Occurrence of horse nettle (*Solanum carolinense* L.) in North Rhine-Westphalia

Auftreten der Carolinschen Pferdenessel (Solanum carolinense L.) in Nordrhein-Westfalen

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Summary

In autumn 2008 during corn harvest (*Zea mays L.*), the driver of the combine harvester spotted an unfamiliar plant species in the field. It turned out that *Solanum carolinense L.* was the unknown weed species. The species had overgrown 40 % of the corn field which had a size of 10.2 ha. The farmer who usually effectively controls all weeds on his field had so far not noticed the dominance of the solanaceous herb species. From his point of view, the weed must have germinated after the corn had covered the crop rows. On the affected field, corn is grown in monoculture since 1973. When the horse nettle was first spotted in October 2008, the plants had reached a height of about 120 cm, rhizomes had grown 80 cm deep and a horizontal root growth of 150 cm could be determined. In the following season (2008/2009), winter wheat was grown instead of corn on the respective field. This was followed by two years of winter rye (2009/2010 and 2010/2011). The change in crop rotation plus an application of ROUNDUP ULTRA MAX® (glyphosate) and SIMPLEX® (fluroxypyr + aminopyralid) had a significant influence on the biomass of horse nettle roots, rhizomes and shoots. A reduction of up to 75 % could be observed until autumn 2011. Apart from that, an experimental trial showed that SIMPLEX® (fluroxypyr + aminopyralid), GARLON 4® (triclopyr), ARRAT® (dicamba + tritosulfuron) + DASH® (adjuvant), MAISTER FLÜSSIG® (foramsulfuron + iodosulfuron), LAUDIS® (tembotrione), ROUNDUP ULTRA MAX® and especially ARRAT® + DASH® + PEAK® (prosulfuron) were suitable for the suppression of *Solanum carolinense L.*.

Keywords: Arrat®, corn, crop rotation, Dash®, long term reduction, Peak®, rhizomes, Simplex®

Zusammenfassung

Während der Körnermaisernte im Herbst des Jahres 2008 fiel dem Drescherfahrer eine unbekannte Unkrautpflanze auf. Es stellte sich heraus, dass es sich um *Solanum carolinense L.* handelte. Unter dem Mais waren ca. 40 % des 10,2 ha großen Schlages mit der Pflanze befallen. Dem Landwirt, der sehr auf eine gute Unkrautkontrolle achtet, war das Nachtschattengewächs bis dahin nicht aufgefallen. Aus seiner Sicht erfolgte eine oberirdische Entwicklung erst nachdem der Mais die Reihen geschlossen hatte. Auf dem betroffenen Schlag wird seit 1973 Mais in Monokultur angebaut. Als die Carolinsche Pferdenessel im Oktober 2008 wahrgenommen wurde, hatte sie eine Höhe von etwa 120 cm erreicht. Wurzelausläufer reichten bis 80 cm in die Tiefe und auch eine horizontale Ausbreitung der Wurzelrhizome bis 150 cm war festzustellen. In der folgenden Saison (2008/2009) wurde anstelle von Mais Winterweizen angebaut. In den darauffolgenden Jahren 2009/2010 und 2010/2011 folgte Winterroggen. Durch die Änderung der Fruchtfolge und dem Einsatz von ROUNDUP ULTRA MAX® (Glyphosat) und SIMPLEX® (Fluroxypyr + Aminopyralid) konnte die Biomasse der Carolinischen Pferdenessel, in Form von Wurzeln, Wurzelausläufern und Stängeln, deutlich reduziert werden. Im Herbst 2011 war eine Reduktion um bis zu 75 % zu beobachten. Unabhängig davon zeigte ein Versuch, dass SIMPLEX®, GARLON 4® (Triclopyr), ARRAT® (Dicamba + Tritosulfuron) + DASH® (Additiv), MAISTER FLÜSSIG® (Foramsulfuron + Iodosulfuron), LAUDIS® (Tembotrione), ROUNDUP ULTRA MAX® und insbesondere ARRAT ® + DASH® + PEAK® (Prosulfuron) geeignet sind um *Solanum carolinense L.* zu unterdrücken.

