

Are alternative weed control techniques viable?

With sugar beet herbicide options dwindling, researchers are testing options using artificial intelligence and robotics. **Mike Abram** reports

German field trials comparing spot-spraying and robotic systems are highlighting both the promise and limitations of alternative weed control techniques in sugar beet.

The trials are being conducted by sugar processor Südzucker, which uses a 317ha farm for research activities in Kirschgartshausen, about 40 miles south of Frankfurt, not far from its headquarters.

The alternative weed control systems based on spot-spraying or autonomous robotic weeding are being tested in large plots in a 25ha area of the farm, says Dr Peter Risser, head of research at the farm for Südzucker. "These bigger plots can more easily handle robotic and spot-spray solutions," he says.

Drilled using a FarmDroid robot, each plot is 50m in length by either 12 or 18 rows of beet on a 45cm row spacing and replicated

four times. Two 9m sections in each treatment were selected for weed control evaluations, Peter says.

In the spot spraying comparison there is an untreated control, a conventional overall three-spray programme, and a spot-spraying programme using Ecorobotix ARA for the second and third sprays following a blanket spray at the first timing.

The final treatment was planned to be a combination of hoeing both between rows and in-row using the FarmDroid each week, with additional spot-spraying with the FarmDroid at the same



A researcher at the trial site monitoring the trial plots

timings as the other herbicide treatments. "This is a system we developed in conjunction with Amazone and FarmDroid where the last few centimetres that are not hoed are sprayed," Peter explains.

In total, the crop was hoed five times and spot sprayed twice as it was too wet to hoe on a couple of occasions.



The Ecorobotix ARA spot sprayer can cover up to 4ha an hour



The Farming Revolution's GT autonomous robot with weeder

the system was used with an additional spot spray – to 97% with Farming GT, with BlueBob achieving 93% control.

With four years' worth of data with the FarmDroid hoe, Peter says weed control has averaged 91%. "That's much higher than we achieve with normal hoeing and harrowing in an organic system."

In Germany, where organic sugar beet is grown, using the robots also contributed to a significant reduction in hand-hoe hours. "In the untreated, it took 67 hours/ha to hand-hoe the plots, and we know from practice that can be even higher at 100 or even 200 hours/ha. This could be reduced to 10-13 hours/ha following the use of these systems, so this is a real advantage."

Autonomous weeding also protected yield with plots yielding around 90t/ha compared with 71.5t/ha in the untreated.

This provides scope for on-farm alternative weed control techniques. "The future could be a combination of chemical, mechanical or autonomous systems with the farmer deciding which best fits to his farm and system." ■

Less herbicide

Herbicide use was reduced by 74% where the Ecorobotix ARA was used and 86% with the FarmDroid spot-spray system. There was no statistical difference in weed efficacy in 2023, albeit with a relatively low weed pressure of 13.2 weeds/sq m. Weed pressure came mostly from fat hen, volunteer oilseed rape, annual mercury, bindweed, pale persicaria and thistles.

Using the full area sprayer achieved 88% weed control, the same as when the latter two treatments were replaced with spot spraying with the Ecorobotix ARA, while efficacy increased to 96% with the FarmDroid hoeing plus spot-spray system. The FarmDroid results were in line with what had been seen in trials in the previous two seasons when weed pressure was higher. "Over the four trials the mean is 97% weed control."

The challenge with the system is both the cost and the speed – FarmDroid only covers 0.7km/hour and has a six row width, compared with a conventional sprayer with boom sizes up to 36m, travelling at 10-12km/hour. "It's very slow machinery," Peter says.

Three autonomous robotic systems were compared in the other part of the trial – FarmDroid without the spot spraying addition, Farming Revolution's Farming GT, and Strube's BlueBob, combined with a conventional Schmotzer hoe.

"Both of these systems use cameras and artificial intelligence to decide what is a crop and what is a weed, and then hoe both between rows and in-row," Peter explains.

