STUDY OF SOIL WATER MANAGEMENT IN PEA (PISUM SATIVUM L.) POPULATIONS OF DIFFERENT SOWING TIMES

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Abstract

Water management of a chernozem soil in the crop year 2010 with good water supply was studied in pea populations. According to our results the development of the upper 200 cm soil layer moisture content was significantly determined by the water utilization of the pre-crop maize before pea.. Comparing the development of soil moisture content of different sowing times it can be stated that soil moisture content of the late sowing time treatment models (V2) showed more dynamic changes over the whole vegetation period in all three soil layers.

Analysing the yield amount results it can be stated that soil water management of irrigated treatments could not ensure conditions that were essential for the pea static water demand, thus anaerob conditions were formed in the root zone of pea populations.

Key words: water deficit, irrigation, pea, sowing time, yield

INTRODUCTION

The effects of climate change due to global warming are becoming stronger and the frequency of draught increases and lower precipitation having an effect on the water supply of plants (Vágó et al. 2006, Stekauerová and Nagy, 2006).

The future possibilities of crop production will probably be widened or limited by the level of adaptation to climatic changes. The primary cause of drought damage is the lack of precipitation (Jolánkai-Birkás, 2009). The weather phenomena of the past 6 years verify the forecasts. Not only the more dry or wet periods are becoming frequent, but the number of extremities within a year or even in a season is increasing (Birkás, 2006). If there is no supply to the water uptaken from the soil (precipitation, irrigation), then the soil moisture level will decrease and the water uptake by plants will become more difficult. Therefore, it is worthwhile to continuously supply the water uptaken from the soil. The soil can balance the extremes of the natural environment to a certain extent and to provide the plants with water and nutrients from the stored stocks at a certain level for a shorter or longer period (Várallyay, 2006, Varga-Haszonits et al., 2008; Láng et al. 2007, Polyák, 2008).

MATERIAL AND METHOD

The experiment was carried out within the confines of a polifactorial long-term field experiment set up at the Látókép Experimental Station of Plant Production of the Farm and Regional Research Institute of the University of Debrecen in the crop year of 2010. The experimental soil is calcareous chernozem with good water infiltration rate and water retention capacity. The area of each experimental plot was 41.1 m^2.

Table 1

Main weather condition parameters of the crop year 2010 (Debrecen-Látókép)

	March (mm)	April (mm)	May (mm)	June (mm)	July (mm)	Total (mm)
Amount of precipitation (2010.)	14,4	83,9	111,4	100,9	97,2	407,8
30-years average	33,5	42,4	58,8	79,5	65,7	279,9
Deviance from the 30-years average	-19,1	41,5	52,6	21,4	31,5	127,9
Temperature (2010.)	7,6	11,6	16,6	19,7	22,0	15,5
30-years average	5,0	10,7	15,8	18,7	20,3	14,1
Deviance from the 30-years average	2,6	0,9	0,8	1,0	1,7	1,4

Two sowing times (optimal-V1: 30.03.2010. and late sowing-V2: 23.04.2010.), two water supply models (not irrigated-Ö1 and irrigated-Ö2), just as the nutrient supply level of $N_{105}P_{90}K_{75}$ were studied in the experiment. Soil tillage, plant protection measurements and harvest were executed in the same way for all experimental treatments. In order to study soil water management soil samples were collected 3 times during the vegetation from each 20 cm of the upper 200 cm soil layer in four replications. First sampling time was before sowing. The second samples were taken in full flowering stage in case of the sowing time V1 and at the beginning of flowering for the population of the late sowing time. The third samples were collected after harvest from the stubble. Pea production is a part of triculture crop rotation system: it is sown after maize and is a pre-crop for wheat. In this crop rotation system irrigation is applied always in the maize population. Wet weight of soil samples was measured and the samples were put into a drying oven to 105^oC until they reached constant weight. Dry samples were weighed again and the difference between wet and dry weights was considered as soil moisture content that was expressed in m/m%. Results were expressed in V/V % using specific volumetric mass of the given soil layer (1.2-1.35 g cm-3).

Regarding the deviations from the 30-years average data in Table 1 the studied crop year of 2010 was rather wet. From april to july in each month of 2010 higher, sometimes two-times as much precipitation amount fell than the 30-years average that promoted the usual development of pea. plants. Temperature values were also favourable in each development phase.