Stichwörter: Arrat®, Dash®, Fruchtfolge, Langzeitwirkung, Mais, Peak®, Rhizome, Simplex®

1. Introduction

The invasive plant species *Solanum carolinense L.* belongs to the family of the solanaceae. It is a rootstock-forming perennial weed and is native to the Gulf States in the South-Eastern part of the United States (BASSETT and MUNRO, 1986). Meanwhile, it is classified as domestic in the North of Mexico, in 31 states of the US and South-Canada. In North America, the plant currently occupies almost its full range of suitable climates (FOLLAK and STRAUSS, 2010). *S. carolinense* also dispersed to

Bangladesh, India, Nepal, Japan, Australia, New Zealand, Haiti, Brasilia and the Georgian Republic (MILLER, 2003 by EBERWEIN and LITSCHER, 2005). In Japan, *S. carolinense* has spread over the whole country and causes serious control problems (MIYAZAKI, 2005). Within the former USSR, it occurs in Abkhazia, Adzharia, Mingrelian and Gurian regions of Western Georgia and it is sporadically distributed in the Far East, Ukraine and Moldova (LARINA, 2009). In Austria, *S. carolinense* was recorded in a corn field in 2004 near Pischeldorf in Carinthia. Seeds of *S. carolinense* have been imported to Europe via contaminated soybean seeds from Canada (FOLLAK and STRAUSS, 2010). A risk analysis for Central Europe by FOLLAK and STRAUSS (2010) showed that climatically suitable conditions for *S. carolinense L*. can be found in Hungary (100 % of the total land area), Poland (83.6 %), followed by Slovenia (70.5 %), Slovakia (64.5 %), Germany (41.5 %), Czech Republic (37 %), Austria (34.9 %) and Switzerland (16.6 %). The plant develops rapidly under hot temperatures and can tolerate high level of drought (BRADBURY and ALDRICH, 1957 by NAPPO, 2003). In the United States, *S. carolinense* is listed under the top ten of the most serious weeds (EBERWEIN and LITSCHER, 2005).

2. Materials and methods

Solanum carolinense L. was observed during corn harvest in autumn 2008 on a field near Coesfeld, North Rhine-Westphalia (Germany). The so far unknown plant was identified as *Solanum carolinense L.* by Wilfried Sagemann, a member of the Plant Protection Service of North Rhine-Westphalia. The solanaceous herb had infested about 40 % of the field that has a size of 10.2 ha. The field is characterized by a sandy soil with 23-26 soil-points, a pH of 5.7 and nutrition contents of 38 mg P_2O_5/100 g soil, 10 mg K_2O /100 g soil and 8 mg MgO/100 g soil. On the field, corn has been grown in monoculture since 1973. That the horse nettle was not recognized before may be due to the fact that the harvest is usually conducted by a contractor and/or that the plants might have been covered by the corn cob mix (ccm) straw after harvest. In 2008, it became evident that the plants had spread in the direction of tillage operations. Normally, ploughing was conducted in autumn after one or two times of harrowing.

Field chronology since detection of the horse nettle in October 2008:

