Annex 1

IIRB
INTERNATIONAL INSTITUTE OF SUGAR BEET RESEARCH

The importance of phenmedipham and desmedipham for weed control in sugar beet

by the IIRB Weed control group

The importance of the sugar beet crop in Europe

In 2017 sugar beets were grown on 1,7 million ha in Europe by about 140.000 growers. The crop is a cornerstone for the arable farm in Europe. The sugar beet crop has a significant role in the crop rotation regarding **I**ntegrated **P**est **M**anagement, biodiversity and soil protection. Additionally sugar beet weed control plays an important role concerning weed management in the crop rotation and is an environmentally important spring-sown crop. **Phenmedipham and desmedipham are crucial for weed control in sugar beet and their removal could make the crop uneconomic to grow**.

The sugar beet crop, with the production of sugar and its derivative products (molasses, sugar beet pulp for animal feed, sugar beet tails for feed and bioenergy and sugar factory lime) is an important source of income in Europe. Not only for farmers but also for sugar and food industry, both directly and indirectly. The sugar beet crop assures self-sufficiency for quality sugar in Europe. But sugar and sugar products are also an important export product for Europe. Besides sugar also animal feed, bio-ethanol and bioenergy are produced from beets in Europe.

The sugar beet crop and the sugar sector in Europe are already under economic pressure since the abolition of the EU sugar quota system in 2017. For the future European sugar production must be competitive with (low) world market prices for sugar e.g. from sugar cane cultivated in South America.

The loss of two key active ingredients phenmedipham and desmedipham which are essential for successful and economical weed control in the sugar beet crop could destroy the viability of the crop and would put at great peril the existence of the crop in Europe and European self-sufficiency in sugar.

However, besides sugar beet, a ban of phenmedipham and desmedipham would also affect crops such as spinach, red beet, chard, energy and fodder beet and strawberries in a detrimental way.

It also has to be pointed out that the PMP/DMP task force, have communicated that the zonal rapporteur member state Finland will submit a request for re-evaluation of the classification of phenmedipham and desmedipham by the ECHA. A classification dossier will be submitted to ECHA in May 2018 for desmedipham and in June 2018 for phenmedipham. ***We would therefore like to ask to await the finalisation of the ECHA classification procedure before a decision is taken about these molecules, which are of vital importance for the sugar beet crop.***

Weed control in sugar beet

Weed control in sugar beet has been a complex and very difficult matter since the crop was first sown. One of the crop's properties is that it has a slow juvenile growth compared to weeds and beet rows do not close until 12 to 14 weeks after sowing. Thus, the period within which weeds have to be controlled is quite long. **If weeds are not controlled efficiently in the sugar beet crop, production losses of 10% up to 90% are possible.** Figure 1, based on trial results generated by NBR (Nordic Beet Research) shows how yield losses occur as function of the percentage cover by surviving weeds that compete with beet until harvest. Another example comes from trials conducted in Germany where fat hen plants (*Chenopodium album*) that emerged between the two to six-leaf stage of sugar beet were left to compete with the crop and **yield losses of 5 to 9% of the white sugar yield could be measured for each surviving fat hen plant/m²** (Welmann, 1997 [1]). Fat hen is one of the most competitive weed species towards the sugar beet crop, it is also one of the most frequently occurring species. These results, and much previous research work, show that even low numbers of weeds reduce sugar yield substantially but with an increasing number of surviving weeds the yield can be heavily compromised and could be virtually lost.

If growers can no longer use phenmedipham or desmedipham for their herbicide strategies, then situations with large numbers of surviving weeds per m² are likely to become a reality in European sugar beet fields and within succeeding crops in the crop rotations.

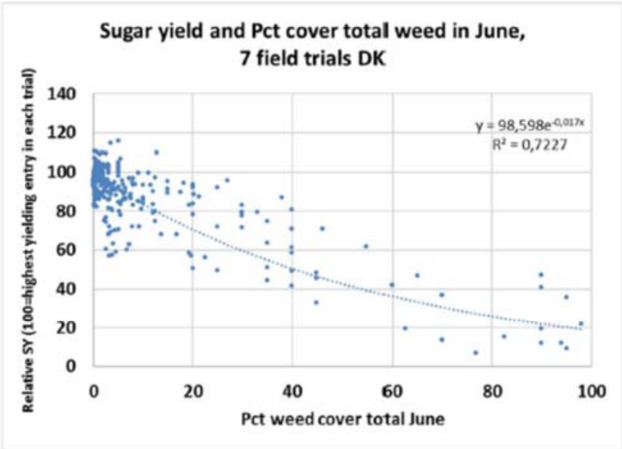

Figure 1: loss of sugar yield in function of the % total weed cover in June, source NBR, trial results of 2006 (3), 2016 (2) and 2017 (2).

