**Soil and Water based Crop Advisories**

Soil is the prime source of nutrients for crops and it provides support for plant growth in many ways. Soil is a precious natural resource and hence maintenance of soil health is important for sustaining its productivity over long run. Knowledge about soil health and its maintenance is critical to sustaining crop productivity. The escalation in fertiliser prices led to skewed use and has severed a setback to the concept of balanced fertilization. Blanket recommendation of fertilisers lead to over or under use of fertilisers ultimately deterioration of soil health. Hence, soil and water testing is essential for sustaining soil health and to improve nutrient use efficiency.

# Soil test-based advisories

The health of soils can be assessed by the quality and stand of the crops grown on them. A scientific assessment is possible through detailed physical, chemical and biological analysis of the soils. Essential plant nutrients such as N, P, K, Ca, Mg and S are called macronutrients, while Fe, Zn, Cu, Mo, Mn and B are called micronutrients. It is necessary to assess the capacity of a soil to supply nutrients in order to supply the remaining amounts of needed plant nutrients. Soils may have large amounts of nutrient reserves but all or a part of these reserves may not be of any use to crops because they may not be in plant-available form. For the purpose of estimation or analysis of plant-available soil nutrients, such methods are to be used that have been tested/verified for the correlation of nutrients extracted and their plant availability.

# Soil properties expected to be analysed

Soil sample should represent the whole field. Soils properties vary from place to place. In view of this, efforts should be made to take the samples in such a way that they are fully representative of the field.

Soil have to be analysed for

1. physical properties
   1. soil texture,
   2. bulk density,
2. physico-chemical properties
   1. Soil reaction (pH) and
   2. Electrical conductivity (EC),
3. Chemical Properties
   1. Organic carbon,
   2. Available nitrogen,
   3. Available phosphorus,
   4. Available potassium,
   5. Exchangeable calcium and magnesium,
   6. available sulphur and
   7. micronutrients and their ratings are given in Table 1 & 2.

**Table 1**

|  |  |  |  |
| --- | --- | --- | --- |
| **Optimum BD for Plant Growth (Mg m-3)** | **Texture** | **pH** | **Electrical Conductivity (dSm-1)** |
| <1.60 | SCL-Sandy Clay Loam | 3.0-5.6 Strongly acid | <2.0 very low |
| <1.40 | CL-Clay Loam | 5.6-6.2 Moderately acid | 2-4 Low |
| <1.40 | SC-Sandy Clay | 6.2-6.7 Slightly acid | 4.-8 Moderate |
| <1.40 | S -Sand | 6.7-7.3 Neutral | 8-16 High |
| <1.10 | SC-Sandy Clay | 7.3-7.9 Slightly alkaline | > 16 Very high |
| <1.10 |  | >8.5 Strongly alkaline |  |

**Table 2 Ratings for Soil fertility properties**

1. **Ratings for Soil Available Nutrients**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S.no | Nutrients | Low | Medium | High |
| 1 | Organic Carbon (%) | <0.5 | 0.5-0.75 | >0.75 |
| 2 | Available N (Kg ha-1) | <280 | 280-450 | >450 |
| 3 | Available P (Kg ha-1) |  |  |  |
|  | Olsen P | <11 | 11-22 | >22 |
|  | Bray P | <24.2 | 4.2-49.7 | >49.7 |
| 4 | Available P (Kg ha-1) | <118 | 118-280 | >280 |

# b. Critical limits for available micronutrients

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S.no | Nutrients | Deficient | Moderate | Sufficient |
| 1 | CaCl2 S (mg kg-1) | <10 | 10-15 | >15 |
| 2 | DTPA Fe (mg kg-1) | <3.7 | 3.7-8.0 | >8.0 |
| 3 | DTPA Mn (mg kg-1) | <2 | 2-4 | >4 |
| 4 | DTPA Zn (mg kg-1) | <1.2 | 1.2-1.8 | >1.8 |
| 5 | DTPA Cu (mg kg-1) | <1.2 | 1.2-1.8 | >1.8 |
| 6 | Hot water Soluble Boron (mg kg-1) |  |  |  |

# Soil test-based fertilizer prescription for crops

Soil test-based fertilizer prescription necessitates to avoid over use or under use of fertilizers for crop requirement. If soil test values or not available, recommended dose of fertilizer as per the Crop Production Guide by Local Agricultural University or biofertilisers and 12.5 tonnes of FYM/Biomass per hectare along with biofertilisers are recommended.

