FIELD GUIDE

Insects Pests of Wheat and Barley in North Africa, West and Central Asia

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Field Guide

*Insect Pests of Wheat and Barley in North Africa, West and Central Asia*

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International Center for Agricultural Research in the Dry Areas
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FOREWORD

This field guide is an important addition to the diagnostic publications offered by ICARDA. Farmers, pest managers and extension workers throughout the CWANA region have needed a practical comprehensive guide to help them identify economically important insect pests and their natural enemies in their fields.

Cereal producers can have, for the first time, a user-friendly encyclopedia to help them identify insects that damage their crops. This field guide has been carefully designed with pictures that can help you determine your production problems.

In this publication the authors have placed major emphasis on two crops that ICARDA has been working on for many years. As our knowledge base increases and new options become available for improved management of insects of cereals, we will update this guide.

We hope that this publication will be of value to you when faced with pest problems. It is intended to facilitate pest identifications and help you with control decisions. ICARDA has placed major emphasis on integrated pest management (IPM) strategies for its’ mandated crops. We have stressed biological control and conservation of natural enemies as the foundations of IPM and with insect-resistant varieties of cereals we will reduce reliance on agricultural chemicals and establish sustainable cropping systems for the future.

Adel El-Beltagy
Director General
ICARDA
Acknowledgments

Special thanks to Dr. Surendra Varma, Editor and Head of Communication, Documentation and Information Services of ICARDA (CODIS) and Mr. Majed Khatib and Mr. Razek Makdis of ICARDA’s Photolaboratory. Most of the photographs in this Field Guide were taken by the authors or obtained from the Photography Unit of CODIS. Other photo acknowledgments are found within the figure captions. The authors thank Dr. Khaled Makkouk and Dr. Bayaa Bassam, ICARDA for reviewing this Field Guide. Thanks to Judythe Parker for proofreading. This publication was supported by funds from the United States Agency for International Development (USAID), Conservation, Food and Health Foundation and Department for International Development (DFID). Page layout done by Haig Tokatlian. Pre-press done by Leogravure, Beirut.
Introduction

Accurate identification of a pest problem is the foundation of effective management. This user-friendly field guide contains information on the major insect pests of wheat and barley. It is useful for making identifications of these insects directly in the field. It is designed for farmers, managers, extension personnel and advisors throughout North Africa and the West and Central Asian regions. Contained within is information on damage symptoms, where to locate the pest within the crop, specific characteristics of the insect, technicalities and management suggestions.

There are very many different insects that attack wheat and barley. In this guide we have included only the major economically important ones that farmers in these regions are likely to encounter. Please take your time to make your identifications carefully. If possible obtain verification of the causal agents of damage from an agricultural extension specialist or professional. If the damage is severe, they may be able to help you with your management decisions.

How to use this guide

Damage symptoms are generally one of the first signs of the presence of a pest and an important tool for correctly identifying a pest. Insects produce specific types of damage depending on the type of mouthparts they have and the part of the plant on which they are feeding. In this guide we have provided damage photos to help with pest identification.

Using the page tabs, locate the part of the plant (either wheat or barley) where the damage is occurring. You will find several pages showing damage symptoms. Look through these pictures to find one that most closely resembles damage seen on the plant or in the field. At the bottom of each damage picture, within a small red box, is a page number that refers to the pest that caused this damage. Go to that page to find a specific description of the damaging agent. Next look for the pest, based on information found in the category "Where to look". If
you find the insect, you can be fairly sure that you have made a correct identification. In some cases you will not be able to locate the pest, either because it has completed development and left the field, or has been killed and washed off the plant. Information about the life cycle of the pest, found in the "Technicalities" section may help you determine when to expect the insect or its damage to be present in the field. It is best to inspect several damaged plants in multiple locations throughout the field. This will increase your chances of finding the insect and help you assess the severity of the damage and determine if a management action is necessary.

It is common that more than one pest is present and causing damage at the same time to the same plant or within one field. It is important to differentiate between multiple symptoms when making a pest determination, and assess the level of severity caused by each pest separately.

**Important Symbols**

In the section entitled “Insect Damage To Wheat and Barley” to the right beneath each figure the numbers in the box refer you to the page with the probable insect causing the damage.

In the section entitled “Insects Causing Damage to Wheat and Barley” in the upper left hand corner there is a hand pointing to page numbers. These numbers refer you back to the damage photos you used to arrive at the current page.
INSECT CLASSIFICATION

Depending on who makes the estimates, there are more than one million insect species on this earth. Each of these species acts and interacts in slightly different ways. About 10,000 of the known species are considered pests of food and fibre. Perhaps about 100 different species create significant problems to the production and storage of cereals and legumes.

To implement an effective integrated pest management strategy (IPM), it is first necessary to accurately identify the insect species that is causing the problem. Often this is not a simple task and cannot be done by individuals who are not specifically trained. To use this guide, it is first essential that you know some basic information relevant to insect classification.

Insects are placed in major categories called "orders" based on their unique structure and form. For example, the flies, which commonly have only a single pair of wings, are placed in the order Diptera (which means having only two wings or a single pair). The individual orders are subdivided into families of very closely related species.

Below we have listed the most common insect orders that cause significant problems to cereals. You will find the common name of each and the particular stage that causes the most economic damage.

<table>
<thead>
<tr>
<th>Order</th>
<th>Damaging Stage</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lepidoptera</td>
<td>Larva</td>
<td>Moth, butterfly</td>
</tr>
<tr>
<td>Coleoptera</td>
<td>Larva and adult</td>
<td>Beetle, weevil</td>
</tr>
<tr>
<td>Hemiptera</td>
<td>Nymph and adult</td>
<td>True bug</td>
</tr>
<tr>
<td>Homoptera</td>
<td>Nymph and adult</td>
<td>Aphid, scale, whitefly</td>
</tr>
<tr>
<td>Thysanoptera</td>
<td>Larva and adult</td>
<td>Thrips</td>
</tr>
<tr>
<td>Diptera</td>
<td>Maggot</td>
<td>Flies</td>
</tr>
<tr>
<td>Hymenoptera</td>
<td>Larva and adult</td>
<td>Sawfly, ant</td>
</tr>
</tbody>
</table>
It is important to realize that not all insect species have been discovered. There are many that have not yet been described according to their unique taxonomic features. Insects often have two names, a scientific one and a common one. Those that have been studied and found to have unique characteristics are assigned a scientific name by the person who originally described the insect. An insect is given one scientific name, which is accepted and used throughout the world. An insect may also be given a common name, which is often locally derived. For example, the black fly in Morocco is quite different from what is referred to as the black fly in North America. The former damages wheat and barley, the latter feeds on the blood of humans.

Most scientific names have three parts. The first part refers to the genus to which the insect belongs. The genus is a subdivision of the family. The second part of the scientific name is called the species. Insects of different species cannot mate and reproduce but individuals within the same species can. The species name is followed by the last name of the person who first described it. Following is an example of a scientific name:

```
Eurygaster integriceps Puton
```

<table>
<thead>
<tr>
<th>Genus</th>
<th>Species</th>
<th>Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eurygaster</td>
<td>integriceps</td>
<td>Puton</td>
</tr>
</tbody>
</table>
LIFE STAGES OF THE INSECT

Insect pests, during their life cycles, go through a number of developmental stages. This process is called metamorphosis. Each of these stages may look quite different. The flies have 4 distinct developmental stages: egg, larva, pupa and adult. Some stages damage our cereals and some stages don’t. For example, the larva of the Hessian fly has chewing mouthparts and causes the damage to wheat. The mature Hessian fly adult has a different type of mouthparts and doesn’t cause damage at all.

