E-821 (Revised)

Biology and Integrated Pest Management of the Sunflower Stem Weevils in the Great Plains

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The sunflower stem weevil, *Cylindrocopturus adspersus* (LeConte), is an insect pest that has caused economic damage to sunflower in the northern and southern Great Plains of the USA and into Canada. It belongs in the order Coleoptera (beetles) and family Curculionidae (weevils), and has also been called the spotted sunflower stem weevil. It is native to North America and has adapted to wild and cultivated sunflowers feeding on the stem and leaves. The sunflower stem weevil was first reported as a pest in 1921 from severely wilted plants in fields grown for silage in Colorado. In North Dakota, the first sunflower stem weevil infestation was recorded in 1973, causing 80% yield loss due to lodging (Figure 1). Populations of sunflower stem weevil have fluctuated over the years with high numbers in some areas from the 1980s to early 1990s in North Dakota.

Another stem feeding weevil called the black sunflower stem weevil, *Apion occidentale* Fall, also occurs throughout the Great Plains, and attacks sunflower as a host. In recent years, severe damage to seedling sunflowers has been reported from southern North Dakota and South Dakota.

Figure 1. Damage caused by sunflower stem weevil – sunflower lodging and stalk breakage.

Distribution

The sunflower stem weevil has been reported from most states west of the Mississippi River and into Canada. Economically damaging populations have been recorded in Colorado, Kansas, Nebraska, North Dakota, Minnesota, South Dakota, and Texas.

The black sunflower stem weevil can be found in most sunflower production areas with the greatest concentrations in southern North Dakota and South Dakota.

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Figure 2. Adult sunflower stem weevil.

Figure 3. Egg site of sunflower stem weevil.

Figure 4. Larvae of sunflower stem weevil.

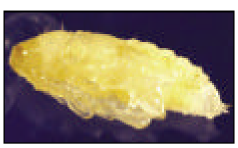

Figure 5. Pupae of sunflower stem weevil.

Figure 6. Adult of black sunflower stem weevil.

Figure 7. Larva of black sunflower stem weevil.

Identification

Sunflower Stem Weevil – *Cylindrocopturus adspersus* (LeConte)

ADULT: Adult sunflower stem weevils are about 3/16 inch (4 to 5 mm) long and grayish-brown with varying-shaped white spots on the wing covers and thorax (Figure 2). The snout, eyes, and antennae are black. The snout is narrow and protrudes down and backward from the head.

EGG: Eggs are deposited inside the epidermis of sunflower stems (Figure 3), and are very tiny (0.51 mm long x 0.33 mm wide), oval in shape, and yellow in color making them difficult to see.

LARVAE: The larvae are 1/4 inch (5 to 6 mm) long at maturity, legless, and creamy-white in color with a small, brown head capsule (Figure 4). They are normally in a curled or C-shaped position within the sunflower stalk.

PUPAE: Pupae are similar to the adult in size and yellow in color (Figure 5).

Black Sunflower Stem Weevil – *Apion occidentale* Fall

ADULT: Adults are 3/32 inch (2.5 mm) long from the tip of the snout to the tip of the abdomen. The snout is very narrow and protrudes forward from the head, which is smaller than the large, oval-shaped body (Figure 6).

EGG: Eggs are deposited inside the epidermis of sunflower stems and leaf petioles, and are similar to *C. adspersus.*

LARVAE: Larvae are similar to the larvae of C. adspersus except they are yellowish in color and only 3/32 to 1/8 inch (2.5 to 3 mm) long at maturity (Figure 7).

PUPAE: Pupae are similar to the adult in size and yellow in color.

Hosts

Both species of stem weevils have a wide host range including cultivated sunflowers, native sunflowers, and many weeds. Native sunflower hosts include *Helianthus annuus, H. pauciflorus, H. petiolaris, H. tuberosus,* and *H. maximiliani.* Accession and hybrids of cultivated sunflower are screened for germplasm with reduced levels of weevil larvae (see Plant Resistance section). Weed records also list ragweed, pigweed, Russian knapweed, lambsquarter, golden ragwort, perennial sowthistle, red clover, cocklebur, kochia, and sugarbeets.

