Integrated nutrient management systems for sustainable yield of crops

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For feeding a increasing population of 1.4 billian by 2025, India will need to produce 301 M t food grain in addition to other commodities . To achieve the production about 45 M t plant nutrient would be needed with the demand of chemical fertilizers nutrient 35 M t and about 10 M t should be came from organic sources.

Reason of low crop production:

– Inadequate imbalance use of chemical fertilizer created a 8-10 M t negative nutrient balance

– Only use of organic manure system can not sustained the crop production due to less availability.

– Deteriorating soil health / quality resulting multi nutrient deficiencies.

– Decreasing nutrient response.

Integrated Nutrient management (INM):

INM is an integrated approach of effective and efficient utilization of all nutrient resources, organic including microbial as well as inorganic which are locally available economically viable, socially acceptable and ecofriendly for sustaining and increasing crop production. INM technology envisaging conjuctive use of inorganic , organic sources, hold great promise in maintenance of soil quality, enhancing nutrient use efficiency and realizing optimum and sustainable yield of crops.

Advantages of INM:

– Combined use of organic and inorganic have been well established.

– INM is helpful in arresting the nutrients deficiencies and favorably optimizing physical, chemical and biological environment of soil and bringing economy and efficiency of fertilizer.

– INM concept is economically favorable, environmental friendly and sustaining productivity and enhancing quality of soil.

Components of INM:

Chemical fertilizers:

With the use of high yielding variety and increase of total irrigated area, chemical fertilizers played the most significant role in increasing the production of crop.

Organic sources:

Organic manure induce improvements in soil quality and sustainable crop production. The integrated nutrient supply including use of chemical fertilizers with FYM, compost green manure, biofertilizers etc helps not only is bridging the existing wide gap between the nutrient removal and also in ensuring balance nutrient proportion, in enhancing nutrient response, efficiency and maximizing crop productivity of desired quality.

The inclusion of legumes as an inter crop or otherwise in the cropping sequence contribute considerable N through biological N–fixation and having residual effect on succeeding cereal crops. Long term fertilizer experiments in different agro ecological zone of India clealy demonstrated that over full application of recommended doses of NPK fails to sustain the soil quality and crop productivity, but combined use of chemical fertilizers and FYM could obtain higher crop yield beside improvement of soil fertility (Swarup,1998). The positive influence of regular additions of organic manures on soil quality was evident in improvements in values of different physical, chemical and biological attributes of soil OC, mean weight diameter, water retention, infiltration, microbial biomass-C and microbial count increased and bulk density and exchange acidity decreased with the application of recommended NPK+FYM compared to NPK alone in long term experiments (Table 1 and 5, Chhibba, 2010).

The integrated nutrient supply has to be based on need based application of fertilizer nutrient and other amendments which may required for correcting any fertilizer induced imbalance in soil environment and health (Goswami and Rattan, 2000).

Biofertilizers:

Biofertilizers are the products containing living cells of different types as micro organisms that have an ability to mobilize nutrients from non usable to usable form through biological process. These broadly include N fixers, P solubulizer capable of mobilizing nonlabile nutrients and transporting metals to and across the plant roots. On global basis biological fixed N potential has been estimated at 139 M t/ha/ yr as against 70 M t N fixed chemically (Brady and Weil, 1998). In India, BNF potential is 20 mt/ annum for 1997-97 against 10.08 mt fertilize N produced (Fertilizer statistics 1997-98). Conjoint application of biofertilizers, chemical fertilizers and organic manures, in addition to include of legumes in cropping system and incorporation of on and off farm generated crop residues constitutes are efficient nutrient management strategy.

Legumes as green manuring:

Usefulness of legumes as soil fertility building practice in multiples cropping systems is well established.

Table 1 : Effect of organic materials on soil physical properties of soil under rice-wheat production system

Treatments	Post wheat harvest soil properties		
	Bulk density (Mg m^{-3})	Infiltration rate (x 10^{-2} cm min^{-1})	Mean weight diameter
Urea to rice	1.72	2.30	0.35
GM (Sesbania) + urea to rice	1.68	3.00	0.40
FYM + urea to rice	1.70	2.75	0.41
FYM+GM to rice	1.64	4.64	0.49
Wheat straw + GM	1.67	4.19	0.44
Wheat straw + GM + urea	1.62	3.92	0.52
Wheat straw + urea + RS	1.65	3.45	0.46
Wheat straw + GM+ Urea + RS	1.58	7.30	0.56
LSD (P =0.05)	0.03	-	0.03