# Soil Test Crop Response Based IPNS (STCR - IPNS) for various crops

General or blanket fertiliser recommendations are not based on soil fertility and may lead either to under or over usage of fertilisers. Therefore, an appropriate approach could be the recommendations emanating from Soil Test Crop Response Correlation (STCR) studies which are based on Inductive cum Targeted yield model (Ramamoorthy *et al*., 1967). It provides a scientific basis for balanced fertilisation and balance between applied nutrients and soil available nutrients (Ramamoorthy and Velayutham, 2011). Integrated Plant Nutrition System (IPNS) is a concept which aims at the maintenance or adjustment of soil fertility and plant nutrient supply to an optimum level for sustaining the desired crop productivity through optimization of benefit from all possible sources of plant nutrients in an integrated manner. Adopting this concept, research work has been carried out in the All India Coordinated Research Project for Investigations on Soil Test Crop Response Correlation (AICRP-STCR) over the past four decades for various crops and cropping sequences, preferably under Integrated Plant Nutrition System (IPNS) during the last two decades. Local university data can be used here.

**Using Organic Inputs based on the soil test reports and university recommendations**

Soil test reports give fertilizer recommendations to be used by farmers as gives the nutrients needed for a particular crop in kilogram per acre (kg/acre). Most of the university Recommendations are made as 4-6 tons of Farm Yard Manure (FYM) + XX-XX-XX as NPK, where in Farm Yard Manure is the source of biomass (organic matter plus several micronutrients) and NPK comes from chemical fertilisers as urea, DAP (Diammonium Phosphate), Muriate of Potash etc or some complex fertilisers.

In the organic growing situations, we may take two different approaches for nutrient management.

1. **Applying organic manures equivalent to nutrients in 4-6 tons of FYM plus Recommended dose of NPK and other fertilisers:**

Because a combination of organic fertilizers is usually needed, the conversion process has several steps.

The main source of nutrients in organic farming comes from any one or combination of the following

1. Biomass added (Green manure/Green leaf manure/cover crops/mulching)
2. Animal Manures (Cattle dung, FYM, poultry litter),
3. Decomposed organic matter (Vermicompost, NADEP compost, Biodynamic compost etc)
4. Organic Concentrates (Bone meal, oil cakes etc)

In general, start with the most complex organic fertilizer, such as compost and animal manures (e.g., poultry litter). Many organic growers use these as a fertilizer base. These fertilizers will contain amounts of all three major nutrients — N, P and K — as well as micronutrients; however, the amount of nutrients in a given animal manure or compost is variable, so these materials should be analyzed. The amount of moisture in animal manures and composts can greatly affect the amount of nutrients applied.

If you don?t have the animal manures and composts tested, approximate values for N, P2O5 and K2O are listed in Table below. When using these materials as a fertilizer base, calculate how much N, P2O5 and K2O are supplied by these materials, then supplement nutrients from other sources as needed for a particular crop.