Life Cycle

Sunflower Stem Weevil – *Cylindrocopturus adspersus* (LeConte) (Figure 8)

There is only one generation per year. Adult sunflower stem weevils emerge from overwintered stalks and root crowns (Figure 9) from early April to early May in the southern Plains and mid-June to late July in the northern Plains. Degree-day (DD) models have been developed to predict adult emergence. Using a base temperature of 5°C (41°F), the first emergence occurs at 379-420 DD, and by 651-865 DD 90% of adults had emerged depending on location (southern plains–northern plains).

Adults first feed on stem and leaf tissue of volunteer sunflowers, and then mate. Weevils migrate to cultivated sunflower in the eight to 14-leaf stage. Females descend to the lower portion of the plant to deposit eggs under the epidermis near the base of sunflower stalks. Adults are present in the fields until late July in the southern plains and until late August in the northern Plains, with peak densities in late June to mid-July. Eggs are initially deposited around the first node (cotyledon) moving higher up the stalk over time. In North Dakota, half of the eggs are deposited by mid-July. Under laboratory conditions, females lay 0.5 to five eggs per day for a total production of 24-195 eggs, depending on temperature. The greatest number of eggs was deposited at 86°F (30°C). Females survived up to 75 days when held at 68°F (20°C) or 73.4°F (23°C).

Larvae begin to hatch in early July. Early instars (first and second) feed in the subepidermal and vascular tissue and move to the pith as larvae mature into 3rd to 5th instars (Figure 10). Larvae feed in the upper stalk until early August and then descend to the lower portion of the stalk or root crown by late August to overwinter. Larvae chew cavities into the stem cortex or crown root and pupate within the chamber (Figure 9). In the spring, adults emerge from the pupae and chew their way out of the stalk. The overwintering survival of the larvae varies with micro-habitat. Mortality of larvae increases when larvae are exposed in the soil.

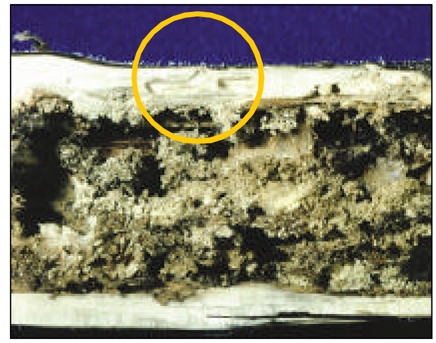

Figure 9. Overwintering chamber inside stem cortex.

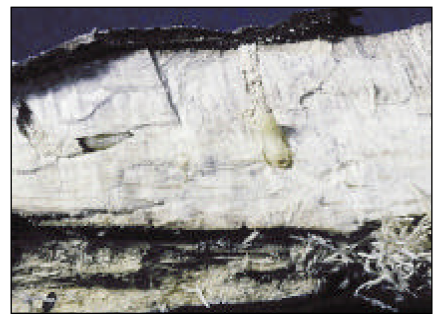

Figure 10. Cross-section of stalk showing larvae.

