RESEARCH CONNECTION BETWEEN WINTER WHEAT PRODUCTIVITY AND THE DISTANCE OF HEDGES

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Abstract

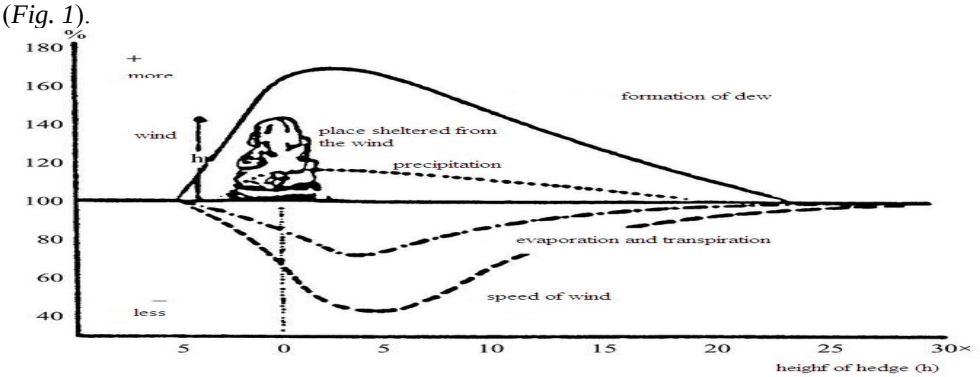
The hedges are useful for the agricultural production which should lead out attention to creating and protecting these habitats. These structures provide better condition for the crop: less wind, reduced evaporation and transpiration, higher humidity of the air and soil, and resulted by this there is higher winter wheat yield-capacity. Because of the agricultural advantages, an aim of creating a correlating biotope network should be set.

Taking the main aims in consideration, a natural system would form, out of forest belts and biotopes connected to them, which is capable of sustaining life of area-specific plant and animal species. By this it would increase the diversity of the area as well as enable us to maintain a close to nature, healthier agricultural farming.

Keywords: hedge, productivity, seed, wind, winter wheat, yield.

1. ANTECEDENTS OF THE RESEARCH

As all-over Europe, the application of hedgerows in agriculturally cultivated territories has a great tradition in Hungary as well (GÁL – KÁLDY, 1977; BARNA, 1994; BARNA, 2003 b; DUTOIT et al., 2003). The maintenance of these structures in the arable lands is desirable for many reasons. Through the moderation of the wind, they help to create a favorable microclimate (DANSZKY, 1972; GÁL – KALDY, 1977; KROMP, 1998; BAUDRY et al., 2000; KUEMMEL, 2003; MARTON – CSIKÓS, 2004; SZÁSZ, 2005) (*Fig. 1*).



(BROGGI, 1986 in ÁNGYÁN et al. 2003)

Figure 1: The impact of hedges on the microclimate of the environment

The smaller motion of air reduces evaporation and transpiration, but at the same time, trees bring a significant quantity of water from the deeper layers of the soil into the air (DANSZKY, 1972; GÁL – KALDY, 1977; BARNA, 1994; BAUDRY et al., 2000; FÜLÖP – SZILVÁCSKU, 2000). The distribution of precipitation also becomes more

equilibrated and the formation of dew at dawn intensifies as well. Because of the higher humidity of the air and soil, the water-supply of the cultivated plants becomes better, which can increase the yield (GÁL – KÁLDY, 1977; RANDS, 1987; PFIFFNER - LUKA, 2000; BAUDRY et al., 2000; FÜLÖP – SZILVÁCSKU, 2000; LEE et al., 2001). The lower speed of wind helps satisfying biological necessities, e.g. stomas will not be closed so respiration and photosynthesis can be continuous and the chance of mechanical damage is also smaller (PETHŐ, 1993; KROMP, 1998; BARNA, 2004 a). Because of their buffering effect, rows of trees contribute to the forming of more equilibrated thermal conditions, which supports the functioning of plants (GÁL – KÁLDY, 1977; BARNA, 1994; MARTON – CSIKÓS, 2004).