To accurately diagnose problems or if you are scouting for pests before damage occurs, it is essential to be able to recognize all life stages of a pest and the damage they cause. Be extremely careful when looking for insect pests in your field. Make sure that the insect stage you have located is the one causing the damage. Do not disregard a specimen merely because it does not have the type mouthparts to cause the damage seen. The presence of the nondamaging adult may provide a clue to the damaging pest. The various types of development among insect pests are listed below.

**Complete Metamorphosis**

Egg  Larva  Pupa  Adult  
(Moths, Beetles, Flies, Sawflies)

**Intermediate Metamorphosis**

Egg  Larva  Prepupa/Pupa  Adult  
(Thrips, Whiteflies)

**Gradual Metamorphosis**

Egg  Nymph  Adult  
(Aphids, True Bugs, Grasshoppers)
COMPLETE METAMORPHOSIS

Adult

Egg

Larva

Pupa (flaxseed)

Resultant damage
DIAGNOSIS OF INSECT PROBLEMS

Extreme care must be taken when diagnosing insect problems so that the correct decisions about crop management are made. Sometimes damage caused by abiotic factors or a disease may look very similar to insect damage. Insects cause specific kinds of damage depending on the type of mouthparts they have. This is particularly important if the insect that caused the damage is no longer present in the crop. Below are several simple steps to follow to diagnose the cause of damage:

1. Carefully inspect the crop for symptoms of damage. If necessary, pull the plant to inspect the roots.

2. Determine the type of feeding that caused the damage (see section below).

3. Locate the insect and life stage that is causing the damage. Beware, sometimes insects present are not the ones causing the damage, or the damaging insect may have already left the plant.

4. Make sure that the insect you think is the damager has the right type of mouthparts to cause the observed damage.

5. Identify the pest using this guide.

6. If you are uncertain of your identification, collect several specimens of all stages available and the damage caused. These should be given to an agricultural specialist or professional for verification.

It is sometimes difficult to distinguish insect damage from a disease problem. Usually if there are actual signs of feeding, and insects are present doing that feeding, it is likely this is the causal agent. If there are small dots or a white, black or yellow layer that rubs off on your finger, these may be spores produced by a disease, which is causing the damage. However, in some cases insects and diseases are closely associated. For example, aphids excrete honeydew on which a black sooty mold grows. Some species of aphids transmit viruses during feeding. In this case, the visible signs of damage may be caused by the virus, not the aphid. As you become more experienced with this guide, the chance for misdiagnosis will decrease.
INSECT MOUTHPARTS

Insects have different types of mouthparts, depending on the order it is in and its life stage. Some have mouthparts that cannot cause crop damage. For example, adult moths and butterflies have coiled mouthparts that suck nectar and other fluids from flowers. However, many species have mouthparts that can damage our crops. Ninety percent of all insect damage to cereals is caused by insects that have either chewing or piercing and sucking type mouthparts. For accurate diagnosis of insect pests, it is necessary to be able to recognize these two types.

Insects with piercing and sucking mouthparts have slender stylets that are protected within a sheath. They pierce plant cells or kernels with the stylet and suck up plant sap or cell fluids. The bugs and aphids are common damagers of wheat and barley with this type of mouthparts. The characteristic signs of this damage are wrinkled, torn or deformed leaves cupped or curled upward, tiny white spots (called stippling) over the surface of the leaf or browning, silvering or drying of the upper leaf surface or around the veins.

Adult and larval stages of the beetles and immature stages of sawflies and moths have chewing mouthparts. They have mandibles that are jaw-like structures with teeth used to tear off or chew plant tissue. Damage by this type of mouthpart includes tunnelling within the stem or root, circular entrance or exit holes in the stem, ragged holes in the leaf (either at the edge or within the leaf), mines in the leaf that appear as light blotches or tunnels with the top and bottom of the leaf surface intact. All stages of the insect that are available and the damage caused should be given to an agricultural specialist or professional for verification.

Fig. 1. The structures of the chewing mouthparts of an insect as seen from the underside. Note the teeth on the mandibles (arrow).
Fig. 2. A close-up of the underside of an insect with chewing mouthparts (arrow). Note the head is not elongated as is the case with insects having piercing and sucking mouthparts (refer to Fig. 4.)

Fig. 3. A close-up of the underside of an insect with chewing mouthparts (arrow).
Fig. 4. A close-up of the underside of a Sunn Pest showing the structure of the piercing and sucking mouthparts (arrow).

Fig. 5. A close-up of the underside of an insect pest showing the structure of the piercing and sucking mouthparts (arrow).
Fig. 6. The piercing and sucking mouthparts of a Sunn Pest (arrow) inserted into the kernel to suck plant fluids.
SCOUTING

To ensure that crop production reaches maximum yield and quality, it is absolutely necessary to keep track of what is happening in your fields throughout the entire growing season. It is essential to visit the fields regularly to inspect the plants and record your observations. It is recommended to scout your fields at least once a week and more often after insect problems are first observed. Depending on the size of the field, you should inspect plants in at least 15 or 20 locations. If you notice damage in certain parts of the field, concentrate your scouting efforts there or in adjacent areas. Keep in mind that the entire plant should be inspected because different insect species prefer to feed in/on different areas of the plant. For example, some prefer to feed in or on the stem while others will attack the spike. Sometimes insect damage that is taking place below ground is expressed in symptoms on the plant above ground. Therefore, it may be necessary to pull up the plant to check the roots for signs of damage. A simple hand lens with 10x magnification will help you see small specimens. Hold the lens close to your eye and move the specimen toward the lens until it is in focus.

Information gained from scouting is most effective if standard methods are followed. This allows you to make comparisons throughout the season and from year to year. By doing this you will be better able to predict damage and take appropriate action early to reduce economic losses.

One of the main reasons for establishing regular intervals for scouting is that often insect populations will invade your fields or increase in numbers very rapidly. If you do not scout regularly you may not discover a pest problem until the crop is severely damaged—and then it may be too late to implement a management strategy. The following diagrams represent patterns that you could follow within your field for scouting purposes.
Fig. 7. Sampling in an overwintering site in Syria to determine Sunn Pest population levels.

Fig. 8. Inspecting the lower parts of plants for indications of stem and lower leaf damage.
Fig. 9. Using a net to capture insects from the upper parts of the crop to determine if pests are present and how many there are.

