Norwegian Journal of Agricultural Sciences

Supplement No. 10 1993

Nordic Guidelines for Biological Evaluation of Pesticides

Norwegian Agricultural Advisory Service, Ås, Norway

NORWEGIAN JOURNAL OF AGRICULTURAL SCIENCES

Norwegian Journal of Agricultural Sciences fills a need created by the folding of Scientific Reports of the Agricultural University of Norway and Research in Norwegian Agriculture for a forum for publishing Norwegian research with international interest within the following areas: Aquaculture, Animal Science, Soil Science, Agricultural Engineering and Technology, Natural Resources and Environment, Food Technology, Crop Science, Forestry, Economics and Society Planning.

PUBLISHER

The journal is published by Norwegian Agricultural Advisory Service, Moerveien 12, N-1432 Ås, Norway. Norwegian Journal of Agricultural Sciences (ISSN 0801-5341) is published four times a year, each issue containing approximately 100 pages. Four issues comprise one volume. Annual subscription NOK 500,–. Subscribers receive supplement issues free of charge, but these can also be ordered separately through the publisher.

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All Correspondence, editorial or otherwise, should be adressed to Norwegian Agricultural Advisory Service.

The drawing on the cover is from Kjell Aukrust's «*Guttene på broen*».

ISSN 0802-1600

NORDIC GUIDELINE FOR THE BIOLOGICAL EVALUATION OF PESTICIDES

This guideline is made by a working group under the Nordic Committee for Biological Evaluation of Pesticides.

The aim is to provide a general scheme for testing of pesticides in the Nordic countries and to improve the cooperation concerning biological evaluation and to make the testing of pesticides standardized and efficient.

The guideline is based on EPPO guideline and national guideline for biological evaluation of pesticides and contains a short description of the biology of noxious organisms and how to establish, manage, evaluate and report plant protection trials.

The work has been financed by the Nordic Council.

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Content . . . . . Page

NORDIC GUIDELINE NO. 12

BIOLOGICAL EVALUATION OF PESTICIDES

1. THE PEA MOTH

1.1 Pathogen

The pea moth (*Cydia nigricana* F.) is a dull grey-brown moth with both pale and dark markings near the tip of the forewing and is about 6 mm long with wingspan of about 15 mm.

The small flattened eggs are laid singly or in small groups mainly on the leaves and stipules. After about a week the young caterpillars hatch and enter the young pods where they remain feeding on the peas until fully grown. They then bite through the pods and descend to the soil where they spend the winter in a cocoon.

In the spring the larvae become pupae from which the moths emerge in early summer. There is only one generation a year.

1.2. Host plants

All varieties of peas are susceptible to attack. Other leguminous plants like *Lathyrus pratensis*, *Vicia cracca* and *Lathyrus odoratus* are also attacked.

1.3. Symptoms

The larvae feed on the peas inside the pods during summer. The peas are damaged and the larvae together with their excrement can easily be seen in the pods. Not only do they ruin the peas which they eat but their presence may reduce the economic value of the crop for canning of freezing, where only a very small percentage of damaged peas can be tolerated.

1.4. Epidemiology

The adult moth emerges in June. The hatching can go on for several weeks and can in extreme cases continue until mid-June. The moth lives for 10-20 days and the copulation take place on the first day after emergence, i.e. in or close to the field where they emerge. Below 18°C the moths do not fly. After a preoviposition period of 2-3 days, the egglaying starts. The eggs hatch after 7-12 days and the larvae move to the pods.

This takes less than one day. If control of the larvae is to be achieved, then spraying must be carried out before or during this stage to derive maximum benefit.

1.5. Possibilities for Misidentification

None.

2. EXPERIMENTAL CONDITIONS

2.1. Selection of Crop and Variety

The trial is carried out in a common variety of peas. The site should be chosen because of its known attack risk expectancy, i.e. attack should have been observed in the area the year

before in peas harvested when ripe.

2.2. Environmental Conditions
Homogenous experimental conditions are essential. Soil type, fertilization and moisture must not vary within the trial. Soil type and fertilization should be noted. Shaded or strongly sloping parts of the field should be avoided.

2.3. Research Plan
Components: product(s) to be tested, reference product(s) and untreated controls are arranged in a randomized plot design. The shape of the plots should be such as to ensure precise application of the products and to allow for the crop to be harvested with the available equipment. If possible, more than one rate of application should be included.
Plot size: depends on the available equipment, and should be at least 50 m^2, of which at least 25 m^2 is harvested. A 5 m wide zone surrounding the trial should remain untreated with insecticides.
Replicates: at least four.

3. APPLICATION OF TREATMENTS

3.1. Product(s) to be tested
According to the trial description.

3.3. Reference Product(s), Standards
Well-known, registered product(s) giving a satisfactory predictable degree of control.

3.3. Mode of Application

3.3.1. Type of Equipment
Application with suitable, up-to-date equipment. The sprayer should give even coverage (maximum deviation 10%). Avoid spraying in wind speed over 3 m/s. If the sprayer leaves tracks within the intended harvest plot, it should also be run through plots that are not sprayed.

3.3.2. Time and Frequency of Application
The time of application is crucial because the young larvae are only susceptible for a few days when they begin to move into the pods. Pheromone traps could be used to detect when the moths are flying. Two traps are used, one is placed near the field border in the wind direction and the other one 75 m into the field. The trap catch is counted every week. When 10 moths are caught in one of the traps on two consecutive weeks, this is an indication that there is risk for attack. The application is carried out after 5-7 days when the weather is warm and after 8-10 days in cooler weather.

3.3.3. Doses and Volumes
The products should be applied in the dosages recommended by the applicant. Spray liquid volumes should conform with common practice unless otherwise specified.

