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Influence of Degree Infestation with *Echinochloa crus–galli* Species on Crop Production in Corn

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1. Introduction

Corn continues to be globally one of the main crops, ranking third, after wheat and rice. In Romania it is the main agricultural plant, whose economic importance, especially in the private sector is growing. Given the particularities of this culture, with particular reference to the high sensitivity at infestation with weeds, especially in the early stages of vegetation, corn crop is feasible only if weeds are controlled through various methods. The damage caused by weeds in maize crop are mostly of 30-70% (Sarpe, 1975; Budoi and Penescu, 1996; Oancea, 1998; Bilteanu, 2001; Berca, 2004; Gus et al., 2004; Bogdan et al., 2005; Rusu, 2008) and when the infestation is strong, culture can be fully compromised. The presence in a culture of a small number of weeds is not harmful, but damage caused by weeds grow along with increasing the degree of infestation, depending on the species and age of occurrence of weeds, soil and climate conditions and the moment when weeds are combat (Paunescu, 1996; Bosnic and Swanton, 1997; Perron and Legere, 2000; Bogdan et al., 2001; Fukao et al., 2003; Clay et al., 2005; Rusu et al., 2009). Therefore, specifying the economic threshold of pest is difficult to establish considering the fact that the number of researches in this field until now, is reduced.

Echinochloa crus-galli is one species with a large requirement to water being able to behave as mesophita, mesohygrophita, hygrophita and hygrohelophita (Anghel et al., 1972; Bogdan et al., 2007). It is especially met on the luvosoils, fertile and wet soils, being wide-spread in all the country but in the north sides it has a lower abundance and general dominance than in the south ones. *Echinochloa crus-galli* is met growing on a large variety of soils and grains, from clay sand or sandy clay soils to medium hard soils. The soils with a relative big capacity of water holding and large fertility insure an ideal sublayer.

Echinochloa crus-galli is a weed with a fascicular, powerful root which is hardly drawn by weeding and it easily sprouts after mowing or while weeding. The seeds get to maturity progressively and they can keep the germinal sufficiency till 8-9 years, germinating by installment. They do not support the flooding (Dimancea, 1967).

The success of this weed can be imputable to a very low number of seeds generation, easily dispersed from the plant, owning a latent state of the seeds, a fast development and capacity of blooming in a large range of photoperiods (Păunescu, 1997). The number of seeds made

by a plant varies between 200 and 10,000. Chirilă (1967) establishes as limits of seeds number/plant from 150 to 10,000. The medium mass of 1,000 bobsleighs is 2.48 g. (Anghel et al., 1972; Berca, 1996). The reserve of *Echinochloa crus-galli* seeds that can be found in the soil can reach impressive values, correlative with the production potential of the species and the vegetative conditions specific to the infestation areas. The number of seeds found by Kott (1953) reported to the surface of one hectare gets to 1-2.5 billion *Echinochloa crus-galli* seeds. Berca (1996) referring to the seeds of this species and their germination, shows that germination happens after one year of seeds forming, by instalment both as structure and life. The germination happens all over the year, especially in the spring time, 1-2 cm depth when the temperature is over 10 ^{o}C. The *Echinochloa crus-galli* seeds have a post maturation period that happens into the soil, especially the upper side of the soil. The length of seminal rest depends by a lot of internal and external factors (Berca, 1996).

The period of germination-rising starts for *Echinochloa crus-galli* in April, depending by the temperature provided by the soil, the minimum germination temperature is 8^{o}C, and it ends in September. The maximum germination is between May and June, after this period there comes an attenuation of germination proportion and plants rising, so that in October it is accomplished to a very low level.

The elongation of the *Echinochloa crus-galli* plants is in a strong connection with the temperature. In the spring time when the temperature is low the elongation is a slow one but in the summer time when the temperature is high the plants grow very fast (Păunescu, 1997; Rusu et al., 2010). At the beginning the plants grow slowly, after 2-3 weeks after their rising starts the tillering period after that the plants start a very fast growing if the conditions of light, humidity and nutritive substances are assured (Berca, 1996). After the floral branches cutting of this weed, or after the first fructification they sprout again during the same year and fructify for the second time (Staicu, 1969).

Echinochloa crus-galli belongs to the yearly monocotiledonate weeds class with late spring germination very harmful for the corn cultures. Growing very fast it asphyxiates the corn crop and infamies the crop.

2. Material and methods

Our researches highlight in terms of Transylvania, the influence of *Echinochloa crus-galli* species (L.) Pal. Beauv. and other weeds on corn production, according to the degree of infestation. Researches have been conducted on Experimental Teaching Resort of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. The experiments were located on the northern slope, weak to moderately sloping land, with soil type preluvosol (SRTS, 2003), medium fertile, humus content 3%, texture loam-clay, 42-45% clay. Experience was held between 2004 and 2009 and had more objectives:

2.1 The vegetative cycle and the productivity characters of *Echinochloa crus-galli* depending on the rise period, at Cluj area

The researches were made between 2004 and 2007, respecting the climatic conditions of the soil appropriate to every year. The researches were made outdoors onto 1 m^2 plots, where we sowed 20 caryopsis of *Echinochloa crus-galli* per plot, at the beginning of April, May, June,

July and August. The observations were made every 10 days between rising and maturity. We analyzed the rising period according to the sowing date; the leaves appearance, the sprouting and the stem elongation, the panicle appearance and the flourishing beginning, the plants' maturation, the caryopsis' maturation and the dissemination and the productivity's characters variation.

In each lot the plants were rarefied, the observations regarding the productivity elements being done upon a number of 3 plants on surface unit. We chose this density for the reason of the necessary space protection for the *Echinochloa crus-galli* growing in order to touch the maximum values of the productivity parametres according to the biological potential of the plant.

The years of experiment with climatic specific (May 1 – August 31)
2004: 405.7 mm (excessively wet climate) and 17.6 ^{o}C (normal temperatures conditions);
2005: 349.6 mm (excessively wet climate) and 18.05 ^{o}C (normal temperatures conditions);
2006: 455.4 mm (excessively wet climate) and 18.5 ^{o}C (warm temperatures conditions);
2007: 167.5 mm (excessively dry climate) and 18.8 ^{o}C (warm temperatures conditions).

Year	Specification	The daily average temperature, ^{0}C	Rainfall, mm
2004	Value	14.88	562.4
	Deviation	- 0.75	+ 204.4
2005	Value	16.1	505
	Deviation	+ 0.47	+ 147
2006	Value	16.83	572
	Deviation	+ 1.2	+ 214
2007	Value	16.98	250.6
	Deviation	+ 1.35	- 107.4
The normal values		15.63	358

Table 1. The climate conditions during the 1st of April and the 30th of September in Cluj.

