Available online at
http://agrospheresmagazine.vitalbiotech.org/

ISSN (E): 2582 – 7022

Agrospheres:e- Newsletter, (2026) *7*(11), 04-07

Article ID: 1111

Impact of Phosphorus Management on Vegetable Production in Acid Soils: Simple Tips for Farmers of Eastern India

Aurobinda Behera[1]
Sunil Kumar Dash[2]
Ashok Mishra[3]

[1]Ph.D. Scholar, Department of Vegetable Science, College of Agriculture, Odisha University of Agriculture and Technology Bhubaneswar-751003, Odisha
[2]Vegetable Agronomist, AICRP on Vegetable Crops, Odisha University of Agriculture and Technology, Bhubaneswar 751003, Odisha, India
[3]Professor and Head Department of Agricultural Biotechnology, College of Agriculture, Odisha University of Agriculture and Technology Bhubaneswar-751003, Odisha

Open Access

*Corresponding Author
Aurobinda Behera*

Article History
Received: 02.11.2026
Revised: 07.11.2026
Accepted: 12.11.2026

This article is published under the terms of the Creative Commons Attribution License 4.0.

INTRODUCTION

Tomato seedlings with purplish leaves, stunted brinjal or okra that flowers late are common sights in eastern India, even where DAP has been applied. Often the soil has simply locked the phosphorus away. About 98.71 million ha, or 31% of India's geographical area, is affected by soil acidity, and the share is far higher in the eastern states (Behera et al., 2026; Table 1). Wasting P is also a national loss: the world has about 74 billion tonnes of phosphate rock reserves, of which Morocco holds 50 billion, whereas India has only about 31 million tonnes (USGS, 2025), and India imported around half of its DAP requirement in 2024–25 (Juneja et al., 2026).

Why phosphorus matters and where it goes

Phosphorus is the "energy currency" of the plant, needed for root growth, seedling establishment, flowering, fruit set and the formation of tubers and bulbs. It is most available at soil pH 6.0–7.0. In acid soils, iron and aluminium convert fertilizer phosphate into forms roots cannot absorb, and aluminium toxicity further restricts root growth (Fageria and Baligar, 2008). The crop to which P is applied rarely takes up more than 25% of it; the rest builds up in the soil, and over many years total recovery can reach 90% (Syers et al., 2008). Soil testing therefore often allows lower P doses on fields fertilized for years.

Phosphorus and potato: a special case

Potato is India's largest vegetable crop by production, with about 58.6 million tonnes in 2024–25 (DA&FW, 2026), and much of the rabi potato in eastern India is grown on acid soils. Potato has a relatively high P requirement but uses soil P inefficiently, and it can respond to fertilizer P even at soil-test levels considered very high for other crops (Rosen et al., 2014).

ISSN (E): 2582 – 7022

Table 1. Extent of acid soils (million ha) in eastern states and India

State	Strongly acidic (pH ≤4.5)	Moderately acidic (pH 4.5–5.5)	Slightly acidic (pH 5.5–6.5)	Total acid soil	Area mapped	% of area
Odisha	0.00	4.37	10.58	14.95	15.60	95.83
West Bengal	0.03	4.15	2.86	7.04	8.62	81.67
Jharkhand	0.00	3.42	3.96	7.38	8.03	91.90
Assam	0.15	7.15	1.20	8.49	8.49	100
All India	**0.61**	**36.25**	**61.84**	**98.71**	**318.37**	**31.00**

Why phosphorus matters and where it goes

Phosphorus is the "energy currency" of the plant, needed for root growth, seedling establishment, flowering, fruit set and the formation of tubers and bulbs. It is most available at soil pH 6.0–7.0. In acid soils, iron and aluminium convert fertilizer phosphate into forms roots cannot absorb, and aluminium toxicity further restricts root growth (Fageria and Baligar, 2008). The crop to which P is applied rarely takes up more than 25% of it; the rest builds up in the soil, and over many years total recovery can reach 90% (Syers et al., 2008). Soil testing therefore often allows lower P doses on fields fertilized for years.

Phosphorus and potato: a special case

Potato is India's largest vegetable crop by production, with about 58.6 million tonnes in 2024–25 (DA&FW, 2026), and much of the rabi potato in eastern India is grown on acid soils. Potato has a relatively high P requirement but uses soil P inefficiently, and it can respond to fertilizer P even at soil-test levels considered very high for other crops (Rosen et al., 2014). In a comparison with cabbage and carrot, potato was less P-efficient than cabbage, whose roots have long root hairs and also release citrate that frees soil P (Dechassa et al., 2003). Phosphorus promotes canopy development, tuber set and starch synthesis, and adequate P is essential for tuber yield, dry matter, quality and resistance to some diseases (Rosen et al., 2014). Apply the recommended P dose at planting in the furrow beside the seed tubers, as per the soil-test report.

