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Abutilon theophrasti L. (velvetleaf): a problem-weed for grain maize

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Abstract Weeds are the main problem of agriculturists and this is why we need to use the entire complex of measures to control them. For these measures to produce good results, we need to pay particular attention to their biology. *Abutilon theophrasti* L. (velvetleaf) is an annual spring-summer thermophile species. It is a problem-weed in many European countries (19). If *A. theophrasti* L. and the crop sprout at the same time, it can overrun the crop which causes a drop of the crop yield because of the interference with crop light interception (12). However, yield drop varies within wide limits depending on the type of crop infested, on weed density, and on environmental conditions (14,8). Moreover, its importance increased in time partly because it is relatively tolerant to many herbicides (12).

Key words

Abutilon theophrasti L. (velvetleaf), trials, analyses, lab measurements, interpretation

The genus *Abutilon* has about 160 species all over the world, mainly in tropical and sub-tropical areas. In China, there are 10 species and 3 varieties. *Abutilon* species are cultivated for medicinal and ornamental purposes and for fibres.

Velvetleaf (*Abutilon theophrasti* L.), a native from China or India, is nowadays a problem-weed in many countries in north America, Europe, Asia, and Af (18, 12, 13). It was introduced in North America in the 18th century from China, and now it is the most widespread broadleaf weed in maize and soy. The first instances of its incidence in New Zealand was when MAF imported it for fibres in 1948 (Herbarium voucher, Allan Herbarium, Lincoln, New Zealand). It is accidentally present together with soy seeds as other grain contaminant. At present, there are four confirmed contaminations: at Waihou, Morrinsville and Mangatawhiri, in Waikato, and at Helensville, north from Auckland.

Velvetleaf belongs to the Family Malvaceae and it is easy to differentiate due to its tall, erect shape, broad, alternate, heart-shaped leaves, soft and velvet-like upon touch, and smelling like musk. It has small yellow to yellow-orange flowers that open up for only a few hours during the hottest period of the day; it has distinct, black capsules that contain about 40 hard, black seeds (18).

Velvetleaf is an annual summer plant that h; as the ability of germinating during warm months. It reaches 3 m in height; its biological and ecological features make it particularly competitive and persistent in crops. It has been reported that it has caused serious damage particularly in such crops as maize, sorghum, soy, and cotton. Damage reached between 37% and 72% in soy at plant densities of 3 – 12 plants /m^2, and 51 – 91% inhibition in maize growth from velvetleaf 5 cm far from a maize plant (16). It also has allelopathic effects on seed germination and on root elongation in other plants (1, 15).

A. theophrasti L. resembles subshrub (*Latin suffrutex)* that can reach 1 – 2 m. The stem and branches are covered by fine hairs. The velvet-like, heart-shaped, alternate leaves are about 5 – 10 cm long; they are densely stellate-pubescent on both faces, with finely indented margins, with long acuminate tips cordate at the basis. The petioles 3 – 12 cm long with stellate hairs. It blooms in July and August; the yellow flowers grow solitarily in the leaves' axilla. The pedicel is pubescent, 1 – 3 cm long, with a knot in the apex. The calix is cup-shaped, with 5 ovate lobes about 6 cm long. The petals are yellow, obovate and about 1 cm long. The fruits are demi-globous capsules about 2 cm in diameter and 1.2 cm long, with 15 – 20 mericarps wearing two long moustaches at the apex. The seeds are brown, stellate, puberous and kidney-shaped.

Material and Method

Research aimed at monitoring the behaviour of the species ***Abutilon theophrasti*** Medik. in different crops and under different conditions.

To have a broader view of the ***Abutilon theophrasti*** *Medicus* morphology we followed the research made to this weed specie, after conducting several experiments both in the laboratory and in the field.

The herbicides effectiveness on this species was studied, at certain time intervals, as well as various methods of awakening from seediness using Petri dishes.

Results and Discussions

Natural components are excellent alternatives for the current uses of chemical herbicides in agriculture. To examine the possibility of using plant extracts for weed control, we determined inhibition of growth in water extracts from six plants – camelthorn (*Alhagi camelorum* Fisch), sweet wormwood (*Artemisia annua* L.), stinkwort (*Inula graveolens* L. (Desf.), clotbur (*Xanthium strumarium* L.), flax-leaf fleabane (*Conyza bonariensis* L. (Cronq.) and European black nightshade (*Solanum nigrum* L.) at rates of 25%, 50%, 75%, 100% (1:10 w/v) on *A. theophrasti* Medik. This experiment was conducted on an intensive design (factorial0 with 3 replicates in the laboratory of the Centre for Agricultural Research in Golestan, Iran, in 2013. Other similar experiments were carried on the same biological material that had been frozen for 4 years.

Results show that stem height in *Abutilon theophrasti* Medik. was shortened in all extracts with no difference in concentration. The same results were also in the germination of *A. theophrasti* L. but, in this case, the inhibiting effects increased with concentration. Except for *A. camelorum* extracts that stimulated root growth in *A. theophrasti* L., all other extracts reduced root size. The strongest inhibition effect on stem height and root length in *A. theophrasti* L. of all extracts was in Petri dishes treated with *A. annua* L., followed by *X. strumarium* L. and *C. bonariensis* L. Germination inhibition was caused by *X. strumarium* L., followed by *A. annua* L. Therefore, *A. annua* L. and *X. strumarium* L. can be useful as an alternative to biological weed control. However, we need comprehensive studies to know the true herbicide potential.

Seed dormancy and germination in velvetleaf (*Abutilon theophrasti* Medik.) and red-root amaranth (*Amaranthus retroflexus* L.).