2.2 Productivity elements variation of *Echinochloa crus-galli* in accordance to density

In order to follow the variations of productivity parameters to *Echinochloa crus-galli*, the experiences were fixed on the field, in 4 random repetitions, after blocks method, on 1m² lot surface. In the last decade of April there were seeded 200 caryopsis of *Echinochloa crus-galli* on each lot so that the rising of the plants to be assured for the beginning of May.

After the plants rising and the forming of two first leaves, there was done their spacing in order to achieve the density of 50, 20, 10, 5, 3, 2 plants per m². The rating of the plants growing parameters and plants productivity was done in the last decade of July – first decade of August – when the plants were mature enough having as goals: plants height, tillering, panicles length, number of seeds (production).

The results interpretation was done by means, percents, statistical elaboration (variance analyzes). In order to analyze the values that were obtained there were used control data, medium values of the parameters obtained in the variant of density 3 plants/m².

2.3 Influence of degree infestation with *Echinochloa crus–galli* species on crop production in corn

Experience was held between 2008 and 2009. Biological material was the hybrid Turda 201, recommended for this area of culture. The research was done on two agrofonds: unfertilized and mineral fertilized (MF) with NPK 100 kg/ha.

In the unfertilized maize crop were made four variants (I-IV) with different degrees of infestation with *Echinochloa crus-galli*, from about 40 to 100 plants/m^2 and witness – 2 holings.

In fertilized plots were used the next herbicides for weed control: V_1 - dimetenamid 900 g/l – 2 l/ha applied p.p.i. (pre plant incorporated). V_2 - acetoclor 860 g/l – 2 l/ha applied preemergent. V_3 - isoxaflutol 750 g/l – 0.15 g/ha, applied p.p.i. + (bentazon 320 g/l + dicamba 90 g/l) – 2 l/ha applied postemergent.

Herbicide application was made with the pomp for experience, applying 300 l solution/ha. The experience was organized after randomized blocks method, in four repetitions and area of a plot is 25 m^2. Competition between corn plants and weeds present was studied in natural density infestation, in unfertilized plots and in those fertilized in which the process of herbicides took place. Weed biomass, corn plants and grain production was measured in the ripening stage. Samples of plants and weeds were harvested using metric frame of 50/50 cm.

3. Results and discussion

3.1 The vegetative cycle and the productivity characters of *Echinochloa crus-galli* in accordance to rising period

The biological particularities of weeds make them be superior to the cultivated plants, as they use more effective the vegetation conditions and the afferent inputs of an agricultural area. *Echinochloa crus-galli* is an annual monocotyledonous species, which germinates late in spring. This species is spread onto extensive areas in the world, covering all continents between 50^0 northern latitude and 40^o southern latitude. In Romania there is plenty of it in all regions, prevailing in the south western part of the country (90%) and in the eastern part (75%). In the other areas, the species varies between 9% (Dobrogea) and 57% (Transylvania). It is very harmful for hoed cultures. In the Cluj County, *Echinochloa crus-galli* represents between 36% and 52% of the weedy rate of the hoed cultures. *Echinochloa crus-galli* produces big damages in Romania's agriculture: in maize – over 70%, in rice – 60 – 65%; in sunflower – 30%; in soybean – 15 – 20%, in sugar beet 25%, in wheat – 10%, in flax – 10%.

In autumn or early spring sowed cultures (that cover the soil to a large extent) *Echinochloa crus-galli* hardly forms a small stem, but when the cultures are harvested off the field, the weed heavily sprouts and it produces a large amount of seeds as it has more space, light, nutrition and moisture.

The high ecological plasticity and adaptability of this species, completed by the possibility of flourishing in a wide range of photoperiods are biological particularities of *Echinochloa crus-galli.*

The plants rising takes place monthly in different percentages until September, when the rising is reduced. The rising period is of 8 – 16 days since the sowing depending on the

temperatures. The correlations established between the soil temperature conditions and the *Echinochloa crus-galli* plants rising are very significantly positive. From the specific equations for the experiment years result that the percentage of the plants that are rising is increasing by 5.75 – 6.87 per 1 ^{0}C of the soil temperature - beginning with 8^{0}C, the minimum germination temperature.

The plants' growth varies according to the rising period. So, the plants that rise up during the second half of April pass through each specific vegetative stage for a longer period comparing to the ones that rise up during the next months – when the temperatures increase (Table 2).

The rising period/The vegetative stage	April	May	June	July	August
1-3 leaves phase	8 – 10	6 - 8	6 – 7	6	5 – 6
Tillering beginning	19 – 23	17 - 20	13 – 17	12 – 15	12 – 14
The intensive tillering, the adventitious roots rising	32 – 38	28 – 34	20 – 21	18 – 20	16 – 19
The end of the tillering, the culm elongation	50 – 56	48 – 50	30 – 34	28 – 30	26 – 30
The skin stage*	70 – 80	64 – 68	43 – 46	38 – 43	36 – 41
The panicle apparition, flowering*	83 – 90	74 – 79	58 – 61	49 – 54	48 – 50
The grains filling *	94 – 105	80 – 88	64 – 70	60 – 63	59 – 63
The seeds' maturation; dissemination*	110 - 115	95 – 99	79 - 82	70 - 79	65 - 72

*This information is specific for the main stem. The shoots pass progressively these stages after the main stem.

Table 2. The period in days passed by a *Echinochloa crus-galli* plant from it's rising to each vegetative stage (the average period for the years 2004 – 2007 on Cluj-Napoca conditions).

The daytime influences the flourishing period so that the plants that rise later (July, August) reach the flourishing phase in a much shorter period (48 -54 days), comparing to the plants that rise in April (83 days). The shorter days of late August and early September stimulate precocious flourishing and ageing.

The caryopses are maturating in a 20 – 30 days period, after heading (depending on the rising period).

The first panicle dissemination is taking place during 10 -16 August for the plant that rose in April; 15 – 19 August for those that rose in May (first decade); 28-30 August for those that rose in June; 25 – 28 September for the plants that rose in July and 15 – 18 October for those that rose in August.

At the beginning of September the first plants dry out; they are those that rose in April, while those that rose in August dry out at the end of October.

The vegetative cycle of *Echinochloa crus-galli* plants is taking place in summer (Fig. 1). It begins in April for the plants sowed in April and it ends in August. But the cycle for the plants sowed in August, it ends in October.

The length of the vegetation period for a plant and the productivity characters (the height, the shoots number, the panicles number, the panicles' length, the caryopsis number of a plant, the bio weight) are reduced as the plants' rising is late (Table 3).

