UNIVERSITY OF WEST HUNGARY
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Department of Plant Protection

DOKTORAL (PhD) THESIS

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2008

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Investigation of Factors Influencing Germination of Volunteer Sunflower Plants (*Helianthus annuus* L.) with the application of GPS

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1. Introduction, objectives

The objectives of our study was to reveal the causes of sunflower achenia dispersion, to find the relationship between the quantity of dispersed and germinated seeds, to find factors influencing dispersion and volunteer plants in order to solve this scope of problems.

1. We assumed that we should separate causes before and during harvesting in our investigations on seed dispersion. Seed dispersion before harvesting greatly influences the rate of volunteer plants that can measurably be reduced by the elaboration of a proper technology.

   Investigating the quantity of dispersion by harvesters means the rate of spreading and its distribution.
2. We assumed that the most effective method was to incorporate seeds shallowly just after harvesting in order to enhance autumn germination and voluntary growing. Shallow cultivation after harvesting could be one of the key elements of controlling voluntary sunflower growing.
3. Scientific publications also confirm that germination of the seeds lying at different depths in the soil depends on soil warming up and it sometimes happens in several waves. This postponement has an important influence on weed control in the following crop, i.e. if abandoned, crop could become weedy.
4. Soil cultivation technology applied after harvesting can also have an important influence on the germination of dispersed sunflower seeds. In case of shallow tillage seeds get under

optimal germination conditions, but those seeds, which got deeper, could be preserved.

5. With the help of GPS we can follow the depletion dynamic of dispersed seeds on a given field. Seeds dispersed after harvesting will not be displaced by soil cultivation too much, so it offers a good opportunity to study the depletion tendency of volunteer plants in the following years.
6. The use of chemicals dominates among weed control methods, but there are notable research results in the field of mechanical and agro-technical methods. A feeding trial was suggested as a new possible "biological" method to find out, how many seeds a day Hungarian poultry could take up.

2. Material and method

2.1 Investigation of seed dispersion

We launched our trials on 4 out of 5 of the chosen fields in autumn 2003 with the application of a desiccation free growing technology.

On each field involved into the investigation we randomly marked 4 sample areas of $10m^2$ and within them 4 of $1m^2$. We estimated the number of sunflower plants on each quadrate and the rate of disease infection, the number of plants knocked down by storm and the damage caused by wild animals and birds as well. We also counted the weed species and the number of dispersed achenia and the rate of dispersion after harvesting by combine harvester.

Sample areas were marked with a highly precise *DGPS* instrument in order to be able to find them at later dates for the sake of further investigations.

Data collected on sample areas were recorded and processed in Excel files.

2.2. Sunflower seed germination in wheat in autumn

Non-chemical methods get an even greater role in voluntary seed germination control strategy. Estimations were done in autumn 2004 on the field M 4-5 of the farm called Annamajor (Baracska). We marked 38 quadrates of 4x4 meter in size per 0.5 hectares in regular arrangement and the location of the sites was marked by DGPS instrument.

Within the sampling sites there were further 4 of 1x4 meter in size. On these small sampling plots we counted the number of dispersed achenia. After harvesting the field was disc-harrowed at a depth of 8-12cm and prepared by a cultivator for winter wheat sowing. Winter wheat was sown on 15th October 2004 using 330 kg/ha seeds leaving working tracks on the field.

On 23rd November we looked for and counted the number of volunteer sunflowers. 3 days after the estimation frost killed all of the volunteer plants.

2.3. Germination depth and trend of emerging

We launched our micro-plot field trials between 2-4th October 2003 in the Plant Breeding and Growing Technology Research Station of the University in Mosonmagyaróvár. The plots were randomly arranged with four repetitions. We marked plots of 29.5 cm x 21 cm large in size with the help of a metal frame made for this purpose. We planted 100-100 seeds of sunflower *(Helianthus annuus)*, abutilon *(Abutilon theophrasti)* and millet *(Panicum miliaceum)* at depths of 0-5-10-15 cm on each micro-plot. We observed the germination conditions of sunflower.