**Nutrient content of various biomass sources**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Manure** | **Percentage content** | | | **Source** |
|  | **N** | **P2O5** | **K2O** |  |
| **Biomass: Green Leaf Manure** | | | | |
| *Pongamia glabra* | 3.2 | 0.3 | 1.3 | Organic Manures', NCOF |
| *Glyricidia maculeata* | 2.9 | 0.5 | 2.8 | Organic Manures', NCOF |
| *Azadirachta Indica* | 2.8 | 0.3 | 0.4 | Organic Manures', NCOF |
| *Calatropis gigantecum* | 2.1 | 0.7 | 3.6 | Organic Manures', NCOF |
| **Biomass: Green Manures** | | | | |
| Cowpea (*vigna unguiculata*) | 0.71 | 0.15 | 0.58 | Handbook, 1964 |
| *Sesbania aculeata* | 0.62 | - | - | Handbook, 1964 |
| Cluster-bean *(cyamopsis tetragonoloba)* | 0.34 | - | - | Handbook, 1964 |
| Horse-gram *(Dolichos biflorus*) | 0.33 | - | - | Handbook, 1964 |
| Mothbean | 0.8 | - | - | Handbook, 1964 |
| Green gram *(vigna radiate)* | 0.72 | 0.18 | 0.53 | Handbook, 1964 |
| Sunnhemp(*Crotalaria juncea*) | 0.75 | 0.12 | 0.51 | Handbook, 1964 |
| Blackgram(*vigna mungo*) | 0.85 | 0.18 | 0.53 | Handbook, 1964 |
| *Sesbania aculeate* | 3.3 | 0.7 | 1.3 | Organic Manures', NCOF |
| *Crotalaria juncea* | 2.6 | 0.6 | 2 | Organic Manures', NCOF |
| *Sesbania speciosa* | 2.7 | 0.5 | 2.2 | Organic Manures', NCOF |
| *Tephrosia purpurea* | 2.4 | 0.3 | 0.8 | Organic Manures', NCOF |
| *Phaseolus trilobus* | 2.1 | 0.5 | - | Organic Manures', NCOF |
| **Dry leaves** | | | | |
| *Calotropis gigantea* | 0.35 | 0.12 | 0.36 | Handbook, 1964 |
| *Careya arborea* | 1.67 | 0.4 | 2.2 | Handbook, 1964 |
| *Cassia ariculata* | 0.98 | 0.12 | 0.67 | Handbook, 1964 |
| *Dillenia pentagyna* | 1.34 | O.50 | 3.2 | Handbook, 1964 |
| *Madhuca indica* | 1.66 | 0.5 | 2 | Handbook, 1964 |
| *Pongamia pinnata* | 3.69 | 2.41 | 2.42 | Handbook, 1964 |
| *Pterocarpus marsupium* | 1.97 | 0.4 | 2.9 | Handbook, 1964 |
| *Terimalia chebula* | 1.46 | 0.35 | 1.35 | Handbook, 1964 |
| *Terminalia paniculata* | 1.7 | 0.4 | 1.6 | Handbook, 1964 |
| *Terminalia tomentosa* | 1.39 | 0.4 | 1.8 | Handbook, 1964 |
| Xylia dolabriformis | 1.37 | 0.3 | 1.61 | Handbook, 1964 |
| **Meals** | | | | |
| Raw bone meal | 3.0-4.0 | 20-25 | - | Handbook, 1964 |
| Steamed bone meal | 1.0-2.0 | 25-30 | - | Handbook, 1964 |
| Blood meal | 10.0-12.0 | 1.2 | 1 | Handbook, 1964 |
| Fish meal | 4.0-10.0 | 3.9 | 0.3-1.5 | Handbook, 1964 |
| **Compost** | | | | |
| Rural compost,dry | 0.5-1.0 | 0.4-0.8 | 0.8-1.2 | A. K. Dhama, 1996 |
| Urban compost,dry | 0.7-2.0 | 0.9-3.0 | 1.0-2.0 | A. K. Dhama, 1996 |
| Vermicompost | 2.0-3.0 | 1,85-2.25 | 1.55-2.25 | Sinha et.al (2009) |
| **Farm Waste: Animal Waste** | | | | |
| Animal refuse | 0.3-0.4 | 0.1-0.2 | 0.1-0.3 | A. K. Dhama, 1996 |
| Cattle dung,fresh | 0.4-0.5 | 0.3-0.4 | 0.3-0.4 | A. K. Dhama, 1996 |
| Horse dung ,fresh | 0.5 -0.5 | 0.4-0.6 | 0.3-1.0 | A. K. Dhama, 1996 |
| Poultry manure,fresh | 1.0-1.8 | 1.4-1.8 | 0.8-0.9 | A. K. Dhama, 1996 |
