SPOILAGE OF FARM-STORED GRAIN by molds, insects and mites IN WESTERN CANADA

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SPOILAGE OF FARM-STORED GRAIN by molds, insects and mites IN WESTERN CANADA

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The problem

Every year, insects, mites, and molds infest stored grain in Western Canada. Grain that is moldy or otherwise out of condition must be downgraded. Insect-infested grain that is to be accepted by buyers must be fumigated, but storage and transportation facilities may still become contaminated. Consequently, moldy or insect-infested grain is hard to sell.

Infestation is usually not discovered until outbreaks occur and by that time much of the damage has been done. Since moldy and insect-infested grain represents a financial loss, it is well to know the causes of infestation and how to prevent them.

Why does the problem occur?

Certain insects and mites are well adjusted to the climate of Western Canada. They live on debris and molds in the cracks of walls and floors, on top plates of empty granaries and outside in spilled grain. In good weather, after the grain has been stored, they enter the grain bulk.

Some molds are air-borne; others are present in freshly harvested grain. If the grain is stored tough or damp, mold can develop. Insects, mites, and molds, alone or together, cause the grain to heat and spoil.

Who has the spoilage problems?

Not all farm-stored grain is affected by pest problems. However, many farmers eventually discover insect outbreaks and hot spots in stored grain.

What are the losses from infestation and grain heating?

Grain damaged by heating is recognized by charring of the seeds. Heating reduces capability of germination and provides favorable conditions for the development of insects and mites. Grain bulks that contain live insects cannot be accepted at country elevators. Moldy grain, if at all salable, has a lower market price and sometimes it is not even fit for animals to eat.

When do infestations and heating occur?

Infestations usually occur when large crops have to be stored longer than usual because of low sales. Also, when unfavorable harvest weather causes a lot of grain to be damp or tough, heating becomes a problem. Infested grain usually heats between October and April.

Where do infestations begin?

Most infestations begin in stored grain. If conditions for growth are right, even a few mold spores or a few insects are enough to start an infestation. Sources of insect infestations are uncleaned granaries and trucks and other equipment used to transfer infested grain. Infestations in freshly stored grain start with one or more adult insects laying eggs in the warmest and dampest parts of the bulk.

Does all infested grain heat?

No. Grain stored when its moisture content is below 11 percent and at a temperature below 40° F does not heat during normal storage. Molds raise the temperature of the grain only when it is damp. Grain is heated by insects only when it is stored at temperatures above 65° F. Fungus beetles and mites do not cause heating but they downgrade tough and damp grain. Mites breed at temperatures as low as 41° F.

What are the main types of grain heating?

There are two main types of heating. Heating caused by mold occurs often in the northern part of the Prairie Provinces, and insect-caused heating is common in the southern part. The first type is much less serious than the second and is easier to control.

Figure 1 Sprouting grain at the surface of a hot spot in a wheat bulk in a farm granary in winter.