3.4. Data on Chemicals used against other Pests, Diseases or Weeds
If other chemicals have to be applied, provision must be made to ensure minimum interference. The chemicals must be applied uniformly on all plots and normally separately from the products being tested and the reference product(s). Precise data on these applications must be given.

4. MODE OF ASSESSMENT, RECORDING AND MEASUREMENTS

4.1. Meteorological Data
Time of application: temperature, wind speed and direction, relative humidity and whether plants are wet or dry. Other climatic conditions are only recorded if they are necessary for understanding the results. Adverse conditions such as hail, drought or excessive precipitation should be noted.

4.4. Assessment of Effect

4.2.1. Time and Frequency
Assessment is made two weeks before harvest.

4.2.2. Methods
Assessment is made on plants at five randomly selected places in each plot. All pods on these plants are examined for larval damage. At least 100 pods must be examined. The number of attacked pods is recorded and also the number of attacked peas per pod.

4.3. Sideeffects

4.3.1. Phytotoxicity
All suspected effects (discoloration, schorching, anormal growth, etc.) should be described and graded.

4.3.2. On Flora and Fauna
Secondary effects are described, especially on beneficial organisms, bees, ladybirds, etc.

4.4. Other Pests and Diseases
Aphids are counted on 10 plants/tillers per plot at seven-day intervals, from the beginning of flowering and until the aphids have disappeared in all treatments or aphids are treated with Pirimor at a population density of five aphids/top shoot.
If other pest or disease attacks occur, their type and estimated extent (by plot) should be recorded.

4.4. Recording of Yield
Grain yield adjusted to a fixed moisture level of 15%
1000 seed weight
Hectolitre weight.

5. INTERPRETATION OF RESULTS

5.1. Statistical Methods

Data are analysed using analysis of variance (after appropriate data transformations), and means are compared using a multiple range method. The coefficient of variation and LSD 95 % are computed.

NORDIC GUIDELINE NO. 13

BIOLOGICAL EVALUATION OF PESTICIDES

1. THE PEA APHID

1.1. Pathogen
The pea aphid (*Acyrthosiphum pisum* Harris) is 3.5-4 mm long and often light green but can also be yellow or rose in colour. It has relatively long legs and antennae and the siphunculi are long and narrow.

1.2. Host Plants
The pea aphid lives on different leguminous plants. It is common on peas, clovers, lucerne and field beans.

1.3. Symptoms
Most often the aphids can be found in a colony in the top shoot and hiding behind the developing leaves. The top shoot is stunted in growth and the leaves are discoloured or deformed as a result of the aphid's sucking. The formation of flowers and pods is disturbed.

1.4. Epidemiology
The pea aphids overwinter as egg on perennial wild or cultivated leguminous plants i.e. in clover and lucerne leys. The first generation develops on these plants and in June winged females fly to the pea field. The population increase is very rapid because the females give birth to nymphs parthenogenetically. The gestation period is 10 days at 20°C and every female bears between 50 and 140 nymphs. Winged generations are born when the aphids are crowded on the plants or when the plants no longer provide enough food. The population is influenced by an entomopathogenic fungi (*Entomophthora*) and is also very sensitive to heavy rains, which cause the aphids to fall off the plants. At the end of the season winged males and females are born and the females go back to the perennial crops for egglaying.

1.5. Possibilities for Misidentification
None.

2. EXPERIMENTAL CONDITIONS

2.1. Selection of Crop and Variety
The trial is carried out in a common variety of peas.

2.2. Environmental Conditions
Homogenous experimental conditions are essential. Soil type, fertilization and moisture must not vary within the trial. Soil type and fertilization should be noted. Shaded or strongly sloping parts of the field should be avoided.

2.3. Research Plan
Components: product(s) to be tested, reference product(s) and untreated controls are arranged in a randomized plot design. The shape of the plots should be such as to ensure precise application of the products and to allow for the crop to be harvested with the available equipment. If possible, more than one rate of application should be included.
Plot size: depends on the available equipment, and should be at least 50 m^2, of which at least 25 m^2 is harvested. A 5 m wide zone surrounding the trial should remain untreated with insecticides.
Replicates: at least four
If products with a gas effect (> 1,0 MPa) are in the plan, a protective plot on both sides of these plots must be used. These protection plots must be treated with a contact insecticide.

3. APPLICATION OF TREATMENTS

3.1. Product(s) to be tested
According to the trial description.

3.2. Reference Product(s), Standards
Well-known, registered product(s) giving a satisfactorily predictable degree of control.

3.3. Mode of Application

3.3.1. Type of Equipment
Application with suitable, up-to-date equipment. The sprayer should give even coverage (maximum deviation 10%). Avoid spraying in wind speeds over 3 m/s. If the sprayer leaves tracks with the intended harvest plot, it should also be run through plots that are not sprayed.

3.3.2. Time of Application
The correct time for spray treatment is at an economic damage threshold of five aphids/topshoot, which normally is reached at the beginning of July.

3.3.3. Doses and Volumes
The products should be applied in the dosages recommended by the applicant. Spray liquid volumes should conform with common practice unless otherwise specified.

3.4. Data on Chemicals used against other Pests, Diseases or Weeds
If other chemicals have to be applied, provision must be made to ensure minimum interference. The chemicals must be applied uniformly on all plots and normally separately from the products being tested and the reference product(s). Presise data on these applications must be given.

4. MODE OF ASSESSMENT, RECORDING AND MEASUREMENTS

4.1. Meteorological Data
Time of application: temperature, wind speed and direction, relative humidity and whether plants are wet or dry. Other climatic conditions are only recorded if they are necessary for understanding the results. Adverse conditions such as hail, drought or excessive precipitation should be noted.