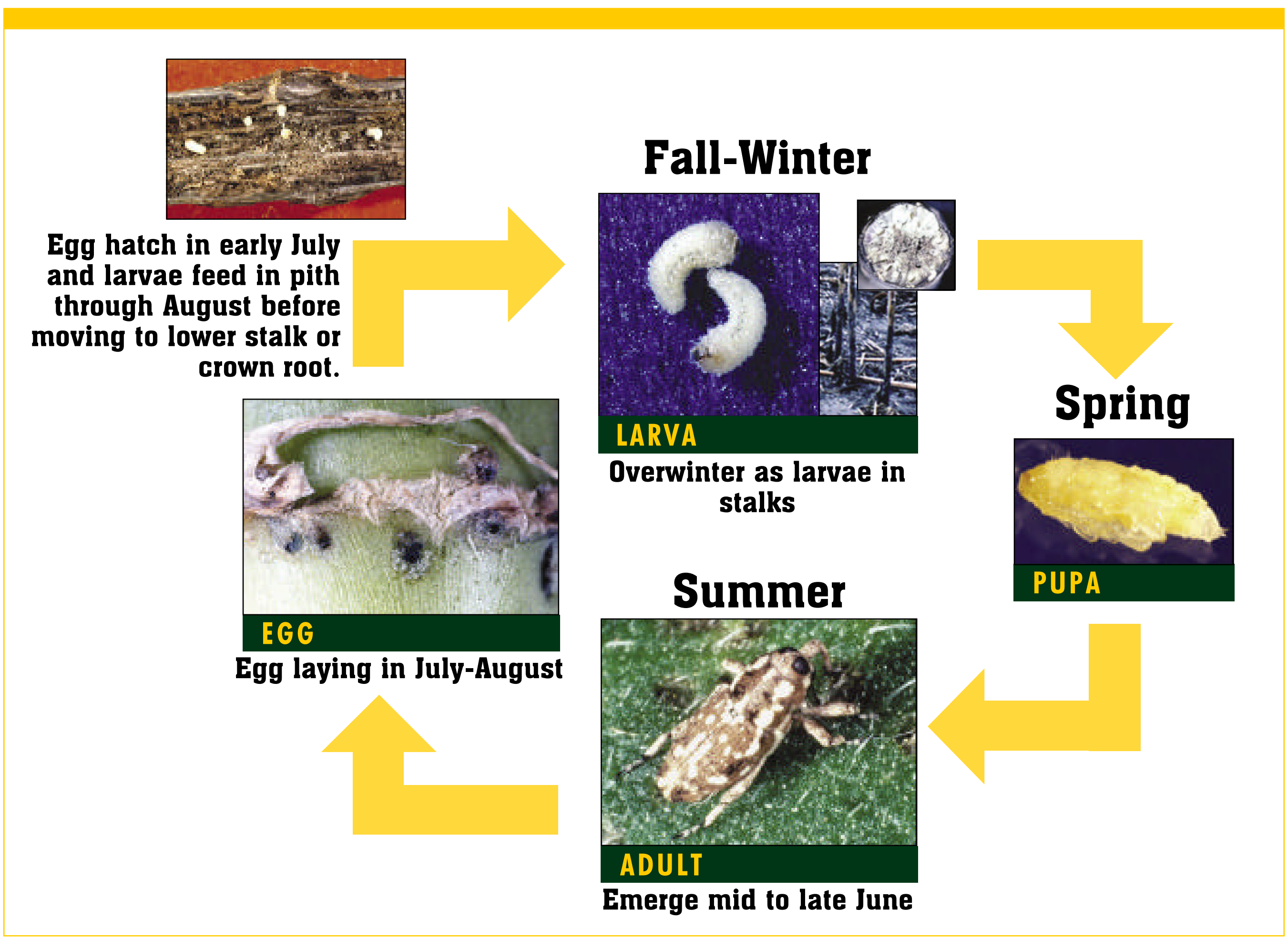

Figure 8. Life cycle of sunflower stem weevil (development time is about 2-4 weeks earlier in southern states).

Life Cycle

Black Sunflower Stem Weevil – *Apion occidentale* Fall

Apion occidentale overwinters as an adult in soil, plant trash, sod and weed clusters. It emerges and feeds on volunteer seedling sunflowers, and later moves to cultivated sunflowers in the two to four-leaf stage. Mated females deposit eggs under the epidermis in the leaf petioles or near axils. Hatching larvae tunnel in the pith area of the stem, pupate and emerge as adults in early August. There is a period of about two weeks in late July and early August when little or no *Apion* adult activity is observed. Adults emerging in August feed on the leaves and stems of the plant, and as the plant matures and leaves die *Apion* moves to the bract of the sunflower heads. It can then be observed feeding on the bracts until sunflower harvest.

Figure 11. Larval of sunflower stem weevil tunneling inside stem.

Figure 12. Pitting damage on seedlings caused by black sunflower stem weevil.

Damage

Adult feeding from both species of stem weevils cause minor damage to the stem and leaf tissue of the plant. More importantly, both weevils have been implicated in the epidemiology of the sunflower pathogen Phoma black stem (*Phoma macdonaldii* Boerma). Phoma is thought to cause premature ripening syndrome (early dry down) of sunflower in North Dakota. Although premature ripening is probably caused by a combination of both abiotic and biotic factors, evidence shows that stem-infesting insects may transmit disease organisms or encourage the disease by stressing the plant. The sunflower stem weevil also has been implicated in the transmission of *Macrophomina phaseolina* (Tassi) Goid, which causes charcoal stem rot in sunflower in the southern Plains.