| Cattle urine | 0.9-1.2 | Trace | 0.5-1.0 | A. K. Dhama, 1996 |
| Horse urine | 1.2-1.5 | Trace | 1.3-1.5 | A. K. Dhama, 1996 |
| Human urine | 0.6-1.0 | 0.1-0.2 | 0.2-0.3 | A. K. Dhama, 1996 |
| Sheep urine | 1.5-1.7 | Trace | 1.8-2.0 | A. K. Dhama, 1996 |
| **Farm Waste: Crop Residues** | | | | |
| Banana,dry | 0.61 | 0.12 | 1 | A. K. Dhama, 1996 |
| Cotton | 0.44 | 0.1 | 0.66 | A. K. Dhama, 1996 |
| Coir pith | 1.2 | 1.2 | 1.2 | Handbook, 1964 |
| Press mud | 1-1.5 | 4.0-5.0 | 2.0-7.0 | Handbook, 1964 |
| Maize | 0.42 | 1.57 | 1.65 | Handbook, 1964 |
| Paddy | 0.36 | 0.08 | 0.71 | Handbook, 1964 |
| Tobacco | 1.12 | 0.84 | 0.8 | Handbook, 1964 |
| Pigeon pea | 1.1 | 0.58 | 1.28 | Handbook, 1964 |
| Wheat | 0.53 | 0.1 | 1.1 | Handbook, 1964 |
| Sugarcane trash | 0.35 | 0.1 | 0.6 | Handbook, 1964 |
| Tobacco dust | 1.1 | 0.31 | 0.93 | Handbook, 1964 |
| **Farm Waste: Farm Yard Manure** | | | | |
| Farmyard manure,dry | 0.4-1.5 | 0.3-0.9 | 0.3-1.9 | A. K. Dhama, 1996 |
| **Food Processing Waste** | | | | |
| Filter-press cake | 1.0-1.5 | 4.0-5.0 | 2.0-7.0 | A. K. Dhama, 1996 |
| Rice hulls | 0.3-0.5 | 0.2-0.5 | 0.3-0.5 | A. K. Dhama, 1996 |
| Groundnut husks | 1.6-1.8 | 0.3-0.5 | 1.1-1.7 | A. K. Dhama, 1996 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Oil Cakes: Edible Oil Cakes** | | | | |
| Coconut cake | 3 | 1.9 | 1.8 | Handbook, 1964 |
| Groundnut cake | 7.3 | 1.5 | 1.3 | Handbook, 1964 |
| Niger cake | 4.7 | 1.8 | 1.3 | Handbook, 1964 |
| Rape seed cake | 5.2 | 1.8 | 1.2 | Handbook, 1964 |
| Sesame cake | 6.2 | 2 | 1.2 | Handbook, 1964 |
| **Oil Cakes: NonEdible** | | | | |
| Castor cake | 4.3 | 1.8 | 1.3 | Handbook, 1964 |
| Cotton cake | 3.9 | 1.8 | 1.6 | Handbook, 1964 |
| Karanj cake | 3.9 | 0.9 | 1.2 | Handbook, 1964 |
| Mahua cake | 2.5 | 0.8 | 1.8 | Handbook, 1964 |
| Neem cake | 5.2 | 1 | 1.4 | Handbook, 1964 |
| Safflower cake | 4.9 | 1.4 | 1.2 | Handbook, 1964 |
| **Other Residues** | | | | |
| Ash, coal | 0.73 | 0.45 | 0.53 | A. K. Dhama, 1996 |
| Ash,household | 0.5-1.9 | 1.6-4.2 | 2.3-12.0 | A. K. Dhama, 1996 |
| Ash,wood | 0.1-0.2 | 0.8-5.9 | 1.5-36.0 | A. K. Dhama, 1996 |
| **Urban Waste** | | | | |
| Sewage sludge,dry | 2.0-3.5 | 1.0-5.0 | 0.2-0.5 | A. K. Dhama, 1996 |
| Sewage sludge, activate dry | 4.0-7.0 | 2.1-4.2 | 0.5-0.7 | A. K. Dhama, 1996 |
|  |  |  |  |  |
| 1. A. K. Dhama (1996) Organic Farming for Sustainable Agriculture, Agro Benificial Publishers (India) | | | | |
| 2. Handbook of Manures and Fertilisers (1964), Indian Council of Agricultural Research, India | | | | |
| 3. Sinha, Rajiv, Herat, Sunil, Valani, Dalsukhbhai, Chauhan, Krunalkumar (2009) Earthworms Vermicompost: A Powerful Crop Nutrient over the Conventional Compost & Protective Soil Conditioner against the Destructive Chemical Fertilizers for Food Safety and Security Am-Euras. J. Agric. & Environ. Sci., 5 (S): 01-55, 2009 | | | | |
| 4. 'Organic Manures', National Centre for Organic Farming, India | | | | |