In these trials, as well as weed control, the number of beet plants/sq m were also counted to check hoeing accuracy. That showed each

system working reasonably well, with FarmDroid and Farming GT having similar beet density to the untreated's 10.8 plants/sq m, with the BlueBob system plant count a little lower at 9.4 plants/sq m.

Weeding efficacy

Weeding efficacy ranged widely from 90% with the FarmDroid – 6% lower than when

SPOT-SPRAY COMPARISON

Date (days after sowing)	Conventional	Ecorobotix ARA	FarmDroid
12/04/23 (7)			(Hoe - too wet)
19/04/23 (14)			FD Hoe + InRow
26/04/23 (21)	Sprayer	Sprayer	FD Hoe + InRow + SpotSpray
03/05/23 (28)			FD Hoe + InRow
10/05/23 (35)	Sprayer	Ecorobotix ARA	(Hoe - too wet)
17/05/23 (42)	Sprayer	Ecorobotix ARA	FD Hoe + InRow + SpotSpray
24/05/23 (49)			FD Hoe + InRow

ROBOTIC COMPARISON

Date (days after sowing)	FarmDroid	Farming GT	BlueBob
12/04/23 (7)	(Hoe - too wet)		
19/04/23 (14)	FD Hoe + InRow		
26/04/23 (21)	FD Hoe + InRow	Farming GT InRow	
03/05/23 (28)	FD Hoe + InRow	Farming GT InRow	BlueBob
10/05/23 (35)	(Hoe - too wet)	(Hoe - too wet)	(Hoe - too wet)
17/05/23 (42)	FD Hoe + InRow	Farming GT InRow	Schmotzer hoe + BlueBob
24/05/23 (49)	FD Hoe + InRow	Farming GT InRow	Schmotzer hoe

NEW WEED CONTROL MACHINERY

The four new weed control machines being tested in the Südzucker trials in Germany are detailed below:

1. Ecorobotix ARA

The Ecorobotix ARA is a tractor-pulled ultra-high precision plant by plant sprayer with a working width of 6m, and forward speed of 7km/ha. It can cover up to 4 ha/hour.

With a precision window of 6x6cm around a weed, it uses image analysis to determine weeds from crop plants, and is operated using a tablet application. A dual water and spray liquid tank are carried on the front of the tractor, allowing mobile refilling in the field. Ecorobotix claims the ARA can reduce pesticide use by up to 95% and spray drift by over 90% thanks to 156 high precision spray nozzles placed 4cm apart. The precision sprayer can also analyse and compare data collected from the field.

2. BlueBob

Strube's BlueBob is being developed in conjunction with NAÏO-Technologies and Fraunhofer Development Centre for X-Ray Technology. The robot works with conventional static hoes between the rows and powered hoes in the row with a working speed on 0.5-1ha/hour and a battery life of eight hours.

Six cameras fitted to the front of the machine detect weeds and crop plants in each row, with artificial intelligence (AI) determining which plants are the crop and which are weeds to determine where to hoe.

3. Farming Revolution

An off shoot of Bosch, Farming Revolution's GT autonomous robot uses one multispectral camera per row mounted 50cm above the soil surface and takes 10 photos a second and AI to determine weeds from crop plants. Again, regular hoeing tines are used

to weed between rows, while rotating blades on electric milling heads move into the row from each side.

SMD LEDs emit pulsed light to ensure the ground is consistently illuminated, while RTK-corrected positioning from two GNSS receivers on the machine along with the cameras help guide progress. Forward speeds of around 1km/hour with a working width of 1.8-3m enable it to cover 1-5 ha/day.

4. FarmDroid FD20

FarmDroid's FD20 autonomous robot uses high precision GPS to first sow and then weed around sugar beet plants. The spot-spraying trial sprays the area around the crop plant which is otherwise difficult to precisely hoe. This was augmented by a specially designed Amazone sprayer that uses the precise position of the beet stored from the FarmDroid GPS sowing system.