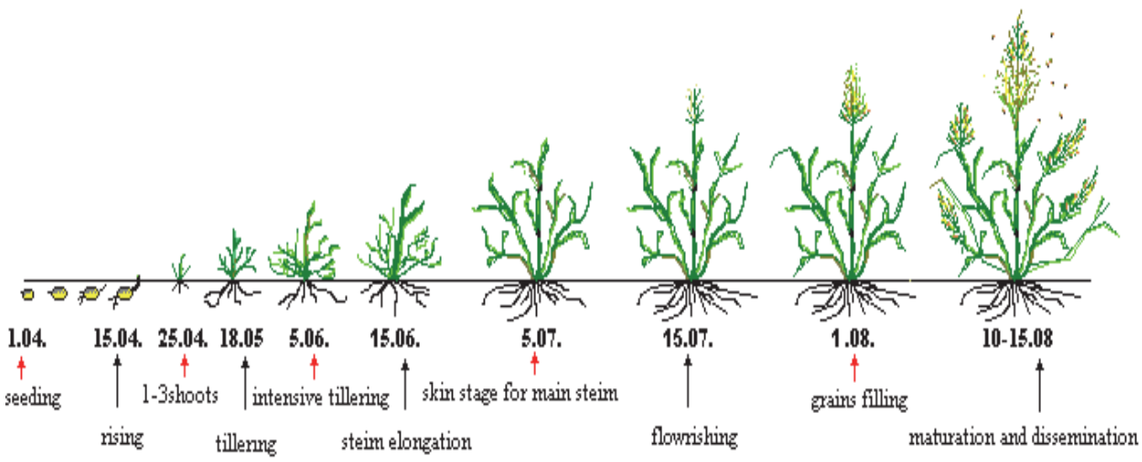

Fig. 1. The growth cycle of *Echinochloa crus-galli* (L.) P.B. on Cluj-Napoca conditions.

The variation of the vegetation period of this species (85 – 140 days) reflects the extraordinary flexibility and the excellent adaptability of *Echinochloa crus-galli* in different environment conditions.

The plants height decreases from 170 cm (the plants that rose in April) to 55 cm (the plants that rose in August). The vegetative growths are reduced as the vegetative period is decreasing and the daily average temperatures are increasing. The plants that rise in spring (April, May) grow and tiller very intensely, they reach considerable heights as a consequence of late flourishing, as the daytime is longer.

The roots of the early plants grow more intensely.

The whole weight reaches impressive values for the long vegetation period plants; it decreases drastically for the plants that rose late. The seeds production decreases as the vegetative periods diminish. It is notable that *Echinochloa crus-galli* seeds production is important (8435 caryopsis/plant) even for the plants that rose in August.

The rising period/The features	April	May	June	July	August
The vegetative period (days)	135-140	125-130	115-120	95-100	85-90
The plants height (cm)	150-170	140-150	120-130	90-105	55,75
Number of shoots	23-25	19-25	16-18	12-14	13-15
Number of panicles	27-31	20-24	16-18	10-16	12-14
The length of the panicles (cm)	12.5-20.4	11.2-18.5	8.5-10.6	7.5-9.4	5.6-7.2
Number of seeds (average/plant)	15794	13406	10898	8762	8435
The length of the roots (cm)	39-45	35-38	30-34	24-27	13-16
Bioweight (gr./plant – herb weight)	895	794	586	338	212

Table 3. The vegetation period and the productivity features of *Echinochloa crus-galli* depending on the rising period on Cluj-Napoca conditions.

There have been variations of the productivity characters among the 4 experimentation years, according to the temperatures and the pluviometric quantities.

The climate of 2006 and 2007 significantly influenced the productivity characters of this species. So, during 2006 – the wealthiest in precipitation, the vegetative growth of the *Echinochloa crus-galli* plants was impressive: the maximum height was 218 cm, the shoots number was 49, and the developed panicles number was 45. During 2007 – when it was drought, there were the lowest values for the vegetative growth, but there were a lot of seeds comparing to the plants height.

3.2 The productivity features variation of *Echinochloa crus-galli* in accordance to density

The productivity features variations of *Echinochloa crus-galli* depend by the plants density to surface unit and climatic conditions specific to experimental years.

The height of the plants is strongly influenced by density, increasing significantly to a low density (2 plants/m² than 3 plants/m²) and a high one (50 plants/m² than 3 plants/m²) due to a strong shading and lack of light (Table 4). This feature (height) did not present a constant variation regarding the climatic conditions specific the experiment years, the single year when the medium difference of height was significantly negative was 2007.

Density / Year	2004	2005	2006	2007	Average
50 plants/m²	172.6***	135.6***	184.5*	65.8ooo	139.6***
10 plants/m²	159.8***	120.1***	158.6ooo	76.3oo	128.7ns
5 plants/m²	142.2oo	101.3oo	180.2o	81.4**	126.3ns
2 plants/m²	152.6***	118.9***	205.6***	84.2***	140.3***
Control 3 pl/m²	145.6	103.5	182.4	78.5	127.5
LSD 5%	1.85	1.19	1. 58	1.41	1.75
1%	2.63	1.70	2.24	2.01	2.48
0.1%	3.80	2.46	3.25	2.91	3.56

Note: ns – not significant, * signification positives, 0 signification negatives

Table 4. The height of *Echinochloa crus-galli* (cm) in accordance to density.

The other characters of productivity are strongly influenced by the plants density on the surface unit. Between 3 and 5 plants /m² it is achieved a close tillering, panicles number, panicles length and seeds number, with no significant differences while the density growing is 5 plants bigger on the surface unit all these conditions are decreased to limits between signification negative to very signification negative. The density attenuation under 3 plants on square metre has as effect the growing of the species productivity potential.

The danger that this plant represents even to a reduced infestation of the cultures comes from the possibility of achievement both a high biomass through the vegetative growing elongation, and a very high production of seeds that will represent the source of weeding for the next cultures.

The influence of the nutritional space size and development is very strong upon this species *Echinochloa crus-galli.* The tillering, the panicles number and panicles length are very significantly reduced to densities bigger than 5 plants per surface unit (Table 5).

The differences that appear among the years represent a consequence of species adaptability for adjustment conditions of the productivity in accordance to climatic conditions. If during the rainy years the tillering is influenced from distinctive significant to very negative significant by plants density growing with 2 samples per surface unit, during the very dry year – 2007 - this condition does not suffer any adjustment having a significant growing by density increasing with 2 plants per surface unit. The explanation of this fact is found into the high capacity of tillering of this species when the height growing is diminuated.