4.2. Assessment of Effect

4.2.1. Time and Frequency
Aphids are counted before spraying, two days after spraying and then at seven-days intervals until the aphids have disappeared in all treatments.

4.2.2. Methods
Assessment is made on five adjacent plants in a row at five randomly selected places in each plot. The aphids are easily disturbed and the best method is to shake the top shoot over a paper. Then the aphids fall out from their hiding places under the leaves and are easily counted. More than 90% of the aphids are to be found in the top shoot.

4.3. Side-effects

4.3.1. Phytotoxicity
All suspected effects (discoloration, scorching, abnormal growth etc.) should be described and graded.

4.3.2. On Flora and Fauna
Secondary effects are described, especially on beneficial organisms, bees, ladybirds, etc.

4.4. Other Pests and Diseases
The attack, of pea moth is assessed a few weeks before harvest according to specific guidline, for pea moth.
If other pest or disease attacks occur, their type and estimated extent (by plot) should be reported.

4.5. Recording of yield
Grain yield adjusted to a fixed moisture level of 15%
1000 seed weight
Hectolitre weight.

5. INTERPRETATION OF RESULTS

5.1. Statistical methods
Data are analysed using analysis of variance (after appropriate data transformations), and means are compared using a multiple range method. The coefficient of variation and LSD (95%) are computed.

NORDIC GUIDELINE NO. 14

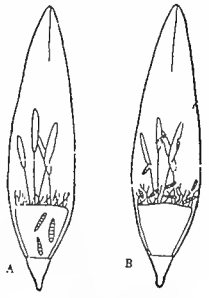
BIOLOGICAL EVALUATION OF PESTICIDES

1. WHEAT BLOSSOM MIDGES

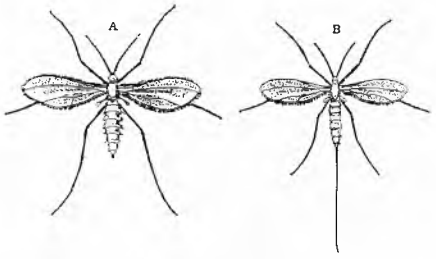
1.1. Pathogen
The two species are:
The orange wheat blossom midge, *Sitodiplosis mesellana* (Gehin) and the yellow wheat blossom midge, *Contarinia tritici* (Kirby)
Descriptions are presented in Figure 1.

1.2. Host Plants
The main host plants are wheat (and rye). In addition, the midges can infest barley, but the intensity of infestation is only one-fifth that on the main hosts. Among uncultivated gramineous plants the couch grass (*Elymus repens*) is known as a host.

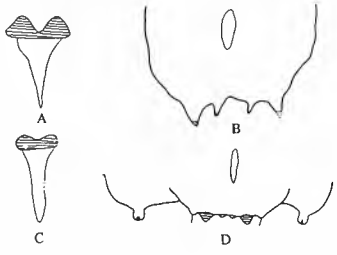
1.3. Symptoms
Orange wheat blossom midge. Attacks occur on the one side of the ear during heading. Midge larvae feed on the surface of the grains and cause shrivelling. This shrivelling of severely damaged grains is characterized by a large number of longitudinal wrinkles in the pericarp and absence of endosperm and germ. The seeds are usually bent into a "J" shape. Seeds that are slightly damaged have a split or a tear in the pericarp, which may expose the endosperm and the embryo. Moisture is easily absorbed by infested grains, which also easily is reduced, the weight being from 70% to 50% that of undamaged seeds.
Yellow wheat blossom midge. Midge larvae are to be found in the brush among the anthers and pollen at the top of the kernel. Groups of two to five (maximum up to 20) larvae can feed on one kernel. As a result of damage no grain is formed.



Position of larvae in flower of wheat (diagrammatic): A, *Sitodiplosis mosellana*; B, *Contarinia tritici*

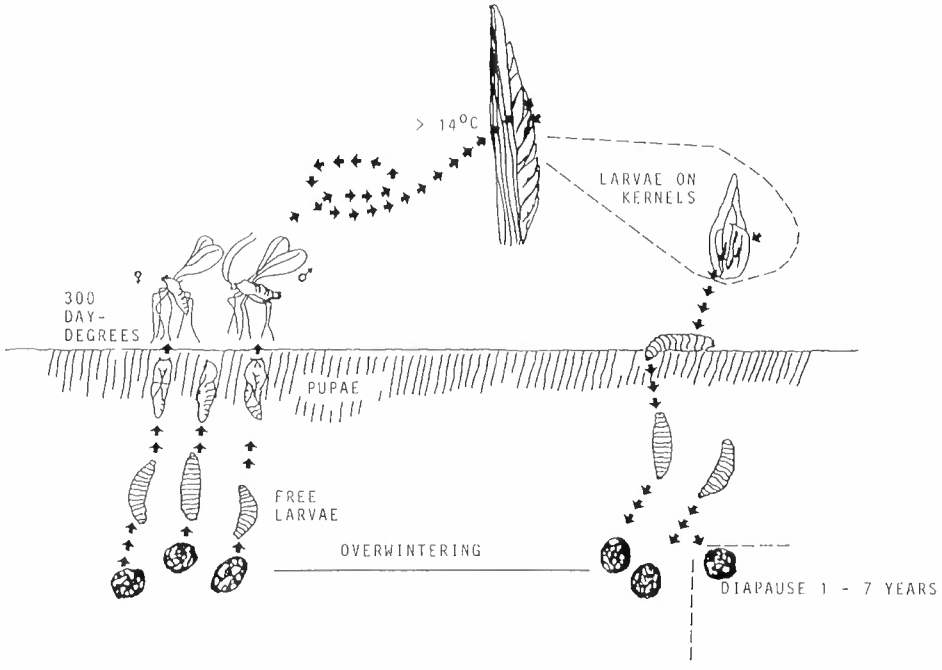


Adult female midges: A, *Sitodiplosis mosellana* (Géhin); B, *Contarinia tritici* (Kirby). (After Wagner)



