

## **Cyperus esculentus - differences in growth and tuber production between cultivated and wild forms**

*Cyperus esculentus* - Unterschiede in Wachstum und Knollenbildung zwischen Kultur- und Wildformen

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### **Abstract**

*Cyperus esculentus* (yellow nutsedge) belongs to the world most important weeds on arable land. This species is classified as an invasive one in Central and North-western Europe. It is not yet present as a weed in the Czech Republic, but its occurrence in neighbouring countries and its ability to survive winters in this region must be taken into account. A cultivated form of *C. esculentus*, known as Chufa or Tiger nuts, is occasionally grown in home gardens as a crop for its edible tubers. In pot experiments we tested the growth of both forms, weedy and cultivated one. Weight of both fresh and dry biomass of plant parts (leaves, roots, rhizomes, tubers, inflorescences) was measured in monthly intervals from May till September 2012. Results show that there were no significant differences in leaf and root biomass. The weight of rhizomes was approximately 50-80 times higher in the wild form. Number of tubers was also higher in the wild form (max. 1118 pcs; crop max. 342 pcs in single pot), but the total weight of tubers was not significantly different. The cultivated form did not produce inflorescences at all, the wild form produced in average 13 inflorescences per plot. Based on our results we can state that growing of the cultivated form does not pose any risk – plants do not show intensive vegetative spread and do not produce inflorescences so crossing with the weedy form is not possible. The wild form can produce high amounts of rhizomes and tubers and is able to produce flowers under our conditions. That makes it a potentially dangerous weed in warmer regions of the Czech Republic.

**Keywords:** Biomass production, crop, CYPES, invasive weed, yellow nutsedge

### **Zusammenfassung**

*Cyperus esculentus* (Erdmandelgras) gehört zu den weltweit wichtigsten Unkräutern auf Ackerflächen. Diese Art ist klassifiziert als invasiv in Zentral- und Nordwesteuropa. Die Wildform kommt in der Tschechischen Republik nicht vor, aber in den Nachbarländern. Ihre Fähigkeit, die Winter in dieser Region zu überleben, muss berücksichtigt werden. Die Zuchtform von *C. esculentus*, als Chufa oder Tigernuss bekannt, wird gelegentlich in Hausgärten als Kulturpflanze wegen ihrer essbaren Knollen angebaut. In Gefäßversuchen haben wir das Wachstum der beiden Formen, Wild- und Kulturpflanze, getestet. Frisch- und Trockenmasse von Pflanzenteilen (Blätter, Wurzeln, Rhizome, Knollen, Blütenstände) wurden in monatlichen Abständen von Mai bis September 2012 gemessen. Die Ergebnisse zeigen keine signifikanten Unterschiede in der Blatt- und Wurzelbiomasse. Das Gewicht der Rhizome war bei der Wildform etwa 50- bis 80mal höher. Die Anzahl der Knollen war in der Wildform ebenfalls höher (max. 1.118 Stück/Gefäß) als bei der Zuchtform (max. 342 Stück/Gefäß). Das Gesamtgewicht der Knollen war nicht signifikant verschieden. Die Zuchtform bildete keine Blütenstände; die Wildform bildete durchschnittlich 13 Blütenstände pro Gefäß. Basierend auf unseren Ergebnissen können wir feststellen, dass der Anbau der Zuchtform keine Gefahr ist, denn die Pflanzen zeigen keine intensive vegetative Ausbreitung und bilden keine Blütenstände, sodass die Kreuzung mit der Wildform nicht möglich ist. Die Wildform bildet große Mengen an Rhizomen und Knollen und ist fähig, unter unseren Bedingungen zu blühen. Das macht dieses Unkraut in wärmeren Regionen der Tschechischen Republik potenziell gefährlich.