The goal of the study was to determine the influence of different methods of interrupting the dormancy of velvetleaf (*Abutilon theophrasti* Medik.) and red-root amaranth (*Amaranthus retroflexus* L.).

The influence of sowing depth on sprouting and growth in weeds was also assessed. Results show that the best treatment to interrupt dormancy in velvetleaf was to immerse the seeds in hot water (60°C) for one hour, while immersing them in distilled water and a solution of 0,2% KNO_3 had no significant effect. Seed germination in red-root amaranth increased significantly with all treatments; however, the solution of 2% KNO_3 and cold stratification at 5°C for 12 days had the best effect.

Treatments had different effects on the germination time mean, on germination dynamics, and on sprout length. The highest sprouting rate was in velvetleaf when seeds were sowed 1 – 4 cm in the soil ad it varied between 55,6 and 67,9%. the increase of the sowing depth resulted in a decrease of the sprouting rate; however, ¼ and 1 /5 sprouted at 7 and 9 cm depth, respectively. Both sprout length and fresh weight were higher at smaller sowing depths. The emergence of red-root amaranth was not significantly influenced by sowing depth, but sprout length and fresh weight were higher when sowed at 5 cm than at 1 cm.

Velvetleaf is a problem-weed in maize and soy. It occurs in cultivated fields, in gardens, in waste areas, and along fences. Velvetleaf is a very prolific seed producer, and its seeds are long-lasting, hence the importance of managing population dynamics. More than 1,000,000 seeds /ha remained in the seed bank 17 after no other seed was introduced. After 5 years, velvetleaf emergence shared only 27% of the seeds in a second long-term trial on the persistence of velvetleaf seeds; 37% of the initial seed bank remained viable after 5 years in uncultivated soil, compared to 15% in undeveloped cultivated soil (20,6). Bentazone is a post-emergent herbicide for weed management providing control over broadleaf weeds, including red-root amaranth, wild spinach (*Chenopodium album* L.), and velvetleaf (Weed Science Society of America, 1994). Bentazone is a triazine-based herbicide clocking photosynthesis through inhibition of electrons in dicots (5).

Applying herbicides at the proper time is very important, as is applying the herbicide in post-emergence on young weeds is more effective because easier to control. Likewise, successful control by using low herbicide rates critically depends on the sensitivity of the weed growth stage and on environmental conditions (2,17).

Bentazone rates can be reduced with 75% in general during short growth stages (4) or in combination with other weed control strategies (3).

Likewise, **Roggenkap *et al.* (2000)** reported that controlling velvetleaf (*Abutilon theophrasti* Medik.) and green foxtail (*Setaria viridis* L.) with low rates of alachlor and atrazine in maize (*Zea mays* L.) was effective. **Popp *et al.* (2000)** reported that low rates of herbicide in soy in Arkansas, U.S.A., yielded higher economic income with lower financial risks. However, studies carried out in west Canada assessing low rates of herbicides in common wild oat (*Avena fatua* L.) and found that, depending on location, using low herbicide rates were without economic risk (7, 9). These authors drew the conclusion that the risk associated with low rates of herbicide increased without other weed control practices as well as larger amounts of crop and competitive crop seeds.

Velvetleaf (*Abutilon theophrasti* Medik.) is one of the most important invasive species in Hungary. The hazard comes from its strong allelopathic effects and competitive abilities. Many authors proved its effects on crop yield. Some authors claim allelopathy is responsible for reducing fields, while others claim competition is the main reason for field yield diminution. So far, arginine in the seeds, free amino-acids and phenoloids in the shoots are thought to have inhibiting effects. In this study, they examined volatile substances and phenoloid compounds of the plant. Volatile substances in the shoots of *Abutilon theophrasti* L. were isolated with SPME-GC/MS, while thin-layer chromatography was used to detect phenoloids in seeds and plants at different phonologic stages.

Weed control and sensitivity of clomazone (360 g /l active ingredients) was tested in several ways, for a rate of 90 g /ha as pre-emergent herbicide in mixture with metamitrone and chloridazone. Field trials were conducted on different soils and on *Abutilon theophrasti* L. and *Polygonum aviculare* L. as target.

Selectivity and efficacy of different weed control programmes were tested in comparison with pre- and post-emergence standards. Clomazone selectivity was good on different soils, except for low-clay content ones. In this case, there occurred beetroot whitening in small percentage, but this symptom was transitory and it did not affect crop development. Active ingredients showed good efficacy against *Abutilon theophrasti* L. on different soils, weather conditions, and weed populations. Moreover, extended activity of pre-conditioning against *Abutilon theophrasti* L. and *Polygonum aviculare* L. allowed the delay of treatments in post-emergence with tri-flu-sulphur-methyl. As for pre-emergence substances with clomazone, there was improvement on metamitrone and chloridazone in the control of Polygonaceae and Cruciferae.

Conclusions

Results show that it is possible to reduce bentazone rates (even 70%) if the herbicide is applied at the proper time of weed growth. Among advantages are low cost and safer control if herbicides are applied on young, growing shoots and with proper moisture. Results show that applying low rates of bentazone in initial growth stages in velvetleaf produces the best control.

Results show that we can use several methods to break down dormancy in weed seeds. The best method is to apply hot water in velvetleaf, while in red-root amaranth it consisted in applying a solution of KNO_3 and cold stratification. The pot experiment showed that both weeds sprouted well when sowed at 5 cm. Understanding weed biology and ecology is important for the development of ecological strategies of weed management.

Because of the extreme rainwater amounts during vegetation, competitiveness between maize and *A. theophrasti* L. was considerably low even with high density in *A. theophrasti* L. Only the yield of weeded control parcels was strongly reduced. A slight yet significant decrease of the yield was because of two plants of *A. theophrasti* L. per m^2.

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