Fig. 10. Digging in the soil at the base of the plants to locate pests causing damage to roots and/or stems.
Rating Pest Populations and Damage in your Fields

To accurately evaluate insect population levels and damage throughout the growing season, it is necessary to establish standard rating systems. These systems will provide an estimate of overall damage and pest population levels in the total hectares scouted from which management decisions can be made. Following are two examples of rating systems:

**Adult Sunn Pest Populations**

<table>
<thead>
<tr>
<th>No. adults/m²</th>
<th>Comments</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No problem – survey populations again in a few days</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>Low population level – no action</td>
<td>1</td>
</tr>
<tr>
<td>2 - 4</td>
<td>Expect significant damage if action is not taken</td>
<td>2</td>
</tr>
<tr>
<td>5 or more</td>
<td>Severe or total loss of yield if action not taken</td>
<td>3</td>
</tr>
</tbody>
</table>

**Damage Caused by Thrips**

<table>
<thead>
<tr>
<th>No. damaged spikes/m²</th>
<th>Comments</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No problem – survey damage again in a few days</td>
<td>0</td>
</tr>
<tr>
<td>1-2</td>
<td>Anticipate a relatively low level of yield loss</td>
<td>1</td>
</tr>
<tr>
<td>3-10</td>
<td>Anticipate a moderate level of yield loss</td>
<td>2</td>
</tr>
<tr>
<td>11 or more</td>
<td>Extremely significant loss of yield</td>
<td>3</td>
</tr>
</tbody>
</table>
DATA SHEET FOR INSECT PEST SCOUTING

Date __________________ Person scouting ___________________

Crop _____________ Location ______________________________

**Data**

<table>
<thead>
<tr>
<th>Field survey stop</th>
<th>Observations</th>
<th>Number of plants damaged by pest</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Most plants look healthy</td>
<td>2 plants with white heads/Sunn Pest.</td>
</tr>
<tr>
<td>2</td>
<td>Some plants appear stressed</td>
<td>6 plants showing signs of thrips damage</td>
</tr>
<tr>
<td>3</td>
<td>Most plants healthy</td>
<td>1 larva of Wheat Ground Beetle found</td>
</tr>
<tr>
<td>4</td>
<td>A few with poor roots</td>
<td>1 plant damaged by thrips</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
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<tr>
<td>7</td>
<td></td>
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<td>8</td>
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<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
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</tbody>
</table>

General observation ______________________________________________

Recommendation ________________________________________________

---

1 Presented is an example of a typical data sheet. It is suggested that farmers or pest managers develop their own data sheets to fit their particular needs.
Natural Enemies

Like all creatures, insects are plagued by numerable living organisms that feed upon them and impact their population dynamics. These organisms are called natural enemies or beneficials and are of great value to cereal producers. A pest population commonly is attacked by several different species of natural enemies. Extreme care should be taken to allow them to thrive whenever possible because if left undisturbed they can sometimes keep pest populations below economically damaging levels. In some cases pesticide use can kill the natural enemies as well as the pest species. Because natural enemy populations sometimes increase slowly, a resurgence of the pest after a pesticide application can occur. When the natural balance between the pest and its natural enemies is disrupted, a different previously minor pest species can cause major damage.

The natural enemies include parasitoids and predators. Parasitoids lay their eggs near, in or on the host insect. They feed inside the pest and ultimately kill it. Predators feed on the outside of the host by either chewing host tissue or sucking out internal fluids.

Many of the natural enemies look very similar to cereal pests and they should not be mistaken for harmful species. Among the beneficials are organisms such as bacteria, fungi, nematodes, viruses and protozoans that infect and kill pests. Each of these is an important component of the natural biological control system. In any given area of your field, about 30% of the insects present are natural enemies of other insects. A few of the common ones are shown on the following pages.
Natural Enemies

Fig. 11. Predator. An adult lady beetle.

Fig. 12. Predator. The eggs of a lady beetle often seen on leaf surfaces.
Natural Enemies

Fig. 13. Predator. The larval stage of a lady beetle. This stage is extremely active and feeds extensively on many soft-bodied pests.

Fig. 14. The pupal stage of a lady beetle. Although this stage does not feed, it will soon develop into an adult which does feed on pests.
Natural Enemies

Fig. 15. Predator. Some lady beetles will aggregate in plant debris during periods of cold. Photo by M. Mendelson.

Fig. 16. Predator. An adult praying mantid.

Fig. 17. Predator. A Praying Mantis immature in the process of eating an insect. Photo by Jack Kelly Clark, courtesy of the University of California Statewide IPM Project.
Natural Enemies

Fig. 18. Predator. An adult lacewing.

Fig. 19. Predator. A lacewing nymph feeding on an aphid. Photo by Jack Kelly Clark, courtesy of the University of California Statewide IPM Project.
Natural Enemies

Fig. 20. Predator. The adult syrphid fly is an important pollinator. The larvae of many species (shown in the following figure) are predators of aphids.

Fig. 21. Predator. Syrphid fly larva is an important natural enemy of aphids. © James L. Castner
Natural Enemies

Fig. 22. Predator. True bugs are shown feeding on a pest immature. Note the bugs are sucking the internal fluids from the pest.

Fig. 23. Predator. A long-jawed orb weaver spider in a wheat field. Photo by Scott Bauer.
Natural Enemies

Fig. 24. Predator. A crab spider feeding on an insect pest. Photo by E. Memmler.

Fig. 25. Microorganism. A Sunn Pest killed by an insect-killing fungus. The white fluffy mass is fungal material growing out of the insect’s body.
Natural Enemies

Fig. 26. Microorganism. The grub on the left is healthy with a dark posterior portion of the body filled with material it has been feeding on. The grub to the right is infected with an insect-killing bacterium. Photo by Michael Klein.

Fig. 27. Microorganism. Nematodes on the outside of a pupa. Photo by A. Hara.
Fig. 28. Microorganism. The larva has been killed by a nuclear polyhedrosis virus. Photo by David Nance.

Fig. 29. Parasitoid. A wasp laying an egg directly into a nymph. Photo by Scott Bauer.
Natural Enemies

Fig. 30. Parasitoid. A wasp laying an egg directly into the tunnel leading to a pupa in the soil. Photo by Scott Bauer.

Fig. 31. Parasitoid. Sunn Pest eggs with parasitic flies.
Natural Enemies

Fig. 32. Parasitoid. Note the parasite egg (arrow) that has been laid on the surface of the body of a larva.

Fig. 33. Parasitoid. Note the mummified body of an aphid (arrow). This is often seen within active aphid colonies. The mummified body either has a parasite within or an obvious hole towards the rear portion of the body. From this hole an adult parasite has already emerged.
Natural Enemies

Fig. 34. Parasitoid. Fly laying eggs in a larva.

Fig. 35. Parasitoid. A wasp laying eggs in a pupa.
Natural Enemies

Fig. 36. Parasitoids. Tiny wasps laying eggs in an egg mass of a pest. Photo by S. Chenus, Cornell University.

Fig. 37. Parasitoid. An adult wasp recently emerged from a mummified aphid. Photo by Jack Kelly Clark, courtesy of the University of California, Statewide IPM Project.
Natural Enemies

Fig. 38. Parasitoid. A tiny wasp emerging from the posterior portion of an aphid which it has killed.
“A healthy productive crop is your goal”

Locate the picture that closely resembles the damage you see in the field.

Then refer to the page number at the bottom right of the figure.

If you cannot find a picture that closely resembles the damage you see consult your local agricultural specialist for advice.
Fig. 39. The end of the leaf is dried and curled up – the remainder of the leaf is green.

Fig. 40. Varying degrees of leaf damage. The arrow points to the initial feeding site of the insect. As the leaf ages (left to right) the outer portions beyond the feeding site dry out.
Leaf Damage

Fig. 41. The leaves have a silvery appearance. The upper surface has been eaten and green coloration is gone. Note the healthy plants to the right.

Fig. 42. Close-up of chewing damage to the upper surface of the leaves.
Leaf Damage

Fig. 43. Upper surface of leaves with length-wise narrow feeding strips or patches.

Fig. 44. Severe damage to the upper surface of the leaf. No or little green plant material is present. Leaves appear silvery.
Leaf Damage

Fig. 45. Feeding damage created between the upper and lower leaf surfaces in the middle areas of the leaves.