Evaluations were carried out on 27th April, 6th 13th 20th and 27th May 2004, as there were no more germinations we closed the trial on 27th May. We counted the number of germinated plants at every date of time. Meteorological data were delivered by meteorological station BCU-3 type, which was settled near the experiment site and its temperature measuring terminals were put into the soil of the trial plots at depths of 0, 5, 10 and 15cm.

2.4. Emergence of volunteer sunflower in spring after the year of dispersion

Dispersion trials were launched in autumn 2003 on the fields of the village Jánossomorja. We did not collect the counted achenia but left them on the sampling plots marked by DGPS for further investigations in spring. On 12th April 2004 we counted the volunteer sunflower plants.

We counted the volunteer sunflower plants in maize on 3rd May, when the plants were at four-leaf stage. There was no chemical treatment applied on the field yet. In our investigations we recorded the number of germinated volunteer sunflower plants and data were analysed with a statistical programme.

2.5. Tracking the germination of volunteer sunflower plants by geographic-positioning methods

Our investigations were carried out on the field M 4-5 outside the village Baracska, where sunflower was grown in 2000 then winter wheat was sown in autumn the same year followed by 2-year-maize growing. On the field we marked 2x2m large sampling quadrates in regular arrangement and of 0.5 hectare sample density. We counted the volunteer sunflower plants (and several other weeds) on the sampling plots in autumn 2001 on stubble and later in the years 2002 and 2003 before post-emergent weed killing treatment in maize.

2.6. Biological method for reducing voluntary sunflower germination by feeding brood hens

Trials were launched with 20-22-week old *SHAVER 579* hybrid brood hens. Brood hens were grouped according to body mass, 7-7 young adult hens were put into each of the 3 test groups and one untreated control group. Each group was put in a separate cage and was let accommodate to test conditions. The ground of the cages was set up of

2 parts: one part was covered with quartz sand and the other part was covered with concrete. Each part was of 2x2m in size.

During the time of egg laying hens of the test groups were feeding on achenia and the test group was feeding on hen diet both ad Libitum for 14 days.

3. Results and Conclusion

3.1 Results of achenium-dispersion estimations

Dispersion of sunflower seed may happen before harvesting as a result of overripening, damaged by wild birds, stem break under the head or stem tőkidőlés. The average number of dispersed achenia was 4.5 seeds/m^2.

But the main reason of sunflower dispersion is the harvester. Our investigations showed that following the track of the harvester we found 652.65 seeds/m^2, compared to other field parts with 67.35 seeds/m^2 , so altogether 360 seed/m^2 were found on the soil surface after harvesting.

Based on estimations before and after harvesting we found that 364.5 seeds/m^2 got lost on sunflower fields , which is eaqual to a yield of 291 t/ha.

3.2. Sunflower seed dispersion in winter wheat

Our trials were launched on the field M 4-5 of the farm called Annamajor (Baracska) in autumn 2004.

On 23rd November we visited the sample areas, which were marked and surveyed earlier and we counted the number of volunteer sunflowers in winter wheat. In our trial 51 seeds/m^2 out of the dispersed 271 seeds/m^2 germinated in autumn. This value showed a high scattering. Minimum value was 0.89%, and the maximum value was 75.21% volt.

We observed that 14.42 %-of the seeds dispersed during harvesting germinated in autumn, but were killed by a frost (-3 ^oC) on 29th November at sapling stage.

3.3. Germination depth and emerging trend of sunflower

4.5%- of achenia germinated in spring in the trial including all variables and repetitions. The earliest germinating plants emerged on 27th April from depths of 0.5 and 10 cm, but seeds at 15 cm depth emerged only after 20th May. Considering soil temperature data we can state that germination started in great numbers when soil temperature reached 14 ^oC. Germination trend developed in accordance with it. We should mention that a greater part of sunflower seeds germinated from deeper layers.