**Stichwörter:** Biomasse-Produktion, CYPES, Erdmandelgras, invasives Unkraut, Knollenbildung

### **Introduction**

*Cyperus esculentus* L. (syn. *Chlorocyperus esculentus* /L./ Palla, Yellow nutsedge) belongs to the world most important weeds on arable land (HOLM *et al.*, 1991). Native in mediterranean and tropical regions, this species is classified as an invasive one in Central and North-western Europe (DE VRIES, 1991; DANCZA *et al.*, 2004). The wild form is not yet present in the Czech Republic, but its occurrence in neighbouring countries and its ability to survive winters in this region must be taken

into account. The cultivated form of *C. esculentus*, known as Chufa or Tiger nuts, is occasionally grown in home gardens as a crop for its edible tubers (KUBÁT *et al.*, 2002). A detailed study on its growing under the conditions of the Czech Republic was published already in the mid-20th century (JIRÁSEK, 1955) but it is a crop of minor importance without large-scale field production.

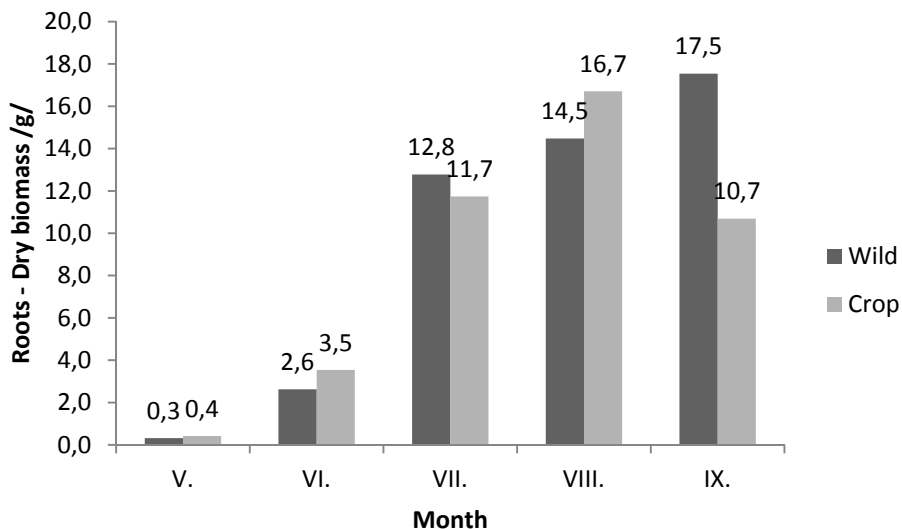
The aim of this study was to describe growth dynamics of the wild form under the conditions of CZ and to compare it with cultivated plants to observe differences and possible risk of spread of both forms as weeds/volunteers on arable land.

### Material and Methods

A pot experiment was realised at the experimental field of the Czech University of Life Sciences in Prague – Suchbát (280 m a.s.l.). Plastic pots 18 x 18 x 23 cm were filled with commercially produced planting substrate Agro CS. The lower 5 cm of the pots were permanently in water. Each pot contained 4 seedlings of *C. esculentus*, pre-planted in laboratory. In the experiment established 23. 4. 2012 we tested growth of weedy and cultivated forms from collections of the department of Agroecology and Biometeorology. The wild form originated from Hungary, Kaposvár region. Weight of both fresh and dry biomass of plant parts (leaves, roots, rhizomes, tubers, inflorescences) was measured in monthly intervals (24. 5.; 25. 6.; 20. 7.; 22. 8.; 26. 9.) starting in May with the last one in September 2012. During each term, 3 pots of both wild and cultivated forms of *C. esculentus* were used as replicates. In this work, only weights of dry biomass data are presented. Data were analysed by analysis of variance ( $\alpha=0.05$ ) using statistical software Statistica ver. 9.

