EFFECT OF SOWING DATE ON THE WEED INFESTATION OF WINTER WHEAT IN LONG-TERM EXPERIMENTS

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Detailed coenological studies were made at four developmental stages during the vegetation period in three sowing date variants in a long-term multifactorial experiment carried out in the Crop Production Institute of Pannon University. Both experimental years had poor rainfall supplies. The Balázs-Ujvárosi scoring method was used to register the extent of weed infestation and how it changed over the vegetation period. Both the wheat grain yield and the level of weed infestation were greatly influenced by the sowing date. Averaged over the two years, the largest volume of weeds was recorded in March. After the wheat started shooting, the weeds were suppressed. The three sowing dates had the greatest effect on weed growth from the stage of initial development to shooting. After late sowing, the smallest number of weeds was observed during this period in both years. By the time the crop matured the level of weed infestation had changed, with the largest number of weeds in the late-sown variant, where the wheat did not form a closed canopy. Averaged over all samplings in both years, the following five species had the highest ***cover area? abundance?***: *Stellaria media* (4.86%), *Veronica hederifolia* (3.38%), *Papaver rhoeas* (1.97%), *Capsella bursa pastoris* (1.41%), *Matricaria maritima* (0.96%).

Key words: winter wheat, sowing date, weed infestation

Introduction

Winter wheat is one of the most important cereals in Hungary, occupying almost a quarter of the country's arable land. The yields and milling quality of this crop have a substantial influence on the profitability of agricultural production. The economic problems encountered in recent decades and the increasing interest in environment protection have drawn increasing attention to cheaper production technologies requiring lower amounts of chemicals. Chemical weed control is currently carried out on 75–80% of wheat fields in Hungary. However, not only the lack of weed control, but also a poor choice of chemicals may lead to the infestation of cereal fields (Szentey, 2000). If chemicals and environment-friendly techniques are to wisely chosen, it is essential to obtain precise information on the weed conditions in the fields.

Many correlations have been discovered between the crops and the weeds in densely sown cereal fields. Surveys made during different periods by Balázs (1944), Jeanplong (1951) and Ujvárosi (1949; 1970) revealed that cereal species have a characteristic weed flora, despite the great diversity of the geographical locations and the fact that the agronomic background of the fields was unknown. This was confirmed by the results of five field weed surveys initiated by Miklós Ujvárosi and carried out by the staff of the Plant and Soil Protection Service

over a period of more than six decades (1947–53, 1969–71, 1987–88, 1996–97 and 2007–08).

Among the factors influencing wheat production, the sowing date is of particular importance. This in turn is closely correlated with soil preparation, which has a decisive effect on the periodicity of weed seed germination, allowing the weed species composition to be controlled (Berzsenyi, 2000).

When examining the effect of sowing date and N fertilisation on wheat crops, Fodor and Pálmai (2008) found that wheat produced less biomass after late sowing, while that of weeds was greater. Higher N rates resulted in fewer weeds in early and optimum sowing date variants, while it increased weed infestation after late sowing.

Materials and methods

The investigations were carried out in 1987–1989 in a multifactorial sowing date experiment set up in 1976 in the Crop Production Institute of the Georgikon Faculty (University of Veszprém). The following factors were studied in the experiment: a) sowing date (early, optimum, late), b) variety (Mv 15, Yubileinaya 50), c) N rate (150, 200 kg/ha), d) seed rate (5, 6 million seeds/ha).

The soil was favourable for wheat production, being a Ramann's brown forest soil poor in organic matter, with poor supplies of available phosphorus and moderate supplies of potassium. When the experiment was set up the following data were recorded: upper limit of plasticity K_A = 38, $pH_{(H2O)}$ = 7.2, $pH_{(KCl)}$ = 6.8, humus content = 1.6%. In both years the forecrop was pea. Mineral fertiliser rates of 100 kg/ha P_2O_5 and 100 kg/ha K_2O were applied to all the plots in autumn, while the N fertiliser was applied in two splits, in autumn prior to sowing and before shooting in spring.

In both seasons rainfall quantities were below the long-term mean, but the distribution was more favourable for wheat production in 1987–88 than in 1988–89. Compared with the long-term mean (10.8°C) the temperature was higher in 1987–88 (11.1°C) and lower in 1988–89 (10.56°C) (Table 1).

Weed surveys were carried out using the Balázs–Ujvárosi method on four occasions during the vegetation period: 1. before the onset of winter (December), 2. at tillering in spring, before shooting and the application of chemical weed control (March), 3. at flowering (May) and 4. at full maturity (July).

Results and discussion

The yields in the two years varied according to the differing weather conditions (Table 2). Of the three sowing dates, the optimum variant (mid-October) gave the highest wheat yields in both years, but there were no significant differences between the sowing dates under favourable weather conditions (1988), i.e. in good years late sowing did not cause substantial yield losses. When the weather was unfavourable, however, the yield was reduced by 35–40%.

Among the factors examined, variety and fertiliser had no effect on the weed infestation rate, and the effect of plant density was not significant, so only the effect of sowing date will be discussed here.

The weed infestation level was always greatest in early spring. When the autumn was wet, there were significant differences between the three sowing dates as regards weed infestation and wheat ***cover***. In the early sowing variant, the weeds were able to emerge and become established before the onset of winter (Table 3).

