POSSIBILITIES OF APPLYING PRECISION WEED CONTROL IN HUNGARY

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SUMMARY

There are many reasons for applying precision weed control on agricultural areas, efficiency, cost-effectiveness, and environmental protection being some of the most important factors of. Precision plant protection provides a solution of decreasing input costs, and at the same time of minimising the coverage of weeds and their negative effects on yield. Precision weed control is recommended in crops where herbicide costs per hectare are relatively high, wherefore even a lower level of economy (e. g. 10 %) covers the emerging extra costs (e. g. weed sampling). A basic condition of the application of precision weed control is that the economy from the reduced herbicide use have to cover the increased machine operation and technology costs. Location-specific plant protection may be applied primarily in large-scale farms (above 1000 ha) to decrease the high input costs.

INTRODUCTION

Location-specific weed mapping and the accurate location of weed management, along with the local occurrence of weeds, facilitates the reduction of herbicide use, and, as aresult, the reduction of herbicide costs too. According to *Pfau et al. (2001)* the costs of plant protection are highly dependant on chemical (herbicide) costs. The possibility of reducing the costs of plant protection should be therefore primarily investigated in this field. This concept is supported by *Rew and Cussans (1995)* in *F. R. Leiva et al. (1997);* they report of a 27-95 % economy of herbicides in consequence of the application of precision techniques. *Heisiel et al. (1997)* in *E. C. Luschei et al. (2001)* reached a 59 % reduction of herbicide use as compared to different weed control methods. Their research was carried out on a 4 ha field in randomised block treatments. *Gerhards et al. (1997)* in *Gerhards et al. (2003)* found, that depending on the rate of weed coverage, herbicide use can be decreased even by 21-94 %. According to their results herbicide economy were more considerable in winter wheat and winter barley than in maize or sugar beet.

Wagner (2000) in *Gerhards et al. (2003)* drew the conclusion that, in order to guarantee the competitiveness of variable rates of herbicides applied precisely as compared to whole field spraying, herbicide economy should be high enough to compensate the costs of weed mapping, data processing, and computer-assisted decision making, as well as the extra costs of location-specific spraying technology. *Takácsné (2003)* stated in her paper a 0-40 % economy of herbicides use when having applied precision

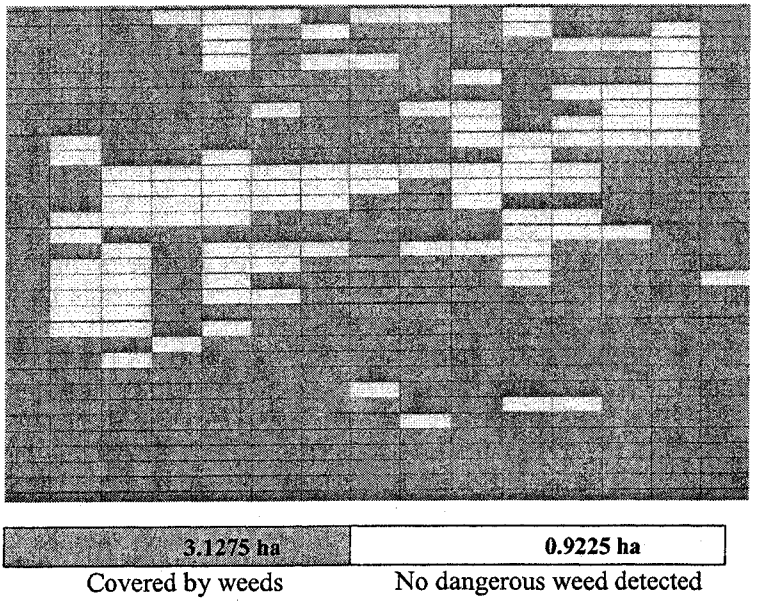
weed control. According to *Hunyadi (1998)* chemical weed control increased the yield by 18 % on the average of a 23-year multi-factorial research. *Berzsenyi (1973)* in *Pfau et al. (2001)* investigated the correlation between weed coverage and maize yield. According to his results a 10-25 % weed cover (at a 4,61 t/ha average yield) may result in a 24.06 % yield decrease (1.46 t) as compared to a field where 0-weed coverage amounted to 3 %, and average yield to 6.07 t/ha.