Besides this biotopes with woody vegetation give place to countless animal populations. Many of these are useful for us because they feed on pests, by this cutting back on agricultural injury (RANDS, 1987; FARAGÓ, 1989; FARAGÓ, 1990; HERRMANN - PLAKOLM, 1991; BOZSIK, 1994; KERÉNYI, 1995; ALTIERI, 1999; BAUDRY et al., 2000; FÜLÖP – SZILVÁCSKU, 2000; PFIFFNER - LUKA, 2000; LEE et al., 2001; ÁNGYÁN et al., 2003; MAROSÁN – GÁL 2003; MARTON – CSIKÓS, 2004). If we give place for these very useful species, we can use less chemical pesticides. This has many obvious advantages: the comestibles become potentially less dangerous, if the amount of chemicals used is minimized. We can also reduce damage to the environment. Agricultural machinery would have to spend less time on the field, which could result in cost reduction as well as lightened soil compaction and dusting, less animals will be disturbed and noise levels will be reduced (THYLL, 1996).

In an ecological perspective, beyond agricultural interest, the existence of hedges are needed. The ecological diversity increases with this, animal and plant species can settle that would not in the agricultural ecosystem. This also helps the self sustainability of the area (HERRMANN – PLAKOLM, 1991; KROMP, 1998). As a green isle the forest would aid the migration and settlement of plants and animals therefore allowing the possibility for given populations to grow strong acting against the segregation of isolated species. This would make the area stable in the long run (BARNA, 1994; ALTIERI, 1999; BAUDRY et al., 2000; FÜLÖP – SZILVÁCSKU, 2000; MARTON – CSIKÓS, 2004).

Other positive effects would be the amelioration of soil life, the increase of aesthetic and landscape values and the stabilization of climate. In an economical perspective it would supply timber, pasture for bees, small game, herbs and fruit (MÜLLER, 1991 in KÁTAI et al., 2002; ZSUPOSNÉ, 2002; BARNA, 2004 a; BARNA, 2004 b; MARTON – CSIKÓS, 2004).

In an optimal case a system could come to existence which is more natural and under no excess load (SÁRKÖZY et al., 1993; BÁLDI - KISBENEDEK, 1994; BARNA, 1994; FÜLÖP – SZILVÁCSKU, 2000; DUELLI – OBRIST, 2003; SAUBERER et al., 2004).

The actual status unfortunately does not show this. During the last decades many privately owned forests were cut out and not replaced (BARNA 2003 b, BARNA, 1994). During the industrialized agricultural farming the main aim was to create giant fields for crops, due to which forests were sacrificed (ÁNGYÁN-MENYHÉRT, 2004).

The question arises whether the advantages or the disadvantages of creating forest belts are stronger.

2. THE AIMS OF THE RESEARCH

During my research about characterizing forest belts, getting an insight to their ecology and their impact, I clarified the following aims:

1. Quest to find wheat fields bordered by hedges or line of trees.
2. Exploration of the forestry background of ligneous structures.
3. Gathering local meteorological data, evaluation of the data as observation angle.
4. Revealing the effect of woody rows to the productivity of crops. Defining the connection between productivity and the distance of hedges.

3. METHODOLOGY OF THE RESEARCH

For the relationship between the productive quality of the wheat and the distance of the woods I measured the mass of the grain crop. For two seasons I took samples on 6 fields once before harvest. I started at the side of the field, moving inward I collected 20-20 spikes a couple of meters apart. I repeated this operation multiple times (following different lines). I choose 200-200 seeds from all the collected samples and measured their mass. I organized the stripes (from the side of the field inward) into groups and compared the productivity of these zones.

In 2006 there was a field surrounded by forest belts on all the four sides. This area presented the clearest results of research so these will be shown. This plot takes place in Hungary between Püspökladány and Szerep, called Ürmöshát, coordinates: 47^{o} 15' 10'' N, 21 ^{o} 04' 59'' E. The official codes of hedges are: 32/B, 32/C, 32/D and 33/E. Main species were: *Quercus robur, Populus sp., Fraxinus pennsylvanica.* These hedges consisted 6-9 rows, 18-20 meter height and 38-45 meter width. The form of the field is quadrilateral, with 750-540-670-500 meter long sides.

