

# MANAGING CADMIUM IN VEGETABLES

## 1. FOOD SAFETY

Of the various heavy metals present as impurities in fertilisers, cadmium (Cd) receives the most attention. This is for two reasons. Firstly, cadmium is taken up from the soil by plant roots. Other heavy metals such as lead and mercury are not, and only find their way into farm produce by soil and fertiliser dust contamination. Secondly, while well within safe limits, dietary intake of cadmium, as a percent of the Provisional Tolerable Weekly Intake (PTWI), is higher than for the other heavy metals.

Consequently, attention is focused on containing the amount of cadmium consumed in the diet, by setting Maximum Limits for cadmium in farm produce, and minimising cadmium additions to the soil.

Maximum Limits (MLs) for heavy metals in farm produce are set at the lowest level that is achievable with good farming practices, provided they do not result in dietary intake exceeding the Provisional Tolerable Weekly Intake. Maximum Limits are “action levels” which indicate that investigation or action may be required. Consumption of food that exceeds the Maximum Limit is not harmful to health. Food that is high in cadmium would need to be consumed over a lifetime to be of concern, and even then is unlikely to be detrimental.

Farm produce that exceeds the Maximum Limits, however, may be rejected by buyers. This in turn may restrict the choice of crops that farmers can grow, and affect farm profitability. Vegetables tend to have higher concentrations of cadmium than most other foodstuffs. Potatoes, because of the quantity consumed, represent the biggest single source of cadmium in our diets.

## 2. CADMIUM IN SOILS

Cadmium occurs naturally in the soil, and can be added in various ways. Cadmium is present as an impurity in many fertilisers. Depending on the cadmium concentration in the fertiliser and its rate of application, fertiliser use may add to background levels of cadmium in the soil.

Cadmium is found at highest concentrations in phosphorus (P) and metallic trace element fertilisers. Nitrogen (N) and potassium (K) fertilisers are low in cadmium. Phosphorus fertilisers represent the most significant source of cadmium inputs to Australian agricultural soils.

The presence of cadmium in phosphorus fertilisers is of most concern in vegetables.

1. phosphorus is applied at much higher rates in vegetables than in other crops, so soil cadmium inputs are higher.
2. plant root uptake of cadmium tends to be higher in root and tuber crops, and in leafy vegetables.

### 3. CADMIUM IN PHOSPHORUS FERTILISERS

Phosphorus fertilisers vary in their cadmium content, depending on the amount of cadmium in the phosphate rock from which they were manufactured. The cadmium concentration in phosphorus fertilisers can be expressed in two ways:

- mg/kg Cd – milligrams of cadmium (Cd) per kilogram (or parts per million) in the product;
- mg Cd/kg P – the cadmium concentration per kilogram of phosphorus (P) in the product. Expressing the cadmium concentration this way allows easier comparisons to be made between fertilisers with different phosphorus contents.

The maximum cadmium concentration that is allowed in phosphorus fertilisers in Australia under State fertiliser legislation is 300 mg Cd/kg P. Incitec Pivot SuPerfect (single superphosphate or SSP) is manufactured to this specification (a maximum of 300 mg Cd/kg P). SuPerfect is primarily used on legume based pasture. Cadmium concentrations in livestock products such as meat and dairy products (excluding offal) are typically well within the Maximum Limits.

SuPerfect should not be used as the sole source of phosphorus in in vegetables, and other risk situations. Fertilisers with a lower cadmium content should be chosen.

The MAP and DAP produced at the Incitec Pivot manufacturing facility at Phosphate Hill in north west Queensland are low in cadmium, containing less than 50 mg Cd/kg P. Most imports also meet this specification. Incitec Pivot MAP has a maximum specification of 75 mg Cd/kg P, to allow for the occasional import of MAP with a cadmium concentration between 50 and 75 mg Cd/kg P.

The maximum cadmium concentrations in Incitec Pivot's most commonly used phosphorus fertilisers are tabulated below.

### 4. PLANT UPTAKE OF CADMIUM

Many factors, including soil characteristics and cadmium concentrations, irrigation water quality, plant species and variety, and cadmium inputs as fertiliser, affect plant uptake of cadmium. Plant uptake is not always highest in soils that are high in cadmium, or to which high amounts of cadmium have been applied as fertiliser.

For example, phosphorus is applied at high rates on red basalt volcanic soils, but plant root uptake of cadmium on these soils is not usually as high as on lighter textured soils. Soils that fix phosphorus also fix cadmium, so that reduced amounts of cadmium are available for plant root uptake. In addition, red basaltic soils are permeable and well drained, and are not usually associated with salinity issues (discussed below).

**Maximum Cadmium Concentrations in Incitec Pivot Phosphorus Fertilisers**

Product	Analysis (%)	Maximum Cadmium Concentration

	% N	% P	% S	mg/kg Cd	mg Cd/kg P
SuPerfect		8.8	11	25	300
MAP	10	21.9	1.5	15	75
DAP	17.7	20	1.6	10	50

Cadmium is most available for plant uptake on acid sandy soils and in soils low in organic matter. Salinity, either from the soil itself or the use of poor quality irrigation water, affects cadmium uptake. Chloride (Cl<sup>-</sup>) mobilises cadmium in the soil, increasing cadmium concentrations in the soil solution. CdCl<sup>+</sup> is more available for plant uptake than Cd<sup>2+</sup>. Higher cadmium concentrations are found in tuber (e.g. potatoes) and root crops (e.g. carrots) and leafy vegetables (e.g. spinach, lettuce) than in most other farm produce.