MATERIAL AND METHOD

The authors' investigations were carried out in April 2003 on the A_1 winter wheat field of the model farm of the University of Western Hungarian, Faculty of Agricultural and Food Sciences. Sampling plots were planned in advance, after the previous definition of the 5 corner points of the field (by means of DGPS) and of the coordinates of the 18-m strips. Some students of the university were trained to identify weed species, and each student mapped a 3-m strip. Location positioning was continuous throughout the weed mapping. Students walked slowly, and after every 25 m reported whether herbicide treatment was required, or spraying was unnecessary. Their report was registered by an administrator on a field map (Figure 1), where the size of one plot was 3 x 25 m (75 m^2). The size of the investigated field was 4.04 ha, of which 77.22 % (3.1275 ha) were covered by Cirsium arvense (CIRAR), Galium aparine (GALAP) and Papaver rhoeas (PAPHR), and only 22.78 % (0,9225 ha) were considered to be free of these weed species.

Figure 1.

Weed map of the field investigated



Source: own investigations 2003

ECONOMIC EVALUATION OF THE PRECISION PLANT PROTECTION BY MEANS OF A MODEL CALCULATION

Weed control technologies offer the following herbicides, and their combinations, against the most dangerous weed species (Table 1).

A Jambol + Starane herbicide combination was used, since the model farm is engaged in seed production, and has to take into consideration also the presence of dangerous weed species among the preceding crops as well as on the seed producing fields. The costs of weed mapping per hectare were the following (without taxes and social insurance rates): when calculating with 2 persons, wages for 4 hours of engineering, 4 x 784 HUF/hour/4.05 ha, 774 HUF/ha; when calculating with 10 persons, minimum wages for 20 hours of student work, 20 x 395 Ft/hour/4.05 ha, 1950 Ft/ha. Tin this case the total labour cost amounted to 2724 HUF/ha.

Table 1.

Weed control techniques and herbicide combinations recommended against the most dangerous weed species

Herbicides and their combinations	Recommended doses	Herbicide costs HUF/ha
1. Huszár	200 g/ha	8023
2. Jambol M 750 SL + Starane 250 EC	*0,8 l/ha + 0,6 l/ha*	*6445*
3. Sekator	300 g/ha	3256
4. Banvel 480 S + Buvirex 240 EC	0,2 l/ha + 0,04 l/ha	3086
5. Optica Trio	1,5 l/ha	2840

Source: Trade prices 2003.

The cost of herbicide treatment was 1200 HUF (model farm data), but it should be mentioned that the location of the field is very favourable, as there is no need for an extra water transporting vehicle (a water source is available at the spot), and the transportation route is very short. Contract prices for spraying vary between 2500-3500 HUF/ha in the surroundings of the town Mosonmagyaróvár (e. g. in the Lajta-Hanság Co., with its more than 8000 ha of arable land the greatest farm, and also the greatest servicing company in the area in question) depending on the location of the field. If location-specific precision weed control had been applied on the test field, an area of 0.9225 ha ought not to have been sprayed, and economy from the application of the herbicide combinations No. 1-4 (Table 1) could have compensated the weed mapping costs of 2724 HUF/ha.

Precision plant protection is not used in Hungary except in research, and foreign studies also frequently quote only research results. These results should only be considered a guideline in economic models for Hungary due to the great variety of influencing factors (e.g. weed coverage, costs of machinery and herbicides, economic conditions).

Table 2 shows different weed control systems using different technologies. Research was carried out in Germany (in the area of Cologne and Bernburg) in

winter wheat, winter barley, sugar beet, and maize.

According to the above data the operation costs of specific weed control technology are 2,8-3,5 times higher than those of the traditional spraying technology. According to the data of the Lajta-Hanság Co. (Table 3) the herbicide costs in winter wheat amounted to 1907 HUF/ha and in maize to 10 797 HUF/ha on the average of four years of production (1999-2002). This company produces winter wheat on an area of 2330 ha and maize on an area of 1340 ha on the average. If only about one third of the area of the crops listed in Table 2 (i. e. 4833 ha: 3 = 1611 ha) could have been sprayed using the location-specific precision technology, and herbicide economy of only 10 % could have been reached, the yearly economy would have been over 1 million HUF. However this sum may vary significantly in different crops and under different weed coverage conditions, considering also the differences in herbicide prices plus the size and location of the field to be treated.

Table 2.