RESULTS AND DISCUSSION

Development of soil moisture content of the upper 200 cm soil layer under pea population was studied in a polifactorial long-term field experiment during the vegetation of populations with optimal and late sowing time, the results of that are shown in Figure 1.

From the Figure it can be revealed that despite the favourable water supply the soil moisture content of the populations with late sowing time showed more intensive changes; the shape of the curves is not as balanced as in case of the optimum sowing time treatment population. Due to the adequate water supply no difference was found between not irrigated and irrigated treatments' water management. The shape of the curves, that is the development of soil moisture content is significantly affected by the water utilization of the main plant, i.e. maize sown in the same plots in the previous crop year. Regarding soil moisture content values measured in the end of March it can be stated that the upper 0-100 cm soil layer was saturated to the field capacity (22-31 V/V%), but lower values (18-20 V/V%) were measured in the 100-140 cm deep soil layer, that was close to wilting point (16 V/V%), in both irrigated and not irrigated treatments. This proves the high uptake of maize as a pre-crop, because the most of its root system is located in this soil layer.

Analysing water management of the whole soil profile it can be stated that in a wet crop year pea utilizes the moisture from the upper 0-100 cm soil layer intensively, while there was no significant change in the lower, 100-200 cm layer's moisture content, the shape of the curves was similar during the whole vegetation period. Irrigation of the pre-crop affects soil water management. During the whole vegetation period of pea lower water deficit values were calculated in the irrigated treatments , than in treatments without any additional water supply (V1 – 6.1-25.5 mm, V2 – 4.0-26.3 mm differences were calculated respectively).