Density/Year	2004	2005	2006	2007	Average
50 plants/m²	3.2^{ooo}	2.9^{ooo}	4.2^{ooo}	2.4^{ooo}	3.2^{ooo}
10 plants/m²	12.9^{ooo}	12.1^{ooo}	14.3^{ooo}	9.3^{ooo}	12.2^{ooo}
5 plants/m²	19.3^{oo}	18.8^{oo}	20.4^{ooo}	16.9*	18.9^{ns}
2 plants/m²	23.4^{ns}	20.1^{ns}	26.2*	18.5***	22.1*
Control 3 pl/m²	22	20	25	16	20.5
LSD 5%	1.59	0.73	0.97	0.88	1.35
1%	2.26	1.04	1.38	1.25	2.13
.1%	3.27	1.5	2.00	1.81	2.97

Table 5. The tillering per plant on *Echinochloa crus-galli* in accordance to density.

The number of panicles per plant (table 6) follows, in general, the same tendency of a very significant decreasing to densities bigger than 5 plants per surface unit and increasing or decreasing from insignificant to very significant in the situation of a density increasing with only 2 plants, in accordance to the climatic conditions of the year. The weed density decreasing under 3 plants /m² has as effect in both character situations (tillering and panicles number) increasing from insignificant to very positive significant. The number of panicles is, especially, the most influenced positively character by the density decreasing.

Density/Year	2004	2005	2006	2007	Average
50 plants/m²	2.4^{ooo}	2.6^{ooo}	3.1^{ooo}	3.9^{ooo}	3.0^{ooo}
10 plants/m²	13.1^{ooo}	14.5^{ooo}	16.6^{ooo}	9.6^{ooo}	13.5^{ooo}
5 plants/m²	20.8^{ooo}	21.2**	26.8^{ns}	18.2^{ns}	21.7^{ns}
2 plants/m²	25.2***	26.1***	32.4***	20.8***	26.1***
Control 3 pl/m²	23	20	27	18	22
LSD 5%	0.96	0.83	0.95	1.22	1.12
1%	1.36	1.19	1.35	1.73	1.49
0.1%	1.97	1.72	1.95	2.50	2.38

Table 6. The number of panicles on *Echinochloa crus-galli* in accordance to density.

The panicles length is very significant reduced to plants densities of *Echinochloa crus-galli* bigger than 10 plants /m² while density of 5 plants /m² does not make significant differentiations (Table 7).

The production of caryopsis per plant is very significant reduced to increasing of plants density per surface unit starting with density of 5 plants /m². On this density, where the other productive features are less influenced compared with witness density (3 plants/m²), the seeds production suffers major decreasing especially during the years that are rich in

precipitations, when the productive potential of the species is directed to vegetative features (Table 8).

Density/Year	2004	2005	2006	2007	Average
50 plants/m²	11.4^{ooo}	11.3^{ooo}	12.2^{ooo}	10.3^{ooo}	11.3^{ooo}
10 plants/m²	14.1^{ooo}	13.4^{o}	14.3^{ooo}	12.1^{ooo}	13.5^{ooo}
5 plants/m²	16.1^{ns}	13.6^{ns}	16.2^{ns}	13.4^{ns}	14.8^{ns}
2 plants/m²	16.4^{ns}	15.1***	17.1*	14.9*	15.9*
Control 3 pl/m²	16.1	13.9	16.4	13.9	14.85
LSD 5%	0.56	0.43	0.63	0.73	0.65
1%	0.79	0.61	0.83	1.04	1.25
0.1%	1.15	0.89	1.29	1.52	1.56

Table 7. The length of panicles on *Echinochloa crus-galli* (cm) in accordance to density.

Density/Year	2004	2005	2006	2007	Average
50 plants/m²	1,289^{ooo}	1,216^{ooo}	1,482^{000}	2,105^{ooo}	1,523^{ooo}
10 plants/m²	9,462^{ooo}	8,324^{ooo}	9,874^{ooo}	7,304^{ooo}	8741^{ooo}
5 plants/m²	13,821^{ooo}	10,918^{ns}	12,956^{ooo}	10,021^{oo}	12,179^{oo}
2 plants/m²	15,659^{ns}	12,164*	16,102^{ns}	11,434*	13,840^{ns}
Control 3 pl/m²	15,208	11,303	16,018	10,795	13,406
LSD 5%	457.05	667.1	669.8	511.3	678.6
1%	649.71	948.3	952.1	731.08	973.4
0.1%	940.74	1,373.1	1,378.7	1,058.5	1,354.8

Table 8. The number of seeds/plant on *Echinochloa crus-galli* in accordance to density.

The productivity features of *Echinochloa crus-galli* suffer changes in accordance to the weed density per unit surface, to high densities the increasing in high are very visible while the tillering, panicles number, panicles length and the number of seeds produced by a plant are reduced very significant. Between 2 and 5 plants of *Echinochloa crus-galli* /m², the productivity parameters vary in more reduced limits, being in the most cases the consequence of the climatic conditions of the experimentation years. The inter specific concurrency is felt even when speaking about the increasing with one plant per surface unit, but this one becomes hypercriticalism in case of density growing with more than 5 plants/m².

3.3 Influence of degree infestation with *Echinochloa crus–galli* species upon the maize crop

Echinochloa crus-galli is known as a weed which germinate in late spring, invades especially weeding crops on wetlands, fattened with manure, grows very quickly, suppress and compromise the culture. Precipitation in April - May 2009 (102 mm in April compared to 47 mm multiannual average and 105 mm in May compared to 76 mm) have delayed corn seeding until the end of the optimal period and promoted the accumulation of moisture in the soil of 30% on average depth from 0 to 50 cm and a reserve of water on the same depth of 977 m³/ha. Under these conditions, sown late, high humidity, fertilization in the last year

with manure, favoured an excessive infestation of the culture, with species that germinate in late spring and especially *Echinocloa crus-galli*. At the same time, shortcomings on internal drainage of the soil aggravate the maintenance of crops in critical periods. Under these circumstances, competition for factors of vegetation was quickly won by *Echinochloa crus-galli* which influenced the subsequent development of maize and other weeds (Fig. 2).

