Efficacy of different mechanical impacts on weed growth
Background

- Very diverse equipment for mechanical weed control
- Recent innovations (camera-steering, digital analysing)
- Often insufficient control effects
- Herbicide problems in conventional cropping systems
- New technical options for the future (e.g. robots)
- Data on systematic effects are not available
Material & Methods (Test A)

- Pot experiments in greenhouse (2015-2016)
- Treatments: pulling, cutting and spilling
- Growth effects on 18 weed species
- Interactions with soil moisture (dry/wet)
- Data: aboveground biomass, control efficacy
## Results (Test A)

Control level (%), mean values of 18 weed species:

<table>
<thead>
<tr>
<th>Soil</th>
<th>Spilling</th>
<th>Cutting</th>
<th>Pulling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet</td>
<td>73</td>
<td>100</td>
<td>72</td>
</tr>
<tr>
<td>Dry</td>
<td>85</td>
<td>100</td>
<td>99</td>
</tr>
</tbody>
</table>

Cutting is highly effective but has to be precisely:

<table>
<thead>
<tr>
<th>Soil</th>
<th>Cutting above soil surface</th>
<th>Cutting at soil surface</th>
<th>Cutting below soil surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet</td>
<td>60</td>
<td>100</td>
<td>44</td>
</tr>
<tr>
<td>Dry</td>
<td>68</td>
<td>100</td>
<td>67</td>
</tr>
</tbody>
</table>
Results (Test A)

Weed Species

- STEME
- SOLNI
- POLPE
- MYOAR
- MERAN
- CHEAL
- AMARE

Efficacy (%)

- Spilling
- Cutting
- Pulling
Material & Methods (Test B)

- Pot experiments in greenhouse (2018)
- Test of 2 grass weed species: 
  *Alopecurus myosuroides* and *Apera spica-venti*
- Treatments: pulling, cutting and spilling (same as before)
- Water supply: 
  - F0 = 10 DAT without watering
  - F1 = 3 DAT without watering
  - F2 = 2 DAT without watering
  - F3 = watering shortly after treatment
- Growth stage: 
  - B1 = BBCH 11-12 (1-2 leaves)
  - B2 = BBCH 13-21 (begin of tillering)
  - B3 = BBCH 29-30 (end of tillering)
- Data: aboveground biomass, control efficacy
Control efficacy (ANOVA)

<table>
<thead>
<tr>
<th></th>
<th>ALOMY</th>
<th>APESV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A) Mechanical impact</td>
<td>0,000</td>
<td>0,000</td>
</tr>
<tr>
<td>B) Growth stage</td>
<td>0,000</td>
<td>0,013</td>
</tr>
<tr>
<td>C) Soil moisture</td>
<td>0,000</td>
<td>0,000</td>
</tr>
<tr>
<td><strong>Interactions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A x B</td>
<td>0,000</td>
<td></td>
</tr>
<tr>
<td>A x C</td>
<td>0,000</td>
<td>0,000</td>
</tr>
</tbody>
</table>
Results for black-grass

% reduction of fresh weight

pulling

cutting

spilling
Results for black-grass: pulling

- Strong efficacy effects due to duration of dry period
  - 3 days as a threshold
- Growth stage had no direct effect on weed regrowth after uprooting
  - Interaction with watering
  - Tillering plants seem to be more tolerant against water loss
Results for black-grass: cutting

- No strong effect by watering treatment
- Weak effects at early growth stages
  - energy reserves out from the germ
Results for black-grass: spilling

- Very effective even under wet conditions
- High decrease in efficacy for bigger plants
- Reverse effect for duration of dry period

% reduction of fresh weight

- Can we achieve a complete spilling?

pulling  cutting  spilling

B1  B2  B3
Results for silky bent

% reduction of fresh weight

<table>
<thead>
<tr>
<th></th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
</tr>
</thead>
<tbody>
<tr>
<td>pulling</td>
<td>80</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>cutting</td>
<td>90</td>
<td>70</td>
<td>50</td>
</tr>
<tr>
<td>spilling</td>
<td>100</td>
<td>80</td>
<td>60</td>
</tr>
</tbody>
</table>

Legend:
- F0
- F1
- F2
- F3
Summary

• The overall efficient method was cutting - even under conditions of wet soil and greater plants
• Beside dicots, also grass weeds, can be efficiently controlled by mechanical methods
• Adaption of mechanical weeders to the situation in the field important for a good weeding efficacy
  • Wet conditions: spilling
  • Dry conditions: pulling
  • Big weeds: cutting
• The findings indicate new options for mechanical control
• Development of weed-specific-knowledge for reaction on mechanical impacts seems promising
Prospects

If robots will work with cutters this …
- results in better control effects for a wide range of weeds
- works without moving of soil
- avoids erosion by minimum impact and low energy input
- allows late weed removal (with benefits for biodiversity)
Thanks for your attention!