FERTILIZER TYPES AND METHODS OF MANUFACTURE

The basic plant nutrients, N, P₂O₅, K₂O and MgO are derived from a variety of raw materials. Until recently, fertilizer was available in a limited range of products that contained one plant nutrient or a physical mixture containing two or more nutrients.

With advances in fertilizer technology and more exacting demands of a more sophisticated agriculture sector, the range of fertilizers available expanded dramatically. Perhaps, even more dramatic are the new terms to describe fertilizers today. These terms are often ambiguous and interpreted differently in different countries.

In Malaysia, it has become necessary to clearly define, if not explain, the different types of fertilizers available.

1. Straight Fertilizers
   Straight fertilizers usually contain a single plant nutrient. For example, nitrogenous straight fertilizers include products like Ammonium Sulphate, Ammonium Nitrate, Ammonium Chloride and Urea. Christmas Island Rock Phosphate, Triple Superphosphate are examples of straight phosphatic fertilizers while Muriate of Potash is the more common form of potassic straights.

   Straight fertilizers are available in the form of a mineral salt, crystal or ground into powder or grit of varying mesh size or when required processed into granules, pellets and prills.

2. Fertilizer Mixtures
   The term ‘fertilizer mixture’ refers to a product derived from the dry mixing of two or more straight fertilizers of differing particle size, shape and specific gravity. The physical mixing is effected simply through a screw type mixer with no chemical interaction. The resultant products are prone to segregation due to varying particle size distribution and caking due to the formation of crystal bridges as no anti-caking agents are used.

3. Fertilizer Blends
   Fertilizer blends are dry physical mixtures of two or more straight fertilizers of relatively uniform particle size. In Malaysia this term is often loosely used even when particle size varies considerably. Hence, blends are, in essence dry powdered mixtures with no chemical bonding of the nutrients.
4. Granulate Mixtures

Granulated mixtures are physical mixtures of two or more wet straight fertilizers processed into granular forms. The raw materials are pulverised, moistened with water and passed through a drum or pan granulator to agglomerate the moist mixture into granules. The resulting product is a physical mixture with virtually no chemical bonding.

5. Granulated Compound Fertilizers

A compound fertilizer is a complex homogeneous product containing two or more of the plant nutrients that have undergone chemical interaction during the manufacturing process.

This chemical combination can be achieved in a number of ways. For the manufacture of CHB compounds, CCM Fertilizers employ a single liquid phase process where hot liquid Ammonium Nitrate (170°C) is reacted with dry powdered Christmas Island Rock Phosphate, Muriate of Potash and Kieserite. Imported European compound is manufactured through a double liquid phase process where liquid nitric acid and phosphoric acid are reacted with Ammonia, dry powdered Muriate of Potash and Kieserite. The chemical combing is followed by the process of granulation with the addition of anti-caking agents to form free-flowing compound granules.

The manufacture of compound fertilizer is complex and requires heavy capital investments in setting up plants. The process involves the manufacture of the liquid phases from raw materials, reaction and granulation. (See process chart).

CHARACTERISTICS OF FERTILIZER TYPES

Plant nutrients can be made available as a straight fertilizer in dry powder mixtures or blends, granulated mixtures or in granulated compounds. It is agronomically desirable for balanced nutrition to apply the basic NPK requirements together but if individual nutrients are used, applications should follow closely. The application of mononutrient straight fertilizer is therefore more demanding in terms of storage, handling, supervision and timing.

Though both fertilizer mixtures and compounds can supply the basic NPK requirements, they differ in consistency, nutrient availability and physical characteristics which collectively determine crop response.

Sirim Standards

Granulated compound fertilizers like Cock's Head Brand (CHB) Granulated Compound Fertilizers are manufactured with highly sophisticated technology to very exacting international standards.

CHB granulated compound conforms to exacting Sirim standards for granulated compounds (MS49:1984) and are marketed in Malaysia with a Sirim mark. In 1986 CHB No. 44 was awarded product of excellence by the government of Malaysia.

Though the Sirim standards for fertilizer mixtures have been established, dry powdered mixtures or granulated mixtures are not marketed with the Sirim mark. For various technical reasons, mixtures are by and large highly variable in their nutrient contents because of segregation.

Particle Size and Nutrient Analysis

CHB granulated compounds manufactured by sophisticated equipment with computer control are of

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Fig. 1a – Nitrogen Analyses of Samples of a Mixture Fertilizer Specified to Contain 10% N

Fig. 1b – Nitrogen Analyses of Samples of a CHB Granulated Compound Fertilizer Specified to Contain 10% N
regular size (1 – 4mm diameter). Even more important is that each CHB compound granule contains the same specified nutrient ratio. Hence crop responses to CHB granulated compounds are uniform and predictable.

Fertilizer mixture the result of physical mixing of two or more straight fertilizers (of differing particle size, shape and specific gravity) tend to segregate and generally show uneven analyses leading to uneven and unpredictable crop responses.

