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EFFECT OF WINTER RYE CATCH-CROP ON BUCKWHEAT YIELDING (*FAGOPYRUM SAGITATUM*)

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Abstract

The main aim of the studies was to identify the effect of winter rye catch-crop on buckwheat growth and yielding. Winter rye was sown in the autumn and in the spring its biomass was incorporated into the soil by a rototiller or a plough. During incorporation, winter rye was at the 2nd node or just at the beginning of heading stage. The treatment without above ground biomass where only stubble of rye was incorporated into the soil was taken into consideration as well. Rye incorporated into the soil affected buckwheat emergence rate, number of plants and leaf area index. Positive effect of rye catch crop on buckwheat yield was observed in the year with higher precipitation.

Key words: buckwheat, winter rye, catch-crop, weeds.

Introduction

Catch crops are introduced into crop rotations as an effective means for the improvement of soil conditions, particularly in simplified crop rotations. Studies conducted in different countries / Benoit et al., 1962; Chou et al., 1976; Barnes, Putnam, 1983; Barnes et al., 1986; Barnes, Putnam, 1986; Chase et al., 1991; Burgos, Talbert, 2000; / show that rye could play an important role in weed infestation control. There is a great number of weed species whose emergence and growth can be effectively limited by the allelopathic compounds of winter rye. Putnam and de Frank (1983) and Shilling et al. (1985) indicate that *Amaranthus retroflexus*, *Chenopodium album, Portulaca oleracea* and *Ambrosia artemisiifolia* are among the species most sensitive to allelopathic compounds of rye. Their emergence was limited by above 90%. High efficacy of weed control by rye biomass was confirmed in the experiments conducted in Pulawy /Grabiński, 2006/, particularly of *Chenopodium album, Stelaria media*, *Viola arvensis*, *Capsella bursa pastoris* or *Anthemis arvensis*. These results were the base to plan experiments to verify the possibility of winter rye catch crop use in practice. In Poland, buckwheat is sown in the 2nd and 3rd ten-day periods of May, when rye is at the stage of heading. Buckwheat was chosen as a test crop because chemical weed control methods have not been worked out yet. As a result, non - chemical weed control methods in buckwheat production technology are useful not only in organic agriculture but also in intensive agriculture.

The aim of the study was to identify the effect of winter rye catch-crop on buckwheat growth and yielding.

Materials and Methods

The field experiments were conducted in 2006 and 2007 on a heavy loamy sand soil at the Osiny Experimental Station of the Institute of Soil Science and Plant Cultivation. The pH of the soil was 5.6, the status of phosphorus was very high and that of potassium high. The experiment was established using a long belt method. Six experimental treatments were studied:

1 control treatment – without catch crop, preparation of field for sowing using a plough;

2. above ground mass of catch-crop harvested and taken out from the field; preparation of field for sowing using a plough;

3. winter rye catch crop at 2nd node incorporation into the soil using a plough;

4. winter rye catch crop at 2nd node incorporation into the soil using a rotary cultivator;

5. winter rye catch crop at the end of shooting stage incorporation into the soil using a plough;

6. winter rye catch crop at the end of shooting stage incorporation into the soil using a rotary cultivator.

The catch crop of winter rye cultivar 'Słowiańskie' was sown in the 3rd ten-day period of September.

Emergence rate and growth stages of buckwheat were observed. Plant number per 1m^2 was recorded after full emergence of buckwheat on each plot on an area of 0.25 m^2 in four replications. Weed infestation was estimated visually in percentage in relation to the control treatment (about 4 weeks after buckwheat emergence) at budding stage of buckwheat. Weed infestation in the control (without catch-crop) was assumed as 100%.

During the growing season, about 4–5 weeks after emergence (budding stage) and at full flowering of buckwheat leaf area index was measured in four replications on each plot using a plant canopy analyzer LAI 2000 (LiCor).

The results were estimated statistically using Tukey test.

Results and Discussion

In spite of good soil moisture after sowing, negative effect of winter rye catch-crop on buckwheat emergence was observed only in 2006. That year, 4–6 days' delay of emergence in the treatment with winter rye biomass incorporated into the soil at the beginning of heading stage was observed (Table 1). In 2007, very intensive rain (20 mm in short time) shortly after sowing of buckwheat leached soil phenolic compounds, created during rye biomass decomposition, into the deeper layers. But the two true leaf and the next stages occurred at almost the same time in all the treatments (differences not greater than 1 day).