Fig. 46. Close-up of damage created between the upper and lower leaf surfaces. Note the larvae feeding inside the leaf at the leading edge (arrow).
Leaf Damage

Fig. 47. Leaves have a yellow-brown patch. Sometimes small green insects can be seen on or near the patch.

Fig. 48. The leaves appear yellow and chlorotic. Some small yellow patches as in Fig. 47. are evident on some leaves (arrow).
Leaf Damage

Fig. 49. The leaves are rolled and appear chlorotic.

Fig. 50. The leaves are rolled and bleached out.
Leaf Damage

Fig. 51. Close-up of a rolled leaf opened to show the streaked white damage symptom.

Fig. 52. The leaves appear off-color, yellowish to brown and look dried out.
Leaf Damage

Fig. 53. A wheat field showing patchy bare areas without plants.

Fig. 54. Close-up of patchy bare area in a wheat field. Note sparse wheat growth and wilting leaves.
Leaf Damage

Fig. 55. The leaves are unusually wide (see arrow) and have a very dark green color.

Fig. 56. Note the stunted growth of plants (arrow). Refer to page 61 for stem damage symptoms.
Leaf Damage

Fig. 57. The plant is stunted and completely dead. On close examination the problem may be associated with the lower stem area which is weakened and damaged internally.
Damage to the Spike

Fig. 58. The end of the spike is dried up, white in color, bent over and the kernels are undeveloped and of no value.
Damage to the Spike

Fig. 59. The end of the spike is dried up, bent over and the kernels are undeveloped and of no value.

Fig. 60. This is referred to as a white head. The spike is completely dried and the kernels undeveloped and of no value.
Damage to the Spike

Fig. 61. Close-up of the white head condition.

Fig. 62. White head spikes are seen scattered randomly in the field. Note: these are not mature spikes that are almost ready for harvest.
Damage to the Spike

Fig. 63. Spikes are normal in size but appear chlorotic and extremely bleached out.

Fig. 64. Note the discoloration at the bases of the kernels (arrows) and the general chlorotic appearance of the spikes.
Damage to the Spike

Fig. 65. Individual kernel showing damage. Note the dried appearance of the kernel held by the forceps.

Fig. 66. The entire plant is stunted and the spike is small and poorly formed.
Fig. 67. The seed head is trapped by the rolled flag leaf (arrow).
Fig. 68. Near the middle of the stem bearing the spike there is damage (arrow) in the form of dead plant tissue that results in drying of the upper plant.
Stem Damage

Fig. 69. Poor stand establishment, the presence of green leaves but many dead and dying stems.

Fig. 70. Plants with green leaves but also dried dead stems.
Stem Damage

Fig. 71. Close-up of plants with green leaves and dried dead stems.

Fig. 72. Individual plant with apparently healthy roots but dead stems.
Stem Damage

Fig. 73. Plant is stunted and tillers are dried and dead. This is often referred to as a plant with a "deadheart".

Fig. 74. A barley field showing severe damage with broken stems.
Stem Damage

Fig. 75. Base of the plant showing stems evenly cut off.

Fig. 76. Stem and root damage. Note the white residue (arrow) which is the waxy covering on the surface of the pest.
Stem Damage

Fig. 77. Damage to the lower stem area. Note the washed out pale color of the stems and the feeding damage to the surface areas.

Fig. 78. The base of the stem has an enlargement (gall). In this photo the insect immature appears inside the gall.
Root Damage

Fig. 79. Close-up of a plant found within a patchy bare area in a wheat field.
Root Damage

Fig. 80. Stem and root damage. Note the white residue (arrow) which is the waxy covering on the surface of the pest.

Fig. 81. Roots of the plant have been completely eaten, which is evident when the plant has been pulled up.
Less Frequent Damage - Usually Minor

Fig. 82. Close-up of the insect causing the damage as seen in Fig. 83 below.

Fig. 83. Kernels in the spike have been eaten. On first glance it appears like bird damage, but close examination of adjacent spikes reveals an insect.
Less Frequent Damage - Usually Minor

Fig. 84. A&B. Damage caused by an insect called a "soft scale". The green tissue on the surface of leaves and stems is eaten.
Fig. 85. Ants are sometimes seen on the spike. It is often a sign that aphids are also present and the ants are feeding on the honeydew excreted by the aphids.
Damage That Looks Like it is Caused by Insects

Fig. 86. This is a fungal disease called Tan Spot. Photo by L. Lamari.

Fig. 87. This is a fungal disease called Barley Stripe. Photo by A. Yahyaoui.
Damage That Looks Like it is Caused by Insects

Fig. 88. This is a fungal disease called Septoria. Photo by A. Yahyaoui.

Fig. 89. Bird damage. Note the ends of the leaves are torn off (arrow). Usually in the vicinity of the plant one finds pieces of torn leaves dropped by birds. Photo by S. Ceccarelli.
Damage That Looks Like it is Caused by Insects

Fig. 90. Snail damage. Note the feeding damage that is length-wise on the upper surface of the leaves.

Fig. 91. Snails will feed on all parts of the plant as seen in this figure.
Abiotic Factors Causing Damage

Fig. 92. Heat damage. The plants have a scorched appearance as a result of high temperatures. Photo by S. Ceccarelli.

Fig. 93. Drought damage. The plants are stunted and show signs of extreme water stress. The leaves are rolled and the plants are brown and dried. Photo by S. Grando.
Abiotic Factors Causing Damage

Fig. 94. Frost damage. Plants appear brown and desiccated. Frost resistant plants are to the right O.

Fig. 95. Frost damage to the spike. Note the dried areas at the very tip and to the middle of the spike. Refer to page 105 to ensure that the damage is not caused by an insect or disease.
INSECTS CAUSING DAMAGE TO WHEAT AND BARLEY

For use in

North Africa
West and Central Asia

Fig. 96. CWANA refers to Central Asia, West Asia and North Africa. These are the areas that ICARDA places major agricultural research and development emphases.
Sunn Pest

Damage.
Early in the season adults feed on the stem, causing a constricted zone, which reduces sap flow to the outer parts. Outer stem appears off-color, white and dried. Heading often does not occur. Leaf feeding results in an abnormal string-like, dried up portion at the end. Direct feeding on kernels results in what is called "white heads".

Insect characteristics.
Feed by piercing plant tissue and sucking fluids. Adults about 13 mm long. Broad, shield-like body varying from light to dark brown or reddish brown, with white and blackish markings (Fig. 97). Nymphs are round and black to dark brown (Fig. 98). Eggs typically laid in 2 even rows on leaves. At first they are light green and darken as hatch nears (Fig. 99). Emit sweet-smelling odor when handled.

Where to find Sunn Pest.
Beware, adults are sensitive to your presence and drop to the ground and feign death when they sense danger. It is best to scout in the early morning when they are actively feeding. From a distance, adults can be seen feeding on the spike. Nymphs are easily seen clustered on the developing kernels.

Technicalities.
Sunn Pest are in cereal fields for only about 2.5 months per year. They overwinter in litter beneath trees and shrubs in foothills adjacent to fields. They cause direct damage to wheat and barley and inject chemicals into kernels when feeding. Flour from these grains is of poor quality. One generation per year.

