

The Use of V.Gro Vermiculite Fertilizer for Agriculture: An Interim report

IBI Corporation Executive Summary



Maize on left, grown in control media, compared with maize on right grown in V.Gro Vermiculite Fertilizer

COMMERCIAL CONFIDENTIAL

Introduction...

This executive summary was prepared by IBI Corporation staff and consists primarily of excerpts from a report prepared by Dr. Peter Van Straaten, associate professor, University of Guelph, Department of Land Resource Science. The University is located in Ontario, Canada.

Dr. van Straaten's report is entitled, "*The use of Namekara vermiculite by product for agriculture: An interim assessment*". The vermiculite by product referred to is a branded product of IBI known as *V.Gro Vermiculite Fertilizer* ("V.Gro"). The product is sourced at IBI's Namekara Vermiculite Mine in Uganda, Africa. IBI has a strategic alliance with the University of Guelph and Dr. van Straaten for research purposes.

Background...

The full 33- page report on the use of Namekara vermiculite by-product for agriculture is based on an extensive background review, a field visit by Dr. van Straaten to Canmin/Uganda from May 28 to June 19, 2005 and subsequent mineralogical and chemical laboratory analyses from several laboratories in Ontario, Canada. Canmin Resources Limited ("Canmin") is IBI's wholly- owned Uganda subsidiary and operates the Company's Namekara Mine.

The two products to be investigated were (1) the fine grained 'residues' from the mining operation from which magnetite was removed (by magnetic separation), the so-called unexfoliated vermiculite by-product, and (2) the same product which was thermally treated (exfoliated) at temperatures around 700 degrees C.

The exfoliated vermiculite by-product is marketed in Uganda under the trade name V.Gro. It should be noted that the data reported below are reflecting the vermiculite-rich by-products but not the pure vermiculite products that are exported.

The mine section at Namekara is characterized by high magnesium (Mg) concentrations as well as elevated phosphorus (P) and copper (Cu) concentrations. The highest magnesium concentrations are located in the section with the highest vermiculite contents.

The large and medium size vermiculite crystals (the standard grade designation for ore concentrate in the international marketplace) are currently mined and processed at the mine site and exported. The fines that were previously discarded are currently processed at Namekara as vermiculite by-product as they showed highly soil enriching properties.

Methodology...

A detailed characterization study of the unexfoliated vermiculite by-product, and the exfoliated Namekara vermiculite by-product, marketed under the name V.Gro, was completed, and included scanning electron microscopy (SEM) with high resolution and magnification and energy dispersive X-ray (EDS) analysis, as well as mineralogical and chemical analyses.

The chemical analyses included X-ray fluorescence (XRF) methods and inductively coupled (ICP) methods. These methods provide highly accurate determinations of major and trace elements in rock samples. In addition, samples of the Namekara vermiculite by-product were analyzed by X-ray diffraction (XRD) to determine the mineralogical composition.

Note: The analyses of available magnesium and phosphorus are high to very high indicating good availability of these plant nutrients for plant growth. Both K and Ca concentrations in the vermiculite by-product are medium to high. The pH values of unexfoliated and exfoliated vermiculite by-products are slightly acid (5.7-6.5), and the organic matter content is very low.



Above -- Observation at Namekara June 2nd, 2005: Maize/corn growth over dumped vermiculite 'waste' heap (centre: dark green and healthy looking, no visual signs of nitrogen (N) and phosphorous (P) and Potassium (K) deficiencies), in comparison to maize/corn performance on sides with visible N and P deficiencies.

Visual observations of growth of corn/maize at places where Namekara vermiculite 'waste' were dumped showed extremely good growth response. Based on these visual observations it seemed clear that a positive growth response of maize/corn on residues from vermiculite mining could be expected.



Above -- Detail of pot experiment showing root growth in exfoliated vermiculite by-product. The light exfoliated vermiculite by-product in which the seed emerged has high aeration properties.



Above -- Root growth after 2 weeks, with control (no vermiculite by-product added) (left), and with unexfoliated vermiculite by-product (right). The development of root laterals is strongly enhanced in the soil treatment with vermiculite by-product.

Note: Weight of the maize/corn sample grown on exfoliated vermiculite by-product (V.Gro) on 13 July 2005 is much higher than maize/corn grown on soil treated with unexfoliated vermiculite by-product. Leaves of maize plant grown on soil with exfoliated vermiculite by-product dried much slower than other plants.

Pot trials...

The results from pot trials at Namekara using maize/corn on a red P-deficient soil showed high early root development, enhanced shoot growth and stem diameter of both exfoliated vermiculite by-product and unexfoliated vermiculite by-products as compared to the control. It is interesting to note that up to week 4 unexfoliated vermiculite by-product had higher root development than the exfoliated vermiculite by-product (V.Gro).

Unexfoliated vermiculite compared with exfoliated...

The initially better crop responses to the application of unexfoliated vermiculite product in comparison to exfoliated vermiculite by-product could be related to several factors. As the material added to the soil was made on a volume basis (180 cc) and not on a dry weight basis the unexfoliated material provided more material and consequently higher amounts of nutrients to the emerging plant than the exfoliated by-product. This means more plant nutrients (N, P, Mg, Cu) were supplied in the initial seed emergence phase by the unexfoliated material than with the exfoliated vermiculite by-product. Secondly, the unexfoliated material contains more combined nitrogen from both nitrate-N and ammonium-N sources than the exfoliated by-product and was thus more available in the initial phase.

