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Growth and development of Cyperus esculentus

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The genus *Cyperus* comprises over 600 species, which occur mainly in tropical and temperate regions of the world. *Cyperus esculentus* (yellow nutsedge, watergrass, Nqonqodwana) has prolific vegetative activity, which produces a complex underground system of basal bulbs, rhizomes and tubers. Tubers are the primary means of overwintering in cultivated lands, but reproduction can occur by way of seeds, bulbs and rhizomes. Due to its prolific growth habit, it is classified as one of the most difficult weeds to control.

Various studies have indicated that the weed should be controlled at an early stage during crop development. Yields of cucumber were reduced when more than 15 *Cyperus* plants/m^2 grew with the crop (Johnson III and Mullinix Jr. 1999). In a study done with tomatoes the shoot dry weight was reduced by 34% due to *C. esculentus* competition (Morales-Payan et al. 2003).

Maize yields were reduced by 11% on a Hutton soil and 23% on an Avalon soil in Mpumulanga, South Africa in a study done by Jooste and van Biljon (1980). Reinhardt and Bezuidenhout (2001) found that maize emergence was retarded in soil where *C. esculentus* grew for 28 days and then removed on the day the maize was sown. Maize was not affected if tubers and maize seeds were planted at the same time.

Growing conditions during the early stages of maize growth are also important. Results from a study currently being done on Cedara indicated that seedlings growing with nutsedge weighed 29% less than the control at 42 days after maize emergence. However, in dry and hot conditions, seedlings weighed 80% less compared to the control for the same period.

FIGURE 1: The competitive influence of *Cyperus esculentus* on maize growth

Tubers

Tubers are spherical, tan to brown, and are the primary dispersal unit. They are produced at the end of rhizomes and consist of numerous buds. Buds will sprout and develop into seedlings. Tubers form 3-6 weeks after the seedling has emerged. More than 95% of the tubers usually form in the upper 45 cm of the soil, most in the upper 15 cm. Rhizomes do not penetrate deeply in heavily textured soils and tubers thus occur deeper in sandy soils. The total number of viable tubers decreases with time after burial.

Tubers are most dormant at the end of the season in which they were produced and least dormant in spring

and early summer. Dormant tubers will germinate under warm and wet conditions. Scarification, desiccation, water leaching and tillage can break dormancy. Tubers will remain attached to the plant throughout the season.

Tuber sprouting

Emergence can occur at temperatures as low as 12°C, but emergence percentages are higher with fluctuating temperatures than with a constant temperature. Soil warming is usually a stimulus for sprouting in temperate climates, while soil moisture is the stimulus in arid regions. When the tubers sprout, the rhizomes elongate vertically from the tuber. Roots radiate horizontally from the rhizomes as they grow towards the soil surface. When the rhizome tip is exposed to sunlight or fluctuating temperatures, it leads to basal bulb formation.

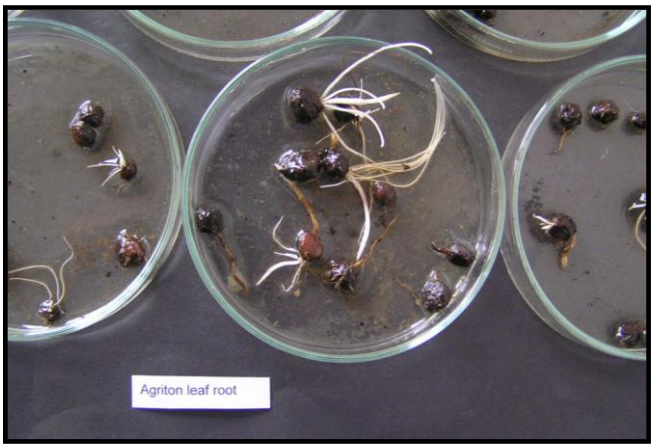

FIGURE 2: Yellow nutsedge tubers starting to form sprouts

Basal bulb

The basal bulb represents the basic site of leaf, shoot and subterranean growth. Several weeks after the primary shoot emerges, the secondary rhizome emerges horizontally from the basal bulb. When the rhizome tip turns upwards, secondary basal bulbs are formed, which are similar to primary bulbs. Secondary bulbs produce shoots, leaves and rhizomes as primary bulbs. The basal bulb of the parent plant produces, on average, 15 rhizomes.