Phosphorus fertilisers are typically applied at higher rates in vegetable crops than in most other crops. Their application can increase plant uptake of cadmium in two ways.

1. cadmium is added to the soil with the fertiliser, and may be taken up directly by plant roots.
2. by stimulating root growth and plant vigour, the uptake of cadmium inherently present in the soil may be increased. The regular use of phosphorus fertilisers high in cadmium adds to soil cadmium concentrations.

## 5. IRRIGATION WATER QUALITY

In potatoes, the probability of cadmium concentrations in tubers reaching the Maximum Limit is low when using irrigation water with a conductivity of less than 2.0 dS/m. The probability then rapidly increases to above 50% as the salinity of the irrigation water increases above 3.0 dS/m. Management strategies that can be considered where the conductivity of the irrigation water is above 2.0 dS/m include:

- Chose an alternative irrigation water source with lower salinity, if available;
- Selecting potato varieties such as Wilwash, Russet Burbank, Lemhi Russet, Ranger Russet, Winlock, Tarago, Pontiac, Atlantic, Desiree and Delaware which take up cadmium from the soil in lower amounts;
- Use Sulfate of Potash rather than Muriate of Potash to supply potassium.

If cadmium concentrations remain high, alternative crops that take up less cadmium may need to be grown.

## 6. AUSTRALIAN CADMIUM MINIMISATION STRATEGY

The "Australian Cadmium Minimisation Strategy" is an initiative of the Primary Industries Standing Committee. It is sponsored by the Fertilizer Industry Federation of Australia (FIFA), now known as

Fertilizer Australia (Incitec Pivot is a member), the Horticultural Research and Development Corporation and the Grains Research and Development Corporation. Details on the "Australian Cadmium Minimisation Strategy" can be found on their web-site ([cadmium-management.org.au](http://cadmium-management.org.au)), including the following publications:

- National Cadmium Strategy
- Managing Cadmium in Vegetables
- Managing Cadmium in Potatoes for Premium Quality Produce
- Cadmium in Potatoes - Managing the Risk from Saline Irrigation Water

Under the Strategy, it is recommended that potato (and other vegetable) growers choose fertilisers with as low a cadmium content as possible. Phosphorus fertilisers should contain less than 150 mg Cd/kg P. If repeated applications of phosphorus are made at high rates, e.g. more than 100 kg/ha P per crop, it is desirable that fertilisers containing less than 100 mg Cd/kg P be used. Fertilizer Australia members have agreed to target low cadmium fertilisers at those areas and industries that have an existing or potential cadmium problem.

## 7. INCITEC PIVOT NPK BLENDS FOR HORTICULTURE

Incitec Pivot NPK blends for the horticultural segment are formulated so as to contain no more than 150 mg Cd/kg P. The analyses of some of the more commonly used NPK planting fertilisers are shown below:

**Analyses on Commonly Used Incitec Pivot NPK Planting Fertilisers for Vegetables**

Product	Analysis (%)			
	%N	%P	%K	%S
Complete Mix 1	7.6	9.5	9.6	8.6
Croplift 800	8.0	10.5	10.0	7.6
NPKS 11-15-14-1 (Vic)	11.0	14.9	14.0	1.1
Grower 11 (NSW)	9.6	14.5	9.5	4.6
CK 55 (Qld)	13.5	15.0	12.5	1.2

The source of the phosphorus used in these blends, and the blend's cadmium specifications (maxima), are shown in the following Table.

### Phosphorus Sources and Cadmium Specifications for Commonly Used Incitec Pivot NPK Planting Fertilisers in Vegetables

Product	Phosphorus Ingredients	Maximum Cadmium Concentration	
		mg/kg Cd	mg Cd/kg P
Complete Mix 1	MAP + SuPerfect	< 15	< 125
Croplift 800		< 15	< 125
NPKS 11-15-14-1	MAP + DAP	< 10	< 75
Grower 11	MAP	< 15	< 75
CK 55	DAP	< 10	< 50

## 8. CUSTOM BLENDS

Incitec Pivot has a policy of not knowingly supplying fertilisers containing more than 150 mg Cd/kg P for use in the production of vegetables. Before supplying a Custom Blend based on SuPerfect that contains more than 150 mg Cd/kg P, Incitec Pivot asks its Agents and Dealers to sign a Disclaimer testifying that the product is not being sold for use in vegetable crops. SuPerfect should not be used as the sole source of phosphorus in fertiliser programs where vegetables are to be grown.

## 9. OTHER READING

An Agritopic on "Heavy Metals in Fertilisers and Agriculture" is available in which cadmium and other heavy metals (lead and mercury) are discussed in more detail.

## WARNING

The information and guidelines in this publication summarise existing knowledge and are presented to help farmers and graziers in their decision making process. Many variables affect cadmium uptake. It cannot be predicted in advance what the effect of fertiliser on soil concentrations of plant-available cadmium and crop or pasture uptake will be.

District advice may need to be sought from local Departmental Advisers and others.

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