◆ EPPO Standards ◆

GUIDELINES ON GOOD PLANT PROTECTION PRACTICE

SUNFLOWER

PP 2/21(1) English

European and Mediterranean Plant Protection Organization
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APPROVAL

EPPO Standards are approved by EPPO Council. The date of approval appears in each individual standard.

REVIEW

EPPO Standards are subject to periodic review and amendment. The next review date for this set of EPPO Standards is decided by the EPPO Working Party on Plant Protection Products.

AMENDMENT RECORD

Amendments will be issued as necessary, numbered and dated. The dates of amendment appear in each individual standard (as appropriate).

DISTRIBUTION

EPPO Standards are distributed by the EPPO Secretariat to all EPPO Member Governments. Copies are available to any interested person under particular conditions upon request to the EPPO Secretariat.

SCOPE

EPPO guidelines on good plant protection practice (GPP) are intended to be used by National Plant Protection Organizations, in their capacity as authorities responsible for regulation of, and advisory services related to, the use of plant protection products.

REFERENCES

All EPPO guidelines on good plant protection practice refer to the following general guideline:

OEPP/EPPO (1994) EPPO Standard PP 2/1(1) Guideline on good plant protection practice: principles of good plant protection practice. *Bulletin OEPP/EPPO Bulletin* **24**, 233-240.

OUTLINE OF REQUIREMENTS

For each major crop of the EPPO region, EPPO guidelines on good plant protection practice (GPP) cover methods for controlling pests (including pathogens and weeds). The main pests of the crop in all parts of the EPPO region are considered. For each, details are given on biology and development, appropriate control strategies are described, and, if relevant, examples of active substances which can be used for chemical control are mentioned.

EUROPEAN AND MEDITERRANEAN PLANT PROTECTION ORGANIZATION
ORGANISATION EUROPEENNE ET MEDITERRANNEENNE POUR LA PROTECTION DES PLANTES

PP 2/21(1) English

Guidelines on good plant protection practice

SUNFLOWER

Specific scope

This standard describes good plant protection practice for sunflower.

Specific approval and amendment

First approved in September 2000.

This guideline on GPP for sunflower forms part of an EPPO programme to prepare such guidelines for all major crops of the EPPO region. It should be read in conjunction with EPPO Standard PP 2/1(1) Principles of Good Plant Protection Practice. The guideline covers methods for controlling pests (including pathogens and weeds) of sunflower *(Helianthus annuus)*.

The two basic types of sunflower cultivars grown are oilseed (linoleic or oleic) types and non-oilseed (for the bird-food and confectionery market). Sunflower is a major source of vegetable oil in Europe. It is used for cooking oil, industrial raw material (oil, cellulose), poultry and animal feeds (seeds, pressing residues, green material). Seeds contain 20-40 % protein, 30-65% oil, comprising up to 80% linoleic acid. Sunflower provides a useful nectar source for bees.

Most sunflower cultivars now grown are hybrids. These have replaced open-pollinated cultivars because of their increased yield, pest resistance or tolerance (especially to rust, downy mildew), uniformity (facilitating harvest), stem quality and self compatibility (reducing the need for bees and other insect pollinators for cross pollination).

Selection of adaptable hybrids combined with use of recommended production practices are important factors for profitable sunflower production. High-quality, uniform seeds, with high germination, known varietal purity, and freedom from weed seeds and disease, should be selected to reduce production risks. Most seeds are now treated with a fungicide and insecticide to protect the germinating seedling.

Sunflower has modest soil and water requirements, but grows best on well-drained, high water-holding capacity soils with a near neutral pH (pH 6.5-7.5). It tolerates a wide range of soil types, but high levels of nitrogen encourage excessive plant growth, delaying maturity of the flower heads. Adequate levels of phosphorus and potassium are recommended. The seedbed for sunflower should be moist, firm and free from weeds. Planting should be done immediately after final tillage. Roots go deep and spread extensively, so sunflower can withstand some drought and nearby cultivation. Sunflowers should not be water-stressed during the critical period about 20 days before and after flowering.