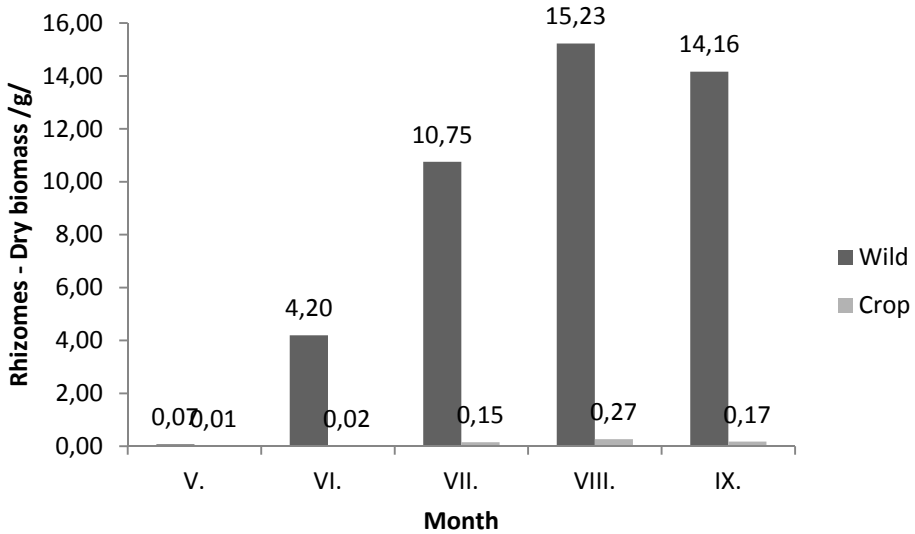
### Results

Results of dry biomass production of plant parts of both wild and cultivated forms of *C. esculentus* are presented in Figures 1-6.



**Fig. 1** Dry weight of the roots of wild and cultivated forms of *C. esculentus*.

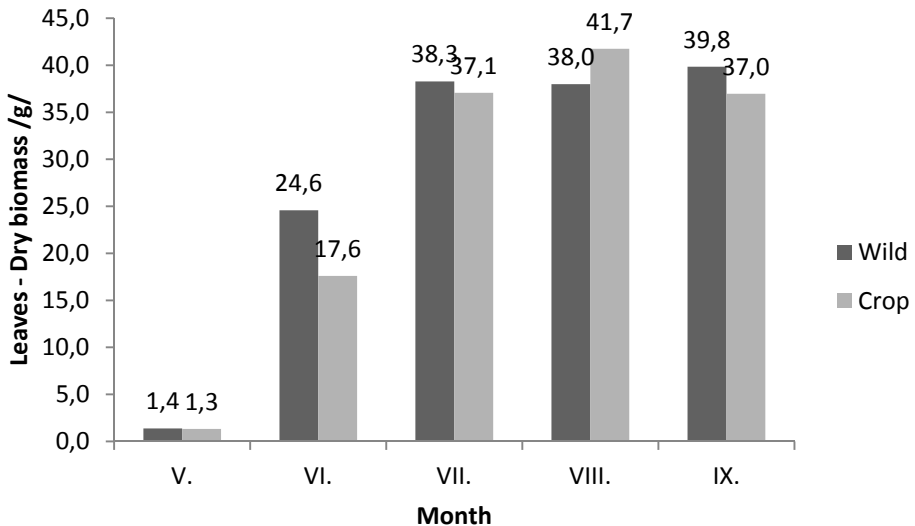
**Abb. 1** Trockenmasse der Wurzeln der Wild- und Kulturform von *C. esculentus*.