Biomass incorporation into the soil affected the number of emerged plants, particularly strongly in the drier year (2006) in which the number of plants in the treatment with rye biomass was lower in the range of 20–30% (Table 3). In the year 2007, with higher precipitation the negative effect on plant number per unit area was weaker – differences in plant number between the treatments with rye biomass and control did not exceed 13%. It should be noted that in both experimental years smaller plant losses in the treatment with winter rye applied at 2nd node stage were observed.

Table 1. Dates of full emergence and 2-true leaf stage of buckwheat in different treatments in 2006

Treatment – method (stage) of catch-crop incorporation – machinery use for field preparation for sowing	Year 2006	
	Full emergence	2 true leaves
1. Control – without catch crop *	1 July	16 July
2. Stubble of winter rye – plough	1 July	16 July
3. Winter rye at 2nd node – plough	1 July	16 July
4. Winter rye at 2nd node – rotary cultivator	1 July	16 July
5. Winter rye at heading – plough	5 July	16 July
6 Winter rye at heading – rotary cultivator	7 July	17 July

* – detailed description of treatments is provided in Materials and Methods

Table 2. Weather characteristics during the growing season of buckwheat

Year	Temperature °C					Rainfall mm				
	May	June	July	August	September	May	June	July	August	September
2006	13.9	17.7	22.5	17.7	15.5	58.0	19.2	20.7	239.7	10
2007	15.8	19.1	19.3	19.2	13.1	79.8	62.8	49.0	26.6	71

Table 3. Number of emerged plants of buckwheat

Treatment – method (stage) of catch-crop incorporation – machinery used for field preparation for sowing	2006	2007
1. Control – without catch crop	344	322
2. Stubble of winter rye – plough	254	303
3. Winter rye at 2nd node – plough	272	330
4. Winter rye at 2nd node – rotary cultivator	273	328
5. Winter rye at heading – plough	247	316
6 Winter rye at heading – rotary cultivator	166	279
LSD (α=0.05)	28.3	34.1

Analysis of leaf area index shows that the effect of rye biomass on crop plants was changing during the growing season. Just after the budding stage of buckwheat (about 4–5 weeks after buckwheat emergence) leaf area index in the treatments with the abundant mass of winter rye incorporated into the soil at heading stage was significantly lower than in the treatments with rye incorporated at 2nd node (Table 4). Three weeks later (full flowering of buckwheat) the situation was quite different (higher leaf area index was in the treatment with the bigger mass of rye incorporated into the soil (Table 4). It is likely that the negative effect on leaf area index 4–5 weeks after emergence resulted from the response of buckwheat plants to phenolic compounds in decomposing rye biomass. However, the positive influence on stand density measured as a leaf area index at later stages of buckwheat development was affected by improvement in physical soil properties.

Table 4. Leaf area index (LAI) of buckwheat at different stages

Treatment – method (stage) of catch-crop incorporation – machinery used for field preparation for sowing	2006		2007	
	Budding phase	Full flowering	Budding phase	Full flowering
1. Control – without catch crop	1.78	3.59	3.18	4.15
2. Stubble of winter rye – plough	2.21	5.19	3.54	5.00
3. Winter rye at 2nd node – plough	1.81	4.66	3.12	3.99
4. Winter rye at 2nd node – rotary cultivator	2.07	4.46	2.72	3.97
5. Winter rye at heading – plough	1.56	5.16	2.71	4.50
6 Winter rye at heading – rotary cultivator	1.64	5.40	3.15	4.70
LSD (α=0.05)	0.256	0.795	0.401	0.756

Our studies confirmed the results of different authors / Chou, Patrick, 1976; Barnes et al., 1986 a; Barnes, Putnam, 1986; Barnes, Putnam, 1987; Chase et al., 1991; Benoit et al., 2000; Burgos, Talbert, 2000/ that rye exerted herbicidal effect. This effect was stronger in the plots with rye incorporated into the soil at heading stage than in the plots with rye incorporated at 2nd node (Figure 1). Weeds were effectively controlled in the treatment where biomass was mixed with the soil using a rotary cultivator (treatments 4 and 6). It is noteworthy that in the year with higher quantity of precipitation strong herbicidal effect was observed in the trial (2) without the above ground biomass of rye.