Costs of weed control in different crops at different technologies

Crop	Whole-field spraying		Location-specific treatment with one herbicide combination		Location-specific treatment with a direct injection spraying system	
	EUR/ha[1]	HUF/ha	EUR/ha	HUF/ha	EUR/ha	HUF/ha
Cost of machinery	5	1300	14,76	3837	18,66	4851
Cost of herbicide:						
Winter wheat and winter barley	68	17680	47	12220	32	8320
Sugar beet	148	38480	151	39260	69	17940
Maize	103	26780	113	29380	95	24700

[1] 1 EUR= 260 HUF (rate of AUGUST 2003)

Source: Gerhards et al 2003. Research was carried out between 1994-2002 on fields between 2,4-5,6 ha

CONCLUSIONS AND RECOMMENDATIONS

At present it is simpler to use whole field spraying techniques than location-specific precision weed control. However, the latter offers an alternative solution to decrease herbicide input costs and at the same time to minimise the propagation of weeds and to limit their negative effect on yields.

According to the authors' calculations the cost economy could have reached 1 million HUF in the investigated farming company. The application of precision plant protection is recommended in crops where the herbicide cost per hectare is relatively high (e.g. maize, sunflower or soybean), because even at low herbicide economy levels (10 %) the cost of herbicides may decrease by 1300-2900 HUF/ha (data of Lajta-Hanság Co).

In winter wheat the herbicide costs amount to 1310-2587 HUF/ha (Lajta-Hanság Co.), of which even a 50 % level of economy would not cover the extra

costs of weed mapping on the spot. One should rather rely on the strong natural weed-oppressing ability of the crop, especially in case of low weed coverage, instead of using a precision plant protection technology. In some cases some "location-specific type" weed control is applied in practice when the weeds are easy to define and locate, and experts well know the field from in question.

It can be stated that one basic condition of the application of precision weed control is that the economy from the reduced herbicide use should cover the increased costs of weed mapping, machine operation and technology. Location-specific plant protection can be used primarily in large-scale farms (above 1000 ha) in order to decrease the high input costs.

Table 3.

Herbicide application in the Lajta-Hanság Co. in the most important crops (1999-2002)

Crops	Herbicide use (HUF/ha)[2]	Herbicide use		Possible herbicide economy levels (%)[1]				
		%[3]	HUF/ha	10	20	30	40	50
1999				**HUF/ha**				
Winter wheat	2500	91,5	2 288	229	458	686	915	1144
Maize	8081	90,0	7 276	728	1455	2183	2910	3638
Sunflower	24587	98,8	24 295	2429	4859	7288	9718	12147
Oilseed rape	5924	53,9	3 196	320	639	959	1278	1598
Soya	24331	100,0	24 331	2433	4866	7299	9732	12165
2000				**HUF/ha**				
Winter wheat	1349	97,0	1 310	131	262	393	524	655
Maize	8483	92,3	7 827	783	1565	2348	3131	3913
Sunflower	21944	96,5	21 174	2117	4235	6352	8470	10587
Oilseed rape	2285	56,1	1 282	128	256	385	513	641
Soya	13436	100,0	13 436	1344	2687	4031	5374	6718
2001				**HUF/ha**				
Winter wheat	1894	76,3	1 445	144	289	433	578	722
Maize	10680	87,8	9 383	938	1877	2815	3753	4691
Sunflower	24202	95,2	23 042	2304	4608	6913	9217	11521
Oilseed rape	3869	14,4	557	56	111	167	223	278
Soya	24231	100,0	24 231	2423	4846	7269	9692	12115
2002				**Ft/ha**				
Winter wheat	3303	78,3	2 587	259	517	776	1035	1293
Maize	24870	75,2	18 704	1870	3741	5611	7482	9352
Sunflower	43770	81,2	35 522	3552	7104	10657	14209	17761
Oilseed rape	8170	10,6	866	87	173	260	346	433
Soya	29884	100,0	29 884	2988	5977	8965	11954	14942

[1] Possible (expected) herbicide economy levels were calculated on the basis of other research data (55 % on the average).

[2] The costs of plant protection products, including herbicides, may vary on different fields (depending on weed coverage, the presence of pests and diseases).

[3] Share of herbicides in % of all plant protection products used.

