Weed infestation in long term field trial with different levels of fertilization

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Abstract: In the present study are given the results of the monitoring of the weed infestation in the field crops, grown in crop rotation with different levels of fertilization. The main aim is to investigate the weed infestation in field crops after different precrops grown long time with different levels of fertilization.

The investigation of five crops – wheat, barley, maize, sunflower and peas-sunflower mixture was made for five years by monitoring the structure, numbers and biomass of the weed. The weeds in the wheat and barley fields are in "tillering" phase in March and in "heading" in May. To earth-up crops investigations are made before first and after last vegetation soil tilling.

Weeds' density in wheat, barley, sunflower, maize and pea-sunflower mixture crops cultivated in crop rotation in moderate and intensive fertilizing remain constant and average for the period between 2 - 6 nb/ m^2 for wheat and barley and 5 - 20 nb/ m^2 for sunflower and maize. At low level of fertilizing important influence on the weed density has the climate conditions and the precedent crops. The monitoring shows that in cultivation without fertilizing and herbicides lowest weed infested are barley plots after sunflower as precrop (31.8 nb/ m^2) and wheat after maize (45.0 nb/ m^2).

Key words: weed infestation, field crops, fertilization, long term field trial.

Introduction

Contemporary scientific conceptions suggest regulation of the main components of the agrophytocenosis for diminution of the number of harmful organisms' populations to economically acceptable level (Augustin, 1989; Топалов, 1993; Hain, 1997). The crops cultivation practices, based on scientific researches, includes crop rotations, soil cultivation, fertilisation etc. They are powerful tools for amelioration of the phytosanitary conditions.

Application of high fertilizing levels and good cultivation practices facilitates the biological suppression of weeds by cultural plants (Смирнов, 1980; Смирнов, Смирнова, 1981). Time and way of application of the fertilizers are also important (Blackshaw et.all., 2004). Primary condition for maximal fertilisation effect is establishment and maintenance of appropriate phytosanitary environment on the field (Farahbakhsh, A., Murphy, K.J., 1989).

Long term usage of fertilizers changes the agro-ecological conditions for existence of the whole agro-phytocenosis and its separate components (Dvorjak, 1994; Пупонин и Захаренко, 1995). Furthermore if the cultivated plant reaction is easily predictable the weeds' reaction is very difficult to prognosticate because of the large species' variation. Those are the main reasons for contradictory evidences for fertilizing effectiveness and regulation effect on the weed component in agro-phytocenosis. Climate conditions and crop's viability influence the fertilization effect on the weeds. In well developed and vigorous crop fertilization will contribute for the reduction of weed infestation and in opposite – in rare and physiologically depressed crops it will lead to great development especially of nitrophytic weeds which predominates in such conditions (Господинов, Граматиков и Пенчев, 1990).

Complete mineral fertilizing increases the crops’ tolerance to herbicides in one part and from the other the herbicides themselves create conditions for more effective utilization of mineral fertilizers (Казанова и Козина 1983; Иванцов, 1986).

The aim of this research is to determine the dynamics of weed infestation in wheat, barley, sunflower, maize and pea-sunflower mixture cultivated in crop rotation in different levels of mineral fertilizing.

Material and methods

The investigation is conducted in long term field trial on pellic vertisols in the Institute of Agriculture - Karnobat during the period 1999 – 2003. The crop rotation is by place and time. Wheat is cultivated after maize and pea-sunflower mixture, barley after sunflower and wheat, maize after wheat. Four agricultural systems are maintained. There are described as biological, ecological, moderate and intensive. The biological system does not allow utilization of fertilizers and pesticides. Fertilizing levels in the others are accordingly the correspondent crop and are increasing consecutively. Wheat and barley crops are treated with Derby 175 SK against broad leaved weeds and with Puma Super 7.5 EK against cereal weeds. In sunflower was used Raft 800 WG, in maize Mistral 4 SK and in pea-sunflower mixture Select Super. Each crop is grown in 0.1 ha plot within which are separated four replications by 0.025 ha.

Monitoring of the weed species composition in crops of wheat, barley, maize, sunflower and pea-sunflower mixture had been conducted for five years. Records in wheat and barley plots are taken in “tillering” phase for weeds in March and “heading” in May. In earth up crops monitoring was done before the first and after the last vegetation soil cultivation.