In the unfertilized variant, corn invaded by weeds grows anemic and has a yellowish green color, develops storied, on the upper *Echinochloa crus-galli* dominate, in the middle floor develops *Setaria glauca* (L.) Beauv. and in the lower floor a number of dicotyledonous: *Galinsoga, Convolvulus, Matricaria, Lapsana, Hibiscus, Plantago* etc. (Table 9). The amount of weeds, obviously influenced production levels of maize grain and green mass (Fig. 3). Thus, it is found that on unfertilized agrofond with 22,113 kg/ha weed, maize green mass production is 2,100 kg/ha and with 200 kg/ha weed, maize green mass production is 29,790 kg/ha. The total amount of green mass (weed + maize/ha) varies in very close limits between 24,213 kg/ha to 31,740 kg/ha. On fertilized variant, the competition between weeds and maize, on the one hand and between monocotyledonous and dicotyledonous on the other hand, is more balanced, as dicotyledonous come from 1,700 kg/ha in unfertelized variants (Table 9), to 4,159 kg/ha in untreated, mineral fertilized variant (Table 10). On fertilized agrofond in untreated plot, the whole plant corn production was 27,600 kg/ha, and the grain production was 1,965 kg/ha, while the total mass of monocotyledonous weeds weighed 19,560 kg/ha and dicotyledonous weeds 4,159 kg/ha. In the variant treated with dimethenamid the whole plant corn production increased to 48,500 kg/ha, and the grain at 5,070 kg/ha, while total weed mass was 9,671 kg/ha. Similar results were obtained in the variant treated with acetochlor.

The highest production of whole plant corn 53,600 kg/ha and 7,020 kg/ha grain were obtained in the variant treated with isoxaflutol + (bentazon + dicamba). In this variant, because of the high efficiency of herbicides, the total amount of weeds was the smallest, only 950 kg/ha. In this experience, on fertilized background, in variant treated with herbicides, the amount of corn (27,600 kg/ha) + weeds (23,719 kg/ha) totals 51,393 kg/ha, which is practically equal to the best variants treated with isoxaflutol + (bentazon + dicamba), where were obtained 53,600 kg/ha maize and 950 kg/ha weeds, thus in total 54,550 kg/ha.

The reserve of *Echinochloa crus-galli* seeds in the 0-10 cm soil layer determinates at maize harvest shows the danger constituted by late infestations of maize crops with weeds, in maintaining the cultural hygiene of exploitation. From a valuable point of view this reserve of seeds is about 22,264 seeds/m² (average on the three years) in the variant of no disproof, 3,512 seeds/m² in the variant of a classical disproof, 5,394 seeds/m² in a chemical disproof variant through a pre emergent treatment, 6,042 seeds/m² in a chemical disproof variant through a post emergent treatment and 3,816 seeds/m² in a chemical disproof variant through two treatments (p.p.i. + postem.). We can state that the *Echinochloa crus-galli* seed reserve accumulated in the superficial soil layer is tightly related to the biomass of the weeds present in the culture before maize harvest.

3.4 The influence of climatic and technological factors upon the weed characteristics

The variable characteristics of the clime in the hilly area in the spring time, especially in April-May, completed with the particularities of soils workability from this area build for

many times one impediment to assure the optimal conditions for corn seeding and establish the optimal time for seeding. The repercussions of these deficiencies can be found for the most times in: culture late rising, culture irregularity, a bigger number of weeds, the passing of some phonological phases by corn plants during inappropriate periods, the differentiation of productivity organs during dryness periods, reduced productions.

Field	Group	Species	Plants/ m^2	Mass, kg/ha		
				Species	Group	Total
Plot I	Corn whole plant		4	-	-	2,100
	grains					288
	Mono	*Echinochloa crus – galli*	104	18,052	20,364	
		Setaria glauca	10	2,312		
	Dico	*Galinsoga parviflora*	25	1,516		22,113
		Convolvulus arvensis	4	72	1,749	
		Matricaria, Lapsana, Hibiscus	7	161		
Plot II	Corn whole plant		4	-	-	4,630
	grains					1,116
	Mono	*Echinochloa crus – galli*	95	12,633	12,804	
		Setaria glauca	8	171		
	Dico	*Galinsoga parviflora*	12	1,341		14,587
		Convolvulus arvensis	3	81	1,783	
		Matricaria,Lapsana, Hibiscus	7	361		
Plot III	Corn whole plant		4	-	-	130,000
	grains					2,526
	Mono	*Echinochloa crus – galli*	58	8,323	8,433	
		Setaria glauca	4	110		
	Dico	*Galinsoga parviflora*	22	1,293		10,230
		Convolvulus arvensis	4	102	1,797	
		Plantago,Matricaria, Lapsana	9	402		
Plot IV	Corn whole plant		4	-	-	19,720
	grains					3,866
	Mono	*Echinochloa crus – galli*	47	7,080	7,283	
		Setaria glauca	6	203		
	Dico	*Galinsoga parviflora*	14	1,012		8,464
		Convolvulus arvensis	2	90	1,185	
		Shymphytium, Lapsana	3	83		
Witness (2 holings)	Corn whole plant		4	-	-	29,790
	grains					5,157
	Mono	*Echinochloa crus – galli*	3	990	990	
	Dico	*Convolvulus arvensis*	2	240	960	1,950
		Shymphytium officinalis	2	720		

Mono – Monocotyledonous; Dico – Dicotyledonous.

Table 9. Influence of the density of *Echinochloa crus – galli* species and of other weed species upon the maize crop in the case of unmineral fertilized soil and without any measure of chemical weed control.

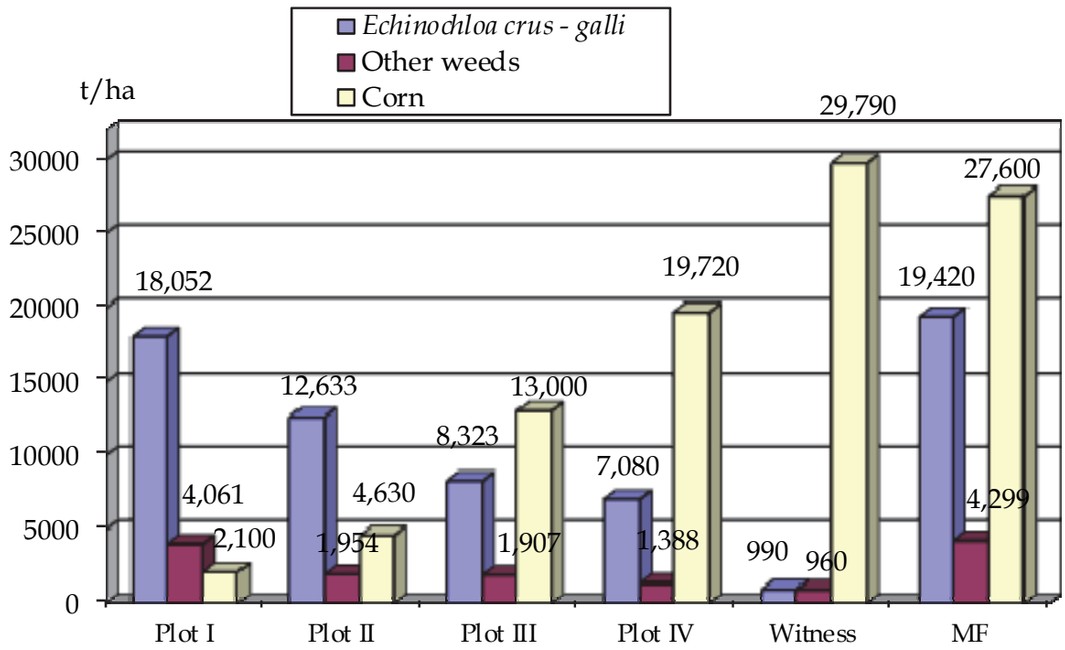

Fig. 2. Influence of *Echinochloa crus – galli* species on the development of other weeds and the green mass corn yield (t/ha).

