Guano Gold-Kwik Start – Some Technical Aspects.

PHOSPHOROUS

A typical analysis of Madura Guano reveals that total phosphate content is around 35 %, which may lead some to conclude that 350 kg of phosphate is available for plant growth for every tonne applied.

[It should be noted that whilst we are discussing Phosphate, which is the compound of Phosphorous and Oxygen, P_2O_5, which is transmitted through the roots to the plant, the actual Phosphorous content (as can be deduced from the formula) is about 1/3 of the Phosphate.]

The conclusion reached above is possible but unlikely in most soils, so for the moment we will assume that only the Citric Acid soluble Phosphate is available for plant feeding, and that is around 14%. What is the significance of Citric Acid soluble Phosphate? A 2% solution of Citric Acid (which is what you get in oranges) is used as an approximate duplication of the situation around the tips of root hairs. Each root tip exudes an acidic solution which dissolves water insoluble ingredients of soil, making the minerals accessible to the plant for growth, fruit production, seed set, etc as the case may be. Citric Acid soluble Phosphate is available to the root tips, and thus can be equated with available Phosphate for plant feeding.

Some of the other very significant benefits of the citric acid soluble Phosphate include the fact that in this form, the phosphate is not significantly leached by rain or irrigation, and it is also not locked up by iron and aluminium, which is a major weakness of acidulated superphosphate products. So when Guano claims to have around 14% available phosphate, it really has that available for plant feeding, as and when the plants require it.

This long-term availability of phosphate has been one of the attractions of Guano, because it allows for instance a paddock to be seeded down to a legume and fertilised, then in the following year to be oversown without additional phosphate needed. In permanent plantings, such as vineyards or olive groves, Guano can be ripped into the planting lines to provide several years of phosphate for tree growth as the roots extend out. It is possible to calculate crop use and future demands for Phosphorous over time.

Guano also contains water soluble phosphate as do chemical fertilizers, and this provides the normal quick boost until leached out or locked up by iron or another mineral.
And in addition, there remains around 10% of total Phosphate not normally considered available, which will contribute to the locked up store in the soil. This may be potentially accessible, but for now we will assume that it is not.

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CALCIUM

What else does Guano contain? About 35% of Guano is Calcium primarily as Calcium Oxide, one of the best forms of calcium fertilizer available. Because the source is from ancient coral residues, it has already been weathered and thus is not subject to leaching, as can be the case with calcium carbonate found in most other fertilizers. Coral-derived calcium absorbs water similar to a sponge, because the material is essentially the skeletal remains of living creatures, with plenty of air pores for water to infiltrate. This is significant in making the Calcium available, as will be noted later.

Calcium is not generally regarded as a fertilizer in conventional agronomy, but because of its relative immobility in plants, it is essential throughout the growth cycle. Unlike phosphorous, which the plant can move from old leaves into new and growing tissue, calcium can be abundant in older growth whilst deficiencies show in young leaves. For this reason, a supply of calcium is needed throughout the whole of the growing period. The interrelationship between calcium and magnesium and potassium may cause an effective deficiency even though soil levels of Calcium are high. The calcium oxide in Guano has an exchange capacity of 129 me/100g, which is a measure of the potential ability of the calcium to translocate, in this case into the plant through the roots. This exchange capacity is high, and in many soils this available calcium will be of the same order of value to the plants as the phosphorous. The coral structure is important in making the Calcium available. Where calcium is deficient, either because of soil acidity or because its availability is restricted by other minerals in the soil, Guano will provide a significant source of Calcium, particularly where the crop involved is a fruit or vegetable.

SILICON

The third significant component of Guano is Silica, or Silicon Dioxide. Virtually unknown to most farmers as a fertilizer, it is nonetheless a specific requirement for rice production, and is in fact in some ways a replacement for Calcium in the Graminae, or grasses, which range from sugar cane to the edible grains. In these plants, called Silicolous, Silica becomes a primary constituent of cell walls. This has the effect of strengthening the cell walls, which is one reason why plants deprived of adequate silicon will be more susceptible to fungal diseases. Silica also enables grass leaves to stand more erect, thus enabling them to catch more light, hence enhancing the process of photosynthesis.