Management suggestions.
Do not grow cereals on marginal agricultural land close to foothills, where Sunn Pest overwinter, and which provides an easy food source to migrating adults. Preserve undisturbed natural areas to conserve natural enemies. Consider using resistant varieties if available. Scout fields early in the growing season. If necessary use selective insecticides if economically significant pest populations levels exist. Early season sprays should be applied to field borders closest to foothills when adults first appear.

Refers to a complex of species the most economically important and common being *Eurygaster integriceps* Puton, (Hemiptera: Scutelleridae). Attacks wheat and barley.
Fig. 97. Adult Sunn Pest feeding on the spike.

Fig. 98. Sunn Pest eggs and newly hatched nymphs moving onto the spike to feed.

Fig. 99. Close-up of Sunn Pest eggs.
Hessian Fly

Damage.
If fly attack occurs at the one-leaf stage, plants may be killed. Later infestation results in stunting, killing of first tillers and a delay of plant growth. Attacked plants often appear to have an abnormal dark green coloration and unusually broad leaves.

Insect characteristics.
Adults are long-legged and look like small mosquitoes (Fig. 100). They are greyish, delicate insects with rather pointed abdomens. The reddish, cylindrical eggs are laid in the grooves of the upper surfaces of leaves of wheat and barley (Fig. 101). These hatch and larvae move to the base of the plant to feed between the leaf sheath and the stem (Fig 103). Their color gradually changes from reddish to white. At the end of the 2nd instar they enter the puparium or flaxseed stage (Fig. 102). Within the puparium, they transform to the 3rd instar and remain there during the summer and colder months. Adult emergence usually occurs following rainy periods.

Where to find Hessian Fly.
Adult flies may be seen mating directly on leaves. Pairs will be attached end to end. At least 10x magnification is needed to see eggs on the upper surface of leaves. If one pulls the leaf sheath at the base of the blade away from the blade, the larvae may be seen. They are maggot-shaped—one end blunt and the other pointed (~1-2 mm long). Often more than one is found and they are orientated in a straight vertical row. The shiny brown flaxseed may be found around the leaf sheath or in the stubble after harvest.

Technicalities.
Adults are weak fliers. The severity of damage is often directly related to the degree of infestation. The larvae have chewing mouthparts and while feeding actually expose the plant to salivary toxins which inhibit growth. In some locations there may be multiple generations each year.

Management suggestions.
Volunteer plants should be removed from the fields and destroyed to eliminate a continual food source and crop reinfestation. Planting dates should be adjusted to avoid or minimize infestations. Resistant varieties should be used if available.

\[1\] *Mayetiola destructor* (Say), (Diptera: Cecidomyiidae). A pest of wheat.
Fig. 100. Hessian Fly adult. Note the cream colored extension at the end of the body. This is the ovipositor with which the female lays an egg on the leaf. Photo by S. Bauer.

Fig. 101. The tiny elongate reddish structures in the long grooves of the leaf are Hessian Fly eggs.

Fig. 102. The dark cylindrical objects are the flaxseed stage of the Hessian Fly.

Fig. 103. The white maggot-like bodies are Hessian Fly larvae feeding on the stem.
Ground Pearls

Damage.
During the seedling stage of the plant, vigor may be greatly reduced and stunting is common. Feeding on roots and stem may cause withering and subsequent death of the plant. Low to moderate populations reduce yield and sometimes cause complete loss of grain.

Insect characteristics.
Ground Pearls are soft bodied, tiny insects that are often difficult to see with the naked eye. You probably won’t find the eggs because they are in the soil. The nymphs (Fig. 106) measure 0.5 mm in length and the adults (Fig. 104) usually about 5 mm. They are red in color. The adult females have an obvious segmented body but are covered with a whitish waxy material. The males are winged.

Where to find Ground Pearls.
The most likely place to locate this insect is at the base of the plant either beneath the sheath or just outside of it (Fig. 105). You are likely to find the nymphs and the adults there. Some may have legs and move about but others may be legless and appear cyst-like.

Technicalities.
This pest has a complicated life cycle. Part is spent in the soil and part is spent actively feeding on the plant. They have mouthparts that pierce the surface of stems and roots and suck up plant fluids. They have a high reproductive rate and females are often able to produce viable eggs without males. A single female can lay up to 300 eggs each. The winter is spent in the soil. One generation per year.

Management suggestions.
In areas where crops are irrigated or adequate rainfall is common, Ground Pearls are not a problem. Avoid continual cropping of barley or wheat in the same field because the pest remains in the soil to reinfest subsequent plantings. Rotate cereals with a legume cover crop or leave fallow.

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Fig. 104. Close-up of the underside of an adult Ground Pearl. Note the segmented body and the red color.

Fig. 105. Immatures feeding at the base of the stem near the root collar.

Fig. 106. Close-up of the upperside of an immature Ground Pearl.
Russian Wheat Aphid

Damage.
Plants have a purplish tinge. Infested leaves develop longitudinal yellow and white streaks, which are easy to see. Tillers are weakened and may bend. Leaves will be rolled and, if the infestation reaches the flag leaf, it may also become rolled and trap the young heads and awns. The trapped head will curl. High populations kill plants and decimate fields.

Insect characteristics.
The Russian Wheat Aphid is a very small, soft-bodied, pale green insect. It is impossible to positively identify this insect to species in the field. Initially rely on plant damage symptoms, but collect numerous aphid specimens, place them in a vial of alcohol and seek assistance with identification from your local agricultural extension agent.

Where to find Russian Wheat Aphid.
This aphid species initially feeds at the base of leaves near the top of the plant. If leaves appear rolled, unwind them and look for colonies of aphids inside. In cool and rainy conditions, aphids will feed in protected areas and are often difficult to locate. Separate the various plant parts and look for the insects in between leaves or under stems that are close to the ground.

Technicalities.
As the aphid feeds it injects saliva into the plant with its piercing and sucking mouthparts. This saliva contains a toxin, which causes the purple appearance and the leaf streaking. If populations become high and the plant’s nutritional value decreases, winged aphids develop. They migrate to other locations to feed. Females reproduce rapidly without males. Many generations are possible in a growing season.

Management suggestions.
Damage may be more severe in dry droughty weather. Remove all volunteer wheat and barley as they serve as reservoirs for aphids. Ask your agricultural specialist for recommendations on the appropriate planting date. Maintain maximum plant vigor with fertilization and removal of weeds. Use resistant varieties if available.

\[1\] Diuraphis noxia (Mordvilko), (Homoptera: Aphididae). Commonly referred to as RWA. Infests wheat and barley.
Fig. 107. Close-up of a Russian Wheat Aphid adult. (length = ~2 mm)

Fig. 108. The rolled leaf is opened revealing a colony of Russian Wheat Aphid adults and immatures.
Other Aphids

Damage.
When populations are high, aphids cause yellowing and dessication of leaves, stems and the spike. Death of the leaves and the entire plant may occur. These soft-bodied insects excrete a sweet substance called "honeydew" which, when it lands on the foliage leaves a small scorch mark. Honeydew also encourages the growth of other microorganisms such as sooty mold, which often appears as a black smudgy substance on the leaf.

Insect characteristics.
Aphids are soft-bodied and feed by piercing the surface of the plant and sucking sap. Some species may inject a toxic substance or transmit a virus into the plant while feeding. Typically they are pear-shaped and when mature are only about 1-1.5 mm long. Some forms may be winged. There are many generations in a growing season.