- 2008-10-23: Ploughing with packer.
- 2008-10-24: Seeding of winter wheat.
- 2008-10-30: Herbicide application with 50 g/ha SUMIMAX® (flumioxazin) and 0.2 l/ha HEROLD SC® (flufenacet + diflufenican).
- 2009-08-04: Harvest of the winter wheat, straw was removed from the field. No stubble tillage.
- 2009-09-08: Part of the field which contained the horse nettle (4 ha) treated with 2 l/ha SIMPLEX® after getting regulatory permission to use SIMPLEX® according to § 18b Plant Protection Act.
- 2009-09-18: Herbicide application of 4 l/ha ROUNDUP ULTRA MAX® against common couch-grass (*Elymus repens L.*) on the whole field.
- 2009-10-10: Ploughing with packer.
- 2009-10-13: Seeding of winter rye.
- 2009-10-26: Herbicide application of 0.4 l/ha HEROLD SC®.
- 2010-08-06: Harvest of the winter rye, straw was removed from the field.
- 2010-09-15: Application of 5 l/ha TAIFUN FORTE® (glyphosate) + 5 kg/ha SSA® (sulfat acid ammonia) against common couch-grass (*E. Repens)* and horse nettle (*S. carolinense*) on the whole field.
- 2010-10-11: Ploughing with packer.
- 2010-10-14: Seeding of winter rye.
- 2010-10-29: Herbicide application of 0.4 l/ha HEROLD SC®.
- 2011-08-01: Harvest of the winter rye, straw was removed from the field.
- 2011-08-10: Tillage with simultaneous seeding of break crop (10 kg/ha) containing 50 % mustard (*Sinapsis arvensis*) and 50 % of radish (*Raphanus sativus*).

In early spring 2010, 2000 m^2 of the winter rye crop were killed with 3.0 l/ha ROUNDUP ULTRA MAX®. The open parts of the field were than occupied by the horse nettle in the course of the following vegetation period. On this part of the field, a herbicide trial with three replications and a plot size of 3 m x 4 m was set up using an randomised block design with 16 herbicide variants (including an untreated control, Tab. 1). Plots with the different herbicide variants were randomly distributed next to each other within each of the three blocks.

On the 22 July 2010 at BBCH grow stage 49-51 and about 40 cm plant height of the horse nettle, the first application of the different herbicides was conducted. The employed herbicides were: SIMPLEX® + DASH®, GARLON 4®, HARMONY SX® (thifensulfuron), ARRAT®, MAIS BANVEL WG® (dicamba), PEAK®, MILAGRO FORTE® (nicosulfuron), MAISTER FLÜSSIG®, EFFIGO® (clopyralid + picloram), LAUDIS®, B-235® (bromoxynil), ROUNDUP ULTRA MAX® and SSA®. To prevent seed setting of *S. carolinense*, all plots were treated with 2.0 l/ha SIMPLEX® + 1.0 l/ha DASH® on 11 September 2010 at BBCH grow stage 69-79. At that time, the plants had reached a height of about 55 cm. Herbicide treatments were applied with an experimental spraying device, equipped with airmix antidrift 11003 nozzles. The herbicides were sprayed in 300 liters water per ha with a pressure of 2.3 bar. The efficacy of the treatments was assessed during the season and again in August of the following year.

3. Results

By alteration of the crop rotation (replacement of corn by winter cereals) plus herbicide treatments the biomass of roots and rhizomes of the horse nettle plants could be reduced by up to 75 %. The horse nettle did not occur in the competitive winter cereals. Only in open spaces, like the tractor tracks, small shoots of the horse nettles were observed. The efficacy of the herbicide application carried out by the farmer in autumn could not be easily estimated as the visible impact on the plants was not substantial. Only some change of leaf color from green to light green and a limping of the shoots could be observed. Nevertheless, after the application of 2.0 l/ha SIMPLEX® on 8th September 2009, roots and rhizomes of treated plants were assessed by the LUFA for aminopyralid residues (Official diagnostic laboratory in Hameln, Germany). The sample was collected on the 13 October 2009 and contained 0.487 mg aminopyralid/kg plant material.

Tab. 1 Efficacy of herbicide applications against *Solanum carolinense L.* assed in 2010 and 2011.