Silicon dioxide or Silica is a naturally occurring mineral that comprises 5% of limestone, 44% of basalt and 68% of granite. Sandy soils may contain over 90% Silica, loams may be 60 – 70 %, but in Laterite soils it can be as low as 2%. The low levels of Silicon in leached soils also contributes to the lock up of Phosphorous, because research has demonstrated that silicates cause an increase in absorption of Phosphorous by plants.

Generally, clay soils rich in Silicon will have higher cation exchange capacities, will be younger, and less leached than those soils with lower Silicon levels. The fact that Guano has available silica, in combination with phosphorous, actually improves the uptake of phosphorous by plants. It must be admitted that relatively little research has taken place on Silicon and its effects in plant metabolism, but there are indications that enhanced flavour and keeping qualities of fruit and vegetables may be attributed to adequate supplies of Silicon in the growing medium. Watermelon in particular uses and concentrates silicon and will not thrive where a deficiency exists.

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CATION EXCHANGE

One of the key factors in the uptake of mineral nutrients is the Cation Exchange Capacity. As already mentioned, the CEC of calcium in Guano is 129 me / 100g which is high indeed. This will ensure the rapid uptake of calcium (and to a lesser extent, magnesium). A secondary effect will be the mobilisation of other soil nutrients around the Guano particles, because of the high CEC involved. In fact the exchange capacity is similar to that of some types of humus, which gives an indication of the potential for the nutrient availability present in Guano.

OTHER CONSIDERATIONS

Some mention should be made here of other factors impacting on the uptake of nutrients by plants. For instance, there should be an adequate supply of humus in the root zone. Humus is not only a source of available plant foods in itself, but also assists in water retention, soil temperature modification and in the breakdown of soil minerals. For maximum benefits to be achieved from Guano, a soil rich in organic matter is necessary.
In situations where it is not feasible in the short term to have humus levels of 5 – 10%, some means of supplying carbon should be found to provide fuel for soil micro-organisms. This in fact will increase the availability of phosphorous by plants, because of the activity of bacteria, actinomycetes and fungi; these are microscopic soil fauna that require carbon to live. Nitrogen in some form will be required to form the proteins to build the bodies of these micro-organisms, and there will be a decrease in soil nitrogen availability whilst these tiny creatures multiply, followed by a corresponding increase as a balance is reached. Any vegetative material contains nitrogen in the form of plant protein to some extent, with leguminous plants typically richer. Some micro-organisms can fix atmospheric nitrogen in the absence of other supplies, but they will usually extract what they can from the soil before using the air as a supply. For this reason, following the incorporation of vegetative material, some time should be allowed to elapse before planting, unless soil nitrogen levels are high, or the vegetative material is high in nitrogen, or a supplement is applied at the same time.

Some of the other benefits of soil fauna include the increased availability of phosphorous provided by the interaction of Vascular-arbuscular (VA) mycorrhizal fungi with plant roots. These growths actually increase the area of root contact with soil particles by several hundred times, thus enabling lower application rates of fertiliser to achieve the same degree and rapidity of plant development. Phosphorous is the nutrient especially favoured in this arrangement, but the supply of some trace elements, particularly zinc, is also greatly improved.
The significance of a soil rich in such micro-organisms may be reflected in the store of locked up phosphorous that was mentioned at the beginning of this report. Ultimately it is possible for all that resource to be made available for plant growth.

For most agricultural soils, huge changes in management and attitude will be needed to reach that point. Until then, Guano is probably the most useful phosphorous source for general use in Australia, and its range of subsidiary benefits make it a powerful tool for a wide range of agronomic activities.

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