Sowing date proved to have a greater role in weed infestation in early spring than the seeding rate. When the wheat stand was sufficiently dense (500–600 spikes/m²) the weed cover had declined by the time the wheat matured, as the wheat plants reached a ***ground cover*** of 70–90% after shooting, and the light-demanding weed species were unable to develop under the closed wheat canopy. By this time the annual species, which emerge in autumn and produce seed in spring, had finished their life cycle. At maturity, however, the wheat foliage withered, reducing the ***ground cover*** and making it possible for weeds that emerge in spring and produce seed in late summer to develop. If harvest is delayed, late summer species and any perennial species present are able to develop rapidly.

In autumn, and in early spring prior to shooting, a dominant role was played by annual species that emerge in autumn and produce seed in spring, allowing their seed to mature prior to chemical weed control (*Stellaria media, Veronica hederifolia, Capsella bursa pastoris*).

The weed infestation in the three sowing date variants differed to the greatest extent from the initial development phase up to shooting. In both years weed infestation during this period was least severe in the late-sown variant.

A total of 25 weed species were recorded in the four surveys. The species could be ranked in the following order of importance based on ***ground cover %*** averaged over the two years: 1. *Stellaria media* (4.86%), 2. *Veronica hederifolia* (3.38%), 3. *Papaver rhoeas* (1.97%), 4. *Capsella bursa pastoris* (1.41%), 5. *Matricaria maritima* (0.96%), 6. *Brassica napus* (0.58%), 7. *Consolida regalis* (0.54%), 8. *Apera spica-venti* (0.49%), 9. *Lepidium (Cardaria) draba* (0.32%), 10. *Sinapis arvensis* (0.23%), 11. *Galium aparine* (0.19%), 12. *Viola arvensis* (0.18%), 13. *Ranunculus arvensis* (0.16%), 14. *Bilderdykia (Polygonum) convolvulus* (0.13%), 15. *Poa annua* (0.14%), 16. *Cirsium arvense* (0.13%), 17. *Veronica persica* (0.12%), 18. *Agropyron (Elymus) repens* (0.11%), 19. *Oxalis europea* (0.09%), 20. *Polygonum lapathifolium* (0.04%), 21. *Chenopodium album* (0.01%), 22. *Avena fatua* (0.01%), 23. *Camelina microcarpa* (0.005%).

The ideal agronomic conditions ensured in the experiment (pea as forecrop, high quality soil preparation at the optimum time) cannot always be achieved under farm conditions, so the weed ranking may not be an exact reflection of the results of nation-wide weed surveys. In the last national survey in 2007–08, the mass incidence of eight weed species (*Tripleuspermum inodorum (Matricaria inodora), Galium aparine, Cirsium arvense, Ambrosia artemisiifolia, Convolvulus arvensis, Papaver rhoeas, Apera spica venti,*

Consolida regalis) was typical of locations where no weed control was carried out (Dancza and Szentey, 2009).

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Table 1
Rainfall sums and temperatures in the 1987–88 and 1988–89 growing seasons. Keszthely

Month	Monthly rainfall sum (mm)			Monthly mean temperature (°C)		
	1987-88	1988-89	Long-term mean	1987-88	1988-89	Long-term mean
August	147	86	77	18.1	20.5	20.6
September	50	63	64	18.3	15.9	10.7
October	27	57	63	11.9	10.5	11.1
November	85	36	59	5.1	0.4	5.5
December	18	27	49	1.7	1.5	1.2
January	41	9	38	3.2	- 0.6	- 0.8
February	70	18	36	3.5	3.7	0.9
March	38	30	40	4.8	8.7	6.2
April	19	81	50	10.4	12.0	11.2
May	44	87	74	16.3	14.9	16.3
June	44	70	74	18.5	17.4	19.4
July	38	87	71	22.0	21.5	21.5
Total	621	651	701	11.1	10.56	10.8

Table 2
Grain yield of winter wheat (t/ha) in 1988 and 1989

Sowing date	Mv 15			Yubileinaya 50			Variety mean
	5 million	6 million	Mean	5 million	6 million	Mean	
1988							
Early	7.66	8.11	7.88	7.51	6.98	7.25	7.57
Optimum	8.22	8.59	8.40	7.68	7.90	7.79	8.10
Late	6.93	7.18	7.07	6.60	6.86	6.73	6. 90
Mean	7.61	7.96	7.78	7.26	7.25	7.26	7.52
1989							
Early	5.81	6.02	5.91	6.19	5.63	5.91	5.91
Optimum	5.77	6.22	6.00	6.36	6.12	6.24	6.12
Late	2.74	3.71	3.23	4.40	4.21	4.30	3.76
Mean	4.77	5.32	5.05	5.65	5.32	5.49	5.27
2-year mean	6.19	6.64	6.41	6.46	6.28	6.37	6.39

Table 3

Trends in wheat and weed ***ground cover***, averaged over varieties and seed rates (%)

Survey period	1987- 1988			1988-1989		
	Sowing date			Sowing date		
	Early	Optimum	Late	Early	Optimum	Late
	Ground cover, % (Abundance)					
Wheat						
December	31.25	22.50	18.75	31.25	25.00	15.62
March	35.00	34.37	28.12	34.53	24.84	17.42
May	70.31	81.25	75.00	68.75	62.50	53.12
July	60.94	71.87	57.81	45.31	36.72	32.81
Weeds						
December	51.71	21.78	1.40	10.42	5.61	2.09
March	58.18	37.38	15.51	22.29	12.65	7.57
May	23.34	11.63	10.22	14.60	29.33	27.32
July	5.54	3.86	8.74	1.94	2.76	13.03
Total						
December	82.96	44.28	20.15	41.67	30.61	17.71
March	83.18	71.75	43.63	56.82	37.49	24.99
May	93.63	92.88	85.22	83.35	91.83	80.44
July	66.48	75.73	66.55	47.25	39.48	45.84