132 m a.s.l., mean annual precipitation over 30 years: 552 mm, mean annual temperature 9.1×C, soil: sandy loam, gleyic luvisol).

Test I: Investigation of yield effects by eight precrop variants on four succeeding crops in the 1st and 2nd year of post-cropping

Variants (precrops):

Precrop	Sowing	Seed harvest year
- Lolium perenne	OSS[1] 1990 (after winter barley)	1991 + 92
- Festuca rubra	OSS 1990 (after winter barley)	1991+92
- Lolium multiflorum [westerwoldicum]	Spring 1992 (after rape)	1992
- Lolium multiflorum [italicum]	OSS 1991 (after oats)	1992
- Lolium perenne	US[2] in oats	1992
- Festuca rubra	US in oats	1992
- Dactylis glomerata	US in oats	1992
- Silage maize	Spring 1992 (after oats)	1992

[1] OSS open spring sowing
[2] US undersowing

Variants (postcrops):

1st year of post-cropping 1992/93:		2nd year of post-cropping:
- winter wheat	—>	spring barley
- spring barley	—>	silage maize
- silage maize	—>	oats
- sugar beet	—>	winter wheat

Test II: Analysis of precrop effects by various grass species after one year of seed harvesting in the 1st year of post-cropping 1992/93 (winter wheat) and in the 2nd year 1994 (spring barley)

This test included 6 different seed grass species and two comparative crops (winter wheat and full fallow) in the role of a precrop. The grasses were sown in spring 1991 under Vicia faba L. as cover crop. In all variants seed cuts of grasses were taken only in the 1st harvest year 1992. In that year all variants were run on 2 N-levels (0 and 60 kg N•ha $^{-1}$). This means that the precrop value was analysed in 16 variants, i.e. in 1992/93 on winter wheat as 1st successor and in 1994 on spring barley as 2nd successor.

Test III: Analysis of precrop effects by various grass species after one year of seed haresting in the 1st year of post-cropping 1993/94 (winter wheat) and in the 2nd year 1995 (spring barley).

Although launched one year later (1991), this test included the same variants as Test II. So precrop effects were analysed for the post-cropping years 1993/1994 on winter wheat and 1995 on spring barley.

RESULTS

The test results were influenced by very versatile weather conditions in spring 1993 and 1994. In 1993 only 38 mm rainfall was recorded between March 1 and April 30, whereas in 1994 187 mm were registered in the corresponding period.

Yields of the succeeding crops in the 1st and 2nd post-cropping year in Test I

Figure 1 contains the grain yields of winter wheat obtained in the 1st year of successive cropping (1992/1993) and of spring barley in the 2nd year (1994). Two years of seed cropping of Lolium perenne and Festuca rubra produced significantly lower seed yields compared with one year of seed harvesting in 1993. The best precrop effects seem to have been exerted by Lolium multiflorum [italicum], Dactylis glomerata and Zea mays. Spring barley yielded very poorly in the 2nd post-cropping year. This can be explained mainly by the late sowing in spring 1994 due to extended rainfall in March and at the beginning of April 1994. There were, however, no significant yield deviations compared to the 1st post-cropping year.

The successor combination silage maize - oats revealed similar precrop/ successor relationships, as shown in Fig. 1 for the combination winter wheat - spring barley. Two years of seed cropping with Lolium perenne and Festuca rubra exhausted the soil water potential much more than only one year of seed harvesting and decreased significantly also dry matter yields of maize (16-17 t•ha $^{-1}$), when it was the 1st successor crop, compared with the precrops Italian ryegrass and Festuca rubra after one-year of seed cropping and maize itself (DM yields 20-21 t ha^{-1}).

Like with spring barley, the wet spring of 1994 forbade to sow the 2nd successor crop oats in proper time. Beyond this, damage was caused by the frit-fly and aphids. Thus, grain yields went down irrespectively of any precrop influence.

As far as the successors sugar beet —> winter wheat are concerned, it was again only the 1st successor that showed clear precrop influence. With the exemption of Festuca rubra in two years of seed cropping, all grass precrops and also silage maize proved to be favourable for the yield formation of sugar beet (root net yield 62-67 t•ha $^{-1}$). After two years of seed cropping with Festuca rubra, the sugar beet yield had significantly decreased to 57.3 t ha^{-1} only.

Yields of the successor pair winter wheat —> spring barley in Test II

In Figure 2 the precrops are demonstrated with their two nitrogen treatments 0 and 60 kg N•ha $^{-1}$ as well as the grain yield graphics of the 1st successor winter wheat (1993) and the 2nd successor spring barley (1994). In the precrop variant 'full fallow' wheat yields were significantly increased vis-à-vis the other precrop species. No major deviations were recorded for the wheat yield 1993 between the various grass precrops. There was a low aftereffect on the wheat yield by Lolium perenne, Dactylis glomerata and the Festuca species in the 60 kg variant, however, the yield differences hinted in Fig. 2 were not significant. Compared with winter wheat in precrop position, the checked grass species offered no benefit for winter wheat as succeeding crop.