Larvae of wheat blossom midges; A, anchor process of *Sitodiplosis mosellana*; B, anal extremity of *S. mosellana*; C, anchor process of *Contarinia tritici*, D, anal extremety of *C. tritici*

1.4. Epidemiology
The epidemiology in the Nordic countries is illustrated in Figure 2.



1.5. Possibilities for Misidentification
From a distance midge-damaged ears appear similar to those infected by a *Septoria* disease. Larvae of many species of thrips have the same yellow or orange colour typical of the wheat blossom midge larvae. Larvae of thrips, however, move livelily on the grain, but midge larvae seem to be less moblie.

2. EXPERIMENTAL CONDITIONS

2.1. Selection of Crop and Variety
Both winter and spring wheat can be used for testing products against the wheat blossom midges, but the spring wheat displays the damage more clearly.

2.2. Environmental Conditions
Field trials ought to be organized in a field where high infestation has been experienced during one to three previous years. In dry experimental years, the field should be irrigated to maintain the water content in the soil, in spring up to midsummer, above 50% of the field capacity. Cultivars should be chosen so that the crop reaches the heading stage at about 400-500 day-degrees (counted above 5°C). The heading of the crop should be as even as possible.

2.3. Research Plan
Components: product(s) to be testet, reference product(s) and untreated controls, arranged in a randomized plot design. The shape of the plots should be such as to ensure precise application of the products and to allow for the crop to be harvested with the available equipment. The experiments should be surrounded by the same crop and a 5 m wide minimum range area around the treatments should be felt untreated.
Plot size: net, at least 25 m^2, gross, preferably 50 m^2.
Replicates: at least four.

3. APPLICATION OF TREATMENTS

3.1. Product(s) to be tested
According to the trial description.

3.2. Reference Product(s), Standards
Registered product(s) that have generally proved satisfactory in practice. Formulation type and mode of action should be as close as possible to those of the product(s) to be tested.

3.3. Mode of Application

3.3.1. Type of Equipment
Application with up-to-date equipment. The equipment used should provide an even distribution of the product on all points of the plant. Any incorrect dosage of more than 10% should be reported. If formulation types of the product(s) to be tested and the reference product(s) are the same, the same type of equipment should be used. Information on the type of equipment and operating conditions (e.g. operating pressure) used should be given.

3.3.2. Time and Frequency of Application
The first application should be given when 25% of plants have reached growth stage 51. Application conditions: in the evening when the midges can be seen among ears, temperature above 14°C, wind less than 2 m/s, relative humidity above 70%. Against orange wheat blossom, midge application should be repeated in 3 to 6 days, but not later than during growth stage 59, if new midges fly to the treated area from surrounding fields. All plots should be treated between 9 and 12 o'clock on the same evening under constant weather conditions. The number of applications and the precise time of each application should be recorded.

3.3.3. Doses and Volumes
According to the applicant. The amount of water used should be recorded.

3.4. Data on Chemicals used against other Pests, Diseas or Weeds
If other chemicals have to be applied, provision must be made to ensure that they cause minimum interference. These chemicals must be applied uniformly on all plots (i.e. the whole area of the trial) and should be applied separately from the products to be tested and the reference product(s). Precise data on these applications must be given.

4. MODE OF ASSESSMENT, RECORDING AND MEASUREMENTS

4.1. Meteorological Data
Time of application: temperature, wind speed and direction, sunny/cloudy, humidity. Time and amount of precipitaion (if within 24 hours application).
Overall recording of climate: daily mean temperature, frost, precipitation, etc.

4.2. Assessment of Effect

4.2.1. Time end Frequency
At growth stage 75 for the orange wheat midge and three weeks after application of the wheat plants for the yellow wheat midge.

4.2.2. Methods
The number of larvae of the two species is counted separately, and the incidence of infested grains per 24 ears is counted.

4.3. Side effects

4.3.1. Phytotoxicity
Special attention should be paid to phytotoxicity caused by the products.

4.4. Other Pests and Diseases
Distinguishing between damage caused by midge larvae feeding or damage by other pests.

4.4. Recording of yield
Grain yield (adjusted to a fixed moisture level of 15%)
1000 seed weight (per treatment)
Hectolitre weight (per treatment)
Hagbergs falling number (per trestment)

5. INTERPRETATION OF RESULTS

5.1. Statistical Methods
Analysis of variance with LSD and coefficient of variation (95%), t-test or Duncans-test.

NORDIC GUIDELINE NO. 15

BIOLOGICAL EVALUATION OF PESTICIDES

1. THE CARROT FLY

1.1. Pathogen
The carrot fly (*Psila rosae Fabricius*) is a 6-8 mm long shining black fly, with reddish brown head and yellow legs. The wings are iridescent and yellow at the base. The larva, which grows to 6-8 mm long, is cylindrical in shape, smooth and shining yellowish white in colour. The pupa is light brown cross wrinkled and about 5 mm long. Its anterior part is abliquely cut off.

1.2. Host Plants
The carrot fly causes the greatest damage to carrots but other umbelliferous plants, for example celeriac, are also attacked.

1.3. Symptoms
The small larvae live on the side roots of the host plant and are therefore not seen. The larger larvae burrow down into the main root, usually starting from the apex. The larvae thereby cause rusty coloured passages which, in a severe attack, can spread to most of the root. If the larvae are not fully grown by harvest and the carrots are kept at a temperature above 1-2°C, the attack can continue in the storeroom.