Where to find Aphids.
If you see leaves with a shiny sticky substance on their upper surface or leaves with blackish mold growing on them, inspect the leaves immediately above. You should find colonies of tiny insects feeding together. Often they congregate around the main vein of the leaf. They also often hide behind the base of the flag leaf or between individual kernels on the spike.

Technicalities.
The aphid life cycle may vary depending on species. At certain times aphids can reproduce without males. When populations get extremely high or food quality and quantity decreases winged forms of aphids will develop that fly off to establish new infestations on healthy plants.

Management suggestions.
Consult your local agricultural specialist for control options appropriate for the species present in your fields.

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1The following species, with their common names, are found on wheat and barley at different times of the year and in different geographical locations:
(Homoptera: Aphididae)
*Schizaphis graminum* Rond. - Greenbug
*Rhopalosiphum padi* L. - Bird Cherry-Oat Aphid
*Rhopalosiphum maidis* Fitch. - Corn Leaf Aphid
*Sitobion avenae* F. - English Green Aphid
Fig. 109. Leaves are heavily infested with Bird Cherry-Oat Aphid.

Fig. 110. Leaf infested with Corn Leaf Aphid.
Fig. 111. Spike infested with English Green Aphid.

Fig. 112. Close-up of the English Green Aphid. Note the long extensions (arrow) at the end of the body. This is where the aphid excretes "honeydew".
Fig. 113. A colony of Greenbug (aphids) on the surface of a leaf. The larger individuals are the adults and the smaller ones the nymphs.

Fig. 114. Close-up of the Greenbug (an aphid).
Wheat Ground Beetle

**Damage.**
Adults feed on sown seed and developing spikes. The larvae feed on roots, stems and leaves. The first signs of a problem with wheat ground beetles will appear as numerous bare spots in the field that increase in size daily.

**Insect characteristics.**
The adults are shiny black beetles about 1.5 cm long. On the upper surface of the hardened wings there are noticeable lines running lengthwise. Towards the head the surface is smooth with numerous puncture marks. A portion of the legs may be yellowish-red. The larvae are about 3 cm long, yellowish white with a noticeable black-brown head and thoracic region (Fig 117).

**Where to find the Wheat Ground Beetle.**
This insect is secretive in nature and will be difficult to locate. Adults hide under debris during the day and feed on the spikes at night. You will not locate eggs because they are laid singly in the soil. The larvae also spend most of their lives in the soil and are only located by careful sifting of soil in areas where damage is evident. If bare areas are located sift through soil at the edges of these areas where plants are growing. One clue that larvae are present is the occurrence of a small pile of fresh soil left on the soil surface by a burrowing individual.

**Technicalities.**
The larvae typically pull young seedlings and leaves underground to feed on them. This is why bare spots are seen in fields. Note this characteristic because other beetles, for example, scarabs and wireworms, feed only on roots and leave the rest of the plant on the surface of the ground. Infestations may be spotty and vary with climatic conditions. Problems are minimal during dry seasons.

**Management suggestions.**
If this pest has been a problem in your area, be alert to its damage during wet seasons. It is worthwhile to scout your fields for this pest. Damage is most severe when cereals are planted continually; it is best to either leave fields fallow or plant legumes every other year.

*Zabrus tenebrioides* Goeze, (Coleoptera: Carabidae). Attacks both wheat and barley.
Fig. 115. Close-up of a Wheat Ground Beetle adult.

Fig. 116. Adult on the ground at the base of the plants.

Fig. 117. Close-up of the larva of a Wheat Ground Beetle.
Cereal Leaf Beetle

Damage.
There are two types of damage. The adults chew foliage in such a way that there appears to be narrow slits left completely through the leaves. (One can see right through the leaf) The larvae will feed along narrow strips only on the upper surface of the leaves leaving the lower surface intact. This results in the typical frosted or silvery appearance of damaged plants.

Insect characteristics.
From above the adults are a shiny metallic blue color and relatively small, about 5 mm in length. The legs and a short area just in back of the head are an orangey-red color (Fig. 120). The larvae are not typical and are about the same size as the adults but look like small yellow slugs with a covering of wet slime and dark fecal matter (Fig. 118).

Where to locate Cereal Leaf Beetles.
During the growing season the damaging stages of the pest are found on the leaves. Look for damaged leaves and you should locate the larvae on the upper surface. They are relatively slow moving and can be spotted with careful examination. The adults move faster and may either fall to the ground or fly off. During the off-season adults are located at the edges of fields in or under debris.

Technicalities.
After emerging from their overwintering sites adults will first feed then lay eggs. The eggs are usually deposited singly on the upper surface of leaves near the mid vein. They are yellow when first laid, darken as they mature and are about the size of a pinhead. When larvae finish feeding and developing they will drop to the ground and pupate in the soil. There is one generation per year.

Management suggestions.
If cereal leaf beetle is a problem in your area it is important that you inspect your fields on a regular basis. Control measures should only be taken when populations are at a level to cause economic loss. Late season damage, especially to the flag leaf is far more important than early season damage. Consult with your local agricultural specialist for advice.

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1Oulema melanopus L., (Coleoptera: Chrysomelidae). Attacks both wheat and barley.
Fig. 119. Cereal Leaf Beetle adult photographed on the surface of a coin to show the relative size of the insect.

Fig. 118. A Cereal Leaf Beetle larva feeding on the surface of a leaf.

Fig. 120. Close-up of an adult Cereal Leaf Beetle.
**Wheat Stem Sawfly**

**Damage.**
Larvae tunnel and feed down inside the stem. Feeding may begin above the top node and continue to the base of the plant. The spike may turn white. Yield and quality of grain may be significantly lowered. Larval feeding may weaken stems and prior to pupation they actually cut the stems and this may cause them to break with strong winds.

**Insect characteristics.**
The adult looks like a wasp with its’ abdomen constricted where it attaches to the thorax (body segment with wings). It is shiny black in color with three distinct broad yellow bands across the abdomen (Fig. 121). It does not sting. The larvae are dull-white with a brown head. Noticeable are stiff bristles which arise from the posterior end of the body (Fig. 123).

**Where to find Wheat Stem Sawfly.**
Adults do not damage wheat or barley but rather feed on nectar of flowers. The larvae can be found inside stems. It is necessary to open stems lengthwise and look inside to find them. When larvae are removed they will usually curl up in the shape of an "S".

**Technicalities.**
The female sawfly lays its eggs singly in the stem. One female may lay up to 70 eggs. It will not lay its eggs in stems that have already reached the boot stage. Adults may be present in wheat fields for as long as 6 weeks. Grain of attacked plants may ripen prematurely. Mature larvae will spin a cocoon inside the cut off portion of the lower stem, about 2-3 cm above the surface of the soil and overwinter there. Sawflies are attacked by several species of parasitoids. One generation per year.

**Management suggestions.**
Preserve parasitoid habitats (wild areas) surrounding fields. These natural areas should not be cultivated or mowed. When rain encourages the production of many stems, expect higher sawfly populations. Consult your agricultural specialist and select the appropriate planting date. If available, resistant varieties will reduce the incidence of sawfly damage. Fallowing fields or planting different crops in alternate years is useful.

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1*Cephus pygmaeus* L. (Hymenoptera: Cephidae). Attacks both wheat and barley. There are also a number of other species that cause damage.
Fig. 121. Close-up of a Wheat Stem Sawfly adult.

Fig. 122. Close-up of a Wheat Stem Sawfly egg inside a stem.