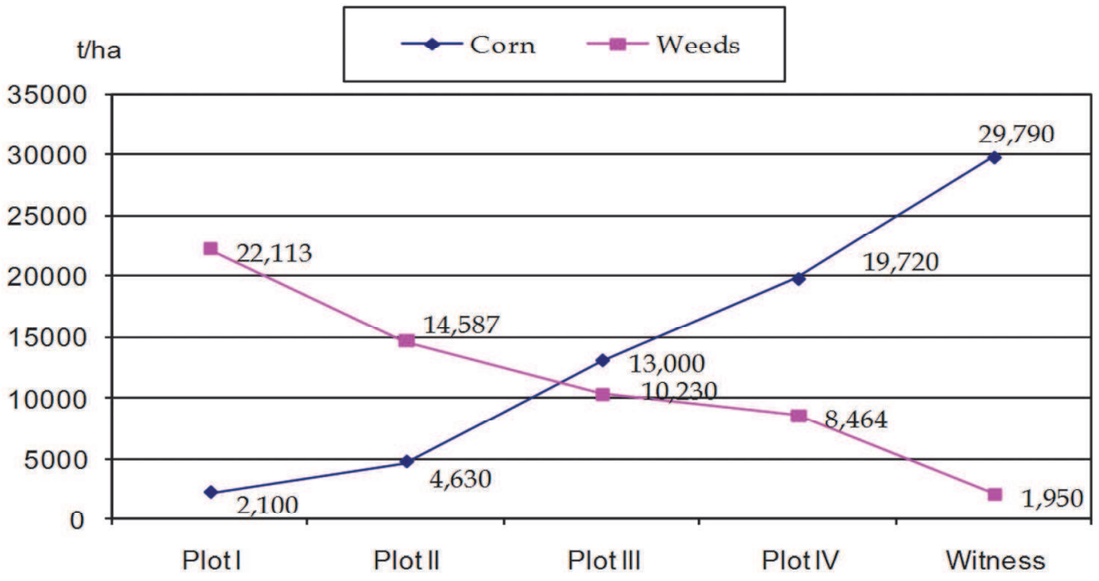

Fig. 3. Correlation between the weeds quantity and the greenery corn (t/ha).

Herbicides kg/ha	Group	Species	Plants /m²	Mass, kg/ha		
				Species	Group	Total
Untrated	Corn whole plant		4	-	-	27,600
	grains					1,965
	Mono	*Echinochloa crus – galli*	34	19,420	19,560	
		Setaria glauca	3	140		
	Dico	*Galinsoga parviflora*	9	891		
		Chenopodium album	8	1,040		23,719
		Polygonum convolvulus	8	1,241	4,159	
		Matricaria, Cirsium				
		Euphorbia helioscopia	14	987		
V_1 - dimetenamid	Corn whole plant		4	-	-	48,500
	grains					5,070
	Mono	*Echinochloa crus – galli*	2	2,060	3,100	
		Setaria glauca	4	1,040		
	Dico	*Amarantus retroflexus*	5	3,230		9,671
		Cirsium arvense	3	940	6,571	
		Chenopodium,Gallinsoga	7	2,401		
V_2 – acetoclor	Corn whole plant		4	-	-	49,120
	grains					5,421
	Mono	*Echinochloa crus – galli*	7	3,880	4,890	
		Setaria glauca	6	1,010		7,092
	Dico	*Amaranthus, Cirsium*	10	2,202	2,202	
V_3 - isoxaflutol + (bentazon + dicamba)	Corn whole plant		4	-	-	53,600
	grains					7,020
	Dico	*Amaranthus retroflexus*	1	950		950

Mono – Monocotyledonous; Dico – Dicotyledonous.

Table 10. Influence of density *Echinochloa crus – galli* species upon the maize crop in the case of a mineral fertilized soil and measure of chemical weed control.

The determined correlations confirmed a very strong connection between the climatic conditions and weed amount inclusively with *Echinochloa crus-galli.* There are also very significant direct relations between the overtaking of the optimal seeding date (April 15) and weed of the culture (Table 11).

One significant correlation exists between the quantity of precipitations and *Echinochloa crus-galli* (r = 0.875), but this species has a lower dependence to humidity, at least in the first periods of growing comparatively to other weeds, fact that explains the big number of exemplaries, even in the years with a low amount of precipitations and soils with a low reserve of humidity. The air temperature has a lower influence upon the weeding (r=0.571) especially during the first period of corn vegetation in conditions in that there were not significant variations of this climatic parameter.

The overtaking of seeding optimal date determinates the increasing range of weed inclusively the amount of *Echinochloa crus-galli* per surface unit. The relation is very significant, the correlation coefficient has values between 0.766 and 0.840 (very significantly)

and the regression equation y=2.5148 x + 288.96 shows that every day of seeding delay conduce to weed increase with more than 2 weeds/square metre.

The explanation of the identified correlations is found in the climatic characteristics of the experimental years. The dry periods influence negatively the corn germination and rising taking in consideration the spent period from seeding rising, culture density and its homogeneity. The weeds are also influenced less as frequency and more as rising and development period. During the years that are rich in precipitations the weeds succeeded in germination, rising and assurance of a high infestation of the culture. The plus of humidity and temperature from May and June favoured the weeding both as frequency and phonological development especially between May 30 and June 30. The weeds concurrence to the corn plants in this period it was an acerbic one.

The existent weeds mass in the corn crop before harvesting reflects on one side the climatic specific of the agrarian year, but mostly the effectiveness of each applied method to combat the weeds and not lastly the capacity of weeds concurrence.

The correlations established between the biomass achieved at harvesting moment of *Ecinochloa crus-galli* and yield (Fig. 4, Fig. 5 and Fig. 6) are – very strong, proving once again the fact that this species is a majoritary one both as frequency in corn crops from Cluj area but also as a corn concurrency potential bringing to significant production reductions. The correlation coefficient (r) is very negative significant having values between 0.861 and 0.952.