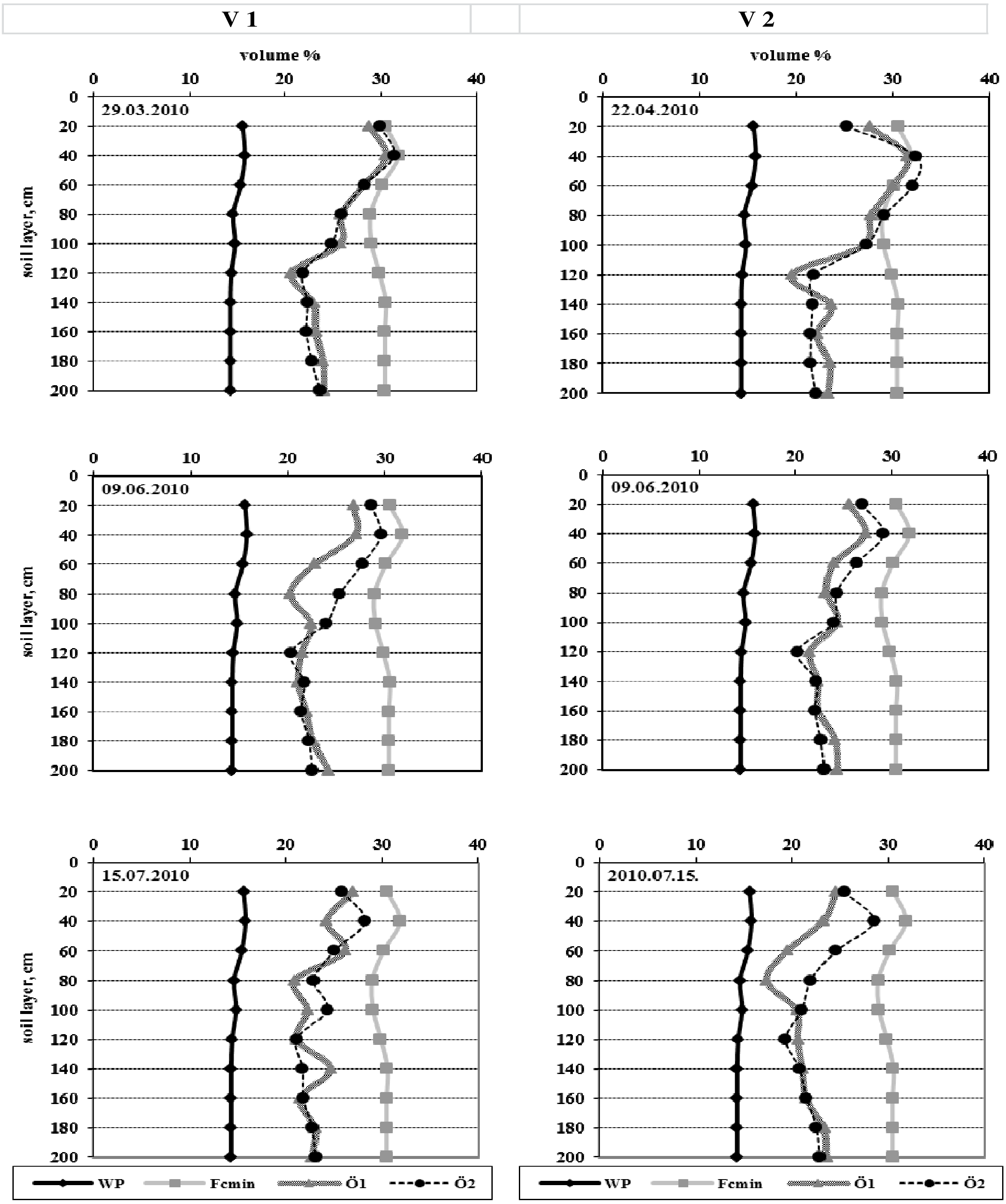
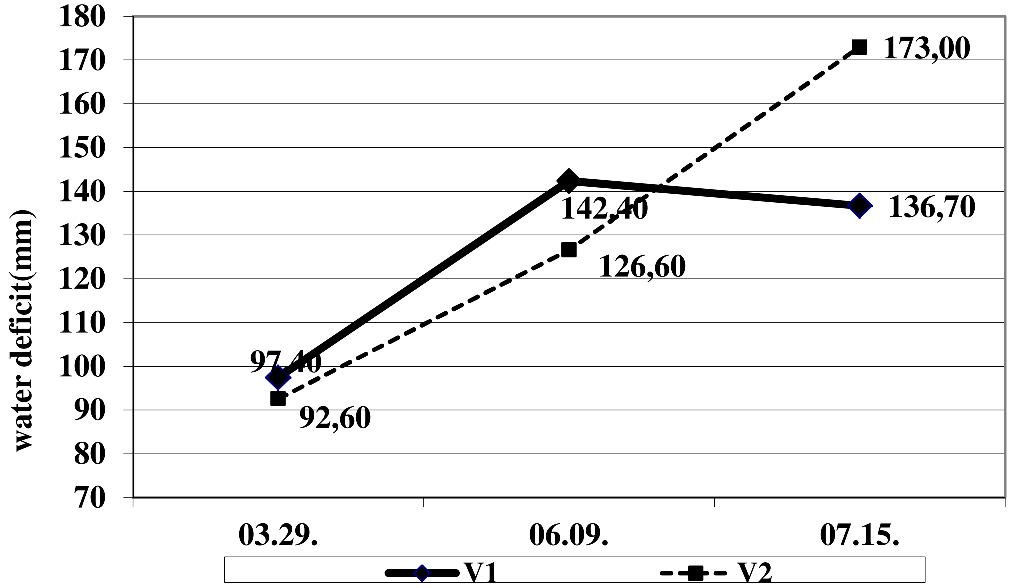


Figure 1. Development of soil moisture content in case of optimal (V1) and late (V2) sowing time in not irrigated (Ö1) and irrigated (Ö2) water supply models in the crop year 2010 (Debrecen-Látókép, 2010.)

Non-irrigated (Ö1)



Irrigated (Ö2)