4. RESULT OF MEASURING THE GRAIN OF WHEAT

The measurements conducted in two seasons at seven locations turned out as expected. At the edge of the field the effect of the hedge could have been pointed out (LÁNG, 2002; CHANEY et al., 1999 in KUEMMEL, 2003; BÍRÓNÉ KIRCSI, 2005), as to say less product because of the effect of natural surroundings. This could also have been affected by the competition of the wheat and the woods for resources (MEYNIER, 1967; LAVERS et al., 1996; PIENKOWSKI et al., 1996; DUHME et al., 1997; PARKER, 2000; KRSITENSEN, 2001; POINTEREAU, 2002) (*Fig. 2*).

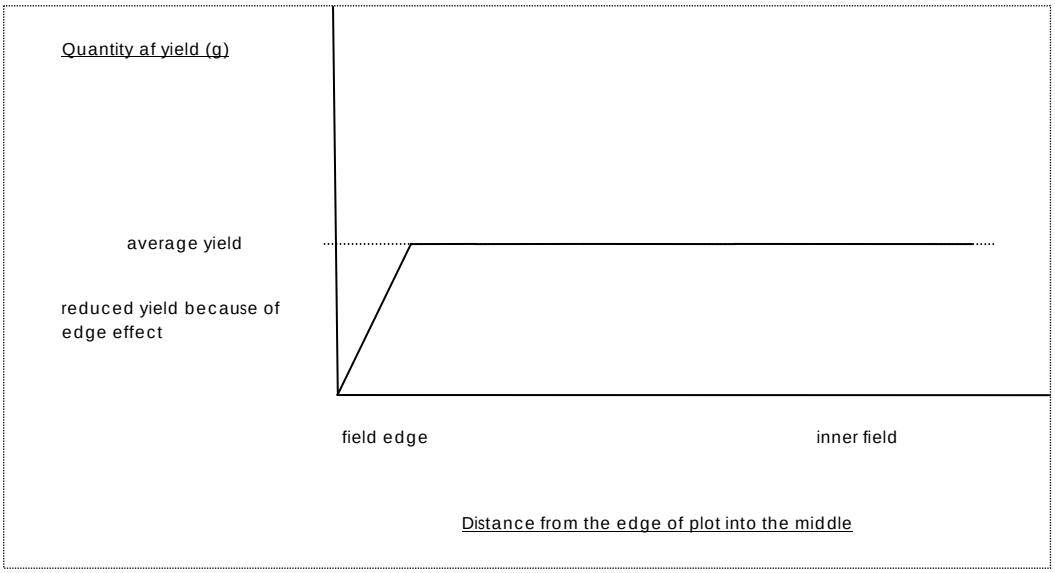
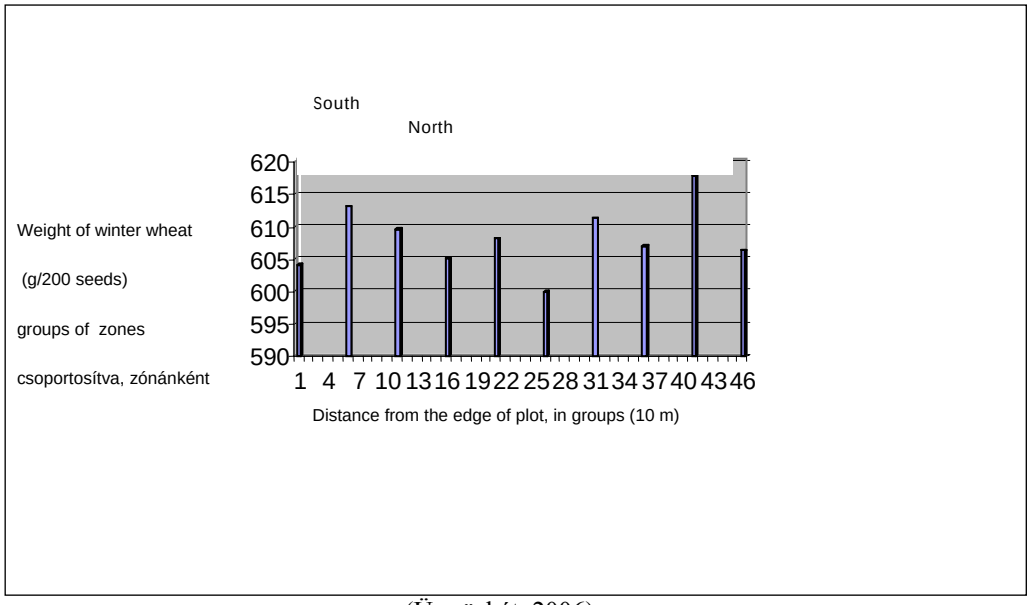


Fig. 2: Yield level in the plot without hedge. On the edge there is smaller production because of edge effect.