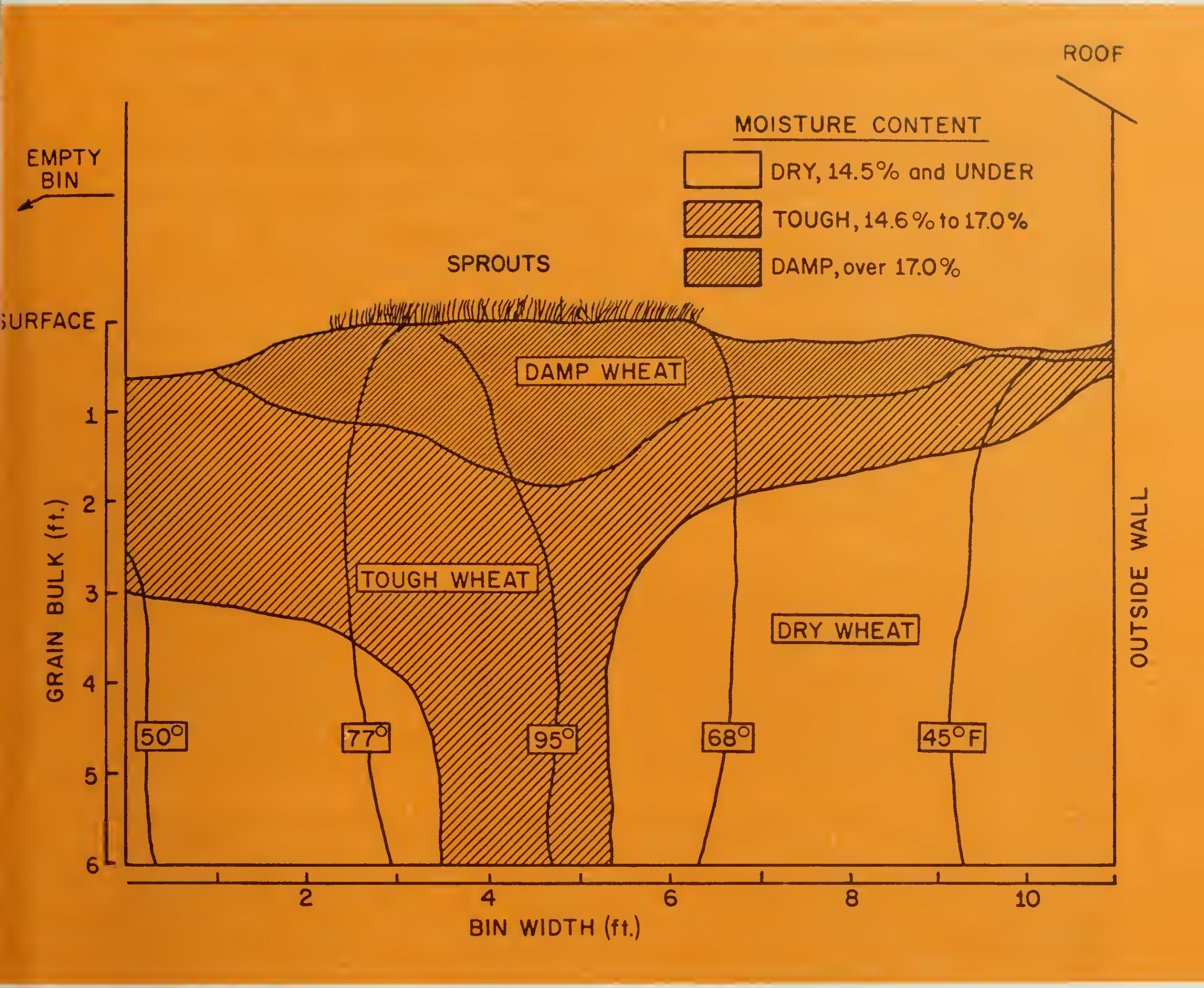


Figure 2 Cross section through the insect-infested hot spot shown in Figure 1.