1.4. Epidemiology
The flies lay their eggs one by one or a few at a time in cracks in the soil around the carrots. The eggs hatch out 6-10 days later and the small 1 mm long limpid larvae burrow down to the side roots of the carrots where they spend the first two larval stages. In the last larval stage it is the main root that is attacked. When the larvae are full grown they pupate in the soil. The carrot fly produces two generations a year. The first generation begins to fly and lay eggs in May. The second generation, which is the greater of the two, flies in July-August. The pupae of the second generation hibernate.

1.5. Possibilities for Misidentification
None for the roots. For the fly, see 3.3.2.

2. EXPERIMENTAL CONDITIONS

2.1. Selection of Crop and Variety
Any susceptible variety of carrots can be used.

2.2. Environmental Conditions
Trials should be placed along a hedgerow where there is most likelihood of sustaining a homogenous attack. Hilly and wind exposed areas should be avoided. Good and

homogenous experimental conditions are essential with regard to soil type, fertilizer and weed control.

2.3. Research Plan
The trial should contain an untreated plot, one plot for each chemical to be tested and one plot treated with a standard for each specific group of chemicals in the trial.
The trial should be carried out with complete blocks, which means that each plot appears once in each block. Within the blocks the plots should be randomly distributed. There must be at least four replications.
The plot size depends on the local circumstances and technical equipment but the plot should be at least 25 m^2.
To reduce the border effect, the trial can be carried out with gross plots, of which some (the net plot) can be used for harvesting, or the experimental plots can be separated by protecting plots of at least one metre width which are treated with standard chemicals.

3. APPLICATION OF TREATMENTS

3.1. Product(s) to be tested
According to the trial description.

3.2. Reference Product(s), Standards
Registered Product(s) that have widely proved satisfactory in practice. Formulation type and mode of action should be as close as possible to those of the products to be tested.

3.3. Mode of Application

3.3.1. Type of Equipment

a. Spray treatments
Application with suitable, up-to-date equipment. The sprayer should give even coverage (maximum deviation 10%). Avoid spraying in wind speeds over 3 m/s. If the sprayer leaves tracks within the intended harvest plot, it should be run through plots that are not sprayed.

b. Seed dressing
The products are applied to the seed as evenly as possible, preferably using a suitable seed-dressing machine. It must be ensured that the specified rate of application is reached. All seeds for an entire trial/trial series must be from the same lot, including those which are sown untreated. Seed should not have been proviously dressed with fungicides, unless otherwise specified by the applicant. Prior to sowing, checks and necessary adjustments must be made to ensure that the drilling machine feeds the same number of seeds per area in all treatments.

c. Burying or spreading of granules
Only burying or spreading equipment which ensures an even distribution of the granules should be used. Any dose error of more than 10% must be noted.

3.3.2. Time and Frequency of Application
This is according to the individual test plan in which the directions for use of the applicant are taken into account. Granules are buried at sowing. Spraying can be carried out after the monitoring scheme described below.

Monitoring
The flying of the carrot fly is monitored on five sticky yellow plates, which are changed weekly. The following directions are used for identification of the carrot fly, see Figure 1.

1. The size is 6-8 mm
2. The fly is slim and shining black
3. The head is rusty coloured
4. Legs and balancers are yellow
5. The wings are iridescent and yellow at the root. In the resting position they project over the abdomen.

A lot of other insects are caught on the yellow sticky traps. One fly, which is often mistakenly identified as the carrot fly, is somewhat smaller and with a black head that is not ball-shaped like that of the carrot fly. Besides, it has yellow legs with black joints so that they look like pearls on a string.
The thersholds mentioned below are the guide lines for the time and frequency of the applications.

For the first generation:	Spraying is carried out 10-12 days after more than 5 carrot flies have been trapped on the five sticky plates in one week.
For the second generation:	Spraying is carried out 10-12 days after more than 10 carrot flies have been trapped on the five sticky plates in one week. The spraying is repeated 14 days later.

3.3.3. Doses and Volumes
According to the experimental plan in which the directions for use of the applicant are taken into account.
Broad-spraying 500 l per hectare is used against the first generation and 1000 l per hectare against the second generation. The quantity of liquid used is noted. By band-spraying the amount is reduced to the width of the band.

3.4. Data on Chemicals used against other Pests, Diseases and Weeds
If other chemicals have to be applied, provision must be made to ensure minimum interference. The chemicals have to be applied uniformly on all plots and normally separately from the products being tested and the reference products.
Diseases and weeds may be controlled as in the surrounding field. Insecticides must not be used.