Sunflower is a high-risk crop for potential losses from diseases, insects, birds and weeds. These potential risks require that growers follow GPP based on the use of economic threshold levels (when available), warning systems (when available), careful monitoring and a combination of various control methods to maintain pest populations below levels which cause unacceptable losses to crop quality or yield. GPP recommends the judicious use of chemical methods when needed and suggests ways to maximize effectiveness and minimize impact on non-target organisms and environment. Sunflower pests are not distributed evenly throughout a field, and fields should be checked in several locations. Usually a weekly field check is sufficient, but field checks should be increased if the number of pests increases rapidly or approaches an economic threshold level. A minimum rotation of 4 years between successive sunflower crops is recommended. This will help to reduce populations of many important sunflower-specific diseases caused by soil-borne pathogens. Some sunflower pathogens attack other crops (such as mustard, soybean, beans), which should therefore not be used in sunflower rotations. Two methods of cultural weed control are commonly employed with sunflower (see section on Weeds). Sunflower, due to the easy accessibility and high nutritional value of its seed, is particularly vulnerable to damage by birds.

The principal sunflower pests considered are the following:

- *Diaporthe helianthi*;
- *Sclerotinia sclerotiorum*;
- *Botryotinia fuckeliana* (grey mould);
- *Plasmopara halstedii* (downy mildew);
- *Leptosphaeria lindquistii)*;
- *Alternaria helianthi*;
- *Macrophomina phaseolina* (charcoal rot);
- *Puccinia helianthi* (sunflower rust);
- soil insects (wireworms, white grubs);
- weevils;

- noctuid larvae (cutworms);
- aphids;
- plant-feeding bugs;
- birds;
- weeds.

Details on desiccation are also given.

Explanatory note on active substances

The EPPO Panel on Good Plant Protection Practice, in preparing this guideline, considered information on specific active substances used in plant protection products and how these relate to the basic GPP strategy. These details on active substances are included if backed by information on registered products in several EPPO countries. They thus represent current GPP at least in those countries. It is possible that, for any of numerous reasons, these active substances are not registered for that use, or are restricted, in other EPPO countries. This does not invalidate the basic strategy. EPPO recommends that, to follow the principles of GPP, only products registered in a country for a given purpose should be used.

Diaporthe helianthi

General

Diaporthe helianthi (anamorph *Phomopsis helianthi*) is the most damaging pathogen of sunflower. It usually attacks after flowering and the symptoms appear on different parts of the plant. The most typical symptoms are spots on the lower third of the stem. They originate from the attachment points of petioles, the pathogen usually having attacked the leaf first. Lesions on leaves appear as collapsed areas bordered by the main veins, from which the fungus spreads to the stem via the petiole. The initially brown stem spots spread rapidly, encircle the stem, and soon become dark grey to black. The upper part of the infected plant turns dry and the stem breaks easily. Pycnidia appear in the form of tiny, black dots on the surface of the infected areas.

D. helianthi also causes brown to black spots on the head. Seeds from the infected capitula carry the pathogen. Perithecia form on overwintered plant residues.

Basic strategy

Moderately high temperatures (25-27°C), rain, dew, and high humidity increase the epidemic spread of the disease. Careful and proper ploughing of infected plant residues into the soil (deeper than 5 cm) prevents overwintering of the pathogen, and eliminates the primary inoculum from infected areas. Less dense planting (about 50000 plants per ha) reduces humidity and limits epidemic spread. Growing tolerant or resistant hybrids, use of healthy seeds, keeping 5-6 year crop rotation and good weed control are also recommended. The pathogen also infects volunteer sunflower plants, so their elimination is essential. Chemical sprays are needed if the disease spreads epidemically. They are most effective when 6 to 8 leaves have developed (BBCH stage 16-18) and at the beginning of flowering (BBCH 61).

Main fungicides

Sprays: benomyl, carbendazim, carboxin, flusilazole, iprodione, mancozeb, procymidone, thiophanate-methyl, vinclozolin.