Damage by larvae of sunflower stem weevil causes serious stalk breakage when larval populations are large. The stem is weakened by larval tunneling, pith destruction, (Figure 11) and/or the overwintering chambers (Figure 9), causing stalk breakage and a loss of the entire capitula (head) prior to harvest. Populations of over 80 larvae/stalk in irrigated sunflower in the southern Plains were required to cause a yield loss from larval feeding. In North Dakota, a mean infestation of 38 larvae resulted in 28% lodging. Stalk breakage due to the sunflower stem weevil is most severe during drought stress or when high winds occur as plants are drying prior to harvest. Lodging is a good indicator of larval densities; however, lodging is also influenced by other factors, including stalk diameter, cortex and pith thickness of the stem, weight of sunflower heads, wind velocity and direction, position of larvae in overwintering chambers in the stalk, and incidence of disease. **Typically, breakage occurs at or slightly above the soil line, in contrast to breakage attributed to a stalk disease, which normally occurs farther up on the stalks.**

Damage from the black stem weevil has not been well documented, but severe pitting on the cotyledons or seedling sunflowers by adult feeding has been observed (Figure 12). In situations of extremely high populations, this has resulted in stand loss. However, in most cases populations are too low to cause economic damage to sunflower. Stalk tunneling causes only minor injury to the plant.

Integrated Pest Management of the Sunflower Stem Weevil

Cylindrocopturus adspersus (LeConte)

Effective Integrated Pest Management (IPM) requires a broad approach that incorporates knowledge of the insect's biology and population dynamics, determination of economic injury levels and the use of resistant cultivars, as well as biological, cultural, and chemical controls. The ideal control strategy utilizes techniques that require low input costs, are cost effective, and avoid negative impacts on the environment. Management techniques that reduce weevil densities in the stalks or improve the plant's ability to tolerate weevil attack are recommended for *C. adspersus.* For example, anything that promotes thick healthy stems helps reduce losses, since damage results from lodging of larval infested stalks. Even with the same number of larvae, a plant that has stems of increased diameter and greater stem density will be less likely to break. Therefore, lower plant populations, adequate fertilization, and proper soil moisture should help decrease sunflower lodging.

Cultural Control

Cultural control tactics use standard farming practices. They are effective when they make the environment less favorable to the pest or more favorable for the plant. Delayed planting, plant population, and tillage are useful for managing the sunflower stem weevil.

Delayed planting is effective at lowering larval densities in stalks in both the northern and southern Plains. Stem diameter is an important factor affecting lodging of weevil infested stalks. Stem diameter decreases with later planting dates, but larval density also decreases significantly reducing the potential for lodging. Larval numbers decreased from 21 to two and from 23 to two larvae per stalk when planting dates were delayed from mid-May to early June in trials at Carrington and Prosper, respectively. There is an indication that more mature plants (earlier planted) may be preferred by ovipositing weevils.

Plant population impacts both the diameter of sunflower stalks and percentage of lodged plants. In a field study, larval stalk population averaging 12 larvae per stalk was not affected by plant density. However, stalk diameter was significantly different among three different plant populations, with the thinnest stalks in the most dense plantings. Lodging was low at both 9,000 and 18,000 plants per acre (22,000 and 45,000 plants per hectare, respectively). In contrast, almost 25% of the plants were lodged when the stalk density increased to 36,000 plants per acre (89,000 plants per hectare). These results from North Dakota demonstrate that with no change in insect levels in the stalk, reducing the plant population can result in decreased damage from lodging.

Cultivation of crop residues may provide some control of the overwintering larvae/pupae. A combination of disking to break up stalks and moldboard plowing to bury them at a depth of 6 inches (15 cm) can cause larval/pupal mortality and severely impact the emergence of adult stem weevils. Otherwise, larvae/pupae are physically protected in the woody stalks. Survival is affected only by performing both operations. The greatest impact is when the practice occurs as an area-wide program. The value of standing stalks in holding snowfall to insure adequate moisture in the field and impact of plowing on soil erosion must also be considered.

