Improving Nutrient Use Efficiency: The Role of Beneficial Management Practices

By T. Nagendra Rao

Several agronomic factors directly or indirectly affect nutrient use efficiency, including crop genetics, plant spacing, nutrient balance, and application rate, as well as placement and timing. Research projects in Southern India have generated valuable information showing the importance of beneficial management practices (BMPs) in improving nutrient use efficiency in important crops such as rice, cotton, banana, and mulberry.

Nutrient use efficiency can be expressed in agronomic, physiologic, and economic terms, but so far in India this subject remains largely confined to the scientific community. Because nutrient use in India is largely subsidy driven and not science-based, the practical benefits of high use efficiency are distorted since N, the cheapest or most subsidized nutrient, is used most while other nutrients are presently ignored. Although fertiliser consumption is increasing quantitatively, the corresponding yield increase per unit of nutrient input is substantially diminished compared to previous years. Ultimately, the blame goes to a perceived ineffectiveness of fertiliser.

It is important to understand that nutrient use efficiency is dependant on several agronomic factors including: soil degradation, land tillage, time of sowing, appropriate crop variety, proper planting or seeding, sufficient irrigation, weed control, pest/disease management, and balanced and proper nutrient use. These factors largely influence nutrient use efficiency, either individually or collectively. For example, selection of proper planting material, population density, and balanced fertilisation could collectively improve nutrient use efficiency by 25 to 50%.

Nutrient balance, plant population, genetics, and other factors affect nutrient use efficiency.

Agronomic Efficiency of Applied Nutrients

Experiments conducted at Tamil Nadu Agricultural University comparing hybrid and non-hybrid plant ability to use P and K nutrients indicate that although non-hybrids and hybrids of rice/cotton have large responses to P and K application, the degree of agronomic response is greater in hybrid crops. For

Table 1. Agronomic efficiency of K for hybrid and non-hybrid cotton.

	Non-hybrid (MCU5)		Hybrid (TCHB 213)	
$N-P_2O_5-K_2O$, kg/ha	Yield, kg/ha	AE, kg grain/kg K_2O	Yield, kg/ha	AE, kg grain/kg K_2O
200-150-0	1,840	–	2,930	–
200-150-100	2,430	5.9	3,810	8.8
C.D. (5%) Fertiliser:		138		
Variety x Fertiliser:		349		

MYR Annual Report (1997-98), Department of Agronomy, TNAU, Coimbatore.

Table 2. Agronomic efficiency of P for hybrid and non-hybrid rice.

	Non-hybrid (ASD 18)		Hybrid (CORH -1)	
$N-P_2O_5-K_2O$, kg/ha	Yield, kg/ha	AE, kg grain/kg P_2O_5	Yield, kg/ha	AE, kg grain/kg P_2O_5
200-0-200	6,010	–	6,120	–
200-75-200	6,180	2.3	6,510	5.2
200-150-200	6,720	4.7	7,890	11.8
C.D. (5%) Variety x Fertiliser		155		

MYR Annual Report (1997-98), Department of Agronomy, TNAU, Coimbatore.
Planted at 10 x 10 cm spacing.

Split-application of N and K improves nutrient use efficiency in banana.

Abbreviations and notes for this article: N = nitrogen; P = phosphorus; K = potassium; AE = agronomic efficiency; RE = recovery efficiency; PFP = partial factor productivity; C.D. = Critical Difference.

Table 3. Plant population and hybrid interaction on agronomic efficiency of P in rice.

	AE, kg rice/kg P applied[2]			
	Non-hybrid (ASD 18)	Hybrid (CORH-1)	Non-hybrid (ASD 18)	Hybrid (CORH-1)
P_2O_5, kg/ha[1]	12.5 x 10 cm plant spacing		10 x 10 cm plant spacing	
75	4.2	12.8	15.6	19.9
150	5.9	6.6	11.4	19.2

MYR Annual Report (1997-98), Department of Agronomy, TNAU, Coimbatore.
Yields at 0 kg P_2O_5/ha at 12.5 x 10 cm spacing: Non-hybrid = 5,010 kg/ha, Hybrid = 5,020 kg/ha.
[1]N and K_2O applied as blanket doses at 200 kg/ha each.
[2]Efficiency values obtained over and above values at 0 level of P.

instance, the cotton hybrid TCHB 213 produces more yield per unit of K fertilisation (Agronomic Efficiency of K or AEK) than the non-hybrid MCU 5 (**Table 1**). Similarly, the rice hybrid CORH-1 is more effective in utilising applied P compared to the non-hybrid ASD 18 (**Table 2**).

Simple Agronomic Practices Enhance Nutrient Use Efficiency in Crops

In addition to choosing the best genetics for the agro-ecological zone, nutrient use efficiency can also be improved by several other simple agronomic techniques. Researchers have found that changes in plant population per unit area and spacing have profound effects on improving P use efficiency (**Table 3**).

At the high rate of fertilisation, the hybrid effectively used applied P and produced higher yields per unit quantity of P, which was improved even further when closer spacing (more plant population density) per unit area was adopted. Contrary to this, conventional varieties were shown to be less efficient in using higher rates of P at close spacing. Although hybrids are efficient P users, low plant populations fail to show their fullest potential. While targeting for high yields, it is not only important to select the right plant type, but also to optimise plant population to improve nutrient use efficiency, especially at higher doses of nutrients.

Effect of K Application on N Recovery

Potassium improves N use efficiency, as the rice and cotton data in **Table 4** clearly show.

The simple agronomic practice of split-application of nutrients does not increase production costs by much, but it significantly improves nutrient use efficiency. Experiments on horticultural crops such as banana and mulberry have shown that split application of nutrients, especially N and K, improved nutrient use efficiency (**Table 5**).

Table 4. Influence of K on N recovery efficiency (REN).

	Nutrient dose, kg/ha	Non-hybrid		Hybrid	
Crop	$N-P_2O_5-K_2O$	N uptake, kg/ha	REN, kg/kg	N uptake, kg/ha	REN, kg/kg
Rice	200-75-0	89	0.44	107	0.54
	200-75-100	103	0.52	122	0.61
Cotton	200-150-0	68	0.34	71	0.36
	200-150-100	97	0.48	98	0.49

MYR Annual Report (1997-98), Department of Agronomy, TNAU, Coimbatore.

Table 5. Effect of split application of nutrients on partial factor productivity.

Crop	Nutrient dose, kg $N-P_2O_5-K_2O$/ha	Number of splits	Yield level, t/ha	PFP, kg yield/kg $N-P_2O_5-K_2O$
Banana[1]	510-162-1530	3 (all NPK)	93.1	42.3
	510-162-1530	4 (all NPK)	97.7	44.4
Mulberry[2]	280-120-120	2 (K alone)	22.7	43.6
	280-120-120	6 (K alone)	29.0	55.9

[1]Annual Report (2001-02), Department of Fruit Crops, Horticultural College and Research Institute, TNAU, Coimbatore.
[2]Shankar and Sriharsha ,1999.

Conclusion

Although the Government is officially recommending P and K, farmers often ignore the importance of applying balanced quantities of these nutrients in their crop production systems. In order to reap the agronomic benefits from nutrient application and target improved nutrient use efficiency, BMPs having sound agronomy must be adopted in the field. BC-INDIA

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