The following example describe a method to balance a crop's nutrient needs with fertilizers and compost. This method will help prevent nutrient imbalances in the soil. You may need to try several different combinations of fertilizers or amendments to find the best combination. You should also compare costs of various combinations.

Another way of converting the inorganic fertilizer recommendations to organic ones is to look for organic fertilizer that contributes most of one nutrient. You can then calculate the amount of each fertilizer you need to meet the crop's needs. Example 3 shows you how to use this approach.

**NOTE**: Wood ash has long been used as a source of K2O; however, it should be used sparingly. Overapplication can raise the pH above the recommended range for crops and can create problems due to high salt concentrations. If you use wood ash, it is recommended that no more than 10 to 12 tons be used per One acre. per year. An analysis of the wood ash will help you know how much to apply.

### Example: Conversion for Farms on an Acre Basis

#### Farmer receives a soil test report for Plot 1 that indicates the soil organic matter is 1.5%, the pH is 6.0, the soil test P is medium and the soil test K is low. She will be growing Chillies in this plot next season. The soil test fertilizer recommendations call for: 150 kg/acre of N, 80 kg/acre of P2O5 and 120 kg/acre of K2O. She usually applies 2 ton of compost (3-4-3) over her 1-acre plot and tills it in to build organic matter.

#### **STEP 1. CALCULATE THE AMOUNT OF NUTRIENTS PROVIDED BY THE COMPOST.**

2,000 kg compost (2 ton) x 0.03 (percent N) = 60 kgs Total N

Adjust total N provided by compost for the amount that will be available during that growing season, usually about 10%.

60 kg Total N x 0.1 = 6 kg2,000 kg compost (2 ton) x 0.04 (percent P2O5) = 80 kg P2O52,000 kg compost (2 ton) x 0.03 (percent K2O) = 60 kg K2O

Nutrients supplied by compost are: 6 kg N, 80 kg P2O5 and 60 kg K2O

#### **STEP 2. SUBTRACT NUTRIENTS SUPPLIED BY THE COMPOST FROM THE NUTRIENTS NEEDED.**

150 kg N ? 6 kg N = 144 kg N80 kg P2O5 ? 80 kg P2O5 = 0 kg P2O5120 kg K2O ? 60 kg K2O = 60 kg K2O

Here, the compost supplies all of the P2O5 needed. Additional nutrients needed by plants are 144 kg N and 60 kg K2O.

#### **STEP 3. PICK AN ADDITIONAL ORGANIC FERTILIZER TO SUPPLY THE REST OF THE NEEDED NUTRIENTS.**

The greatest fertilizer need is for N. Consequently, the farmer wants a fertilizer with a fairly high N content that can also supply K2O. She picks a commercially available product with an 8-5-5 content. Remember, this will supply 8 kg of N, 5 kg of P2O5 and 5 kg of K2O per 100 kg of fertilizer.

Farmer decides to apply enough of this fertilizer to supply the K2O needs.

kgs of fertilizer needed =

= 60 kg K2O / (5 kg K2O / 100 kg fertilizer)= 60 kg K2O / 0.05= 1,200 kg of fertilizer

How much N and P2O5 will be added?

N: 1,200 kg fertilizer x (8 kg N / 100 kg fertilizer) = 96 kg NP2O5: 1,200 kg fertilizer x (5 kg P2O5 / 100 kg fertilizer) = ***60 kg P2O5***

#### **STEP 4. SUBTRACT THE NUTRIENTS SUPPLIED BY THE FERTILIZER TO DETERMINE IF ADDITIONAL N OR P2O5 ARE NEEDED.**

144 kg N ? 96 kg N = 48 kg N0 kg P2O5 ? 60 kg P2O5 = ***-60 kg P2O5***

These calculations indicate that much of the N and all of the K2O needs for the chillies crop can be met by applying the usual 2,000 kg of compost plus 1,200 kg of the organic 8-5-5 on farmers one acre plot. Notice that with this combination of fertilizers, P2O5 is **overapplied**. Because farmer’s soil test P is in the medium range and all the compost P may not be immediately available, this is not an immediate problem. But, if she continues to use this combination, she will end up with high levels of phosphorus in her soils. In some cases this can cause environmental problems. For true sustainability, she should try to better match the crop needs with the applied P2O5. By our calculations, Farmer is still 48 kg of N short. She would need to use an N-only fertilizer like groundnut cake to make up this difference.

## **Summary**

These examples can help you convert inorganic fertilizer recommendations to organic ones. If you need further help, your local county agent is a good resource. How you use these inorganic fertilizer recommendations may depend on whether the field is in a soil building or soil maintenance stage. New and transitioning growers often have fields that need more soil organic matter and available nutrients because the soils are moving to a new biological and chemical equilibrium. If you are in a soil building stage, following the fertilizer recommendations will help you improve your soil fertility and quality.

Fields are likely in the soil building stage if:

* soil organic matter is below 1.5% in the Coastal Plain or 2.5% above the fall line, and/or
* soil test indices for P, K and other nutrients are in the low or medium range.

Many organic growers reduce fertilizer use by 10 to 20% in the soil maintenance stage. The percent reduction depends on site-specific conditions such as the amount of soil organic matter buildup and nutrients available as well as yield goals.

1. Apply biomass equivalent to 4-6 tons of FYM+ organic manures equivalent to 50% of the nutrients in recommended dose of Fertilisers + apply biofertilisers for Nitrogen Fixation, P solubilization and K Mobilisation 750 g to 1.0 kg each or apply 5-6 sprays of Jeevamrit/Panchagavya/Amritjal/Waste Decomposer or equivalent farm made Microbial innoculants approximately 200-400 lit each application per acre. (the microbial content of the jeevamrit/panchagavya/amritjal/waste decomposer widely vary based on the local situations; user discretion advised).