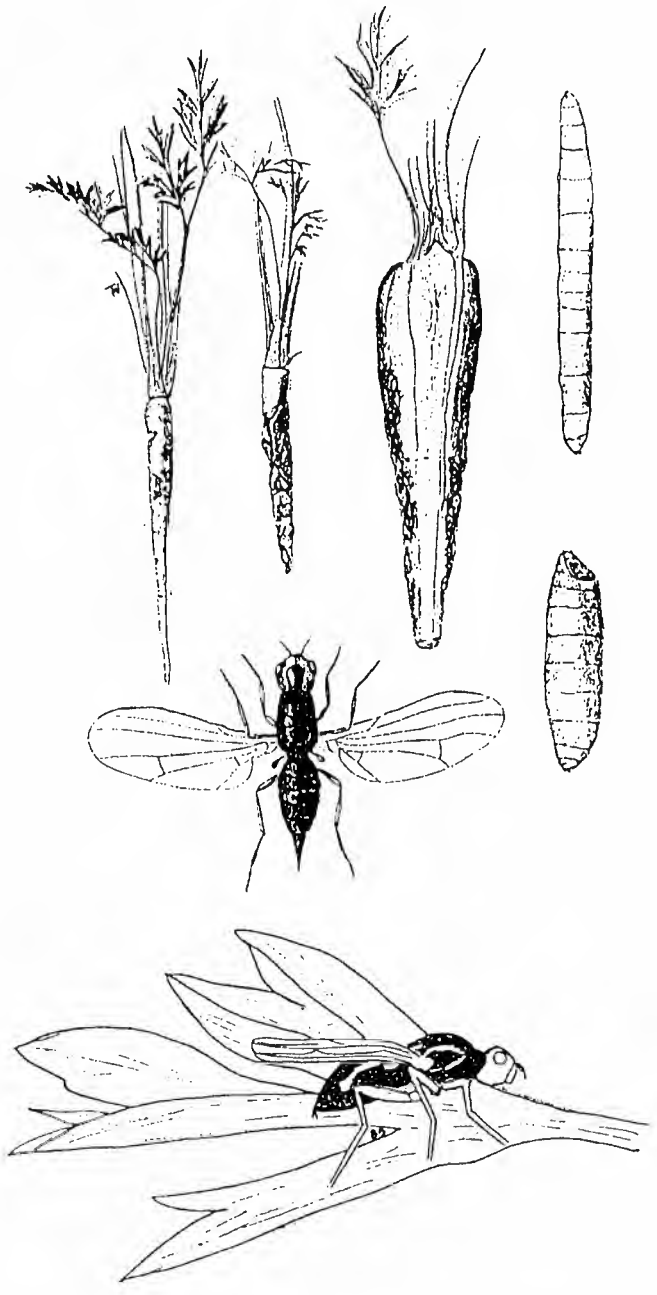


Figure 1. Larva, pupa and imago of the carrot fly and the damage of the carrots. Note that the wings of the carrot fly in the resting position project over the abdomen.

4. MODE OF ASSESSMENT, RECORDING AND MEASUREMENTS

4.1. Meteorological Data
At the time of spraying the following are noted: Temperature, wind direction and speed, relative humudity and whether the plants are wet or dry. Other climatic influences are only recorded if they are necessary for understanding the results. Adverse conditions such as hail, drought or excessive precipitation should always be noted.

4.2. Assessment of Effect

4.2.1. Time and Frequency
The effect is evaluated for the first generation at the beginning of August and for the second generation in October at harvest.

4.2.2. Methods
In every plot the carrots are evaluated on a 4 x 0.5 m row or on at least 100 carrots per plot. During the evaluation the carrots are washed and then screened as attacked and non-attacked carrots. The results are expressed as a percentage of attacked carrots. The results may be expressed as the percentage of marketabel roots.

4.3. Sideeffects

4.3.1. Phytotoxicity
All suspected effects (discoloration, scorching, abnormal growth, etc.) should be described and graded.

4.3.2. On Flora and Fauna
Secondary effects are described, especially the effects on beneficials, bees, ladybirds, etc.

4.4. Other Pests and Diseases
If attacks by pests or diseases occur they should be evaluated according to the guidelines for the specific pests or diseases.

4.5. Recording of Yield
Yield determination can be carried out. The yield is expresses as tons per hectare.

5. INTERPRETATION OF RESULTS

5.1. Statistical Methods
The results should be analysed using analysis of variance, and the mens compared using a multiple range method (Duncan, SNK). The coefficient of variation and LSD 95% are computed. The statistical method used should be indicated.

NORDIC GUIDELINE NO. 16

BIOLOGICAL EVALUATION OF PESTICIDES

1. THE PEA AND BEAN WEEVIL

1.1. Pathogen

The pea and bean weevil (*Sitona lineatus* L.) is 4-5 mm long. The body is quite slim and the snout is short and wide. The weevil is greybrown in colour with lighter and darker longitudinal stripes. Initially, the eggs are white but become black after a couple of days. The larvae are pale, limbless, slightly curved and with a pronounced brown head.

1.2. Host Plants

The pea and bean weevil lives on leguminous plants, with pea, broad bean and vetch being preferred to clover and lucerne.

1.3. Symptoms

The damage caused by the pea and bean weevil is characterized by a crescentshaped gnawing at the edge of the leaves. Gnawing on folded leaves appears after the unfolding as symmetrical holes in the leaf surface. Younger leaves are preferred to older ones.
The larvae gnaw on the bacterial nodules which become hollow. How much damage the larvae's gnawing inflicts on the bacterial nodules has not been fully established but the weevil's gnawing on the seedlings can be totally destructive.

1.4. Epidemiology

The pea and bean weevil has only one generation per year.
In spring, from March to April, the weevils begin to emerge from their hibernation. For flying, the weevils prefer calm weather with clear sunshine and preferably over 20°C. The main flying takes place in May and soon afterwards the egglaying begins which can be extended for one month. One female can lay about 1000 eggs, which are laid on the ground near the plants. The egglaying continues until later in the summer, when the weevils die. After about three weeks the eggs hatch and the larvae search for the bacterial nodules. After 6-7 weeks the larvae are full-grown, after which they pupate in the soil 1-5 cm below the surface. The new generation of pea and bean weevils makes its appearance in the middle og July, but the main population does not appear until August. These weevils do not lay eggs in the same year, but hibernate in perennial leguminous crops.

1.5. Possibilities for Misidentification

Symptoms - none, but other Sitona species may occur.

2. EXPERIMENTAL CONDITIONS

2.1. Selection of Crop and Variety

Trials can be carried out on pea or broad bean, as these crops are susceptible to severe attack.