Fig. 1a and 1b compare the analyses of samples taken from a fertilizer mixture both specified to contain 10% nitrogen and a CHB granulated compound fertilizer.

Samples taken from the CHB granulated compound show a narrow range of nitrogen analyses (9 – 11%) conforming to acceptable SIRIM deviation. However, fertilizer mixture samples show a wide range of analyses with nitrogen values ranging from 6 – 14%.

A similar study, by a leading plantation agency showed that at the time of field application less than 50% of the samples taken from a fertilizer mixture conform to the specified N, P, K and Mg content respectively. (See Table 1.)

**Nutrient Availability:**

During the manufacture of CHB granulated compound, the P₂O₅ in the rock phosphate (CIRP) undergoes chemical reaction which increases the citric solubility of CIRP. The citric soluble P₂O₅ in the various CHB granulated compound fertilizers are listed in Table II. The remaining P₂O₅ fraction in CIRP requires further biodegradation and is gradually released. Hence the CIRP in CHB granulated compounds supplies both the immediate and long term phosphate needs of crops.

In the chemical reaction, complex salts are also formed and nutrients are available in the readily available ionic forms i.e. NO₃⁻, K⁺, Mg²⁺.

As no chemical reactions take place in the manufacture of fertilizer mixtures and blends, the citric soluble P₂O₅ in the rock phosphate used is not increased. No complex salts are formed and nutrients are therefore not in the readily available ionic forms.

Compounds are of high nutrient analysis and are less bulky to handle than mixtures or straight. Raw materials that can be utilised to produce high analysis mixtures are limited due to problems associated with caking or breakdown.

**Physical Characteristics**

CHB granulated compounds are coated with oil and fine anti-caking dust resulting in a product that is free flowing and non-caking. A free flowing product is easy to handle and is essential for mechanised ground or aerial application.

As anticaaking agents are not incorporated in powdered or granulated fertilizer mixtures, they are prone to caking or breakdown into slurry particularly if hygroscopic materials are utilised.

Fertilizer mixtures are therefore messy to handle and the poor physical condition of the products (often lumpy or wet) create problems in storage and do not allow even field application. Mixtures do not lend itself well to mechanical application and are not suitable for aerial application.

**Plant nutrients are available in a number of fertilizer types and it is important to appreciate the properties and characteristic of these products. Compound fertilizers, particularly Cock's Head Brand Granulated Compounds offer balanced nutrients with consistent analysis and in superior physical condition to provide predictably good crop response. Cock's Head Brand Granulated Compounds are manufactured to exacting standards and are sold with the SIRIM Mark.**

**TABLE I. NPK Mg Analysis of 10:5:17:5:2.5 Mixture Samples Taken at the Time of Application.**

<table>
<thead>
<tr>
<th>Nutrient Specification in Mixture %</th>
<th>CHB Granulated Compound Formulation No.</th>
<th>Total P₂O₅ Soluble P₂O₅</th>
<th>Increase in Citric Acid Solubility</th>
</tr>
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<tbody>
<tr>
<td>%Sample* that conform to the specified nutrients</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>10N</td>
<td>5P₂O₅</td>
<td>17.5 K₂O</td>
<td>2.5 MgO</td>
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<tr>
<td>25</td>
<td>13</td>
<td>6.0(3.9)</td>
<td>53.9</td>
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<tr>
<td>33</td>
<td>7</td>
<td>4.2(2.1)</td>
<td>100</td>
</tr>
<tr>
<td>44</td>
<td>6</td>
<td>3.9(1.8)</td>
<td>116.7</td>
</tr>
<tr>
<td>99A</td>
<td>12</td>
<td>3.6(5.5)</td>
<td>52.7</td>
</tr>
<tr>
<td>101</td>
<td>4</td>
<td>2.6(1.2)</td>
<td>116</td>
</tr>
</tbody>
</table>

*Forty-eight samples were taken from the mixture fertilizers at the time of application for NPK and Mg analysis.

* Figures in bracket ( ) are the % citric acid soluble P₂O₅ before compounding.
THE MANUFACTURING PROCESS

Nitric Acid Plant

Control Room

Bagging

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Nitrogen (N)</th>
<th>Phosphorus (P₂O₅)</th>
<th>Total Nutrients</th>
</tr>
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<tr>
<td></td>
<td>Nitrate</td>
<td>Ammonical</td>
<td>Total</td>
</tr>
<tr>
<td>CHB No. 55 15-15-6-4</td>
<td>6</td>
<td>9</td>
<td>15</td>
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<td>CHB No. 45 + TE 12-12-17-2 + TE</td>
<td>5</td>
<td>7</td>
<td>12</td>
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<td>CHB No. 85 15-15-15</td>
<td>6</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>Loong Choong Pau Red 13-13-20-2 + TE</td>
<td>5</td>
<td>8</td>
<td>13</td>
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