The **results of Test III**, obtained in 1994 (1st year of crop succession) under more favourable weather conditions than in Test II (1993), indicate a generally higher yield level. They underlined, however, the yield relationships with the successor wheat as recorded in Test II. The nitrogen rate of 60 kg applied to the precrops increased post-crop yields in all treatments, in case of the precrop winter wheat even significantly.

Yield responses by spring barley to the various precrops in the 2nd year of control cropping (1994 and 1995 resp.) were generally low and without significance between the variants.

DISCUSSION AND CONCLUSIONS

In regions or years with insufficient water supply precrop-related effects of grasses in seed cropping may not occur in the 1st succeeding crop, because especially in perennial grass cropping the comprehensive root system exhausts the available soil water potential, thus limiting yield formation in the successor crop due to the soil water deficiency. It was great luck for the obtention of information that the relatively dry spring of 1993 was followed by completely differing conditions in 1994. In view of this, grass precrop effects can be assessed only for the 1st post-crop and preferably for winter wheat:

1) In case of insufficient water supply in spring, one-year seed cropping of grasses had the same precrop value for winter wheat as maize. The ranking of the single grass species was related to the development of the given plant population and thus to the water uptake by the grass species from the soil.

2) Sufficient water supply in spring provides grasses with better precrop value for the 1st successor crop. There were no significant differences among grasses and their service life (one or two years of seed harvests) concerning their influence as precrops.

3) When silage maize was grown as post-crop under the conditions of insufficient water supply in spring, grasses with one-year seed cropping turned out to be equivalent to maize as precrop.

4) The decisive precrop effects of grass seed growing for crop rotations resulted from the organic matter left in the soil. Depending on the quantity of root and crop residues, benefits ensue for the physical properites of the soil, and the growth of succeeding crops will be supported depending on soil type and fertilizer input. Such effects for the heating of the soil in spring, for microbial processes and efficient water and nutrient supply to crop plants can normally be assessed only after many years of experimenting.

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Figure 1

Precrop effects by various grasses in seed propagation (1-resp.2-year seed harvesting) in the 1st successive year 1993 (winter wheat - WW) and in the 2nd year 1994 (spring barley - SB) in Test I

Var. No.	Precrop 1991	1992	Postcrop 1993	1994	Grain yields (t• ha $^{-1}$ with 86% DM) of the postcrops 2 3 4 5 6
1	Lolium perenne	Lolium perenne	WW	SB	______________ ---------
2	Festuca rubra	Festuca rubra	WW	SB	__________________ ---------
3	rape	Lolium multiflorum [westerwoldicum]	WW		__________________________ ---------
4	oats	Lolium multiflorum [italicum]	WW	SB	__________________________ -------
5	oats	Lolium perenne	WW	SB	_________________________ ------
6	oats	Festuca rubra	WW	SB	________________________ ----------
7	oats	Dactylis glomerata	WW SB		______________________________ -----
8	oats	silage maize	SB SB		______________________________ ----

$GD_{\mu (5\%)t}$ = 0.71 t• ha $^{-1}$ (Wi. wheat)
$GD_{\mu (5\%)t}$ = 0.53 t• ha $^{-1}$ (Spring barley)

Figure 2

Precrop effects by various grasses in seed propagation (1-year seed harvesting) in the 1st successive year 1993 (winter wheat - WW) and in the 2nd year 1994 (spring barley - SB) in Test II

Var. No.	Precrop 1991	1992	N-rate[1)]	Postcrop 1993 N=60[1)]	1994 N=70[1)]	Grain yields (t• ha $^{-1}$ with 86% DM) of the postcrops 3 4 5 6 7 8
1	Vicia faba	Winter wheat	0 60	WW	SB	____________________ ____________________ ====
2	Vicia faba	Fallow	0 60	WW	SB	_________________________ _________________________ ====
3	Vicia faba	Lolium perennne	0 60	WW	SB	____________________ ______________________ ===
4	Vicia faba	Dactylis glomerata	0 60	WW	SB	_______________ _________________ =====
5	Vicia faba	Festuca rubra	0 60	WW	SB	____________________ _____________________ =====
6	Vicia faba	Festuca pratensis	0 60	WW	SB	____________________ ______________________ =====
7	Vicia faba	Festulolium [2)]	0 60	WW	SB	____________________ ___________________ ======
8	Vicia faba	Lolium multiflorum [italicum]	0 60	WW	SB	___________________ ____________________ ====

1) N kg• ha $^{-1}$, in the graphics the upper line of each pair represents the yield at 0 kg N• ha $^{-1}$ and the lower line the yield at 60 kg N• ha $^{-1}$
2) Festulolium-Bastard (Lolium multiflorum [italicum] x Festuca pratensis)
$GD_{\mu (5\%)t}$ = 0.67 t• ha $^{-1}$ (Wi. wheat) $GD_{\mu (5\%)t}$ = 0.36 t• ha $^{-1}$ (Spring barley)