Utilisation of old, extensive pig breeds for yellow nutsedge (*Cyperus esculentus*) control - A non-chemical and appealing approach

Einsatz von alten, extensiven Schweinerassen zur Erdmandelgrasbekämpfung – ein nicht-chemischer, attraktiver Ansatz

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Abstract

Yellow nutsedge (*Cyperus esculentus*) is a troublesome weed in Switzerland. It reproduces mainly by tubers, but also by seeds. Dormant tubers in the soil cannot be controlled with herbicides. Pigs are known to reduce yellow nutsedge infestation levels by rooting up and consuming tubers. We hypothesized, that old pig breeds would especially be suited for yellow nutsedge control, as they search more actively for feed in the soil than modern pig breeds. A field trial with old pig breeds (Turopolje and Mangalica) was carried out in a field infested with yellow nutsedge (2019-2020). The pigs stayed in the field for 8 months. Infestation levels were determined before and after the trial by counting *C. esculentus* plants at 50 monitoring sites in the field. In addition, soil samples were taken before and after the experiment. The samples were placed in the greenhouse and emerging yellow nutsedge shoots were considered as a measure of the tuber bank in the soil. After 8 months of pig grazing in the field, we observed significantly less yellow nutsedge plants at the monitoring sites. Yellow nutsedge infestation levels *i.e.* the tuber bank was significantly reduced by 90%. This reduction is higher than the ones achieved in previous experiments and reported in the literature. Grazing of old pig breeds could be a non-chemical and an appealing approach for the public to considerably reduce yellow nutsedge infestation levels in affected fields.

Keywords: Free range pigs, Mangalica, swine, Turopolje, weed control, yellow nutsedge

Zusammenfassung

Das Erdmandelgras (*Cyperus esculentus*) verursacht große Probleme in der Schweiz. Es vermehrt sich hauptsächlich über Knöllchen im Boden, es werden aber auch keimfähige Samen gebildet. Schweine sind bekannt dafür, dass sie durch ihre Wühl- und Fressaktivität Erdmandelgrasbefall reduzieren können. Wir vermuteten, dass sich alte Schweinerassen besonders für die Erdmandelgrasbekämpfung eignen würden, da sie aktiver nach Futter im Boden suchen als moderne Rassen. Ein Feldversuch mit alten Schweinerassen (Woll- und Turopoljeschwein) wurde auf einem mit Erdmandelgras befallenen Feld durchgeführt (2019-2020). Die Schweine blieben während acht Monaten auf der Fläche. An 50 Stellen im Feld wurde die Erdmandelgrasdichte vor und nach der Beweidung bestimmt. Ausserdem wurden ebenfalls vor- und nachher Bodenproben im Feld gezogen. Diese wurden im Gewächshaus ausgelegt und die Zahl gekeimter Erdmandelgrastriebe als Maß für den Knöllchenvorrat im Boden herangezogen. Nach der Beweidung mit Schweinen beobachteten wir signifikant weniger Erdmandelgraspflanzen im Feld. Auch der Knöllchenvorrat im Boden ging signifikant zurück (-90 %). Diese Abnahme ist größer als diejenige, die wir in früheren Versuchen beobachtet haben. Die in der Literatur angegebenen Werte sind ebenfalls geringer. Die Beweidung mit alten Schweinerassen ist ein nicht-chemischer und für die Bevölkerung attraktiver Ansatz, um die Erdmandelgrasverseuchung in betroffenen Feldern deutlich reduzieren zu können.

Stichwörter: Bekämpfung, Erdmandelgras, Freilandschweine, Mangalica, Turopolje

Introduction

Yellow nutsedge (*Cyperus esculentus*) is a troublesome weed worldwide. In Switzerland, introduced about 40 years ago, it is present in all important arable and vegetable producing regions now. Especially in vegetables, it causes high yield losses (TOTAL et al., 2018). This weed reproduces mainly by tubers, but also by seeds (FOLLAK et al., 2016). Dormant tubers in the soil cannot be controlled with herbicides. Pigs (*Sus domesticus*) are well known for their grubbing and digging activity (D'EATH & TURNER, 2009) and it is commonly known that they consume nutsedge tubers (SCHOENBECK, 2013). Previous experiments have confirmed, that nutsedge infestation levels can be reduced by the utilization of free range pigs (MACDONALDS et al., 2016; KELLER & TOTAL, 2017). In those experiments, modern pig breeds were used. In our own previous experiments (KELLER & TOTAL, 2017), the animals grew fast and became less and less active with increasing weight. In contrast, old pig breeds grow slowly and they are known to search very actively for feed. Thus, we hypothesized, that old pig breeds would be better suited for yellow nutsedge control than the previously used fast growing ones.