Recognising phosphorus shortage

Look for stunted plants with weak roots, dark green leaves turning purplish on the underside (clear in tomato, brinjal and cabbage seedlings), delayed flowering and maturity, and small fruits, bulbs or tubers. Older leaves show symptoms first. A soil test is the only sure way to confirm P deficiency and acidity.

Simple tips for better phosphorus use

- **Test the soil** every two to three years through the Soil Health Card scheme, a KVK or a soil-testing laboratory.
- **Correct acidity** with lime as advised by the soil-testing laboratory; furrow application of a small dose is economical. Apply a few weeks before planting and never mix lime directly with fertilizers.
- **Add organic matter** such as FYM, compost or vermicompost, which keeps more P in available form and improves soil structure.
- **Choose the right P source** for your soil (Table 2), and place it in bands near the seed or seedling at planting instead of broadcasting.
- **Use phosphate-solubilizing bacteria (PSB),** which release fixed soil P (Richardson and Simpson, 2011). Globally, biofertilizers raised crop yields by about 15% in tropical and 20% in dry climates (Schütz et al., 2018). Buy certified packets, store them in shade and do not mix them with chemicals.

ISSN (E): 2582 – 7022

- **Make use of mycorrhiza (AMF),** which partner about 72% of vascular plant species, including most vegetables but not crucifers (Brundrett and Tedersoo, 2018). Their inoculation succeeds better at near-neutral pH (Schütz et al., 2018), another reason to correct acidity first.
- **Rotate with legumes** such as cowpea, French bean or dhaincha green manure to build soil organic matter and microbial activity.
- **Avoid overuse:** excess P wastes money, can induce zinc deficiency and pollutes ponds and streams.

Table 2: Choosing a phosphorus source according to soil condition

P source	Suits best	Farmer's note
Rock phosphate	Strongly acid soils (pH below 5.5)	Cheap; dissolves slowly in acid soil. Mix with FYM/compost and apply 2–3 weeks before planting.
Single super phosphate (SSP)	Mildly acid to neutral soils	Also supplies sulphur and calcium, useful for onion, garlic and crucifers.
DAP	Most soils, at planting	Fully water-soluble; place in bands near the seed or seedling, not broadcast.
PROM / enriched compost	All soils, organic or low-input farms	Phosphate-rich organic manure; adds organic matter while supplying P slowly.

CONCLUSION

Phosphorus shortage in acid soils is a problem of management more than of quantity. With limited phosphate reserves and heavy imports, every kilogram of P saved matters. Testing the soil, correcting acidity, adding organic matter, choosing and placing the right P source and using beneficial microbes can give healthier vegetables and potatoes at lower cost while protecting soil health.

REFERENCES

Behera, S.K., Shukla, A.K., Mishra, R., Mohanty, M. and Nayak, A.K. (2026). *Acid Soils of India*. Indian Council of Agricultural Research, New Delhi, 12 p.

Brundrett, M.C. and Tedersoo, L. (2018). Evolutionary history of mycorrhizal symbioses and global host plant diversity. *New Phytologist*, 220: 1108–1115.

DA&FW (2026). *Final Estimates 2024–25 and First Advance Estimates 2025–26 of Area and Production of Horticultural Crops*. Department of Agriculture & Farmers Welfare, Government of India, New Delhi.

Dechassa, N., Schenk, M.K., Claassen, N. and Steingrobe, B. (2003). Phosphorus efficiency of cabbage (*Brassica oleraceae* L. var. *capitata*), carrot (*Daucus carota* L.), and potato (*Solanum tuberosum* L.). *Plant and Soil*, 250: 215–224.

Fageria, N.K. and Baligar, V.C. (2008). Ameliorating soil acidity of tropical Oxisols by liming for sustainable crop production. *Advances in Agronomy*, 99: 345–399.

Juneja, R., Gulati, A., Nand, S. and Johny, E.T. (2026). *Ensuring India's Fertiliser Security Amid Rising Geopolitical Risks*. ICRIER, New Delhi.

Richardson, A.E. and Simpson, R.J. (2011). Soil microorganisms mediating phosphorus availability. *Plant Physiology*, 156: 989–996.

Rosen, C.J., Kelling, K.A., Stark, J.C. and Porter, G.A. (2014). Optimizing phosphorus fertilizer management in

potato production. *American Journal of Potato Research*, 91: 145–160.

Schütz, L., Gattinger, A., Meier, M., Müller, A., Boller, T., Mäder, P. and Mathimaran, N. (2018). Improving crop yield and nutrient use efficiency via biofertilization – A global meta-analysis. *Frontiers in Plant Science*, 8: 2204.

Syers, J.K., Johnston, A.E. and Curtin, D. (2008). *Efficiency of Soil and Fertilizer Phosphorus Use*. FAO Fertilizer and Plant Nutrition Bulletin 18, FAO, Rome.

USGS (2025). *Mineral Commodity Summaries 2025: Phosphate Rock*. U.S. Geological Survey, Reston, Virginia, USA