3.4. Volunteer sunflower in spring after dispersion

Sunflower seeds have a higher germination rate if shallow cultivation was applied than it was applied deeper. The reason could be the better

germination conditions caused by shallow tillage. This observation relating to spring germinations refers to both wheat and maize crops.
It results from this that shallow tillage after harvesting could be one of the key points of preventing volunteer sunflowers. On the contrary achenia ploughed deep into the soil keep their germinating ability for a longer period and could germinate in great numbers if getting into upper soil layers after the actual tillage.

3.5. Tracking volunteer sunflower germination with DGPS methods

Sunflower seeds can be well preserved in our soils. Therefore we prepared an evaluation of data on our experimental field in Baracska and analysed 3 years after sunflower growing. The fact that achenia can prevail in the soil was well shown in our investigations by the first following crop (winter wheat). There we observed only a fragment of the germinated seeds compared to the following crop (maize), a reduction could only be observed in the 3rd year.
Evaluating data received in 2002-2003 we could observe that peak emerging happened in both years on the same sample areas, but there was a notable reduction between the two years. Compared to the foregoing year 15% of the seeds germinated in 2003, i.e. the depletion tendency of seeds that got into soil after harvesting and preserved was notable.

3.6. Biological method to reduce volunteer sunflower by feeding it to poultry

Brood hens being used to groats feed on sunflower seeds well. Their average consumption amounts 101g/day, but this rate of consumption varies greatly.

Test results show that feed uptake of brood hens drastically reduced after changing fodder. Their consumption recovered after seven days on average and stayed at bout the original level. Maximum values varied between 74.3 - 89% of the adaptation, original value, while their body mass continuously reduced. The rate of reduction was proportional to the recover of food uptake.

But after two days a reduction in continuous food uptake happened, which remained until the end of trial, and as a result egg production started to reduce as well.

Poultry suffered under long term mono diet, so their condition got into poor shape. Dissection showed at some of the hens blocked digestive tract, their liver was pale, and its structure was loose. Their level of nourishment was either weak or medium.

4. New scientific results

1. Achenium dispersion

   Achenium dispersion may also happen before harvesting. But the main cause of sunflower dispersion is the combine harvester. Achenia disper mostly through the threshing parts.

2. Sunflower achenium germination in winter wheat

   On average 14.42% of achenia, dispersed after harvesting, germinated in autumn. But the rate of volunteer sunflowers did not show any close correlation with the dispersed quantity.

3. Germination depth and trends of emerging

   4.5% of sunflower seeds germinated during spring time. The earliest plants emerged on 27th April from germination depths of 0.5 and 10cm, but plants from 15 cm germination depth emerged only after 20th May.

4. Germination test of volunteer sunflowers in spring after the year of dispersion

   There was only a difference of 10cm between the deep and shallow cultivation of the fields. But as a result of shallow cultivation 5.9% of the seeds emerged, and 12.8% of the seeds emerged after deep cultivation.

5. Volunteer Sunflower germination tracked by DGPS methods

   Evaluating data received in 2002-2003 we could observe that peak emerging happened in both years on the same sample areas, but there was a notable reduction between the two years. Compared to the foregoing year 15% of the seeds germinated

in 2003, i.e. there was a considerable depletion tendency of seeds that got into soil after harvesting and got preserved.

6. Biological method to reduce the number of volunteer sunflowers by feeding them to brood hens.
   Based on the research results fodder uptake of hens following the change of fodder greatly varied, but hens that were used to groats feed on sunflower seeds well: we measured an average daily uptake of 100g.

5. List of publications:

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4. O. Páli – P. Reisinger. – **P. Pomsár**(2007): Comperative investigations of non chemical weed management methods in Hungary. 59th International Symposium on Crop Protection

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