Fig. 123. Close-up of the larva of a Wheat Stem Sawfly.
Ear Thrips

Damage.
The immatures damage grains. Infested grains have lower weight and germinate poorly. Resultant plants from this seed have low vigor and poor yield. Their root systems are underdeveloped and total leaf area is reduced. Leaf damage shows up as small areas of dried up tissue.

Insect characteristics.
Thrips have unique mouthparts. They punch the surface of plant tissue to break individual cells. The fluid that exudes is then sucked up and ingested. They are very small, long and narrow insects and hard to see with the naked eye. The brown to black adults (Fig. 125) move about rapidly if disturbed and typically jerk the back portion of the body upright in a defence mode. They tend to be secretive, hiding within crevices of the plant. The nymphs are reddish in color. To identify them correctly, they should be collected in vials of alcohol and given to your local agricultural specialist.

Where to find Ear Thrips.
Ear Thrips prefer to feed on the milky stage of the grain, which is where the most serious damage occurs. Remove several heads of immature grain, and knock them against a white horizontal surface. Thrips will fall out and appear as minute fast moving specks on the surface. Also present may be tiny red, slower moving specks, which are the nymphs. Separate a few grains and look carefully at all surfaces for thrips. You may need a hand lens to actually see these insects on individual heads of grain.

Technicalities.
Adults tend to be excitable and will fly off if disturbed. Eggs are laid within plant tissue usually in grain or surrounding areas. Following the nymphal stage, which is the most damaging, pupation occurs in the soil usually at the base of the plant. They overwinter there and adults appear next at a time coinciding with new spike formation. Two generations per year.

Management suggestions.
These insects are difficult to control. Refer the problem to your agricultural specialist in the area for recommendations.

1Haplothrips tritici  Kurd., (Thysanoptera: Phlaeothripidae). Economically important especially in Iraq, Iran and Central Asia. Attacks both wheat and barley.
Fig. 124. A spike with a high population of thrips. Note the relative size of these pests (arrow). (length = ~1 mm)

Fig. 125. Close-up of the thrips at the end of the arrow in Fig. 124. above.
Winter Wheat Scarab\textsuperscript{1}

**Damage.**
One will first notice random areas within a field that appear as patches of yellow. On closer examination plants will have roots that have been chewed. The plants will eventually die. The upper portions of the plant will remain on the surface of the soil.

**Insect characteristics.**
The adults are robust beetles, about 10-14 mm long with brown or greenish brown heads and bodies. The wings are light brown or yellow with brown or black spots. The larvae are white, soft-bodied grubs with brown heads. When at rest in the soil they are in the shape of a "C".

**Where to find Winter Wheat Scarabs.**
First, locate areas of the field where damage as described above is evident. Then carefully dig the soil around the plants that have damaged roots. The grubs will be found there or in the vicinity of new plants growing at the edges of the yellow patches.

**Technicalities.**
The complete life cycle of this pest takes up to three years to complete. Most of that time is spent as an immature in the soil. The adults do not cause damage to cereals. Following mating they lay their eggs in the soil and after an incubation period they hatch and the larvae begin feeding on roots. The greatest amount of damage is done in year two of the life cycle. When soil moisture becomes scarce larvae will burrow deeper in the soil becoming inactive until winter temperatures and moisture are available. They then move to upper levels and feed again. After feeding in the third year they pupate in soil and adults emerge.

**Management suggestions.**
There are several options available but the easiest is to adopt a strategy that is preventative. If areas are prone to this pest, leave them fallow for at least a year before planting. Remember that the insect must feed on roots. Therefore, early planting before the insect is active, tillage operations which expose the insect to the soil surface and create dry conditions enhancing mortality, will help with control.

\textsuperscript{1}Phyllopertha nazarina Mars., (Coleoptera: Scarabaeidae). Also commonly called the Nazarene Chafer. Pest of wheat and barley.
Fig. 126. Larvae of the Winter Wheat Scarab. Note the typical "C" shape of the body.
Barley Stem Gall Midge\(^1\)

**Damage.**
Larvae feed at the base of the plant between the leaf sheath and the stem. They stunt plant growth. Infested plants are a darker green than normal, undamaged plants. A small pea-shaped gall will form at the site of larval feeding at the base of the stem. Ultimately the insect causes a reduction in yield.

**Insect characteristics.**
The adults look like small mosquitoes and are similar in appearance to Hessian Fly (Fig. 100). The larvae, which cause all the damage, are maggot-like and pale red at first. Later they turn white and gradually increase in size to about 3 mm long. Because all of the life stages can be confused with the Hessian Fly, do not attempt to identify them. Field-collected specimens should be sent to a specialist.

**Where to find the Barley Stem Gall Midge.**
Separate the sheath at the base of the stem of a symptomatic plant. You may find a maggot-like larva feeding on the surface of the stem. If not, look carefully for a pea-shaped gall formation. Carefully split this and you may find the larvae or a later stage of the insect inside.

**Technicalities.**
If you find the gall formation, you can be fairly sure that it was caused by the Barley Stem Gall Midge. Galls are an abnormal outgrowth of the plant responding to Barley Stem Gall Midge feeding. The adults do not feed. There may be two or part of three generations each year.

**Management suggestions.**
Plant barley after the peak of adult emergence. Enhance crop tolerance to the pest by encouraging plant vigor and rapid growth with fertilization. If available, use resistant varieties. Obtain recommendations on these factors from your local agricultural specialist.

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\(^1\) *Mayetiola hordei* Keiffer, (Diptera: Cecidomyiidae) A pest of barley.
Fig. 127. The white larva (black arrow) and the dark brown pupa (white arrow) of the Barley Stem Gall Midge.
Wheat Stem Borer

Damage.
Young larvae bore into stems and mine internally downward causing stunting of the plant and even death. Older larvae move out of the mines and bore into the ears after the milk stage of kernel development. This feeding causes the ears to dry out and ultimately reduces yield of useable grains.

Insect characteristics.
The non-distinctive looking adult moths are only seen at night when they are actively flying. The larvae are gray with a single dark stripe along the middle of the back and a green stripe along either side of the body. Mature larvae can reach a maximum length of about 3 cm. In Syria eggs were found laid on rocks.

Where to find the Wheat Stem Borer.
Concentrate your efforts on locating the larvae. Look along the stem of obviously stunted plants. If you find a hole that appears to have been made by an insect, remove the stem and carefully slit it open lengthwise. The insect may be inside. Next locate damaged spikes. These will be abnormally dried out with insect droppings scattered about. Look for the entry point of the borer and separate the kernels to find the larva inside.

Technicalities.
In Syria infestations were heaviest in rocky fields and along field borders and road sides. Relatively low infestations were found in the middle of fields. The immatures will migrate from plant to plant and a single larva has been recorded as potentially killing several plants outright and infesting 4 or more spikes. The pest is not normally economically important. One generation each year.

Management suggestions.
Observations have shown that natural enemies (parasitoids, predators, insect-killing fungi and bacteria) play an important role in population management of this insect. Preserve their natural habitats at field borders. Avoid planting in rocky areas because rocks are preferred for egg laying. Fallowing your land will help reduce subsequent populations.

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1*Oria musculosa* Hubner, (Lepidoptera: Noctuidae). Attacks both wheat and barley.
Fig. 128. Larva of Wheat Stem Borer (arrow).
Fig. 129. Root Rot disease. Note the off color and the destruction of the root system.
White Head Damage Key

To accurately determine the cause of the White Head damage, follow these steps:

1. Hold the plant by its damaged spike and pull upwards. The spike and a portion of the stem should become detached from the plant.