The pellic vertisol in cultivated layer 0 - 40 cm can be characterized as soil with heavy mechanical composition (volume density 1.10 - 1.20 g/ cm^3), weak acid reaction ($pH_{(KCl)}$ 6.5), moderate humus content ($pH_{(KCl)}$ 6.5), poor reserve of mineral nitrogen (30 - 40 mg/ kg soil) and mobile phosphorus (2.5 - 3.8 mg/ 100g soil) and very good reserve of absorbable potassium (35-42 mg/ 100g soil).

The climate in Karnobat region is continental with average annual rainfall 549 mm. The winter is comparatively warm, the spring is short and cool, the summer is hot and dry and the autumn is long and warm.

Results and discussion

The climate conditions of the investigated period are different which determine specific development of cultivated plants and weeds in the separated years.

During our research insufficient rainfall was observed (Figure 1). The sum of average perennial rainfalls during the biological development of cereal crops and weeds (October – June) is 427.8 mm. For the same period in 2000/2001 it marks a decrease by 90.3 mm, in 2001/2002 by 145.7 mm, in 2002/2003 by 118.8 and in 2002/2003 by 156.4 mm. Only in 1998/1999 the rainfall is close to the average data. The period in 2000/2001 was with dry autumn, warm winter, cool spring and hot and dry summer. The insufficient humidity during the autumn provoke late emergence of the cereal crops in the second part of December and the tillering was in the spring. The rare crops were precondition for lower competition ability of the cultivated plants and stronger weed infestation. The occurred drought during the spring had negative effect on the emergence and growth of earth up crops. Additionally they were depressed by weeds. The winter of 2001/2002 had very low temperatures but the snow cover kept the winter crops from frost bite. In 2002/ 2003 the sharp decrease of temperatures in December and February provoked frost damages on winter crops and this necessitated the re-sawing of the plots (Figure 2).

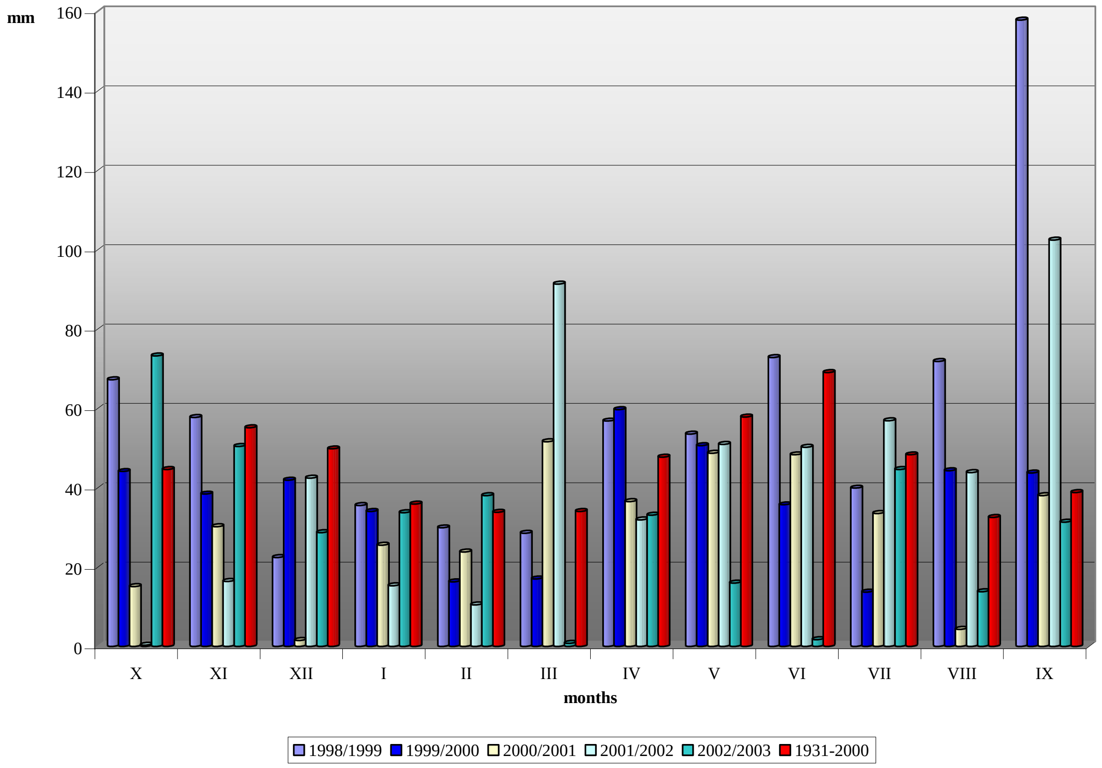

Figure 1. Rainfall distribution by months in 1998-2003, mm.