Material and methods

Trial description

The trial was carried out in a field in Cham (ZG), in Switzerland (8.470 E, 47.207 N), which was moderately infested with yellow nutsedge. Average temperature at trial site is 11.3 °C and average rainfall is 1251 mm (nearest weather station, agrometeo). The soil was heterogeneous. This was due to the fact, that soil from road construction sites had been stored in the field. Thereafter, left over soil was spread across the field. This is also how yellow nutsedge has been introduced. Trial area was 0.2 ha. In 2020, cereals were grown. 17 young pigs (body weight 10 to 15 kg) of the races Turopolje and Mangalica were put on the cereal stubbles on 10 October 2019. This corresponds to a density of 118 m^2 per pig. They stayed in the field until 28 May 2020. The soil had to be loosened twice (19 March 2020 and 20 April 2020) with a cultivator (working depth: 0.25 to 0.30 m). Top soil compaction was due to weather conditions (heavy rains followed by dry periods). Feed rations were increased in winter to account for higher energy consumption due to low temperature.

Soil and pig feces samples

Soil samples of 10 l (sampling depth: 0.2 m) were taken before (6 September 2019) and after the trial (12 June 2020) at 5 sampling sites in the field. An adjacent field (325 m^2) also infested with yellow nutsedge was taken as untreated control and 4 soil samples were collected accordingly. The soil samples were put in shallow trays (0.35 by 0.55 m) in the greenhouse (average temperature 20-25 °C). Before soil samples had been stored at 4 °C for stratification. The number of yellow nutsedge shoots were counted after 8 weeks. Values were transformed to shoots per m^2. These data was taken as a measure of yellow nutsedge infestation in the field. Around 25 pig feces samples were collected in the field (25 November 2019). The feces samples collected that day were fresh to several days old (visual assessment). Sample weight varied between 50 and 100 g. The samples were treated in the same way as the soil samples, however counting was carried out after 4 weeks.

Infestation levels in the field

At 50 monitoring sites within the pig grazing area the number of yellow nutsedge shoots were counted before (6 September 2019) and after the trial (2 July 2020). The size of monitoring sites varied between 1 and 2 m^2. Monitoring sites were georeferenced with a precise Trimble device (precision: 0.02 m) allowing to sample exactly the same sites and areas at the 2 monitoring dates.

Statistical analyses

For the pig feces samples, no statistical analysis was carried out. A paired t-test was carried out for the observations of yellow nutsedge infestation levels in the field before and after pig grazing. For the greenhouse samples, paired t-tests (sampling before and after experiment) were carried out separately for the treatments “pig” and “untreated check”. Analyses were performed in R (R CORE TEAM, 2020).

Results

Immediately after the pigs were let on the field, they started rooting up the soil. They remained very active during the whole experiment. We observed higher digging activity in field regions with higher yellow nutsedge infestation levels. The soil had to be loosened twice to ensure continuous digging over the trial period. Pig grazing reduced yellow nutsedge infestation levels significantly. Pigs caused a reduction in yellow nutsedge infestation levels of 90% (greenhouse data) (Tab. 1). In contrast, the paired t-test did not indicate any significant difference between the samples taken before and after the trial in the untreated check (p-value: 0.58). The higher value after the experiment in the untreated check is most likely due to inherent variability. In the field, a reduction of 54% was determined (Fig. 1). After 4 weeks of favourable germination conditions, no yellow nutsedge plants were observed in the feces samples in the greenhouse (data not shown).

Table 1 Potential *C. esculentus* density based on the soil samples put in the greenhouse for the treatment “pig” and the untreated check. Group means and standard deviations are shown.