2.2. Environmental Conditions
The trial can be carried out in fields with good and homogenous experimental conditions with regard to soil, fertilizer and weed control. Hilly areas and border areas should be avoided. General notes should be made on special research schemes.

2.3. Research Plan
The trial should contain an untreated plot and one plot for each product to be tested and one plot with a standard for each specific group of chemicals in the trial.
The trial should be carried out with complete blocks, i.e. each treatment should have one plot in each block. Within the blocks the plots should be randomly distributed.
There must be at least four replications. The plot size will depend on the local circumstances and technical equipment but the plot should be at least 25 m^2, net.
To reduce the border effect, the trial can be carried out with gross plots, of which some (the net plot) are used for harvesting, or the experimental plots can be separated by protecting plots of at least one metre width.
The trial should start and end with a plot which is not counted. These plots as well as the protecting plots should be treated with a standard product.

3. APPLICATION OF TREATMENTS

3.1. Product(s) to be tested
According to the trial description.

3.2. Reference Product(s), Standards
As far as possible the standard product used should be an approved product with the same mode of action as the compounds to be tested.

3.3. Mode of Application

3.3.1. Type of Equipment
Application with suitable up-to-date commonly used equipment. The sprayer should give even coverage (maximum deviation 10%). Avoid spraying in wind speeds over 3 m/s. If the sprayer leaves tracks within the intended harvest plot, it should also be run through plots that are not sprayed. The width of the sprayboom must correspond to that of the plot.
By seed treatment the product is applied to the seed as evenly as possible, preferably using a suitable seed-dressing machine. It must be ensured that the specific rate of application is reached.

3.3.2. Time and Frequancy of Application
This is according to the individual test plan in which the directions for use of the applicant are taken into account. Seed-dressing products should be applied no earlier than three months before sowing.
Spraying is carried out at stages 1-4 at a threshold of 10% attacked plants, and again one week later.

3.3.3 Doses and Volumes
This is according to the individual test plan in which the directions for use of the applicant are taken into account. During spraying, 300 l water per ha is used. The quantity of liquid used should be noted.

3.4. Data on Chemicals used against other Pests, Diseases and Weeds
For the control of aphids a selective aphidicide is used at the beginning of flowering. Against diseases, the appropriate fungicides can be used.

4. MODE OF ASSESSMENT, RECORDING AND MEASUREMENTS

4.1. Meteorological Data
Time of application: temperature, wind speed and direction, relative humidity and whether the plants are wet or dry. Other climatic conditions are only recorded if they are necessary for understanding the results. Adverse conditions such as hail, drought or excessive precipitation should be noted.

4.2. Assessment of Effect

4.2.1. Time and Frequency
In **trials with seed treatment** the number of plants is counted at germination and again two weeks later in order to reveal any phytotoxic effect or effects of fungicides from combined products. At the same time the symptoms on the leaves are evaluated.
In **spraying trials** the symptoms on the leaves are evaluated before spraying and again one week after each treatment, i.e. on the new pair of leaves.
In combined seed treatment and spraying trials the evaluation should as far as possible be made at the same time.
In the middle of July soil samples should be taken to assess the number of pests in the soil and the damage inflicted on the root nodules.

4.2.2. Methods
The number of germinating plants is counted on 4 x 1 m^2 in each plot.
By counting plants with symptoms 100 plants per plot are investigated.
By investigation of pest in the soil, five soil samples per plot are taken.
Germination: The number of plants is noted as a percentage of the number of seeds being sown.
Symptoms on the leaves: The percentage of plants with clear symptoms. This can vary from trial to trial and can for instance be expressed as the number of plants with more than five gnaw marks.
Soil samples: Soil samples of a uniform size of approximately one litre are taken directly over the plants. The pests are separated by flotation and counted as number of larvae, pupae and imagines.

4.3. Sideeffects

4.3.1. Phytotoxicity
All suspected effects (discoloration, scorching, abnormal growth, etc.) should be described and graded.

4.3.2. On Flora and Fauna
Secondary effects are described, especially effects on beneficials, bees, ladybirds, etc.

4.4. Other Pests or Diseases

4.4.1. Diseases
If attacks by diseases occur, they are evaluated according to guidelines for this specific disease.

4.4.2. Pests
The damage is described. If it seems reasonable the percentage of coverage is noted. If the damage is evenly distributed over the trial, an average evaluation is given. Notes can be made at the same time as those made for the pea and bean weevil.

4.5. Recording of Yield
The yield is given in hkg per ha with 14% water, 1000 seed weight and Hl weight.

5. INTERPRETATION OF RESULTS

5.1. Statistical Methods
The results should be analyses using analyses of variance, and the means compared using a multiple range method (Duncan, SNK). The coefficient of variation and LSD 95% are computed. The statistical method used should be indicated.

NORDIC GUIDELINE NO. 17

BIOLOGICAL EVALUATION OF PESTICIDES

1. THRIPS IN CEREALS

1.1. Pathogen
Thrips, several species. The most common species is the barley thrips, *Limothrips denticornis*. Adult barley thrips are 1.2-1.6 mm long and dark coloured, while the larvae are bright yellow. Other main species are *L. cerealium* and *Frankliniella tenuicornis*.

1.2. Host Plants
Oats, rye, barley and wheat. They also live on various grasses.

1.3. Symptoms
Both adults and larvae live and feed in the protected parts of the plant. They rasp the plant tissue and suck sap from the cells. Attacked surfaces develop a silvery sheen. With heavy attack, large areas of the plant become silvery and dry. Tiny dark spots of excrements can be seen.