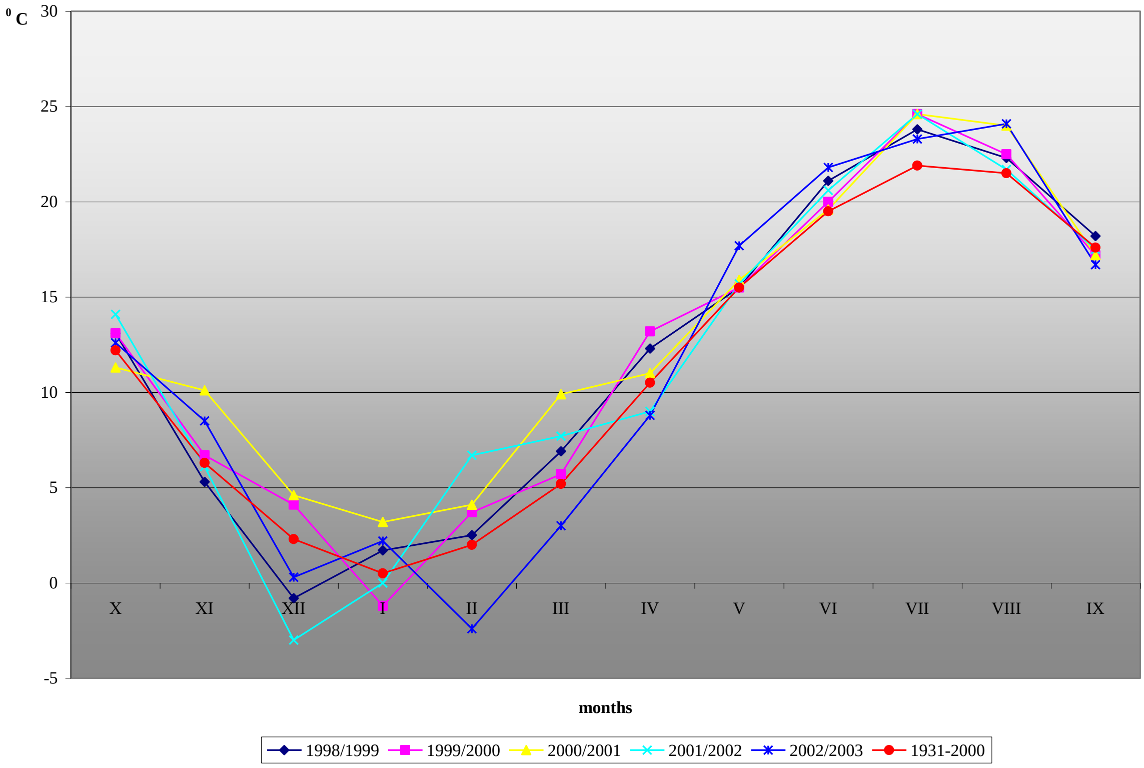

Figure 2. Average air temperature per months in 1998 – 2003, ^{0}C.

The tillering was inadequate and the crops were rare which facilitated the increase weed density. The lack of rainfall in March had negative effect on the spring crops emergence. The low soil humidity prevented the herbicides action. As result of those unfavorable conditions the sunflower crops were rare and severely weeded.

The climate conditions created friendly environment for winter emergency, development in early spring and rapid growth in late spring of the weeds.