The yield depended on the described effect of catch crop on growth of buckwheat and weed infestation but the correlation was not simple. In drier year (2006), the yield of buckwheat was lower. That year the highest yield was obtained from the control treatment and the treatment with rye incorporated into the soil at the 2nd node stage using a rotary cultivator (Figure 2). The differences between particular trials were very small that year.

In the year 2007, with higher precipitation after sowing of buckwheat, the yields were much higher than in 2006. The yields from the control treatment and the treatment with rye incorporated at the 2nd node stage were on the same level. The highest yield was obtained from the trials with rye incorporated at the beginning of heading stage by using a rotary cultivator.

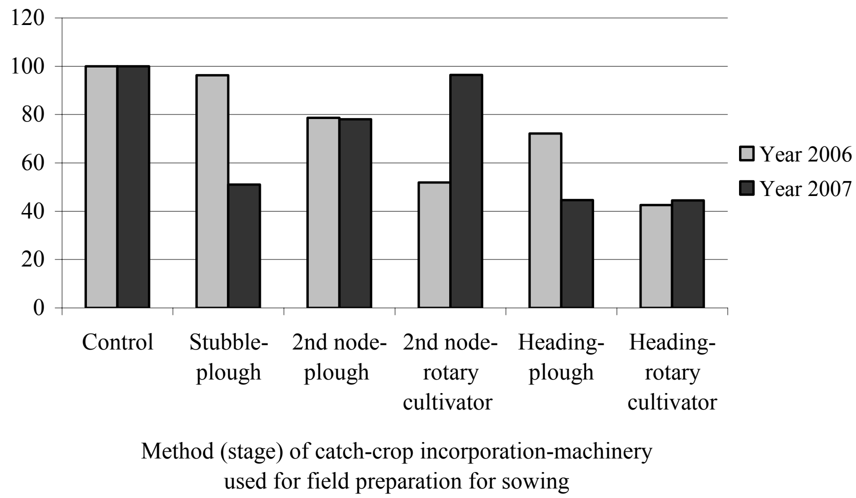

Figure 1. Weed infestation in relation to the control (as 100% weed infestation in the control treatment was assumed)

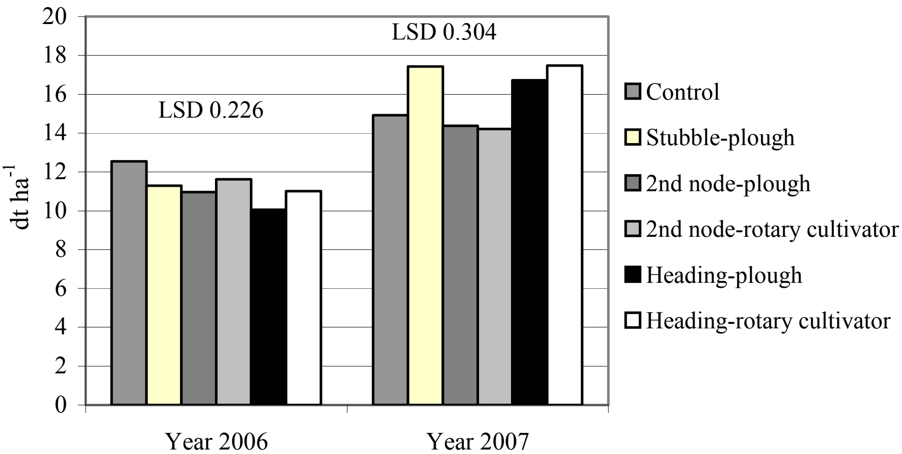

Figure 2. Buckwheat yield as affected by the method of winter rye catch-crop incorporation

Our research evidence suggests that winter rye can be used as a catch crop incorporated into the soil before sowing of buckwheat but when there is a shortage of precipitation, it can decrease buckwheat yield. Additional experiments should be done following a similar experimental design on the soils differing in water capacity.

Conclusions

1. Rye catch crop affected buckwheat emergence rate and number of plants, especially in the year with little precipitation.

2. Rye catch crop incorporated at the heading stage influenced an increase in leaf area index at full flowering stage of buckwheat.

3. Negative effect of winter rye catch crop on buckwheat yielding ability was observed in the year with insufficient precipitation. In the year with high precipitation, positive effect of rye biomass incorporation was observed.

4. Winter rye catch crop significantly limited weed infestation in buckwheat.

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