Characteristic	1	2	3	4	5	6
1. Weed number/m^2	1	0.65**	0.85**		0.92***	0.84***
2. Covering range, %		1		0.571^{o}		0.90^{ooo}
3. Number of *Echinochloa crus-galli* /m^2			1		0.578*	0.766***
4. Medium rising temperature – 15 days after seeding (^{0}C)				1		
5. The amount of precipitations rising - 15 days after seeding (mm)					1	0.859***
6. Number of days behind seeding						1

r / p 5% = 0.497; 1% = 0.623; 0.1% = 0.742

Table 11. The existent correlations between the weed characteristics, climatic and technological conditions from the corn crop.

The assessment of each combating method both under efficiency in corn crop weeds control aspect and achieved productions level after weeds combating (Fig. 7) it is compulsory and objective. The combating range of *Echinochloa crus-galli* accomplishes with the production a strong positive relation r = 0.959***. Therefore, in the case of a 10% increasing of combating range, the production rises with 48.65 kg/ha.

4. Conclusion

Significant particularity of *Echinochloa crus-galli* species is its growing plasticity according to the rising period and the respective climate during the vegetation period. The vegetative phases and vegetative parameters are adjusted so that the plant would completely pass the generative phase and would assure the species perpetuation.

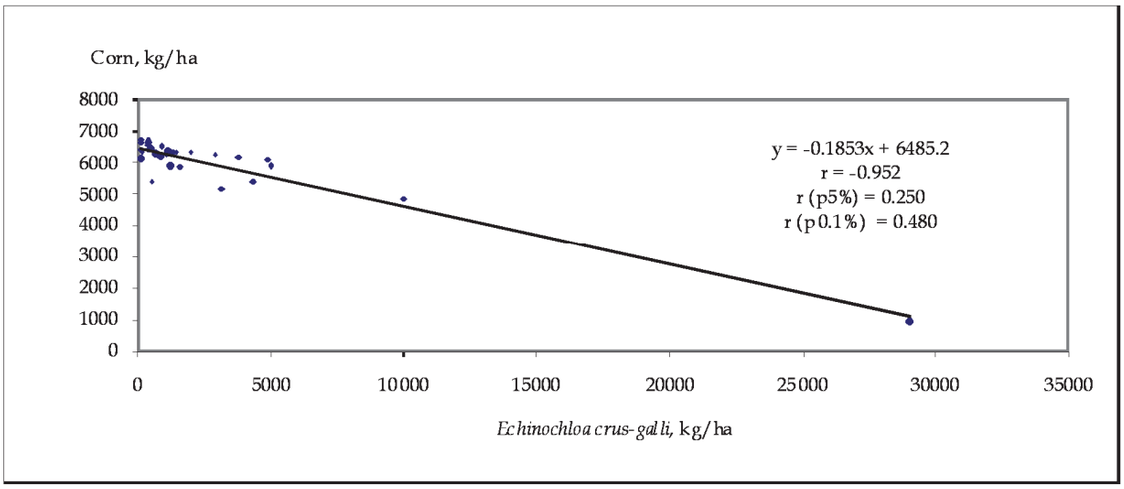

Fig. 4. The relation between biomass of *Echinochloa crus-galli* and corn yield during the dry years.

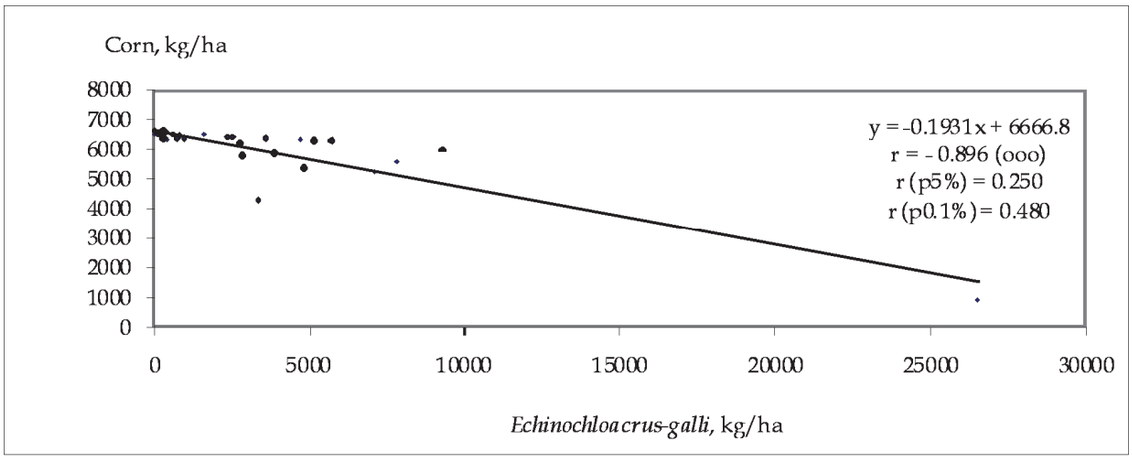

Fig. 5. The relation between biomass of *Echinochloa crus-galli* and corn yield during the rainy years.

The problem of the influence of different species of weeds on the production of agricultural plants has been studies by many researchers. The damage caused by weeds in maize crop is mostly of 30-70%, and when the infestation is strong culture can be fully compromised. Our researches highlight in terms of Transylvania, the influence of *Echinochloa crus-galli* species (L.) Pal. Beauv. and other weeds on corn production, according to the degree of infestation. Researches have been conducted at the University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Romania.

The researches was done on two agrofunds: unfertilized and mineral fertilized with NPK 100 kg s.a./ha. The unfertilized maize crop has been made in four variants with different degrees of infestation of *Echinochloa crus-galli*, from about 40 to 100 plants/m^2 and witness – 2 holdings. In fertilized plots were used 4 herbicides for weed control (isoxaflutol 750 g/l; acetoclor 860 g/l; dimetenamid 900 g/l; bentazon 320 g/l + dicamba 90 g/l). Weed biomass, corn plant and grain production was measured in the ripening stage.