The monitoring shows that the weed infestation in experimental plots before the starts of our study in 1997 is weak to moderate. Weed density is between 5 and 20 nb/m^2. In wheat and barley plots predominate winter-spring and early spring weeds - *Alopecurus myosuroides Huds*. *Lithospermum arvense L., Consolida orientalis J. Gay, Sinapis arvensis L., Myagrum perfoliatum L., Polygonum convolvulus L. and Avena spp*. In earth up crops more often are seen late spring weeds - *Amaranthus retroflexus, Anagalis aestivalis* and *Setaria spp.*

Winter cereals fertilized moderately or intensively and treated with herbicides have constant for the period weeds' density between 2 and 6 nb./ m^2 (Table 1). At low fertilizing level important influence have the climate conditions and used precedent crops (11...24 nb./ m^2). Under exceptional climate conditions as in 2002/2003 when plots were re-sawn in the spring and crops were rare the weeds' density was great in all variants (20...73 nb./m^2).

The rational five years crop rotation of wheat and barley (records taken in 2003) resulted in significant decrease of density of annual monocotyledonous weeds - *Alopecurus myosuroides Huds*. and *Avena spp.* in the non fertilized variant without herbicides treatment. Meantime the density of annual dicotyledonous species *Sinapis arvensis L., Veronica hederifolia L* has risen several times. *Galium tricorne With.* and *Anthemis arvensis L. a*re not present in the treated with herbicide variants but occur here.

Monitoring of spring crops (sunflower, maize and pea-sunflower mixture) reveals no difference in weeds' density (5...20 nb./m^2) between the variants with moderate and intensive fertilizing.

Spring crops cultivated without herbicides are infested with *Sinapis arvensis L.* and *Falopia convolvulus L.*. They are well developed in earth up crops and in wheat and barley. In maize and pea-sunflower mixture crops in conventional cultivation sporadically are recorded *Chenopodim albumL., Capsella bursa-pastoris (L.) Medic.* The density of *Amaranthus retroflexus, Anagalis aestivalis* and *Setaria spp.* has raised several times, especially in pea-sunflower plots - 50.4 nb/m^2.

Lower level of weed infestation in spring crops is observed in maize plots cultivated without fertilizing and herbicides. This crops is the last sawn. Two mechanical soil cultivations are made till the middle of April. In 5 – 8 leaves a hand earth up is also made. The soil cultivations destroy all emerged weeds in this period.

The monitoring results indicate that in field crops highest weeds' density, average for the period) is observed in pea-sunflower mixture cultivated without fertilizing and herbicides – 158 nb/ m^2. This value is three times bigger then in the other crops. In variants without fertilizing and herbicides lowest density is established in barley cultivated after sunflower (31.8 nb/ m^2) and wheat after maize (45.0 nb/ m^2).

Conclusions

Weeds' density in wheat, barley, sunflower, maize and pea-sunflower mixture crops cultivated in crop rotation in moderate and intensive fertilizing remain constant and average for the period between 2 - 6 nb/ m^2 for wheat and barley and 5 - 20 nb/ m^2 for sunflower and maize.

At low level of fertilizing important influence on the weed density has the climate conditions and the precedent crops.

The monitoring shows that in cultivation without fertilizing and herbicides lowest weed infested are barley plots after sunflower as precrop (31.8 nb/ m^2) and wheat after maize (45.0 nb/ m^2).

Table 1. Weed infestation of field crops during 1999 – 2003, (nb/ m^2).