Sclerotinia sclerotiorum

General

Sclerotinia sclerotiorum causes a progressive soft rot on unlignified tissues of a wide range of hosts. In sunflower, first symptoms may already appear on seedlings. Stem infection starts at the soil level and plants first exhibit wilting, rapidly followed by total collapse and lodging. Lesions also occur on leaves but only spread if conditions are favourable. At the end of summer, the back of the heads can first be affected, then infection may spread among the seeds. Characteristic features are the formation of extensive, soft, usually light-coloured lesions and the growth of a white, fluffy carpet of mycelium on the surface of the plant.

Sclerotinia sclerotiorum overwinters as sclerotia and can survive in the soil for 6-8 years. The plants are infected by mycelium directly developing from sclerotia or by ascospores from apothecia developing from sclerotia. On sunflower, about 42 h of wetness is needed for ascospore infection of the capitulum, and the symptoms appear about 5 weeks later. The disease is favoured by temperatures of 15-20°C.

Basic strategy

Cultural methods of control are important: 5-6 year crop rotation, correct nutrition, correct density per ha, good weed control, healthy seeds, use of resistant hybrids which tolerate stem infection. Biological control is possible with the "biological fungicide" *Coniothyrium minitans*, which prevents pathogenic strains of *S. sclerotiorum* from penetrating and thereby infecting treated plants. Chemical sprays are directed at protecting plants from ascospore infection. Sprays should be applied as advised by warning services if available, or under favourable conditions (warm, wet weather). Desiccation may reduce damage to heads.

Main fungicides

Seed treatments: benomyl, mancozeb.

Sprays: benomyl, carbendazim, *Coniothyrium minitans*, flusilazole, flutriafol, iprodione, procymidone, vinclozolin.

Botryotinia fuckeliana (grey mould)

General

Botryotinia fuckeliana (anamorph *Botrytis cinerea*) is a non-specific parasite which attacks sunflower as well as many other hosts. Grey mycelium appears on the seed surface, on both sides of the head, on different parts of the stem, and on leaves and buds. The infected tissues become brown and soft, and later dry. Under humid conditions, grey mould spreads rapidly. In dry weather, the mycelium produces conidia. Tiny, black sclerotia sometimes appear among the seeds. Infection of the heads is most impressive, as they rot and fall to the ground. The fungus mainly overwinters on infected plant debris. The main source of inoculum is conidia, which are wind-borne and are also spread by rain (splash dispersal).

Basic strategy

Prevention is the basis of control: use of good quality seeds, optimal nutrition, adequate crop rotation, optimal density. Chemical control is possible, by seed treatment or by spraying in the field.

Resistance

Resistance to benzimidazoles and dicarboximides is well known in *B. fuckeliana* but has not been reported as a problem in sunflower.

Main fungicides

Seed treatments: benomyl, carboxin, mancozeb, oxine-copper, vinclozolin.

Sprays: carbendazim, flutriafol, flusilazole, iprodione, prochloraz, procymidone, tebuconazole, vinclozolin.

Plasmopara halstedii (downy mildew)

General

Plasmopara halstedii has been observed on cultivated and wild sunflower. It is a soil-borne pathogen, its oospores serving as primary inoculum to young underground tissues of sunflower. Oospores are capable of surviving for as long as 8-10 years in the soil. It may also be wind-borne, causing secondary infection of the leaves, or even seed-borne when seeds produced by affected plants carry mycelium and/or oospores of the pathogen. Secondary, aerial, spread is not important. Accordingly, the disease is extremely difficult to eliminate once it is established in the field. Sunflower plants are susceptible to systemic infection for only a very short period, up to a maximum of 2-3 weeks, depending on soil temperature and moisture. Cool, water-saturated soil during this period greatly favours infection.

Typical symptoms in seedlings include dwarfing and yellowing (chlorosis) of the leaves and the appearance of white cottony masses (mycelium and spores) on the lower and sometimes upper leaf surface during periods of high humidity and dew. Many seedlings are killed, but those that survive produce stunted plants with erect, platform heads with little if any seed.

Basic strategy

Sunflower hybrids resistant to downy mildew are available, but new pathogenic races appear naturally. Chemical control relies on the use of long-lasting systemic fungicides. Use of certified seeds, and seed treatment, is highly recommended. Additional management practices which minimize mildew problems include extended crop rotations, eradication of volunteer sunflower, avoiding poorly drained fields or those with excessive low areas, and delaying planting until soil temperatures foster rapid seedling growth. Water running through an infested field may carry mildew spores into a previously disease-free field.

