

Plant Toxicoses in Israel

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The evolutionary battle between plants that don't want to be eaten before they can propagate, and herbivores (largely insects, but also domestic animals) that want to eat them is a fascinating stratagem whereby plants produce many toxic secondary compounds whose sole role is to repel, harm or kill their enemies. An additional intriguing factor for the diagnostician is the fact that such toxins in a "poisonous plant" may vary up to a hundredfold in their concentration, depending on genetic changes in cultivation, climate, season, soil type and the degree of precipitation, so making risk assessment of toxicity particularly difficult.

In many countries, toxic plants are a significant threat to the health of grazing domestic animals. This is particularly evident in large countries such as Australia, Brazil and the USA that have substantial areas of natural pasture in different ecosystems, thus having a naturally rich plant biodiversity, with a correspondingly diverse variety of endemic and introduced toxic plants. The incidence of plant-induced toxicoses in pastured animals is very difficult to even estimate, and is often sub-divided into direct losses (usually mortality), and reduced production, that is also difficult to quantify (comprising mainly abortions, reproductive problems and other losses in calf production); additional financial costs are those made by operations to control the poisonous plants or prevent toxicoses. In Brazil, one state recorded 11.3% mortality in cattle caused by toxic plants. In Australia, the financial losses from reduced production in cattle were almost 7 times higher than the cost of the more obvious deaths from plant toxicoses. It can therefore be seen that plant toxicoses can be one of the most important causes of losses in pastured herbivores and, in some countries, also in milking ruminants that extensively graze between milkings.

In contrast, plant toxicoses in Israel constitute a very minor cause of direct financial losses; the losses induced by re-

duced production in beef cattle have not been investigated. The finding of minimal importance of plant poisonings in Israel may be due to a variety of factors:

1. Israel is a very small country and does not have different ecosystems in the main areas of pasture grazing;
2. Natural pastures in Israel contain few toxic plants, most of which contain secondary toxicants that impart a strongly aversive smell and or taste;
3. Most beef herds are relatively well monitored and when the farmer finds a deficient pasture status, additional feedstuffs (often dried poultry litter) are given to avoid animals ingesting toxic plants that they would not normally eat;
4. Well-organized farming operations have been in existence for just a few decades in Israel, and so no data have been accumulated over tens of decades on the incidence of toxicoses, particularly in the context of loss in production.

However, reports of plant toxicoses in Israel have been made over the years in the following animal species:

A. CATTLE

By far the most important toxicosis is that caused by plants containing high concentrations of nitrate, that lead to nitrite intoxication in cattle. This occurs invariably in "naïve" cattle that have been previously given feed containing low concentrations of nitrate (usually <0.2% nitrate dry weight), often dairy cattle. Beef cattle at pasture are often gradually acclimatized (through ruminal microorganisms) to weedy plants containing high nitrate levels when seeds germinate after the first autumn heavy rains (in the hot, dry summer, cool wet winter Mediterranean climate) and increasingly eat the

weeds as the high nitrate-containing plants grow. However, we have seen toxicoses in beef herds when there has been no rain for 4-6 weeks after initial heavy precipitation, stressing the germinated plants so that they contained extremely high nitrate levels that killed insufficiently-conditioned cattle. It should be emphasized that nitrate is a primary plant compound and so has no repellent effect of smell or taste to cattle.

The most important nitrate-containing plants in Israel are 2 abundant winter annual weeds that have been introduced to many other countries world-wide. These plants, *Malva nicaeensis* (bull mallow) and *Silybum marianum* (Mediterranean milk thistle) both grow on largely heavy soils and are often found between areas of human habitation and pasture, and so animals being driven from housing on the farm to-and-from pasture may eat these plants on the way and be poisoned. In addition these weeds may contaminate fields of fodder grown for hay if they are not selectively killed with herbicides, and even more commonly grow profusely at the edges of these fields and are often harvested together with the good feed. They are therefore often seen as a contaminant of hay on dairy farms, and, depending on their nitrate content and degree of contamination, may induce even fatal toxicoses on a herd basis. Summer annual weeds containing excess nitrate are invariably of the *Amaranthus* (amaranth) species, that may likewise contaminate cattle feed, but to a much lesser extent than the winter annuals. Unconventional feedstuffs such as dried tomato vines may also contain excess nitrate. Efforts have been made in Israel to encourage summer growth of the fodder grasses *Setaria* and *Pencillaria*, but after several nitrate toxicoses were recorded, it was noted that such fodder could be a potential health threat. A survey of cattle feed conducted by the author in 50 Israeli farms about 10 years ago revealed widespread nitrate content of hays. High concentrations of nitrate (> 1.5% dry weight) were seen in > 50% of corn straw and *Setaria* hay samples, in about 25% of clover, oat and vetch hay samples, in 5-10% of alfalfa and wheat hay samples but in none of the pea hay, chickpea hay or peanut straws; corn, wheat and sorghum silages also contained < 1.5% in all instances. The nitrate is stable in dried hay, but excess is readily degraded in ensiling. Although the toxicosis is invariably peracute, an efficacious antidote, methylene blue, readily saves lives if administered in time. There have been several abortion storms several days after exposure to

excess nitrate from these weeds. There is a suspicion that the high levels of nitrate in Israeli feeds may be associated with poor breeding success in dairy herds.