2. Inspect the area of the stem where it has become detached from the plant.

   A. If the area is darkened and it appears that feeding damage has occurred on the outside of the stem (refer to page 61, Fig. 68) the insect causing the damage is Sunn Pest. Page 78.

   B. If the area appears to have been damaged by feeding inside the stem, slit the stem length-wise and look for the following:

      a. A white, rather fat, nondescript larva.
      b. Small dark insect droppings and a weakened stem structure.

      If a or b are found, the damage was caused by the Wheat Stem Borer. Information on this pest is found on page 102.

3. If neither A or B above are found, and/or the entire plant was pulled up rather than becoming detached, inspect the root system. If the roots are degenerated and appear bluish-purple, the damage may have been caused by a disease called Root Rot. (Fig. 129) Ask your local agricultural specialist for advice regarding this problem.
Shoot Fly

Damage.
The larvae are the damaging stage of the pest and they feed inside the shoot of the tiller. The surrounding leaves will remain green but the shoot will gradually yellow and die. In the case of the Barley Shoot Fly, the larvae bore down through the tissue to the growing point, which causes the death of the central shoot. This is called "dead heart".

Insect characteristics.
The adult is a small fly about 4-5 mm in length. The different species have slightly different coloration. For example, one adult species that prefers barley is gray–yellow with a red band between the eyes. Another on wheat is completely black. The larvae are white or slightly yellowish and when mature, can be 8 mm long. The eggs are white and small (less than 1 mm long).

Where to find the Shoot Fly.
To locate this pest one must concentrate on finding the immatures. Look for shoots or stems that are beginning to turn yellow. Open these carefully and look for the larvae within. Although you may see adult flies on plants, you will not be able to identify them. A specialist is needed for this.

Technicalities.
Depending on the species, location and climatic conditions, there may be up to 5 generations each year. More commonly there are 1 to 2. The first generation is usually the most damaging to wheat and barley. The adults lay eggs for about 2 weeks and some species lay about 100 eggs total. A single larva can kill 4 shoots in a lifetime. However, some species will remain within a single shoot. Pupation is normally within the shoot near the base of the plant.

Management suggestions.
Cultural practices such as rotation that avoids cereal followed by cereal, and fertilization to favor tillering are the only means of reducing damage by some Shoot Fly species. In some conditions a delay of planting date helps.

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1This common name refers to a complex of various species which attack both wheat and barley. One species is Phorbia securis Tien., (Diptera: Anthomyiidae) which is found on wheat. Another species, Delia arambourgi Seguy is found on barley.
Fig. 130. Close-up of a typical adult Shoot Fly.

Fig. 131. The Shoot Fly immature (maggot) after removal from the stem. See arrow.
Cereal Leafminer

Damage
Larvae feed internally beneath the surface of the leaves of wheat and barley. They consume green tissue from these areas and leave behind transparent mines. These mines may encompass the entire width of the leaf. They usually start feeding from the tip of the leaf. As the larvae develop the mines increase in size. When the leafminers feed causing extensive tunnelling, they kill leaves.

Insect characteristics
The adults are moths and you are not likely to see them because they are very small and active at night. They lay their eggs in the soil in the spring and both the eggs and young larvae have a lengthy inactive period. In Syria it is usually in February or early March before the larvae will leave the soil and move to cereals to feed. They live in the leaves for 2-2.5 months before again burrowing into the soil to pupate. One generation annually.

Where to find Cereal leafminer
Remove a leaf that has an obvious mine. Hold this leaf up to the light and you should be able to see the leafminer larva feeding inside at the very edge of the transparent tissue where it meets healthy green tissue.

Technicalities
In Syria when soil temperatures reach about 12°C, the larvae will leave the soil and climb to cereal leaves. The eggs are extremely hardy and can withstand low humidity, which are common in the Mediterranean region. However, they are very sensitive to high humidity and survival is influenced by this factor.

Management suggestions
Yield loss is generally not noticeable until over 50% of the total leaf surface of a plant is destroyed. If infestations are high and drought occurs, the likelihood of plants dying is high. Optimal conditions for leafminers are heavy rain in late fall and winter followed by a dry spring. Consult your local agricultural specialist for control recommendations.

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Fig. 132. Leafminer larva (arrow) is seen at the edge of the damaged area.
Useful References


MSN Encarta – Hessian Fly

Kentucky Wheat IPM: Wheat Insects
http://www.uky.edu/Agriculture/IPM/scoutinfo/wheat/insects/inslist.htm

Wheat Insects
http://lubbock.tamu.edu/ipm/AgWeb/wheat.insect/insect.html

Pest Management – Insects – Wheat Stem Sawfly – Manitoba Agriculture and Food
http://www.gov.mb.ca/agriculture/crops/insects/fad20s00.html

Utilizing Plant Resistance to Insects in Wheat and Barley
http://www.pswcrl.ars.usda.gov/hpr.htm

IPM: Agriculture at the University of Illinois: Wheat
http://www.ipm.uiuc.edu/agriculture/wheat/wheat.html

Insect Management in Wheat
http://edis.ifas.ufl.edu/1G067

Diseases/Insects
http://jgg.unl.edu/links/insects.htm

Wheat
http://www.css.orst.edu/cereals/Wheat/INSECTS

Insects & Pests: Nebraska Extension Publications
http://www.ianr.unl.edu/pubs/insects

Biological Control
http://www.nysaes.cornell.edu/ent/biocontrol
GLOSSARY

**Awns**  Slender bristles that terminate the end of the spike.

**Borer**  An immature insect in the order Lepidoptera that feeds by excavating a tunnel through plant tissue, i.e. a stem or a root.

**Chlorotic** (chlorosis) A condition whereby plants that are normally green appear yellow or bleached out.

**Family**  A taxonomic group of related insects made up of numerable genera. It is a category just below the order level.

**Flagleaf**  The leaf immediately below the spike.

**Flaxseed**  The late 2nd instar of certain insects (as Hessian and Shoot Fly) with its outer cuticle darkened and hard. It is commonly called flaxseed because of its resemblance to the seed of flax.

**Gall**  An abnormal growth of a plant. It is a physiological response of the plant to something foreign that has been introduced, such as a toxin from an insect feeding on the plant.

**Genus**  A category of biological classification ranking between the family and the species. It contains species that are physiologically and structurally similar.

**Honeydew**  A sticky, clear exudate produced by some aphids during the feeding process. It contains large amounts of carbohydrates and amino acids.

**Insect**  An animal that belongs to the class Hexapoda having three pairs of legs and a hardened shell-like body that has three divisions. It may be wingless or have one or two pairs of wings in the adult stage. They possess different types of mouthparts.

**IPM**  Integrated pest management. IPM is a philosophy and strategy that is used to manage pests. It involves the integration of many different aspects of pest dynamics and crop production. The following are included: mechanical -, cultural -, biological -, chemical - and legal controls. IPM takes into account economical aspects of management and environmental impacts as well as societal concerns.
**Larva(e)**  The immature stage of an insect. It is often worm-like or soft-bodied in appearance and may or may not have legs. It has chewing mouthparts and can cause damage to many crops.

**Life cycle**  The series of stages in form and activity that an insect passes through from life to death.

**Maggot**  The immature stage of insects belonging to the order Diptera (the flies). Typically, it is white, broad at one end and tapering at the other. Some species damage
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