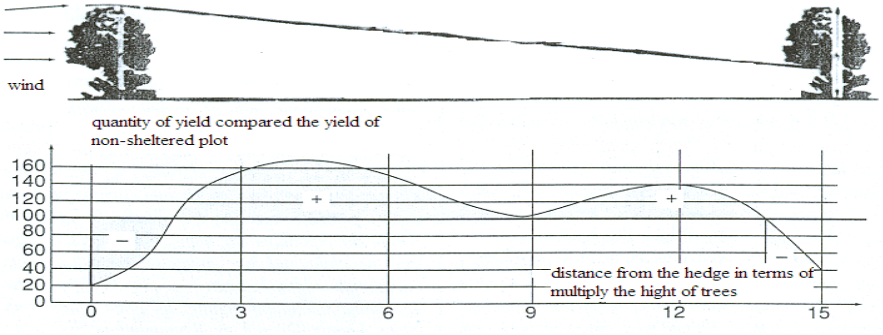
Moving inward the field there was a growth tendency up to a point then a steady decline was visible. This could be due to the slowing of the wind and the possibility for an optimal microclimatic area to form. We were able to determine the product maximum at a substantially large field at 5 times tree height on the leeward side of the field, and 3 times tree height on the windy side (generally the wind blows from the North) (*Fig. 3*). Minimum was measured in the middle of the field, at the greatest distance away from the trees. We could look at it as the average quantity without the effect of the line of trees. According to our experience there is a quantitative increase with the help of the hedge (*Fig. 4*).



(Ürmöshát, 2006)

Fig. 3: Quantity change of winter wheat yield in the plot between the two edges

According to these results lots of the scientists have the same opinion (RANDS, 1987; PFIFFNER - LUKA, 2000; BAUDRY et al., 2000; LEE et al., 2001). In Hungary measured also similar tendencies Gál – Káldy (1977) (*Fig. 5*).



(BATES – GUYOT, 1988 in BARNA, 1994)

Fig. 4: Quantity of yield on plot sheltered by forest belts on both side

Crop	Extra-yield (%)	Extra-yield (kg/ha)
winter wheat	2,7 – 26,8	84 – 610
winter barley	1,7 – 21,73	50 – 425
spring barley	6,1 – 33,5	190 – 790
maize	2,9 – 32,03	110 – 854
field beet	6,2	2.500
lucern	20,3 – 22	410 – 510
grass	15,3	320

(GÁL-KÁLDY, 1977).

Fig. 5. Increased yield level on plots surrounded by hedges in proportion to non-sheltered plots

5. CONCLUSION, NEW SCIENTIFIC RESULTS

Observing the level of winter wheat yield it is fact that the hedges provide better condition for the crop and we can measure higher biological production than without forest belts. In this case the counted extra-yield is 2.48% but it comes from only the weight of the seeds. The number of seeds in the spike was not counted but probably it is also higher than at the non-sheltered filed.

From the ecological point of view these hedge rows model the edges of a forest, where both forest and arable (meadow-like) species exist. As a whole it is more rich and diverse than only one of these habitats, because the characteristics are more diverse as well. They provide more possibilities, there is more ecological niches to settle. The diversity of the area helps to create stability on the one hand. On the other hand beyond the agricultural advantage, it might be a member of a habitat network which allows the movement of more vulnerable species (both plant and animal populations), the possibility of interconnection to the area (e.g.: species that can colonize difficultly can grow in the area if the conditions are stable for a period of time; or omnivorous arthropods do not move when there is not enough prey if they have access to nectar and pollen resources).

These hedges have great relevance in the growing of cultivated plants. This is due to the creation of a more stable and balanced habitat because of the tree row, as well as decreased number of pests because of the carnivorous and omnivorous insects living there. The final result of this is the increase in the quantity of the grown crops and a more balanced agriculture.

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