It was not until the 1970s that efficient herbicides became available on the market. Their usage made the sugar beet crop less labour intensive and allowed farmers to increase their acreage. These molecules, such as phenmedipham, ethofumesate and metamitron, still form the basis of our current weed control system (chloridazon already existed). At first these molecules were applied separately or in combinations of a maximum of two molecules at high dosages, often to more developed weeds. From the **early 1990s**, after many years of research, these practices changed and the **low dosage FAR system was taken into use by farmers**. **With this FAR system a synergistic mix of three components at low dosage is applied repeatedly (3 to 6 times) to each time newly emerged weeds at the cotyledon stage.** Although there are variations on the system, the principles are the same for all the subscribing countries. The FAR abbreviation stands for:

F= foliar or **phenmedipham** or a combination of phenmedipham and desmedipham

A= activator, this is always **ethofumesate**

R= radicular or **soil-acting herbicide** which is most often metamitron but can be chloridazon (if still registered, depending on the EU country) or for certain EU countries (often after the 2 to 4 leaf stage of sugar beet) dimethenamide-P, clomazone, S-metolachlore or lenacil (see table 1 in annex for registration status in the different countries).

Most often also an adjuvant is added to improve efficacy by improving the foliar uptake of the herbicides by the weeds. In rarer cases, actives like clopyralid, triflusulfuron-methyl, quinmerac or tri-allate are added to control rarer weeds, which are not covered by the FAR weed control spectrum.

The dosages and choice of the FAR components are modulated in function of the flora present on the field (but also the developmental stage of beets and weeds). However, there are no alternatives for the F and the A component. The use of this FAR system follows IPM principles where the optimal timing for application is chosen in order to use the lowest dosage of herbicides possible while maintaining a high efficacy (> 99%), this slows down the selection of resistant weeds, while the system is selective to the sugar beet plants at the same time.

The importance of the F component, the phenmedipham and the desmedipham in this FAR system, is crucial. These "contact" herbicides are absorbed by the leaves of weeds and will in this way also be efficient in **dry conditions**. Both are photosynthesis-inhibitors (PSII inhibitors) and act quickly on small weeds.

Due to the synergistic nature of the FAR system, implementing phenmedipham and desmedipham, high efficacies against the major weed species in the sugar beet crop can be obtained. **Banning phenmedipham and desmedipham, it is likely that nearly all weeds would become difficult to control.** From our experiences weeds such as fat hen (*Chenopodium album*), common orache (*Atriplex patula*), black bindweed (*Polygonum convolvulus*) , cruciferous weeds (*Brassicaceae*), annual mercury (Mercurialis *annua*) and amaranth (*Amaranthus*) species would become very difficult to control without phenmedipham and desmedipham. Due to the synergistic nature of the FAR system mixing actives is crucial and allows the weed spectrum to be covered which is broader than the weeds mentioned above; mixing also allows growers to keep the dosages of the individual components relatively low. Phenmedipham is clearly more important than desmedipham concerning the weed spectrum it covers, however if weather conditions are dry and restrictions on soil-acting herbicides and their dosages are continued, the importance of desmedipham would further increase as well.

Resistance management

For a number of years we have known that ***Chenopodium album* populations have been selected to be resistant to metamitron** (Herbicide Resistance Action Committee, HRAC, group C1, also a PSII inhibitor, triazinone). These resistant populations occur in a number of EU countries such as Belgium, France, the Netherlands, Germany, Sweden (www.weedscience.org). A reduced efficacy of metamitron can be seen in these populations, the efficacy of phenmedipham and desmedipham (HRAC group C1, PSII inhibitors, phenylcarbamates) and ethofumesate (HRAC group N, fatty acid synthesis inhibitor, benzofurane) remained largely intact. These populations can still be controlled by putting more emphasis on the F and the A component and by dosing the R-component metamitron lower but completing it with low dosages of dimethenamide-P and/or clomazone (respectively a K3, a cell division inhibitor and F4, a DOXP synthase inhibitor). **In this way we apply resistance management by combining three to four different HRAC modes of action in the FAR system and we reduce further resistance selection in the rotation. Resistance management is also a requirement according to the EU directive 2009/128/EC on the sustainable use of pesticides. Resistance management is of crucial importance for the future of sugar beet in Europe.**

In the future phenmedipham and desmedipham will remain vital molecules for resistance management. A new system of ALS herbicide resistant sugar beets, developed by traditional plant breeding, is currently being developed to be used in combination with an ALS inhibiting herbicide. Without phenmedipham and desmedipham the use of such technology is hardly possible as the ALS technology will be sensitive to the selection of ALS resistant weeds. We already use ALS inhibitors to a considerable extent in other crops of the rotation such as cereals, corn, etc. ALS resistant blackgrass (*Alopecurus myosuroïdes*), loose silky bent (Apera spica-venti), common poppy (*Papaver rhoeas*), mayweed (*Matricaria chamomilla*), Shepherd's purse (*Capsella bursa-pastoris*), redroot pigweed

(*Amaranthus retroflexus*) and chickweed (*Stellaria media*) already occur in EU countries. For information sake, a case of ALS resistant fat hen (*Chenopodium album*) is registered in Finland and this population was selected using ALS inhibitors in spring wheat (www.weedscience.org). A proposed strategy to reduce the risk of further resistant weed selection would be to mix the ALS herbicide with phenmedipham and/or desmedipham and ethofumesate. This would not only be necessary for resistance management, but it could also fill a few gaps in the efficacy spectrum of the proposed ALS product. Additionally the use of phenmedipham and desmedipham would allow the control of ALS resistant weed species such as redroot pigweed (*Amaranthus retroflexus*), Shepherd's purse (*Capsella bursa-pastoris*), chickweed (*Stellaria media*), and many more...