**Fig. 2** Dry weight of the rhizomes of wild and cultivated forms of *C. esculentus*.

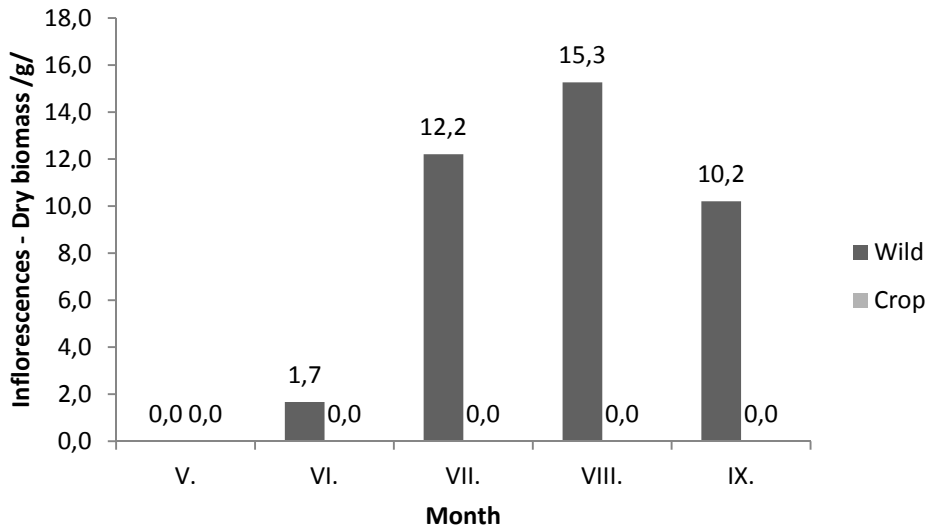
**Abb. 2** Trockenmasse der Rhizome der Wild- und Kulturform von *C. esculentus*.

Root biomass production (Fig. 1) was very similar in both forms of *C. esculentus*, no statistically significant differences were found in any term of evaluation. A completely different situation was found in the production of rhizomes (Fig. 2). The wild form started to produce rhizomes very early. Already in the first evaluation term the differences between the forms were statistically significant and later in the growing season the production of rhizomes of the wild form was 50 – 80 times higher compared to the *C. esculentus* crop.



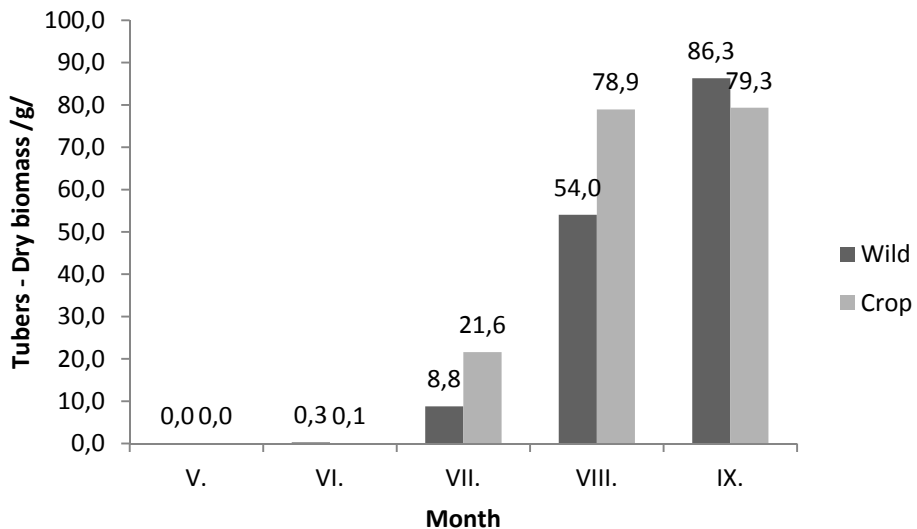
**Fig. 3** Dry weight of the leaves of wild and cultivated forms of *C. esculentus*.