1.4. Epidemiology
L. denticornis overwinters as adults outside cereal fields in grasses, moss or spruce trees. Other species hibernate in the soil in the field. Adult activity starts in May/June with egglaying on the host plants and can continue for several weeks. *L. denticornis* and other species develop at the rate of 1-2 generations per year.

1.5. Possibilities for Misidentification
As symptoms on the plants - none.

2. EXPERIMENTAL CONDITIONS

2.1. Selection of Crop and Variety
Oats (*Avena sativa*), winter rye (*Secale cereale*) or barley (*Hordeum vulgare*).
There is no special requirement as to variety.

2.2. Environmental Conditions
The experiment should be carried out as a field trial. Good and homogenous conditions have to be obtained with regard to soil type, fertilizer and weed control. Hilly areas, border areas and shaded parts of the field should be avoided.

2.3. Research Plan
Components: product(s) to be tested, reference product(s) and untreated controls arranged in a randomized plot design. The shape of the plots should be such as to ensure precise application of the products and to allow for the crop to be harvested with the available equipment.

To avoid wind drift to the trial by spraying of the surrounding field, a well-marked area of 5 m around the trial should be left untreated.
Plot size: net, at least 25 m^2 (10 x 2.5 m); gross, preferably 50 m^2 12.5 x 4.0 m).
Replicates: at least four.

3. APPLICATION OF TREATMENTS

3.1. Product(s) to be tested
According to the trial description.

3.2. Reference Product(s), Standards
Registered product(s) that have proved satisfactoty in practice. Formulation type and mode of action should be as close as possible to those of the products to be tested.

3.3. Mode of Application

3.3.1. Type of equipment
Only spraying equipment which ensures an even distribution of the spraying fluid should be used. As far as possible, the spraying should be carried out when there is no wind or the sprayboom must be shaded to avoid wind drift. Any dose error of more than 10% must be noted. Information on type of equipment and operating conditions used, should be given.

3.3.2. Time and Frequency of Application
The research plan may include one or two sprayings. With one spraying, application should take place at stages 40-45. With two sprayings the first spraying should take place at stages 20-25 and the second spraying at stages 40-45. (Zadok's decimal scale). Each treatment should be dated and the growth stage of the crop noted.

3.3.3. Doses and Volumes
The products should be applied in the dosage recommended on the applicant and if possible at half of this dose. The quantity of liquid used should be noted.

3.3. Data on Chemicals used against other Pests, Diseases or Weeds
If other chemicals have to be applied, provision must be made to ensure minimum interference. The chemicals have to be applied uniformly on all plots and normally separately from the products included in the experiment.
The dates of treatments, the growth stage and the chemicals used must be noted.

4. MODE OF ASSESSMENT, RECORDING AND MEASUREMENTS

4.1. Meteorological Data
Time of application: Temperature, wind speed and direction, sunny/cloudy, humidity, precipitation (24 hours after application), time of the first rain (if within 24 hours time after application). Overall climatic record: daily mean temperature, degrees, precipitation, etc.

4.2. Assessment of Effect

4.2.1. Time and Frequency
The following assessments are made
1. Immediately before treatment
2. 3-5 days after treatment
3. 3-4 weeks after treatment

4.2.2. Methods
The number of living thrips on at least 50 plants should be counted before application. After application the number of living thrips, adults and larvae on 25 plants per plot is always counted. The insects can be counted directly on sampled plants, or the insects may be extracted from the plants using a funnel.
In the final assessment the discoloration of the upper leaf is also evaluated.

4.3. Side effects

4.3.1. Phytotoxicity
All suspected effects (discoloration, scorching, abnormal growth, etc.) should be described and graded.

4.3.2. On Flora and Fauna
Secondary effects are described, especially effects on beneficial organisms i.e. bees, ladybirds, etc.

4.4. Other Pests and diseases
If attacks by other pests or diseases occur these are evaluated according to the guidelines for the specific disease.

4.5. Recording of Yield
The plots are harvested by a combine and the following data are recorded per treatment:
Grain yield expressed as kg per ha adjusted to a fixed moisture level of 15%.
1000 seed weight
Hectolitre weight.

5. INTERPRETATION OF RESULTS

5.1. Statistical Methods
The results should be analysed using appropriate statistical methods.
Analyses of variance with LSD and coefficient of variation (95%), t-test or Duncan's-test.

NORWEGIAN JOURNAL OF AGRICULTURAL SCIENCES
INSTRUCTIONS TO AUTHORS

THE MANUSCRIPT

The manuscript shall be typewritten on one side of the paper only. It shall be double spaced and have margins of at least three centimetres. Each of the following elements of the manuscript shall begin on a new page: (1) the title, (2) abstract, (3) the text, (4) summary, (5) list of references, (6) tables, (7) figure legends.

The pages shall be numbered consecutively beginning with the title page.

Articles will usually be organized as follows: (1) introduction, (2) materials and methods, (3) results, (4) discussion and (5) summary. Up to three grades of headings can be used to divide up the text. Articles must not exceed 20 manuscript pages, and two copies should be submitted to the managing editor.

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Use only keywords listed in Agrovoc. The abstract must not exeed 150 words, corresponding to 10 lines in print. The abstract shall briefly describe the purpose/question of the experiment/research project, the method, results and the principal conclusions drawn. Use only standard abbreviations in the abstract.

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ACKNOWLEDGEMENTS

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Oen, H. & S. Vestrheim 1985. Detection of non-volatile acids in sweet cherry fruits. Acta agriculturae scandinavia 35: 145-152.

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Aase, K.F., F. Sundstøl & K. Myhr 1977. Forsøk med strandrøyr og nokre andre grasartar. Forskning og forsøk i landbruket 27: 575-604.

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