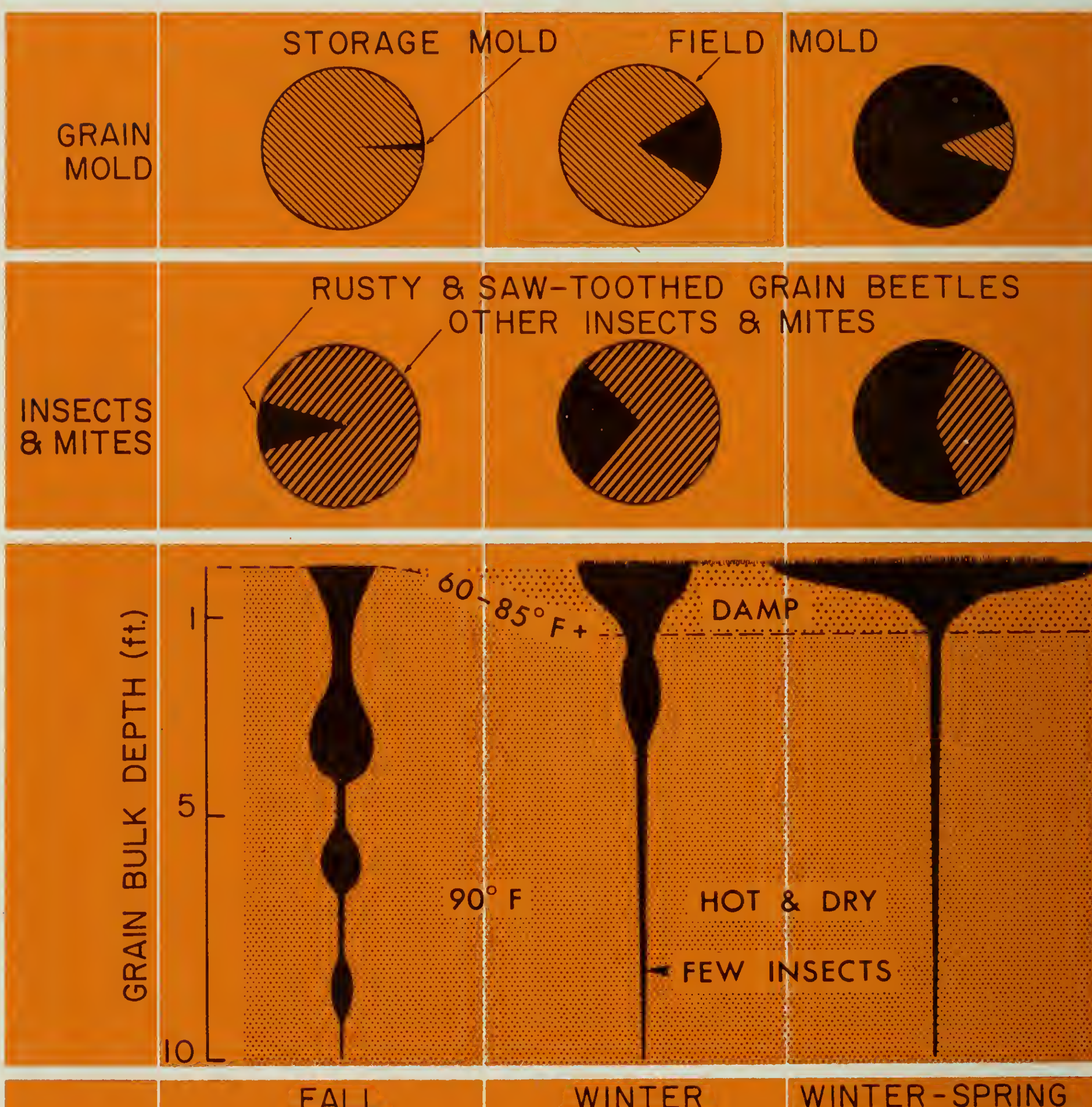
Storage mold, mainly blue mold, starts to grow in a tough or damp spot in the grain bulk. If the entire crop is harvested damp, heating may begin anywhere. Damp pockets in dry grain may be caused by rain seeping through holes in the roof, snow blown through a window, or moisture entering through floor cracks. Heating caused by mold usually starts in fall or early spring, and it lasts for only 1 to 3 weeks in any single spot. As the mold develops, the temperature rises until the heat inactivates or kills the mold. The mold stays in the original damp pocket, but it can be removed and destroyed.

Heat caused by insects begins when the adult insects congregate and breed rapidly in dry pockets in the grain bulk. The heat produced by the growing larvae also favors growth and it promotes breeding. The grain temperature gradually rises, moisture from the insects dampens the grain, crusts form, and mold grows quickly. In extreme cases, the grain sprouts at the top of the bulk (Figures 1 and 2). As the top of the grain bulk is exposed to sub-zero temperatures in winter, convection currents inside the bulk cause heavy condensation along the surface. Heating lasts for several months, and much damage from insects and molds occurs during the latter part of the heating period.

Typical development of molds, insects, and mites in the grain bulk is depicted in Figure 3.

Subsequently noneconomic species of insects, mites and bacteria invade the heated grain bulk. Occasionally, populations of insects and mites reach astronomical numbers. By the time the unsuspecting farmer sees the first signs of infestation, that is, heating, caking, and sprouting on the surface of the grain bulk, the damage has been done. In spring, insects spread from overcrowded quarters and contaminate the surrounding grain mass. Insect and mite infestations are usually restricted to the 1-foot layer of grain along the surface, but molds may grow along the entire grain column.

Figure 3 The development of an insect-infested hot spot shown in Figure 1. The relative abundance of the main molds, insects, and mites in samples is shown in the two-toned circles. The diameter of the columns represents the sizes of insect populations at various depths.



What are the main insects that cause grain heating?

The rusty grain beetle, the saw-toothed beetle, and the red flour beetle are the chief insects that cause heating. They completely destroy the germ of slightly damaged kernels, cause grain to heat, cake, and sprout, and provide places for storage molds to enter the kernels. A list of the main insects and mites that attack stored grain is given at the end of this publication.

How are these beetles recognized and what are their life histories?

The **rusty grain beetle** (Figure 4) does the most damage to farm-stored grain. This insect is flat, reddish brown, and about 1/15 inch long. It flies on warm summer afternoons. Its rectangular shape and straight V-shaped feelers can be detected with a magnifying glass.