Main fungicides

Seed treatments : metalaxyl, oxadixyl.

Leptosphaeria lindquistii

General

Leptosphaeria lindquistii (anamorph *Phoma macdonaldi*) causes black spots on the stems and heads of sunflower. Symptoms are visible on the lower and middle parts of the stem, especially at points of petiole attachment, just as in the case of infection by *Diaporthe helianthi*. The spots are large, black, clearly delimited, with a silvery surface. The stem is hardly injured below the spots, but the medulla turns dark brown then black, and finally dies.

Strong winds can easily break the stem at the point of infection. The fungus persists in infected stem material, forming pycnidia and pseudothecia within 2-3 years. Primary infection is caused by conidia from pycnidia. A film of water is needed for infection. The optimum temperature for the fungus is about 25°C.

Basic strategy

According to observations, green-stem hybrids are more infected. Infected crop residues should be ploughed deeply into the soil and good crop hygiene should be maintained. Fungicide treatments are not recommended especially against this disease, but treatments against *Diaporthe helianthi* and *Sclerotinia sclerotiorum* may be expected to have some effect.

Alternaria helianthi

General

Alternaria helianthi produces dark brown spots on leaves. These spots are irregular in size and shape, with a very dark border and a grey centre. Spots on young plants may have a yellow halo. Leaf lesions may coalesce causing leaves to wither. Stem lesions begin as dark flecks which enlarge to form long, narrow lesions. These stem lesions often coalesce to form large blackened areas resulting in stem breakage. Stem lesions are randomly distributed on the stem and are not associated with the point of attachment of the leaf petiole. Brown sunken lesions may form on the receptacle but *A. helianthi* has not been reported to cause head rot. The fungus overwinters on diseased stems. It can be seed-borne at low levels, but seed is relatively unimportant as a source of inoculum under moist conditions.

Basic strategy

Plants at the flowering to maturing stage are more susceptible than plants in the vegetative or budding stage. Seedling blights may develop when sunflower plants emerge in rainy weather in soil infested by *A. helianthi*. The disease is favoured by a temperature of 25-27°C and at least 12 h of leaf wetness. Extended wet periods of 3-4 days can cause serious losses as the spots will become much larger. GPP includes crop rotation, and chopping and burying of infested crop refuse to hasten decomposition. Seed treatment with fungicide significantly reduces the incidence of *Alternaria* seedling blight. Foliar fungicides may also be applied as a spray, when symptoms are seen.

Main fungicides

Seed treatments: benomyl, carbendazim, carboxin, mancozeb.

Sprays: carbendazim, flutriafol, flusilazole, iprodione, prochloraz, procymidone, tebuconazole, vinclozolin.

Macrophomina phaseolina (charcoal rot)

General

Macrophomina phaseolina forms sclerotia (known as *Rhizoctonia bataticola*) and dark brown pycnidia, containing large pycnospores. It attacks innumerable hosts. On sunflower, it is an important pathogen in hot regions. Attacks vary from year to year, mainly according to temperature (favoured by soil temperatures over 28°C) and rainfall. The fungus persists as sclerotia in the soil, or may be seed-borne. It initially causes dark brown to black lesions on the roots. Infected plants may show a characteristic silvery discoloration of the stem base. The fungus spreads up the vascular tissues of the stem, finally forming numerous small sclerotia, like finely powdered charcoal giving the infected tissues a greyish-black colour. Sunflower shows small distorted heads with a central zone of aborted flowers. The disease reduces yield, seed and oil quality.

Basic strategy

Control is mainly by cultural methods: maintenance of good irrigation under high temperature conditions, destruction of infected plant debris. Crop rotation gives only limited control since the fungus is so polyphagous (infecting about 300 cultivated plants and weeds). No fungicide treatments are recommended.