Plant Resistance

Host-plant resistance utilizes the plant's own defense mechanisms against the insect to either avoid attack, destroy the insect, or tolerate the injury. Greenhouse and field experiments have shown resistance to feeding, oviposition, and larval development in many native species of sunflower. Further development of resistant sunflower has been hampered by populations too low for screening useful germplasm, which can only be conducted when field densities are high. Some examples of sunflower accessions with low density of weevil larvae in stalks are PI 386230, Ames 3391, and PI 431542.

Figure 13. Larval parasitoid of the sunflower stem weevil, *Nealiolus curculionis* (Braconidae). **Size=4-5 mm.**

Figure 14. Larval parasitoid of the sunflower stem weevil, *Quadrastichus ainsliei* (Eulophidae). **Size=4-5 mm.**

Biological Control

Conservation of natural enemies in a crop agroecosystem is important to keep pests below levels that cause economic damage. The naturally occurring natural enemies prevent many plant-feeding insects from achieving pest status. The conservation of these natural enemies allows them to operate at their full potential. Manipulating the environment to eliminate adverse factors, such as pesticides, can effectively protect the natural enemies present.

Parasitoids

The sunflower stem weevil is attacked by both egg and larval parasitoids. The eggs of the weevil are attacked by *Anaphes pallipes* (Ashmead) (Hymenoptera: Mymaridae). Eleven species of Hymenoptera have been recovered from overwintering larvae: *Nealiolus curculionis* (Fitch), *N. collaris* (Brues), *Bracon* sp. (Braconidae); *Neocatolaccus tylodermae* (Ashmead), *Chlorocytus* sp., *Mesopolobus* sp., *Pteromalus* sp. (Pteromalidae); *Quadrastichus ainsliei* Gahan, *Tetrastichus ainsliei* Gahan (Eulophidae); *Eurytoma tylodermatis* Ashmead (Eurytomidae); and *Eupelmus* sp. (Eupelmidae).

Parasitoid species are more diverse in the central Plains. The reduced number of parasitoid species found attacking *C. adspersus* in the northern Plains may be related to factors including low host populations, slower migration by parasitoids into the region, or incompatibility with climatic conditions.

Nealiolus curculionis (Figure 13) is the most prevalent parasitoid attacking *C. adspersus.* It parasitizes larvae of the sunflower stem weevil in both cultivated and native sunflower. *Nealiolus curculionis* also attacks the red and gray sunflower seed weevils (*Smicronyx fulvus* LeConte and *S. sordidus* LeConte) in native sunflowers (*Helianthus* spp.) throughout the central and northern Plains. Adult parasitoids are active in the field from late June to late August. Eggs are deposited in early instar weevils feeding within the sunflower stalk. The immature parasitoids overwinter within diapausing weevil larvae in the sunflower stalk. Studies have shown that overall parasitization has increased from levels reported in the late 1970s and early 1980s from averages of 5% to 27%. The consistent rates of parasitism compared with the variable field densities of adult parasitoids suggest that *N. curculionis* effectively attacks hosts under varying host population densities. This parasitoid appears to be a consistent mortality factor in the population dynamics of the sunflower stem weevil in cultivated sunflower.

Quadrastichus ainsliei (Figure 14) also was frequently recovered representing 3% to 73% of the parasitoid species attacking weevil larvae. *Q. ainsliei* deposits multiple eggs inside the weevil resulting in many parasitoids from one host.

Neocatolaccus tylodermae is more commonly found in weevils from Colorado and Kansas. It was rare in Nebraska and has not been found in North and South Dakota or Minnesota. It has also been reported as a parasitoid of *C. adspersus* attacking sunflower in Texas.

Additional research is needed to understand the sunflower stem weevil parasitoid complex and their population dynamics in order to manipulate these natural enemies to improve biological control of sunflower stem weevil in cultivated sunflowers. The impact of pesticides on natural enemies must be considered in developing management programs, since insecticides that are toxic to the weevil also kill parasitoids.