FYM- Farmyard manure; GM – Sesbania green manure; RS- Rice straw

Table 2 : Effect of rice straw management on soil properties

Straw management	Post - rice harvest soil properties			
	Bulk density (mg m^{-3})	Infiltration rate (cm h^{-1})	Mean weight diameter (mm)	Aggregate stability (%)
Removal	1.69	0.34	0.26	8.0
Burning	1.67	0.34	0.32	10.0
Incorporation	1.59	0.41	0.37	15.0
LSD (P=0.05)	0.03	-	0.067	2.4

Table 3 : Effect of green manuring on crop yield and soil nutrient status

Sequence	Yield (t ha^{-1})		Change over initial			Apparent nutrient balance		
	Rice	Wheat	O.C. (%)	P (kg ha^{-1})	K (kg ha^{-1})	N	P	K
Rice wheat	5.73	5.65	+1.1	+15.5	-7.8	+141	+28	-63
Rice – wheat-green gram GM	6.80	5.71	+19.1	+32.2	+2.1	+210	+76	-04
Rice-wheat-Sesbania GM	6.58	5.69	+14.6	+36.8	+2.5	+166	+70	-10

Table 4 : Crop residue management and soil biological fertility

Parameters	Residue management		
	Removal	Burning	Incorporation
Bacteria (x 10^6)	15.3	2.8	30.7
Fungi (x 10^3)	60	10	109
Phosphatase activity (mg p-NP $g^{-1}h^{-1}$)	125	135	175
Dehydrogenase activity (mg TPFg^{-1} 24 h^{-1})	36	33	52

Table 5 : Effect of burning and incorporation of straw on soil nutrient status

Treatments	Sandy loam			Silt loam		
	O.C. (g kg^{-1})	Available P (kg $acre^{-1}$)	Available K (kg $acre^{-1}$)	O.C. (g kg^{-1})	Available P (kg $acre^{-1}$)	Available K (kg $acre^{-1}$)
Burning	0.35	3.7	30	0.59	9.4	68
Incorporation	0.42	4.6	33	0.66	10.4	73

Source: (Chhibba, 2010)

Table 6 : Contribution of green manure for N fixation

		Biomass (t ha^{-1})	Approx N harvest (kg ha^{-1})
Dhaincha	*Sesbania aculeta*	22.5	125
Dhaincha	*Sesbania rostrata*	20.06	146
Sunhemp	*Crotolaria juncea*	18.4	113
Green gram	*Vigna radiate*	6.5	60.2
Black gram	*Vigna mungo*	5.1	51.0
Cowpea	*Vigna unguiculata*	7.17	63.3

Sources: Pathak and Ram, 2004

Table 7 : Nutrient potentiality of various organic resources

Types of organic resource	Total nutrients (Mt yr^{-1})				
	Availability (Mt yr^{-1})	N	P_2O_5	K_2O	Total (N+ P_2O_5+K_2O)
Crop residues	273	1.28	1.97	3.91	7.16
Cattle manure	280	2.81	2.00	2.07	6.88
Rural compost	285	1.43	0.86	1.42	3.71
Forest litter	19	0.10	0.04	0.10	0.24
City garbage	15	0.23	0.15	0.23	0.61
Press mud	3	0.03	0.079	0.055	0.164
Sewage water (million cubic meters)	6351	0.32	0.14	0.19	0.65
Industrial waste water (million cubic meters)	66	0.003	0.001	0.001	0.005
Total		6.203	5.20	7.976	19.419

Symbiotic association of the legumes with different species of Rhizobium has proved useful in sequestering significant amounts of atmospheric N in the soil plant system to the extent of 25-50% of the chemical fixed N requirement of the succeeding cereal crop can be met by atmospheric N fixed by legume (Table 6).

Urban waste:

Large quantity of city and urban waste is available that can be used as source of plant nutrients after proper treatment. Urban sludge improve soil structure contain secondary and micro nutrients as well a NPK.

Recycling of agriculture waste:

Composting is the best method of recycling. Enriching of the nutrient value of compost is possible with gypsum. Rock phosphate, microbial inoculants and pressmud resources production from sugar factories is a good sourced amendment for acid and sodic soils. For quick decomposition of agricultural waste application of efficient strategies of micro-organics is a practical (Table 7).

Conclusion:

The integrated management should we based on the need of fertilizers nutrients and amendments for optimum supply of nutrients to the crop using all the possible nutrient sources for sustainable crop production.

References:

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