Puccinia helianthi (sunflower rust)

General

Symptoms (cinnamon-coloured spots or pustules) of sunflower rust may appear on all the above-ground tissues of plants but are more prevalent on leaves. The fungus overwinters on plant debris as teliospores which germinate early in the spring, giving rise to primary infection of volunteer and wild sunflower plants, as sunflower is not normally seeded until later in the spring. Rust multiplies rapidly under favourable conditions of warm temperatures and frequent rain or dew. Sunflower can generally tolerate a moderate attack of rust without any effect on yield, but late-planted susceptible cultivars may be more severely damaged.

Basic strategy

As early in the spring as possible, volunteer plants and wild annual sunflower occurring in the vicinity of commercial fields should be destroyed. Resistant cultivars should be used, if available. Susceptible cultivars should be planted early. Excessive rates of nitrogen fertilization and abnormally high seeding rates result in excessive foliage, which increases humidity within the canopy and favours rust development. If necessary, fungicide sprays may be used.

Main fungicides

Sprays: triadimefon.

Soil insects (wireworms, white grubs)

General

The larvae of certain *Elateridae* (*Agriotes* spp.) and *Melolonthidae* (*Melolontha* spp.) can damage germinating seeds and seedlings until the 2- to 4-leaf stage (BBCH 12-14). Wireworms are particularly important. Their development takes several years, consequently larvae of different sizes may be present in the soil when sunflower is planted. Development of white grubs takes 3-4 years. Damage normally occurs from the third larval stage onwards, starting in the year after adult flight.

Basic strategy

Grassland or uncultivated land as a preceding crop should be avoided. Knowledge of the level of population of wireworms and white grubs in the soil is needed to make a decision on treatment. The main strategy is aimed at reducing the amount of plant protection products applied to soil, so localized treatments in the row are preferred whenever possible to general soil treatments. The type of treatment will depend on the level of infestation and the date of sowing.

Main insecticides

Soil treatments: bendiocarb, carbofuran, chlormephos, chlorpyrifos, diazinon, fonofos, furathiocarb, tefluthrin.

Seed treatments: bendiocarb, fipronil, furathiocarb, methiocarb, thiodicarb.

Sprays: chlorpyrifos, diazinon, fonofos, furathiocarb.

Weevils

General

Sunflower is attacked by several weevils (*Tanymecus dilaticollis, T. palliatus, Psalidium maxillosum*). The crop is most vulnerable from the unfolding of cotyledons to the 4-leaf stage (BBCH 10-14). The adults feed on young leaves from the leaf margin leaving characteristic U-shaped notches. *Tanymecus dilaticollis* has one generation, *T. palliatus* and *P. maxillosum* have two generations per year. The weevils are favoured by successive dry, warm springs. High temperatures enhance feeding.

Basic strategy

Various cultural methods reduce weevil populations and damage: crop rotation, time of sowing, conditions favouring rapid seedling development and plant density. It is important to assess the insect population in autumn before overwintering and then in spring when the plants start emerging. Insecticide spray application is the main control method, but soil treatments against other pests can reduce weevil damage. Seed treatment may also be used.

Main insecticides

Seed treatments: acetamiprid, thiodicarb.

Soil treatments: carbofuran, carbosulfan, chlorpyrifos, diazinon, tefluthrin, terbufos, thiodicarb.

Sprays: chlorpyrifos.

Noctuid larvae (cutworms)

General

Larvae of noctuid moths, especially *Agrotis segetum, A. ipsilon* and *Euxoa temera* (cutworms, i.e. soil-inhabiting noctuid larvae), may attack sunflower. Late-instar larvae are thick, grey-brown with darker marks, and usually curled up in the soil when found. Depending on the species, they can be 30-35 mm long when fully grown. Final-instar larvae overwinter in the soil and pupate in the spring, sometimes after a short resumption of feeding. Adults arising from these pupae are on the wing from May to July depending on location and species, and larvae arising from eggs laid in the soil by these adults cause damage in crops. Sunflower seedlings may be cut at or just below ground level shortly after emergence. Early instar larvae feed on the crop foliage, but more damage is caused by later-instar larvae. Feeding occurs mostly at night. Cutworms spend the day hiding in leaf litter or just under the soil surface near the base of recently damaged plants. Wilted or dead plants frequently indicate the presence of cutworms. Larvae of leaf-feeding noctuids such as *Autographa gamma* may also periodically attack sunflower. Another noctuid species *Helicoverpa armigera* sometimes feeds on flower heads.