All other plant toxicoses in cattle have been few and far between in the last 40 years. The most interesting were poisonings caused by ingestion of the native bush *Cistus salvifolius*, that were manifested by a near pathognomonic urinary retention syndrome, seen as elevated tail-heads with dribbling emission of urine, apparently due to bladder paralysis; morbidity may be very high and animals die from cachexia after suffering for weeks. Despite the facile diagnosis of the syndrome, it had never been reported prior to 1998, and even stranger, the first case in the world (in Israel) was seen at the same time as similar cases in Portugal. Since then it has been reported uncommonly but regularly in Israel, but it is still not known at what exact season or what other factors influence toxicity. Another interesting toxicosis was that seen in recent years in 2 beef herds after ingestion of *Xanthium strumarium* (common cocklebur), an introduced summer annual weed. Toxicoses in the literature refer to deleterious consumption of the toxic seedlings at the cotyledon stage, in soils that are drying out. Germination occurs in Israel in drying seasonal stream beds in the spring, but no harmful ingestion of the seedlings has been reported. However we have seen 2 seasonal lakes that fill up in the winter and dry out gradually in the long hot summer and autumn and provided a continual large monoculture area of germinating cocklebur. The only natural grazing in herds moved temporarily to these areas was cocklebur, and the spiny capsule probably deterred ingestion of mature plants, so encouraging ingestion of the toxic seedlings. The toxin is hepatotoxic and clinical signs are largely derived from brain lesions.

There have been only a few cases of *Nerium oleander* (oleander) toxicosis, which may be surprising as this is an endemic species and is present in hilly pastures in northern Israel. It would appear that these toxicoses occurred after eating dried leaves that had been pruned from ornamental oleander varieties; death was sudden, consistent with cardiotoxicity. There have been 2 instances of toxicosis due to *Heliotropium europaeum* toxicosis, these being the only instances of pyrrolizidine alkaloid toxicosis in Israel, despite the presence of many species containing these hepatotoxins. Photosensitization has been seen several times, with primary photosensitization seen occasionally due to ingestion of

the summer annual *Ammi majus* (St. Annes lace). There has been only one case of secondary photosensitization caused by ingestion of the bush *Lantana camara* (lantana); lantana is probably the most common cause of toxicosis in cattle on a world basis, but fortunately the climate in Israel has not encouraged large scale naturalization from garden varieties, and this sole case was after ingestion of garden-pruned branches.

B. SHEEP AND GOATS

Sheep and goats are often fed feed of a lower quality than that fed to milking ruminants, as many flocks are barely profitable and are kept extensively, and so are more likely to be fed low cost feeds (that may be contaminated with toxic weeds). Sheep and goats are largely resistant to nitrite toxicity and only very high levels (>5% nitrate) pose a threat; several toxicoses have been reported over the years, and considering the high levels of nitrate in hays in Israel, poisoning can never be discounted off-hand. Sheep and goats are often exposed to *Amaranthus* species in fields where they graze the remnants of vegetable plants after they have been harvested. Oleander toxicosis has not been reported, and sheep are known to be much more resistant to toxicosis from the pyrrolizidine alkaloids in *Heliotropeum*. Hearsay reports have suggested that there have been cases of *Cistus* toxicosis. Occasional primary photosensitization has been noted due to ingestion of *Ammi majus*. Single cases of toxicoses were recorded in a sheep flock that ingested the winter annual *Mercurialis annua* and more recently in a flock that suffered cyanide toxicosis after ingesting summer regrowth of harvested sorghum fodder. Goats have been poisoned several times by the annual winter weed *Chenopodium album* (white goosefoot), causing fatal oxalate poisoning with kidney damage. *Malva parviflora* (small-flowered mallow) is a common native winter annual weed that has been associated, both in Israel and Australia, with toxicosis in sheep and horses. This occurs after ingestion of large quantities of the plant for over a week, and has caused mainly weakness and recumbency in sheep, with a low mortality.

The main toxicosis in sheep and goats is caused by an endemic plant, *Ferula communis* (giant fennel), a winter perennial that particularly in the event of a winter drought, may dominate pastures in the Jerusalem foothills and in the Golan heights. The plant is not readily eaten, but re-

search showed that some sheep develop a craving for it and may eat the plant in excess until they are killed by it. Morbidity is therefore low, but mortality is high. The plant has caused toxicosis by being eaten as a growing plant in winter-spring, or as the dried plant in the summer. The plant contains a natural anticoagulant and causes reduced blood coagulation with extensive hemorrhages leading to a fatal anemia. Diagnosis is made by typical necropsy findings. In goats the main manifestation has been with unaffected does giving birth to kids that die in their first few days with typical manifestations of coagulopathy. Research has been conducted in Israel on the toxicosis and aversion therapy, and a scientific justification was made for a protocol of best avoiding toxicoses by conducting a repetitive "6 days on pasture then 1 day off pasture" regimen, or even better, 3 days on / 1 day off. The toxicosis is now uncommon, as many farmers have adopted this prophylactic grazing protocol.

C. HORSES

Specific plant toxicoses are uncommon to rare, although many cases of colic are generally presumed to be caused by the plant feed that they are given. Several incidents of *Malva parviflora* intoxication have been seen, after prolonged intake of virtually just this plant in their diet. Clinical signs were varied, with an acute syndrome of absolutely quiet recumbency alternating with seemingly normal behavior, to an incident of severe muscle fasciculation and tongue paralysis. Diarrhea was seen with high contamination of hay with *Sinapis alba* (white mustard) and *Brassica tourniforti* (Asian mustard) seed pods containing irritant substances. Several cases of *Ferula* toxicosis have been seen, usually when they had little else to eat, but sometimes when the plant was dry.

D. OTHER ANIMALS

Ducks and geese kept outside showed severe cases of primary photosensitization due to ingestion of *Ammi majus* seeds. Severe beak and skin deformations were seen together with eye damage manifested by a permanent mydriasis and pigmentary retinopathy. The perennial desert plant *Pituranthus triradiatus* seeds also caused severe photosensitization. The summer annual *Ammi visnaga* was also a milder photosensitizer.

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