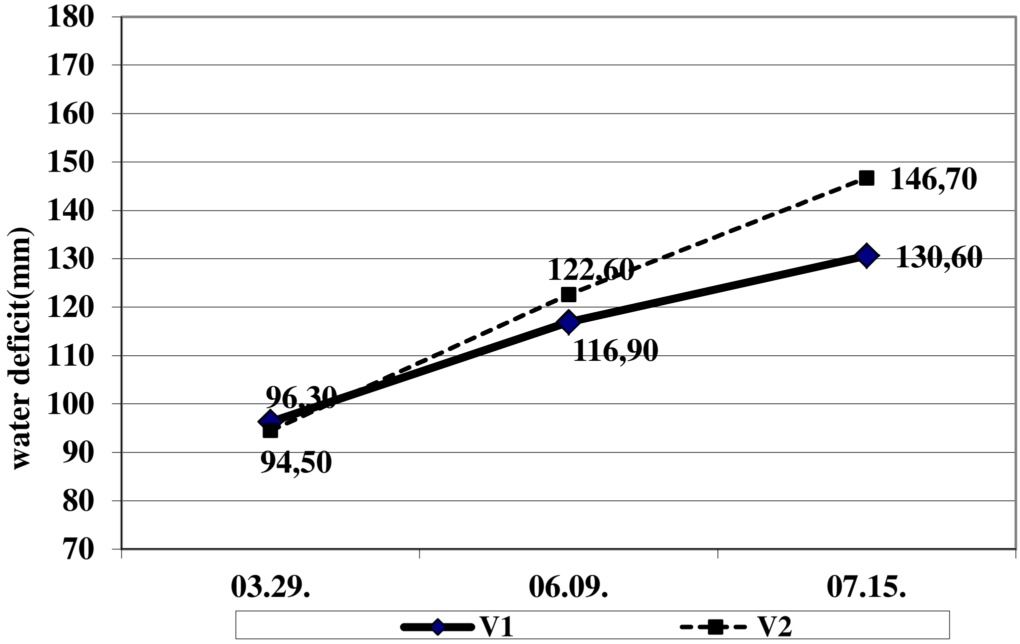


Figure 2. Development of soil water deficit values during the vegetation in pea populations

of different sowing times (V1-V2) under not irrigated (Ö1) and irrigated (Ö2) water management conditions (Debrecen-Látókép, 2010.)

The effect of regular irrigation – always supplied in the maize vegetation – can be revealed regarding the water deficit values of the long-term field experiment. In case of the optimal sowing time (V1) significant difference was found between water deficit values of irrigated and not irrigated treatments. At the beginning of the vegetation the extent of this difference was only 1.1 mm, during flowering 25.5 mm, while after harvest 6.1 mm. The difference between water deficit values of irrigated and not irrigated treatments of the V2 sowing time populations was 3.7 mm before sowing, 4 mm at flowering stage and it increased to 26.3 mm until harvest.

Beside soil water management the yield results od pea populations with different sowing time was studied in both irrigated and not irrigated treatments as well. Yield of optimal sowing time population was 2522 kg ha-1 in case of the not irrigated treatments, while in case of the pea populations with irrigated maize pre-crop it was 1970 kg ha-1 regarding the average of the studied four replications. In case of the late sowing time 232 kg ha-1 yield surplus was measured in the not irrigated treatments on the average, but in contrast irrigated pea populations produced 326 kg ha-1 lower yield.

The effect of regular irrigation applied in the previous crop years on yield amounts was studied as well. It can be stated that the wet weather conditions of the crop year 2010 resulted in yield decrement of the irrigated treatments in contrast to the yield of not irrigated ones.

Table 2

Relationships between sowing time and irrigation in pea populations (kgha-1, Debrecen-Látókép, 2010

	sowing time 1 (V1)	**sowing time 2 (V2)**
non-irrigated	2522	2754
irrigated	1970	1644
$SZD_{irrigation}$	944	653
SZD_{yield}	952	

The difference between the yield amounts of not irrigated and irrigated treatments was 552 kg ha-1 in case of the optimal sowing time pea populations, while in case of the late sowing time the difference was significant 1110 kg ha-1. This conclusion can be explained by the fact that soil water management of irrigated treatments could not ensure conditions that were essential for the pea static water demand, thus anaerob conditions were formed in the root zone of pea populations.

CONCLUSIONS

Water management of a chernozem soil in the crop year 2010 with good water supply was studied in pea populations. According to our results the development of the upper 200 cm soil layer moisture content was significantly determined by the water utilization of the pre-crop maize before pea. Regarding the water management of the studied soil profile it can be stated that pea utilizes the moisture content of mainly the upper 0-100 cm soil layer intensively.

Comparing the development of soil moisture content of different sowing times it can be stated that soil moisture content of the late sowing time treatment models (V2) showed more dynamic changes over the whole vegetation period in all three soil layers. Water deficit values confirm the after-effect of the irrigation of the pre-crop as well. In contrast to the treatments with no additional water supply lower water deficit values were calculated in irrigated treatments of pea populations (V1 – 6.1-25.5 mm, V2 – 4.0-26.3 mm difference).

Regarding water deficit values of the two studied sowing time treatments it can be concluded that water utilization of the later sowing time pea population was more intensive. Analysing the yield amount results it can be stated that soil water management of irrigated treatments could not ensure conditions that were essential for the pea static water demand, thus anaerob conditions were formed in the root zone of pea populations. Furthermore it can be stated that in order to get more precise conclusions further research shall be executed in other crop years with different weather conditions.

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