Rhizomes

Upon germination, rhizomes emerge from the distal end of the tuber, but can also originate from the basal bulb and differentiate into tubers or shoots during the same season. A new rhizome grows as an indeterminate stem, consisting of a series of elongated internodes, nodal cladophylls and pointed terminal buds. Rhizomes are strong and can penetrate mulches.

FIGURE 3: Rhizomes forming at the basal bulb of the yellow nutsedge tuber and can differentiate into either tubers or sprouts

Leaves

The glabrous, shiny and smooth leaves grow out from the bulb in an enfolded triangular fascicle. Leaf development begins at the outermost leaf, progresses inward and terminates with a seed-bearing rachis. A new leaf is initiated every 4-5 days. Each photosynthetically active leaf tends to be longer than the previous leaf in early shoot development. Growth rate will vary, depending on nutrient conditions.

FIGURE 4: Triangular leaves with sharp tips

Flowering

Above-ground shoots consist of a triangular fascicle of leaves, which develop into a solid triangular rachis. The rachis extends through the centre of the fascicle and bears the seed head at the apex. Flowering appears to be dependent on photoperiod, with long day lengths stimulating flowering. The appearance of the triangular foliar tube is the earliest superficial evidence of flowering. Seedlings from seed lack the vigour to survive, but they can reach maturity.

FIGURE 5: Flowers of yellow nutsedge form at the end of the triangular stem

Photoperiod and light

Growth and development is influenced by photoperiod and light intensity. Day length will stimulate tuber production. Short photoperiods stimulate reproductive growth, while longer periods stimulate vegetative growth. Nitrogen enhances basal bulb formation over tuber formation. It thus stimulates vegetative rather than reproductive growth.

Cyperus spp. are highly competitive and efficient in growth under increased sunlight and high temperatures. Because of this, rapid shading decreases their photosynthetic rate and suppresses growth. The number of shoots and tubers decreases linearly with reduced light. Dense shade, however, does not prevent tuber formation. Crop interference will reduce the number and size of tubers.

The amount of light that is intercepted is dependent on the row spacing, number of plants per row, planting time and competitiveness of the crop. Based on the light interception of crops, certain plants will be better competitors with *Cyperus* for light. Maize and potatoes provide quick canopy closure due to their growth rate and therefore provide quick shading, before *Cyperus* can become well established. Additional control methods should, however, also be used.

Control

The occurrence of emergence, flowering and tuberization can facilitate timing of effective control measures. Desiccation and temperature extremes can kill nutsedge tubers. Due to ecological variation, tuber desiccation will vary. Fewer tubers survive in a cool, dry atmosphere than in a cool, moist atmosphere. A combination of low humidity and temperature is more effective in killing tubers than either factor alone.

The lifespan and burial depth is also an obstacle to eradication. Tuber survival increases as the depth increases. At least two years of season-long control is necessary to reduce populations to 20% of the original density. With three years, the number can be reduced to 5%. Tuber mass and longevity are correlated. Smaller tubers die sooner than larger tubers.

Tuber formation is dependent on the season, especially with regard to the light intensity and dormancy of the tubers. Even if the leaf growth declines, tubers can still be formed. Depending on the season, tuber size does influence the number of tubers formed, with smaller tubers producing more tubers.

The best control is achieved by killing viable tubers. Herbicides have to be translocated to tubers and remain active to control the weed. However, herbicides applied to foliage to kill mature tubers are not satisfactory, due to the inactivity of metabolic

sinks. If the herbicide is applied without a sticker, it will roll-off the waxy leaf surface, leading to ineffective control. Killing initial basal bulbs would stop subsequent propagation by proliferation of secondary growth and tuber formation on rhizomes differentiating from basal bulbs. As tubers are deeply buried, killing shoots with herbicides seems logical.

Glyphosate can be used to suppress the growth of *Cyperus*. Maize producers can use EPTC (Eptam Super ®) pre-plant to control tubers beneath the soil surface or halosulfuron (Servian ®) applied post-emergence. Bendioxide (Basagran ®) will suppress yellow nutsedge growth after the maize has emerged.

References

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