Basic strategy

Generally cutworms are difficult to control. Because of the progressive nature of insect development, the susceptible stages of the larvae are often passed by the time infestations have become apparent, and damage may already be quite serious. Population predictions are generally unsuccessful, although much research on population monitoring has been carried out and an appropriate cutworm forecasting/warning system can provide information on the optimum (early timing) of insecticide applications. For several species, pheromone traps are available in addition to light traps. Soil sampling can also be helpful and should begin as soon as sunflower plants emerge, especially around damaged plants, to determine if cutworms are present. Fields should be checked regularly until approximately mid-June. Application of granules pre-sowing or pre-emergence is rarely effective. Cutworms are best controlled when larvae are feeding on the foliage during the early part of larval development. Usually only one spray, applied with a high volume of water, is necessary.

Main insecticides

Sprays: cypermethrin, deltamethrin, fenvalerate, lambda-cyhalothrin.

Aphids

General

Several species of aphids can be observed on sunflower *(Aphis fabae, A. gossypii, Aulacorthum solani, Brachycaudus helichrysi, Macrosiphum euphorbiae, Myzus persicae*). The two most frequent species are *A. fabae* and *B. helichrysi.* They may cause direct feeding damage from the 2- to 4-leaf growth stage (BBCH 12–14) to harvesting (BBCH 92). Aphids are most abundant and damaging on leaves and unopened flowers (up to BBCH growth stage 59). Severe attack may stop head development, and yield may be reduced.

Basic strategy

The crop should regularly be inspected. The first aphids will usually be found on the edge of the field. Seedlings may be protected if seeds were treated or systemic granules were used against soil pests. In the case of heavy infestations, later in the season, insecticide sprays may be needed.

Main insecticides

Sprays: diazinon, fenitrothion, formothion, lambda-cyhalothrin, phosalone, pirimicarb, triazamate.

Plant-feeding bugs

General

Sunflower is attacked by several heteropteran bugs (*Lygus pratensis, L. rugulipennis, Adelphocoris lineolatus*). The *Lygus* spp. are about 6 mm long, oval in shape, brownish-greenish in colour with darker markings. *A. lineolatus* is 6-9 mm long, yellow-green in colour with two black spots on the pronotum. The adults appear early, on sunflower with 5-6 leaves developed (BBCH 15-16). The symptoms can first be seen on stem and leaves, later on bud and head. Severe damage is caused by sucking sap from seeds. If the attack comes within 20 days after flowering (after BBCH 69), yield and oil quality can be significantly lower. These Heteroptera have 2-3 generations per year. Warm dry weather favours their spread.

Basic strategy

Sunflower should preferably not be sown next to lucerne. Fields should be evaluated regularly to determine population levels of these bugs, and threshold levels should be checked before deciding on treatment. If sprays are needed, this is usually during the flowering period when bees and other pollinators are present in sunflower, so the insecticide should be chosen with particular care.

Main insecticides

Sprays: beta-cypermethrin, deltamethrin, fenitrothion, malathion, lambda-cyhalothrin, phosalone.

Birds

General

Many species of birds (rooks - *Corvus frugilegus*, pheasants - *Phasianus colchicus*, domestic pigeons - *Columba livia domestica*) feed in maturing sunflower fields. Sunflower seeds, a preferred bird food, are exposed and the large head serves as a perch during feeding. Less frequently, seeds are attacked immediately after sowing.

Basic strategy

To reduce the risk of bird damage, sunflower should not be planted near well-known nesting or roosting areas. Seeds may be treated with a bird repellent. Weed control should begin early, because weeds are often an attractive food source before the crop reaches a susceptible stage. Sunflower should be harvested as early as possible to avoid prolonged exposure to bird damage. To deter birds, scaring devices can be used. Electronic scarers that broadcast the distress calls of birds are quite effective, but their application is somewhat limited because of their high cost. Flower heads can be covered with plastic netting. Bird-resistant hybrids are being developed for use in high-risk depredation areas.