Source: Lajta-Hanság SCo. 2003 and own calculations

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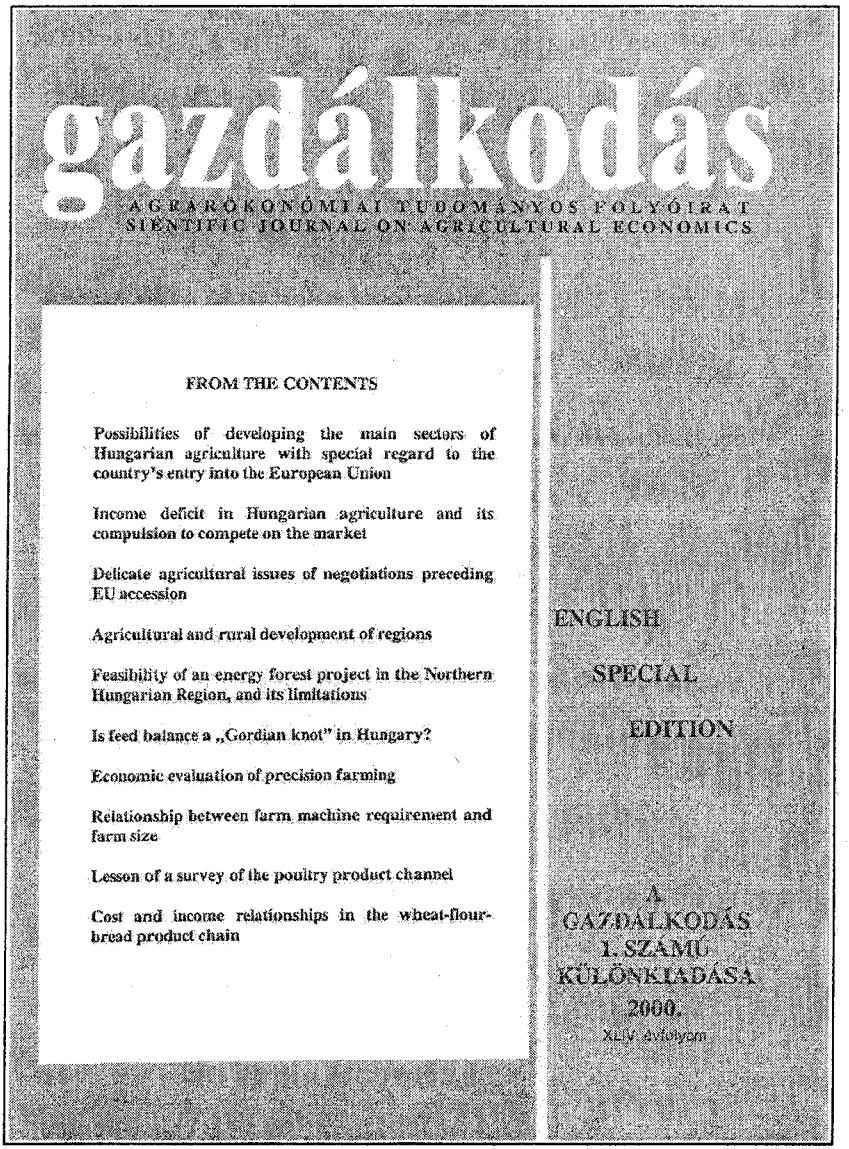
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A PRECÍZIÓS GYOMSZABÁLYOZÁS ÜZEMI ALKALMAZHATÓSÁGA

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A precíziós növényvédelem elterjedése és bevezetése mellett szóló érvek többek között a hatékonyság, a költségtakarékosság és a környezetvédelem. A precíziós növényvédelem olyan alternatív megoldást kínál, ami révén a növényvédelem, mint inputtényező költségei úgy csökkenthetők, hogy közben a gyomnövények terjedését és a terméseredményre kifejtett negatív hatását is mérsékeljük. A precíziós gyomszabályozás alkalmazása elsősorban azon kultúráknál javasolható (kukorica, napraforgó, szója), ahol a hektáronkénti vegyszerköltség magasabb és ezáltal még alacsonyabb (pl. 10%-os) megtakarítási szintek is fedezik a felmerülő többletköltségeket (gyomfelvételezés stb.). A helyspecifikus növényvédelem elsősorban a nagyüzemek (1000 ha feletti gazdaságok) magas inputköltségét hivatott csökkenteni.