There are no alternatives available to replace phenmedipham and desmedipham. The only other products which could be used, where authorised, and have some contact efficacy are tri-allate and triflusulfuron-methyl. However, they cannot be considered as alternatives to phenmedipham and desmedipham as their efficacy spectrum is limited and by no means covers the same weed species spectrum. In addition, both tri-allate and triflusulfuron-methyl must be evaluated for reregistration on Annex I in the near future and it could be expected that their re-registration dossiers will be complicated. Tri-allate is also mentioned on the draft candidates for substitutions list of the EU.

Concerning mechanical weed control, hoeing, which is most certainly a practice recommended and used by some farmers, is currently not a viable alternative to herbicides. Even not in combination with for example ethofumesate/metamitron herbicide applications within the beet row. Replacement modern hoeing machines are very expensive and require a considerable investment (prices go up to €70.000 for a 12 row camera guided hoeing system), they are currently not widely available on farms, their use requires multiple passages through a field causing more CO_2 emissions and are more labour intensive for the farmer, their efficacy in the beet row is not always optimal (dependant on the type of machine and the developmental stage of the weed). Also our climate does not always allow for their usage, certainly it is not possible to hoe in wet conditions. Finally the use of these hoeing machines can cause environmental damage to nesting birds, earth worms and other organisms of the macro-and micro fauna and the use of these machines on uneven and erosion-sensitive fields is limited to unfeasible from a practical point of view but also as it can cause soil erosion on lighter soils. Full mechanical weed control is not possible in sugar beet and currently always requires hand labour to get a field clean (from 60 to 200h of manual labour/ha), this would not be feasible or cost-effective on 1,7 million hectares.

Although there are possibilities currently to reduce the quantity of herbicide applications used today by integrating mechanical weed control, the work on the development and integration of these mechanical techniques is continuing in the sugar beet institutes subscribing to this position paper.

Also evolutions in alternative methods for weed control are taking place such as robotics, hot water, foam, lasers, electricity. All these techniques are being studied and their development supported but they are still in their infancy and are currently too costly and unsuitable for use on large scale crops such as sugar beet.

Integrating combinations of mechanical and chemical weed control is advisable and is advised where and when possible, also for resistance management, but currently mechanical weed control is not a viable alternative to replace the use of the FAR system which relies on phenmedipham.

The International Institute of Sugar Beet Research IIRB is an international, non-governmental and non-profit organisation. *Its aim is to provide a platform for networking and knowledge transfer between scientists and specialists in sugar beet cultivation to advance sugar beet production. To achieve this and to promote the transfer of scientific knowledge into practice, the IIRB organises* *biennial scientific congresses and seminars for scientists, experts and persons involved in efforts to improve the efficiency of beet production, it organises study group and project group meetings enabling experts to exchange experimental results and new information of research stations and to establish international cooperation's, it encourages contacts with other international agricultural organisations and publishes discoveries, new procedures and methods....*

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*While not all Weed control group members are EU members they do follow EU legislation.

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References

[1]Wellmann, Arndt (1999) Konkurrenzbeziehungen und Schadensprognosen in Zuckerrüben bei varriiertem zeitlichen Auftreten von Chenopodium album L. und Chamonilla recutita (L.) Rauschert Cuvillier Verlag, Göttingen. Dissertation Georg-August-Universität Göttingen.

Annex:

Table 1 Authorisation status of selective sugar beet dicot herbicides in the subscribing countries (2018)

Selective herbicides authorised in Sugar beet for dicot weeds	AT	BE	DE	DK	ES	FR	FI	NL	SE	UK	CH
Phenmedipham	x	x	x	x	x	x	x	x	x	x	x
Desmedipham	x	x	x	x	x	x	x	x	x	x	x
Ethofumesate	x	x	x	x	x	x	x	x	x	x	x
Metamitron	x	x	x	x	x	x	x	x	x	x	x
Chloridazon		x	x		x	x		x		x	x
Dimethenamide-P	x	x	x			x		x			x
S-metolachlore	x	x				x		x			x
Clomazone		x		x		x		x	x		x
Lenacil	x	x	x			x		x		x	x
Tri-allate		x				x					
Triflusulfuron-methyl	x	x	x	x	x	x	x	x	x	x	x
Quinmerac	x	x	x			x		x		x	
Clopyralid	x	x	x	x	x	x	x	x	x	x	x