In addition, the exfoliated by-product provided a suitable physical environment for seed emergence, a higher aeration and water holding capacity than the unexfoliated vermiculite by-product, which all came to bear over the time of the experiment.

Note: During 2005 and 2006 many Ugandan farmers have used the exfoliated vermiculite by-product (V.Gro) produced by Canmin Resources Limited. Many independent accounts have been received from farmers and research institutions confirming the effectiveness of the vermiculite by-product, both in respect of increased yields and survival in drought conditions. The reports can be obtained from Canmin Resources Limited in Uganda, and a summary of typical comments is attached.

Reasons for efficiency...

The apparent enhanced plant growth with the application of Namekara vermiculite by-products including the exfoliated vermiculite by-product (V.Gro) is based on two main components: its physical properties and its chemical properties. There might be other yet unknown properties that contribute to its apparent effectiveness.

Physical properties...

The physical properties that contribute to enhanced crop response upon the application of the exfoliated vermiculite by-product (V.Gro) include: Enhanced germination and root and shoot development due to the product's high water holding capacity (203 %), good aeration and excellent thermal properties.

Chemical properties...

The chemical properties of both the unexfoliated and exfoliated products that contribute enhanced root and shoot development include:

- High total and available magnesium (Mg) concentration,
- Sufficiently high total and available phosphorus (P) concentration,
- Elevated copper (Cu) concentrations,
- Presence in vermiculite by-products of nitrogen (N) components, both in nitrate and ammonium form.

The high concentrations of total and available Mg and relatively high concentrations of available P contribute to high initial root development and nutrient supply for the emerging plants on P-deficient soils.

Magnesium...

Magnesium is not only important in the formation of chlorophyll for photosynthesis, but also for phosphorus related functions essential for enzymatic and energy transfer processes. Magnesium is required by a number of enzymes, it activates enzymes associated with energy transfer and is essential for the synthesis of proteins. The Mg ion builds a 'bridge' to phosphate groups especially adenosine triphosphate (ATP) and protein enzymes. The availability of sufficient Mg is often responsible for increased uptake and utilization of phosphorus (Mengel and Kirkby 2001; Marschner 2002).

Phosphorous...

Phosphorus plays a crucial role in life as it is a fundamental component of cells, as well as part of the genetic materials ribonucleic acid (RNA) and deoxyribonucleic acid (DNA). Phosphorus is a key building block in the molecule adenosine triphosphate (ATP), which controls most energy requiring processes in living organisms. Phosphorus is essential for the formation of proteins and enzymes, molecules that are essential to life. In plants, the supply of phosphorous, commonly in the form of phosphate ions, is important as it stimulates early root development and flowering, as well as seed and fruit growth. Phosphorus deficiencies are indicated in most land plants by stunted growth, dark blue-green coloration of mature leaves, restricted root development, as well as delayed maturity and poor seed and fruit development.

Copper...

Copper (Cu) plays an important function for a number of enzyme systems involved in oxidation-reduction reactions in plants (Marschner 2002). The availability of Cu influences carbohydrate and nitrogen metabolism. It is suspected that Cu plays a role in symbiotic N-fixation, although this connection has not yet been proven (Mengel and Kirkby 2001).

Cu-based products are used as fungicides and algaecides (algal growth depressant). It is suspected that the elevated Cu concentrations in the vermiculite by-products contribute to the protection of the emerging roots from pathogenic fungi and pests.

Other factors...

Other potentially contributing factors include the presence of small amounts of other micronutrients (e.g. Fe, Mn), as well as possibly elevated concentrations of Si.

Future experiments...

Initial test results using vermiculite by-product with maize/corn as test crop on a low fertility P-deficient soil clearly show positive yield responses. Further experiments should be conducted using different soils and crops under controlled conditions to verify the results of the initial experiments in Namekara.

Product research should focus on optimizing the vermiculite by-products to evaluate the degree of exfoliation energy needed to achieve optimal plant response. It is conceivable that the exfoliation time and thus energy spent on exfoliation could be reduced without compromising the agronomic effectiveness of the product.

COMMENTS FROM UGANDAN FARMERS 2005/ 2006

Soroti Research Station

Sorghum In plots of 10 meters x 10 meters, application of 300 grams per plot gave a yield almost double that of control plot.

Sebei Farmers Association

Beans Crops sown at end of rain season, with no further rains from flowering to harvest. On harvesting, the yields from the plots with V.Gro were far better than the rest.

Lango Organic

Cotton The maturity period is shorter. In spite of severe drought conditions, the crop planted with V.Gro showed very little signs of withering. Enhanced vigor was apparent after two weeks. The balls opened completely, giving long and clean yarn, compared to control plot where much only opened halfway.

Cabbage The maturation period was shortened, and the crop was good.

Simsim The pods formed in the V.Gro plot were longer and bigger.

Conclusion A small amount of V.Gro substantially improves yield, but a large amount used will make a great impact. The V.Gro is very effective on horticulture.

Kawanda Agricultural Research Station

Aloe Vera Very vigorous compared to control. Very high production of seedlings.