Growth and reproduction of this insect occur at temperatures between 70° F and 100° F. The females lay eggs under the outer layer of the kernel or in surface cracks. The eggs hatch into white, flat, active larvae that feed mainly on the germ and occasionally on the starch portion of the seed. As they grow inside the kernel, the larvae molt four times, finally changing into pupae and then to adults. Development from egg to adult takes between 24 and 98 days, depending mainly on temperature. Adults may live for 6 to 12 months, and under favorable conditions beetles can increase 60-fold in one month. The insects usually pass the winter as adults, but occasionally also in the larval stage.

The **saw-toothed grain beetle** is less common than the rusty grain beetle but it is equally destructive. The adult beetle is slender, flat, and about 1/8 inch long. Its name comes from the six tooth-like projections along the sides of the middle part of its body. It also destroys the germ, and often feeds on dockage and broken grain.

The insect's life cycle can be completed at temperatures from 65° F to 100° F. Growth from egg to adult, at 90° F to 95° F, takes only 20 days. The female beetle loosely deposits about 6 to 10 eggs a day on the grain. The eggs hatch into active larvae that eat broken grain and dust and eventually enter the germ of the kernel. The larvae molt several times before they enter the pupal stage. Adults can live 6 to 10 months. They survive the winter hidden in cracks, under debris, or deep inside the grain bulk.

These beetles can breed when the grain is at a temperature of 65° F and the moisture content is 12 or 13 percent. Fastest development occurs when the temperature of the grain is near 90° F and the grain moisture content exceeds 14 percent. When conditions are favorable, the insect can increase 50-fold each month.

The **red flour beetle** is less cold hardy than the other two beetles. The adults are reddish brown and about 1/8 inch long. The females lay eggs loosely in the grain. The larvae, yellowish white and about 1/4 inch long when fully grown, cannot feed on sound grain kernels. However, they establish themselves quickly in grain bulks that the rusty grain beetle or the saw-toothed beetle have infested. They feed on the germ, on the starchy part of the grain kernels, and on grain dust.

Growth and reproduction take place at temperatures from 70° F to 100° F. At 70° F the time from egg to adult is about 75 days, whereas at 90° F to 95° F it is only 20 days. These beetles can breed when the moisture content of the grain is

Figure 4 Rusty grain beetles and typically damaged wheat kernels.

below 13 percent. Hot spots develop quickly when freshly harvested grain is stored in unusually hot weather. When conditions are favorable, red flour beetles can increase 70-fold in one month.

How can infestations and grain heating be detected?

Grain that is stored damp is always in danger of developing moldy pockets. Since mold infestation causes crusting, a crusted and caked patch is a sign of damage. A metal pipe inserted deep into the grain bulk may be used to detect heating. If after a few minutes the pipe is withdrawn and it is warm to the back of the hand, the grain is heating.

Check all grain stocks for insects and signs of heating at least once every 2 weeks. To check for insects use a 10-mesh sieve to screen samples taken 6 inches below the surface. Heat the siftings slightly and examine them carefully for moving insects. Insect traps such as those developed by Loschiavo and Atkinson at the Research Station, Canada Department of Agriculture, Winnipeg, can be used to detect insects inside the bulk, provided that the grain temperature is above 60° F.

How can infestations and grain heating be prevented?

Clean empty bins before you store new grain. Burn or bury grain debris and bird and mouse droppings gathered from the empty granary. Repair and weatherproof roofs and walls of storage bins.

Cold weather is the best aid in preventing grain from heating. Keep stored grain as dry and as cool as possible. Grain stored when its moisture content is less than 11 percent and at a temperature below 40° F does not heat during normal storage. If tough, damp grain must be stored in warm weather, move the grain during the first spell of cold weather. Augering grain from one bin to another during cold winter months is the cheapest way to control mold, insect, and mite infestations.

Do not store grain next to animal feeds, because they may be infested.

To provide crawl space and permit ventilation, fill granaries only to the top plates.

If the grain is binned when it is tough or damp, examine it every week for heating. If heating is detected act at once to prevent further damage. Turn the grain and allow it to cool.

If the grain that was binned dry has been stored for more than a year, check it every 2 weeks between October and April to see if it is heating. A simple insect trap can be used to check the activity of insects inside the grain. Contact the Research Station, Canada Department of Agriculture, Winnipeg, for information on this trap.

Danger of insect infestation and heating of dry grain, even in well-built granaries, greatly increases when grain is stored and left undisturbed in the same place for a long time. Examine old grain piles more often than new ones. Insect infestations in stored grain occur even on very clean farms.

How can infestations be controlled?