Crops	**Years**					**Average**
	1999	**2000**	**2001**	**2002**	**2003**	
Wheat, precrop maize						
Without fertilizing - $N_0 P_0 K_0$	23	23	121	32	26	45.0
Low fertilizing level – $N_8 P_0 K_0$,	6	5	0	11	54	15.2
Moderate fertilizing – $N_{12} P_5 K_3$	2	2	0	13	15	6.4
Intensive fertilizing – $N_{16} P_{10} K_{10}$	1	1	0	1	8	2.2
Wheat, precrop pea - sunflower mixture						
Without fertilizing - $N_0 P_0 K_0$	5	19	93	106	45	53.6
Low fertilizing level – $N_8 P_0 K_0$,	10	10	19	11	73	24.6
Moderate fertilizing – $N_{12} P_5 K_3$	3	2	4	6	6	4.2
Intensive fertilizing – $N_{16} P_{10} K_{10}$	1	1	0	8	15	5.0
Barley, precrop sunflower						
Without fertilizing - $N_0 P_0 K_0$	13	21	42	19	32	25.4
Low fertilizing level – $N_4 P_0 K_0$	6	6	7	20	20	11.8
Moderate fertilizing – $N_8 P_5 K_3$	2	4	10	5	27	9.6
Intensive fertilizing – $N_{12} P_{10} K_3$	4	4	0	1	27	7.2
Barley, precrop wheat						
Without fertilizing - $N_0 P_0 K_0$	22	25	82	60	109	59.6
Low fertilizing level – $N_4 P_0 K_0$	7	4	13	19	54	19.4
Moderate fertilizing – $N_8 P_5 K_3$	1	6	4	9	7	5.4
Intensive fertilizing – $N_{12} P_{10} K_3$	5	5	1	0	23	6.8
Sunflower, precrop wheat						
Without fertilizing - $N_0 P_0 K_0$	11	13	91	78	104	59.2
Low fertilizing level – $N_4 P_0 K_0$	20	7	34	10	65	27.2
Moderate fertilizing – $N_6 P_5 K_3$	12	19	16	12	21	16.0
Intensive fertilizing – $N_8 P_{10} K_6$	6	21	18	9	35	17.8
Maize, precrop barley						
Without fertilizing - $N_0 P_0 K_0$	23	22	71	57	79	50.4
Low fertilizing level – $N_4 P_0 K_0$	95	22	23	15	38	38.8
Moderate fertilizing – $N_8 P_5 K_3$	17	18	9	12	25	18.8
Intensive fertilizing – $N_{12} P_{10} K_{10}$	52	8	5	12	23	20.0
Pea - sunflower mixture, precrop barley						
Without fertilizing - $N_0 P_0 K_0$	120	78	250	69	273	158.0
Low fertilizing level – $N_0 P_0 K_0$	21	11	24	10	27	18.6
Moderate fertilizing – $N_4 P_3 K_3$	10	12	14	9	68	22.6
Intensive fertilizing – $N_8 P_6 K_6$	48	18	18	33	39	31.2

References

Augustin, B. (1989). Gezielte Spritzunden schonen Getreide, Geldbeutel und Umwelt. Top Agrar. 1, 58-66.

Blackshaw, R. E., L. J. Molnar and H. H. Janzen. (2004). Nitrogen fertilizer timing and application method affect weed growth and competition with spring wheat. Weed Science, vol. 52 (4): 614-622.

Dvorzak, J. (1994). Zapleveleni jecmene jarniho pri rozdilnim hnojeni. Acta Univ. agr., 42, 1-2, 55-63.

Farahbakhsh, A., K. J. Murphy. (1989). Competitiveness of wheat cultivars with broad leaves weeds in relation to nitrpgen and fluroxypyr applications. Ann. Appl. Biol., 114, 128-129.

Hain, E. (1997). Dem Unkraut im Getreide Schon in Herbst zu Leibe rucken. Fortschr. Land wirt, 20, 11-13.

Господинов, Г., Б. Граматиков, П. Пенчев. 1990. Значение на предпазните и някои агротехнически мероприятия при борбата с плевелите при ечемика. В сб: Научни трудове от юбилейна научна сесия “65 години Научноизследователски институт по ечемика Карнобат. Карнобат, 204-210.

Иванцов, Н. К. 1986. Эффективность гербицидов в борьбе с сорняками в посевах ячменя на фоне минеральных удобрений. Трудове ЛСХА, 234, 44-48.

Казанова, И., Е. Козина. 1983. Совместное применение минеральных удобрений с гербицидами. Земледелие, 2.

Пупонин, А. И., А. В. Захаренко. 1995. Роль элементов системы земледелия в регулировании сорного компонента агрофитоценоза. Известия ТСХА, 2, 3-21.

Смирнов, Б. 1980. Научные основы совместного применения гербицидов и удобрений при возделывании зерновых культур в Нечерноземной зоне. – В сб: Актуальные вопросы борьбы с сорными растениями.

Смирнов, Б. А., В.И. Смирнова. 1981. Удобрения и сорняки в Нечерноземной зоне. – Известия ТСХА, №6, 20-31.

Топалов, В. 1989. Научна основа за развитие на борбата с плевелите в условията на интензификация и екологизация на земеделието. Научни трудове, ВСИ, XXXIV, кн. 1, 75-80.