Monitoring

Field monitoring for sunflower stem weevils to estimate population is important. However, adults are difficult to see on the plants due to their small size, cryptic color, and "play dead" behavior. They are inactive on the plant or fall to the ground when disturbed and remain motionless. Adults can be found on both surfaces of the leaves, the lower portions of the stem, in leaf axils, within the dried cotyledons, or in soil cracks at the base of the sunflower plant. Yellow sticky traps were unsuccessful in relating captured adult numbers to larval infestations.

Sampling for the larval stage is difficult since they completely develop within the sunflower plant. Thus, the only method for detecting the presence of larvae is to split the sunflower stem, a time-consuming process.

Field scouting for adults should begin when plants are in the eight to 14 leaf stage (Figure 15), developmental stage V-8 to R1, or late June to early July, and continue until mid-July. Select sampling sites 70 to 100 feet in from the field margin. Count the number of adults on five plants at five randomly selected sampling sites throughout the field for a total of 25 plants. Calculate the average number of weevils per plant. Use an "X" pattern (or "W" pattern) to space sample sites over the entire field. When scouting for stem weevils, approach plants carefully and slowly to avoid disturbing the adults.

Chemical Control

Chemical control strategies are directed at adults and must be initiated prior to late June or early July to prevent significant egg laying and to reduce the risk of economic damage from larval induced lodging. By mid-July, 50% of egg deposition has occurred.

The use of both foliar and systemically applied insecticides has been shown to be effective in reducing larval populations and percentage of stalks lodged. Application of a foliar insecticide is recommended only when adult weevil populations have reached the economic threshold level in a field. Keep in mind that insecticides destroy natural enemies of the weevil and are more adverse to the environment.

Insecticides registered for the sunflower stem weevil in North Dakota as of 2002 are listed in the following table. Please check with the current Field Crop Insecticide Management Guide — E-1143, NDSU Extension Service, North Dakota State University, Fargo, ND 58105 — for updated insecticide registrations. It is important that insecticide users READ, UNDERSTAND, and FOLLOW ALL LABEL DIRECTIONS.

Figure 15. Proper crop development stage, 8-14 leaf, for scouting for sunflower stem weevil.

Economic Threshold

1 adult sunflower stem weevil per 3 plants

Average field counts of one adult sunflower stem weevil per three plants can result in damaging larval densities of over 40 larvae per stalk at the end of the season (based on sampling during the two-week period between 24 June and 7 July in North Dakota.) Larval populations of 25-30 or more per stalk can weaken the stem tissues and cause breakage.

Insecticide Recommendations for Sunflower Stem Weevil

Insecticide	Dosage lb ai/ acre	Product Per Acre	Restrictions on Use
FOLIAR APPLICATIONS			
Asana XL* *RUP* *esfenvalerate*	0.03-0.05	5.8-9.6 fl oz	Do not apply within 28 days of harvest.
Baythroid* *RUP* *cyfluthrin*	0.025-0.0375	1.6-2.4 fl oz	Do not apply within 30 days of harvest.
Sevin *carbaryl*	1-2	rate varies by formulation	Do not apply within 60 days of harvest. Do not allow livestock to graze on treated forage.
Furadan 4F* *RUP* *carbofuran*	0.5	1 pt	Do not apply within 28 days of harvest.
Lorsban 4 E* *RUP* *chlorpyrifos*	0.5	1 pt	Treat about 5 to 7 days after adult stem weevils begin to appear. Do not apply within 42 days of harvest. Do not allow livestock to graze in treated areas. Do not apply more than 9 pints per acre per season.
Scout X-TRA* *RUP* *tralomethrin*	0.014-0.0164	2-2.33 fl oz	Do not apply within 21 days of harvest.
Warrior* *RUP* *lambda cyhalothrin*	0.02-0.03	2.56-3.84 fl oz	Do not apply within 45 days of harvest.
AT PLANTING APPLICATIONS			
Furadan 4F* *RUP* *carbofuran*	0.08	2.5 fl oz per 1000 linear feet of row (or 1.4 quarts per acre with 30 inch row spacing.	Apply directly into the seed furrow. May be mixed with water or liquid fertilizer.

*RUP - Restricted use pesticide

For more information on this and other topics, see: www.ag.ndsu.nodak.edu

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