**Abb. 3** Trockenmasse der Blätter der Wild- und Kulturform von *C. esculentus*.



**Fig. 4** Dry weight of the inflorescences of wild and cultivated forms of *C. esculentus*.

**Abb. 4** Trockenmasse der Blütenstände der Wild- und Kulturform von *C. esculentus*.



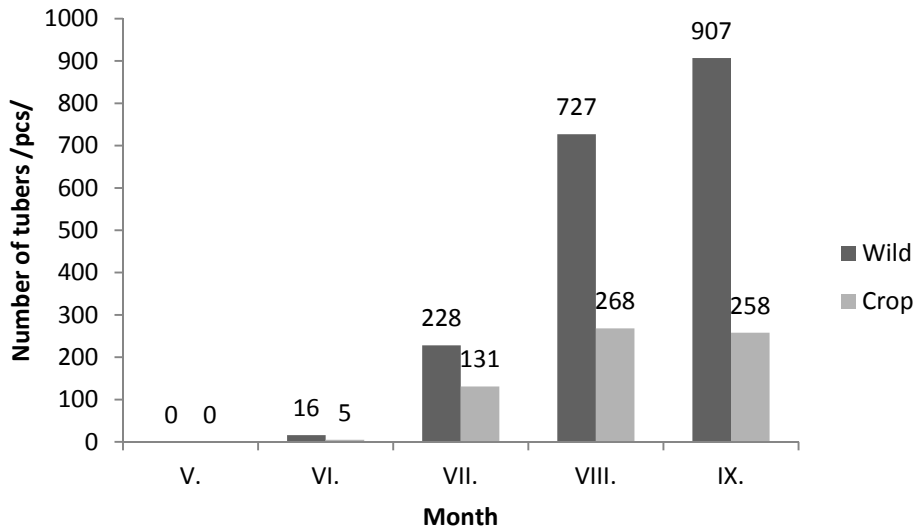
**Fig. 5** Dry weight of the tubers of wild and cultivated forms of *C. esculentus*.

**Abb. 5** Trockenmasse der Knollen der Wild- und Kulturform von *C. esculentus*.

There were no statistically significant differences found in the production of leaves (Fig. 3). There was a relatively more rapid leaf production of the wild form at the beginning of the growing season but later the total leaves biomass of both forms was very similar.

While the wild form produced inflorescences already during June with the highest weight of this plant part reached in August (Fig. 4), the cultivated form did not produce any inflorescences at all

and stayed in vegetative phase during the experimental period. The wild form was also able to produce seeds (data not shown).



**Fig. 6** Number of tubers of wild and cultivated forms of *C. esculentus*.

**Abb. 6** Anzahl der Knollen der Wild- und Kulturform von *C. esculentus*.

The tuber production started in June (Fig. 5). When we look at the dry weight of tubers, the production of both forms was not very different, higher tuber biomass production was found with the cultivated form in July and August, but the differences during the growing season were not statistically significant. But when we look at the number of tubers (Fig. 6), the wild form produced higher amounts of them compared to the cultivated form. During June and July the differences were not statistically significant. During August and September the wild form produced statistically significantly more tubers than the crop. The maximum values obtained in a single pot were as follows: wild form 1118 pcs. per pot; crop max. 342 pcs. per pot.

### Discussion

The wild form of *C. esculentus* occurs in Central Europe as a neophyte. It can easily become a troublesome weed species also under the temperate climate of this region. DANCZA *et al.* (2004) refer about the situation in Hungary, where *C. esculentus* occurred for the first time in 1993 and 10 years later it occupied 3000 hectares. In our crops the management of weeds of the Cyperaceae family can be problematic. During the last decades, *Bolboschoenus* species (*B. maritimus* s.l., resp. *B. koshewnikowii*, *B. yagara* x *B. koshewnikowii*) became hard-to-control weeds in sugar beet or maize stands (KNEIFLOVÁ and MIKULKA, 2006). This makes predictions of potentially successful spread of *C. esculentus* in CZ realistic. There is an intensive vegetative spread via rhizomes which are produced during the whole vegetative period. The tuber production is also very high compared to the cultivated form. Moreover, tubers of the wild form were able to survive the hard winter 2012-13 under field conditions (data not published), while the tubers of the crop did not. The wild form also produced inflorescences and seeds as well. Generative reproduction can help the species to select biotypes well adapted for our climatic region. That makes it a potentially dangerous weed in warmer regions of the Czech Republic. On the other hand, based on our results we can state that growing of the cultivated form does not pose any risk – plants do not show intensive vegetative

spread and do not produce inflorescences so crossing with the weedy form is not possible. Unlike other European countries, where *C. esculentus* is a more important crop with productive cultivars (PASCUAL-SEVA *et al.*, 2013), growing of this crop is not common in the Czech Republic and we can find it only rarely in home gardens.

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