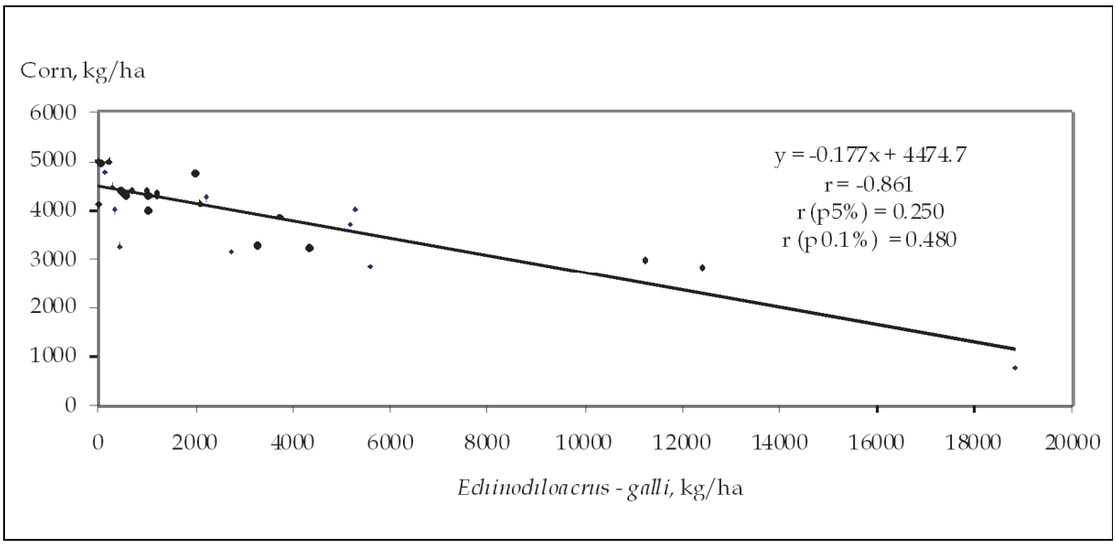

Fig. 6. The relation between biomass of *Echinochloa crus-galli* and corn yield during normal climatic conditions.

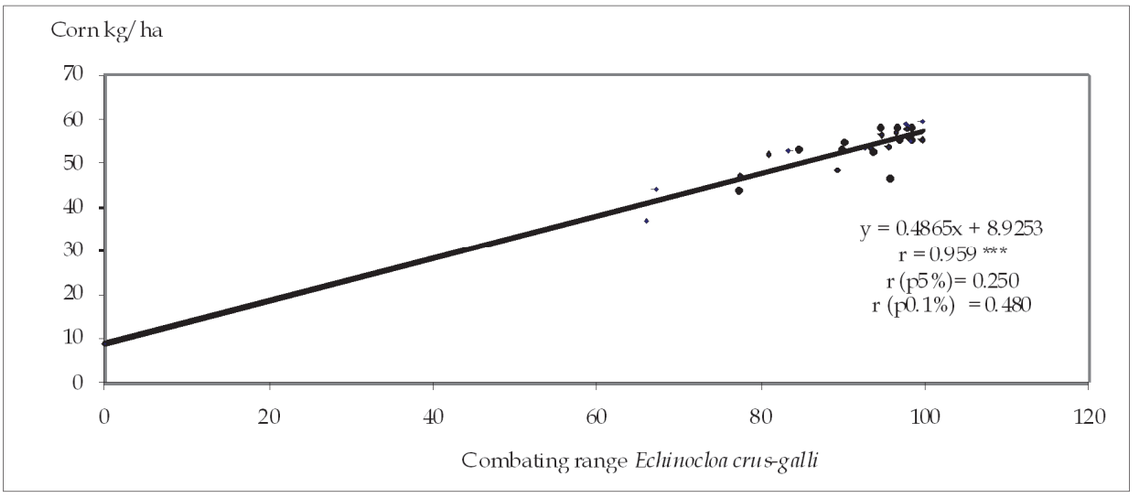

Fig. 7. The relation established between the *Echinochloa crus-galli* combating range assured in the tested variants and production level.

Corn invaded by weeds grows anaemic and has a yellowish green colour, in the unfertilized variant the corn develops storied, on the upper *Echinochloa crus-galli* dominates, in the middle floor develops *Setaria glauca* (L.) Beauv. and in the lower floor a number of dicotyledonous. On fertilized variant, the competition between weeds and maize, on the one hand and between monocotyledonous and dicotyledonous on the other hand, is more balanced, as dicotyledonous come from 1,700 kg/ha in mineral fertilized variants, to 4,100 kg/ha in mineral fertilized variant. The amount of weeds, obviously influenced production levels of maize grain and green mass. *Echinochloa crus - galli* had favorable conditions for maize crop infestation; the losses of production are depending on the degree of weed infestation and can reach 5,000 kg/ha maize grain, compared with those obtained in conditions of weeds control. Production losses in terms of green mass per hectare can be

considered equal to the weight of green weeds. At a density of 104 plants/m² of *Echinochloa crus-galli* with green mass of 18,052 kg/ha corn crop is fully compromised.

The prevention of maize crops infestations with weeds and weed control must be adjusted to topoclimate conditions. Along with agro technical, physiomechanical, biological and control means against weeds to share an equal importance for maize crops. All these must be so established as to succeed in efficiently controlling weeding all through the vegetation period of maize.

In central Transylvania, abundant rainfalls in July, August and even September and high temperatures favours late infestation of maize crops with annual species, very plastic as concerns the springing period and the bio-mass accumulated in the time period, especially *Echinochloa crus-galli.* Thus, when maize is harvested we can observe a high weeding level and the weed seeds reserve accumulating in the soil increases.

The protection of maize crops in the centre of Transylvania against weeds must to be into consideration some factors that are specific for that area. These factors are: large weed seeds reserve in soil, which, every year, provides a high weeding degree of crops; whimsical rainfalls; alternative springing of dominant weed species and their biological specific features, in order to reduce specific maize weeding under the economic deleterious level.

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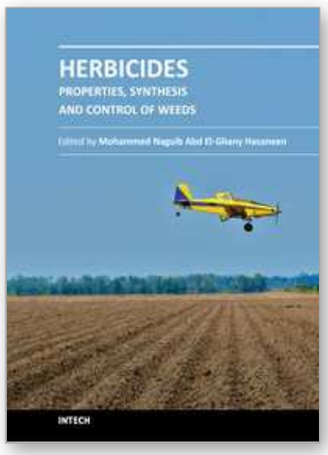

Herbicides - Properties, Synthesis and Control of Weeds
Edited by Dr. Mohammed Nagib Hasaneen

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This book is divided into two sections namely: synthesis and properties of herbicides and herbicidal control of weeds. Chapters 1 to 11 deal with the study of different synthetic pathways of certain herbicides and the physical and chemical properties of other synthesized herbicides. The other 14 chapters (12-25) discussed the different methods by which each herbicide controls specific weed population. The overall purpose of the book, is to show properties and characterization of herbicides, the physical and chemical properties of selected types of herbicides, and the influence of certain herbicides on soil physical and chemical properties on microflora. In addition, an evaluation of the degree of contamination of either soils and/or crops by herbicides is discussed alongside an investigation into the performance and photochemistry of herbicides and the fate of excess herbicides in soils and field crops.

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