India

Long-Term Field Trials Reveal Importance of Plant Nutrients in Sustaining Productivity

By K.K.M. Nambiar

TO EVALUATE the long-term sustainability in intensive farming, the Indian Council of Agricultural Research (ICAR) initiated the All India Coordinated Research Project on Long-Term Fertilizer Experiments in 1970 at 11 selected centres representing the major soil-climate regions of the Indian Subcontinent. The experiments have been in progress since then.

During the period 1971-1988, grain yield responses of rice and wheat to nitrogen (N) averaged 1.45 and 2.09 tonnes/ha, respectively, on Hapludolls at Pantnagar (Uttar Pradesh). Responses to potassium (K) were also obtained for rice, **Table 1**. However, **Table 1** shows responses to applied phosphorus (P) have been small in the case of both crops, consistent with its high native availability in the soil.

Grain yield responses of corn and wheat to N on Ustochrepts at Ludhiana (Punjab) were also high–1.01 t/ha for corn and 1.83 t/ha for wheat. Yield responses of wheat to P and K were 1.38 t/ha and 0.74 t/ha, respectively. Similarly, the average grain yield responses of corn to P and K were 0.46 t/ha and 0.56 t/ha, respectively.

Although the balanced use of NPK fertilizers could maintain productivity over an extended period of time in comparison to individual nutrients (N, P or K), it was not adequate to sustain long-term productivity in intensive farming systems. Integrated use of chemical NPK fertilizers and farmyard manure enhanced and stabilized productivity over a considerable period of time. Similarly, amendment of acid soils with lime along with recommended doses of NPK fertilizers maintained higher productivity.

Usefulness of Zinc in Long-Term Productivity

Significant loss in grain productivity was noticed for corn at Ludhiana and

Table 1. Average grain yield response to NPK fertilizers, organics and lime under long-term fertilizer use (1971-89).

Location	Crops/ Cropping systems	Mean grain yield over the years, t/ha Treatment (1971-88) No manure	N	NP	NPK	NPKM[1]	NPKL[2]
Ludhiana	Corn*	0.41	1.42	1.88	2.44	3.24	–
	Wheat	0.91	2.74	4.02	4.76	4.87	–
Jabalpur	Soybean**	1.08	1.36	2.16	2.29	2.51	–
	Wheat	1.16	1.64	3.87	4.02	4.48	–
Bhubaneswar	Rice*	1.67	2.29	2.36	2.90	3.48	3.59
	Rice	1.51	2.37	2.81	3.06	3.71	3.83
Palampur	Corn**	0.25	0.88	2.37	3.27	4.75	4.12
	Wheat	0.37	0.59	1.99	2.59	3.27	3.10
Pantnagar	Rice	4.08	5.53	5.49	5.95	6.67	–
	Wheat**	1.79	3.88	3.90	3.96	4.56	–

[1]M = Manure, farmyard at 10 t/ha (*) and 15 t/ha (**)
[2]L = Lime

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Table 2. Mean grain yield response to Zn addition under long-term fertilizer use.

Location	Crop	Period	No. of Crops	Mean grain yield, t/ha Treatment NPK	NPKZn
Ludhiana	Corn	1971-78	8	2.74	2.75
		1979-88	9	2.17	2.63
Pantnagar	Rice	1972-82	11	6.35	6.27
		1983-88	6	5.37	6.01
	Wheat	1972-75	3	4.42	4.46
		1975-89	14	3.86	4.15

Pantnagar after eight annual cropping cycles. This yield loss was probably due to depletion of available soil zinc (Zn), **Table 2**. Corn grain yields declined by 21.2 percent over the period 1979-88. Loss of rice and wheat yields was also observed after 11 annual cropping cycles in the absence of Zn fertilization. The reduction was of the order of 11.9 percent and 7.5 percent, respectively. The initial productivity of both the crops was almost restored with the application of Zn.

Usefulness of Sulfur in Long-Term Productivity

As shown in **Table 3**, sulfur (S) had a pronounced effect on the productivity of kharif (monsoon) rice at Barrackpore (West Bengal) and at Bhubaneswar (Orissa) after three annual cropping cycles. Average reduction in kharif rice production in the absence of S addition amounted to 35.4 and 33.7 percent, respectively. However, its effect on the productivity of rice (kharif) and wheat on an initially producive Hapludoll soil at Pantnagar became evident only after 13 annual cropping cycles. The average reduction in rice productivity was 11.9 percent over the last four-year period (1985-89). The effect of S was also marked on the productivity of wheat and soybean at Jabalpur after 9 to 11 annual cropping cycles. The average loss in productivity of both the crops was 12.4-12.7 percent. Similar effects were also noticed with respect to a corn-wheat rotation at Palampur after seven annual cropping cycles.

Long-term experiments showed that deterioration in productivity was often encountered after 3 to 11 annual cropping cycles in intensive farming systems with the drawdown in readily available soil plant nutrients, including secondary and micronutrients. Nonetheless, sustained productivity could be maintained through application of adequate quantities of NPK along with the proper rates of secondary and micronutrients. ■

Table 3. Mean grain yield response to S addition under long-term fertilizer use.

Location	Crops	Period	No. of Crops	Mean grain yield, t/ha Treatment NPK	NPKS
Barrackpore	Rice, kharif	1971-73	3	4.59	4.90
		1974-88	15	2.91	3.94
Jabalpur	Soybean	1972-83	11	2.06	2.15
		1984-88	4	2.36	2.66
	Wheat	1973-82	9	3.69	3.73
		1983-89	6	3.79	4.26
Bhubaneswar	Rice, kharif	1972-75	3	2.55	2.59
		1976-88	14	2.58	3.45
Palampur	Corn	1981-88	8	2.84	3.31
	Wheat	1981-89	8	2.35	2.60
Pantnagar	Rice	1972-84	13	6.09	6.28
		1985-88	4	4.36	4.88

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