Determine the cause of grain heating before you apply control measures. If the heating is caused by mold, and none of the chief pest insects are present in damp grain pockets, probably only one or two small pockets are infested. Remove and destroy these pockets. In cold weather, auger the rest of the grain to a new pile and dry it as soon as possible. Fungus beetles and mites in damp and moldy grain do not cause heating. Canada Department of Agriculture, Publication 1398, *Damp Grain,* tells what to do with grain that has become damp.

If heating is caused by insects, carefully separate and burn or bury the badly infested patches of grain. Transfer and clean the remaining grain in very cold weather to lower the grain temperature to below the freezing point.

If fumigation of the entire bulk is necessary, do it only in warm weather. Fumigation is effective only when the temperature of the whole grain pile is at least 60° F. Your local provincial agricultural representative or district agriculturist will give you information on fumigants, how to use them, and safety precautions to take.

How can more information be obtained?

For help on a particular problem write to the Provincial Pest Control Specialist, care of your provincial department of agriculture, or to the Research Station, Canada Department of Agriculture, 25 Dafoe Road, Winnipeg 19, Manitoba.

COMMON AND SCIENTIFIC NAMES OF THE INSECTS AND MITES

Confused flour beetle	*Tribolium confusum* Jacquelin du Val
Foreign grain beetle	*Ahasverus advena* (Waltl)
Granary weevil	*Sitophilus granarius* (Linnaeus)
Hairy spider beetle	*Ptinus villiger* (Reitter)
Meal moth	*Pyralis farinalis* (Linnaeus)
Merchant grain beetle	*Oryzaephilus mercator* (Fauvel)
Psocid	Psocoptera
Red flour beetle	*Tribolium castaneum* (Herbst)
Rusty grain beetle	*Cryptolestes ferrugineus* (Stephens)
Sawtoothed grain beetle	*Oryzaephilus surinamensis* (Linnaeus)
Sigmoid fungus beetle	*Cryptophagus varus* (Woodroffe & Coombs)
Squarenosed fungus beetle	*Lathridius minutus* (Linnaeus)
Brown grain mite	*Androlaelaps casalis* (Berlese)
Cannibal mite	*Cheyletus eruditus* (Schrank)
Glossy grain mite	*Tarsonemus* spp.
Grain mite	*Acarus siro* Linnaeus
Long-haired mite	*Glycyphagus destructor* (Schrank)

CONVERSION FACTORS FOR METRIC SYSTEM

Imperial units	Approximate conversion factor	Results in:	
LINEAR			
inch	x 25	millimetre	(mm)
foot	x 30	centimetre	(cm)
yard	x 0.9	metre	(m)
mile	x 1.6	kilometre	(km)
AREA			
square inch	x 6.5	square centimetre	(cm^2)
square foot	x 0.09	square metre	(m^2)
acre	x 0.40	hectare	(ha)
VOLUME			
cubic inch	x 16	cubic centimetre	(cm^3)
cubic foot	x 28	cubic decimetre	(dm^3)
cubic yard	x 0.8	cubic metre	(m^3)
fluid ounce	x 28	millilitre	(ml)
pint	x 0.57	litre	(ℓ)
quart	x 1.1	litre	(ℓ)
gallon	x 4.5	litre	(ℓ)
bushel	x 0.36	hectolitre	(hl)
WEIGHT			
ounce	x 28	gram	(g)
pound	x 0.45	kilogram	(kg)
short ton (2000 lb)	x 0.9	tonne	(t)
TEMPERATURE			
degrees Fahrenheit	(°F-32) x 0.56 or (°F-32) x 5/9	degrees Celsius	(°C)
PRESSURE			
pounds per square inch	x 6.9	kilopascal	(kPa)
POWER			
horsepower	x 746	watt	(W)
	x 0.75	kilowatt	(kW)
SPEED			
feet per second	x 0.30	metres per second	(m/s)
miles per hour	x 1.6	kilometres per hour	(km/h)
AGRICULTURE			
bushels per acre	x 0.90	hectolitres per hectare	(hl/ha)
gallons per acre	x 11.23	litres per hectare	(ℓ/ha)
quarts per acre	x 2.8	litres per hectare	(ℓ/ha)
pints per acre	x 1.4	litres per hectare	(ℓ/ha)
fluid ounces per acre	x 70	millilitres per hectare	(ml/ha)
tons per acre	x 2.24	tonnes per hectare	(t/ha)
pounds per acre	x 1.12	kilograms per hectare	(kg/ha)
ounces per acre	x 70	grams per hectare	(g/ha)
plants per acre	x 2.47	plants per hectare	(plants/ha)

Examples: 2 miles x 1.6 = 3.2 km; 15 bu/ac x 0.90 = 13.5 hl/ha