Tabelle 1 *Potentielle Erdmandelgrasdichte bestimmt anhand der im Gewächshaus ausgelegten Bodenproben für das Verfahren «Schwein» und die unbehandelte Kontrolle. Dargestellt sind die Mittelwerte und Standabweichungen.*

treatment	***C. esculentus* per m²**		**significance**
	before	**after**	**p-value**
untreated check (n=4)	95 (115)	145 (82)	0.58
pig (n=5)	208 (116)	20 (24)	0.01

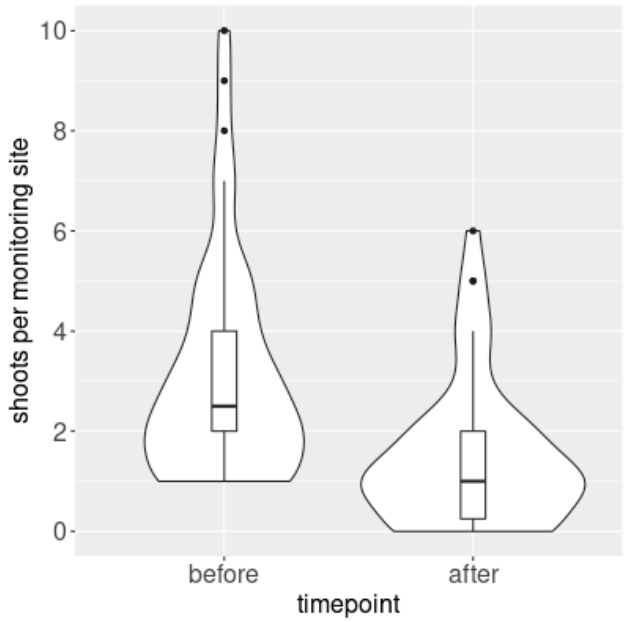

Figure 1 Distribution of yellow nutsedge (*Cyperus esculentus*) infestation level (number of shoots) at the 50 monitoring sites within the pig fence "before" and "after" the experiment *i.e.* the pig grazing. The pairwise t-test was significant.

Abbildung 1 *Verteilung der Erdmandelgrasverseuchung (Anzahl Erdmandelgrastriebe pro Beprobungsstelle) an den 50 Beprobungsstellen innerhalb des Zaunes vor (before) und nach (after) der Beweidung mit Schweinen. Der paarweise t-Test war signifikant.*

Discussion

In the greenhouse experiment, a high reduction of 90% in the tuber bank could be achieved by grazing old pig breeds for several months. The observed reduction of yellow nutsedge infestation in the field at the monitoring sites was smaller (-54%). Counting was done once in autumn (before) and once in summer (after). This could have contributed to the smaller observed reduction, as summer is the "heyday" of yellow nutsedge growth. The reduction in the tuber bank determined in this experiment is higher than in our previous experiments and higher than the values reported in the literature (KELLER & TOTAL, 2017; MACDONALDS et al., 2016). Comparisons between experiments are difficult to be made, as experimental conditions varied considerably. In the experiments carried out in Florida in 2014 and 2015, infestation levels were reduced by 48%. The pigs in those experiments stayed for less time in the field (12 weeks), but the pig density was considerably higher (50 and 25 m^2 per pig) than in our experiment (118 m^2 per pig) (MACDONALDS et al., 2016). No yellow nutsedge plants germinated in the feces samples. In a small pretest, we fed yellow nutsedge tubers (cultural form) directly to the pigs. They clearly chewed the tubers. These two findings strongly suggest that yellow nutsedge tubers are actually destroyed and inactivated by in- and digestion. This is an important prerequisite. Otherwise, the tubers would not be destroyed, but merely be relocated within the field and even worse be provided with additional nutrients. Grazing pigs as a control measure against yellow nutsedge is labor intensive. In addition, the infrastructure for free range pigs has to be available (fences, housing, feed station and watering place). In contrast to other control approaches such as fallow (WIRTH et al., submitted) or maize combined with intensive chemical control (KELLER et al., 2018), a certain profit can be achieved by selling the pig meat. The high nutrient input due to grazing pigs has to be accounted for. In our experiment, pig densities were relatively high. In practice, pig densities in the fields would have to be chosen according to the legal requirements of the respective country. The use of herbicides and pesticides in general is strongly debated. Grazing pigs is a non-chemical approach with the advantage, that also dormant tubers in the soil are controlled. In addition, other problematic perennial weeds could be diminished (e.g. WÜNSCH et al., 2011). Free range pigs – especially old races – are an

attraction for the public. In the press, there were many positive reports about our experiment. Concluding, grazing pigs is an effective, non-chemical and appealing approach to control yellow nutsedge in infested fields.

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Further information

An extended trial report is available in German (TOTAL & SCHMID, 2020). The report was written for farmers and advisors and provides hands-on advice concerning pig husbandry and management.

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