Bird repellents

Seed treatments : anthraquinone, ziram.

Weeds

General

Weeds are usually a problem because sunflower does not develop ground cover rapidly enough to prevent them from becoming established. The competitive advantage of sunflower comes into play only after plants are well established. Weeds allowed to compete longer than 4 weeks may cause poor growth of sunflower and important yield loss. Dicot weeds present a more serious problem than monocots. Control of *Ambrosia artemisiifolia* is extremely difficult, owing to botanical similarity between the weed and the crop itself. Only a limited number of herbicides can be used.

Basic strategy

The most effective weed management is accomplished by a good system of cultural and chemical control. Weeds should be controlled in other crops in rotation to reduce the potential infestation level in sunflower. Pre-sowing and pre-emergence tillage practices to reduce

weeds that emerge before sunflower, and post-emergence cultivation to control weeds between the rows, may be needed to supplement use of herbicides.

Sunflower should be sown after the last tillage operation so the crop can rapidly germinate and compete more with emerging weeds. Weeds frequently emerge before sunflower, especially during cool weather, and they can be controlled by pre-emergence harrowing.

Post-emergence mechanical weed control consists of harrowing and cultivating. Sunflower seedlings, which are strongly rooted, can be harrowed three times during the 4- to 6-leaf stage (BBCH 14-16). Some sunflower loss (5-8%) can be expected, so if this system of weed control is planned, the sunflower should be seeded at higher rates than normal. Cultivation can also be done later in the season, but not closer to the row centre than the leaf to the plants, to avoid damaging shallow lateral sunflower roots. During later cultivations, soil may be thrown into the row to bury weeds and provide extra support for the crop.

Against *A. artemisiifolia*, pre-sowing treatments are commonly used, or else aclonifen or flurtamone post-sowing and pre-emergence.

Sunflower is sensitive to many of the post-emergence herbicides commonly used on crops in close proximity (e.g. glyphosate, dicamba, 2,4-D, MCPA, paraquat, bentazone, atrazin, cyanazine, imazethapyr, picloram, methylarsonic acid, and the sulfonylureas nicosulfuron, metsulfuron-methyl, primisulfuron-methyl, tribenuron-methyl, thifensulfuron-methyl). Therefore, care must be taken to avoid drift and spray equipment must be thoroughly washout.

Main herbicides

Pre-sowing treatments

trifluralin, benfluralin, EPTC, incorporated before sowing against annual monocots and some annual dicots.

Pre-emergence treatments

Against annual monocots: acetochlor, metolachlor, propisochlor, propachlor, alachlor, dimethenamid, ethalfluralin, oxadiargyl, pendimethalin.

Against dicots: bifenox, chlorbromuron, fenuron, flurochloridone, linuron, metobromuron, oxadiargyl, oxyfluorfen, prometryn, terbutryn, (15-20 mm precipitation is needed for these to be effective).

Post-emergence treatment

Against dicots: bifenox.

Against perennial monocots: propaquizafop, fluazifop-P-butyl, fenoxaprop-P-ethyl, haloxyfop-methyl, quizalofop-P-ethyl, quizalofop-P-tefuryl, cycloxydim, sethoxydim.

Desiccation

General

Desiccants are only used on oilseed crops. They allow earlier harvesting by permitting the head, stalk and leaves to dry more rapidly. However, they may cause loss of grain and, if applied before the plant reaches physiological maturity, reduce yield and lower oil percentage. Their use is not, therefore, generally recommended but may be appropriate if there is a problem of uneven ripening or weed infestation. Desiccants also control weeds which may interfere with harvesting and, by advancing harvest, reduce exposure to birds.

Basic strategy

Desiccants are applied at physiological maturity of sunflower when the back of the head has turned from green to a light lemon yellow and the bracts are turning brown. This usually occurs 30-45 days after flowering, depending on temperature during the maturation period. Seed moisture should be less than 35% (dimethipin reduces seed moisture content at harvest, so the seed moisture should be 40-50 % if this product is used).

Main desiccants

Sprays: dimethipin, diquat dibromide, glufosinate-ammonium.