Tab. 1 *Wirkung von Herbizidbehandlungen gegen Solanum carolinense L. bonitiert in 2010 und 2011.*

No.	Spraying date: 22.07.2010 BBCH 49-51 Product (l/kg/ha)	2010-07-28	2010-08-20	2010-09-20	2010-09-11 Product (l//ha)	2011-08-31 % cover/ % efficacy
		% cover (untreated)/ % efficacy (treatments)				
1	Untreated	33	38	40		70
2	(only second spray – 11.09.2010)	0	0	0	Simplex® 2.0 + Dash® 1.0	30
3	Simplex® 2.0	60	90	90		86
4	Simplex® 2.0 + Dash® 1.0	63	92	95		84
5	Garlon 4® 2.0	49	80	80		84
6	Harmony SX® 0.045 + Dash® 1.0	35	63	60		73
7	Arrat 0.2® + Dash® 1.0	46	85	85		85
8	Mais Banvel WG® 0.5 + Dash® 1.0	25	53	40		60
9	Peak® 0.020 + Dash® 1.0	43	63	55		48
10	Milagro Forte® 0.75	25	70	65		58
11	Milagro Forte® 0.75 + Peak® 0.02	40	70	75		65
12	Arrat® 0.2 + Dash® 1.0 + Peak® 0.02	44	78	90		95
13	Milagro F®. 0.75 + M. Banvel WG® 0.5	33	35	50		84
14	Maister flüssig® 1.5	38	70	80		82
15	Effigo 0.35® + Peak® 0.02	40	50	50		70
16	Laudis® 2.0 + B 235® 0.5	45	85	90		65
17	Roundup Ulta Max® 4.0 + SSA® 5.0	47	80	85		86

The results of the herbicide plot trial are shown in Table 1. Not included in the table are treatments with U 46 M-FLUID® (MCPA), U 46 D-FULID® (2.4 D) and EFFIGO®. All three had little impact on the horse nettles. Therefore, these plots had to be sprayed again in mid August 2010 with other herbicide products. On 9th August 2010, herbicide efficacy (reduction of top growth) was estimated at 20 % (U

46 M-FLUID®), 33 % (U 46 D-FLUID®) and 10 % (EFFIGO®). In comparison, SIMPLEX® showed, at the same time, an efficacy of 80 %. Beside that, the impact of U 46 M-FLUID® on the horse nettle plants was interesting. It enhanced plant development so that the plants reached the flowering stage earlier.

4. Discussion

Solanum carolinense L. is described as an extremely competitive weed. It infests corn, other cereal crops, potatoes, soybeans, tomatoes, alfalfa and other perennial crops, gardens, pastures and waste lands (LARINA, 2009). Apart from the described case of *S. carolinense* in the region of Coesfeld (North Rhine-Westphalia, Germany), no horse nettle was found on fields in the neighborhood. So it can be assumed that the establishment of *S. carolinense* in Coesfeld is correlated to the continuous cultivation of corn (*Zea mays L.*) since 1973. It can be speculated that seeds of *S. carolinense* were introduced on the field with corn seeds from abroad. The likelihood of this assumption may be increased by the fact that corn variety trials have been carried on the respective farm for more than 20 years. The replacement of corn by winter cereals in the crop rotation was helpful in controlling *S. carolinense*. Except in open spaces were daylight reached the ground, *S. carolinense* did not germinate. Besides the reduced light intensity this may also have been influenced by soil temperature.

Chemical control of *S. carolinense* seems to be difficult. Even so, in the course of the herbicide program, long-term activity of up to 95 % could be achieved. When treating an uncovered weed stand, the repeated application (twice) was most promising. However, this is not possible for every crop species. BRADLEY and HAGOOD (2009) found that BEACON® (primisulfuron) + BANVEL® (dicamba) provided the highest level of horse nettle suppression with an efficacy of 74 %. However, horse nettle populations were not reduced by any of the herbicides applied in the experiment when assessed one year after herbicide treatment. These lower levels of horse nettle control commonly observed in corn may be due to a lack of translocation of these herbicides from the foliage to the root systems. Previous studies have illustrated that the maximum translocation of herbicides into the roots occurs when horse nettle plants are in the early- to mid-blooming growth stages (WHITWELL et al., 1980).

Due to the displacing of roots, rhizomes or seeds, *S. carolinense* has a very high capacity for spatial dispersal. To prevent the establishment and therefore serious consequences for agriculture (FOLLAK and STRAUSS, 2010), crop rotation is a suitable measurement.

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