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Influence of Seed Priming with Urine, Phosphorus and Zinc on Maize (*Zea mays* L.) Yield in an Acid Soil of Northeast India

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Soil acidity limits crop production worldwide and the problem afflicts nearly one-third of cultivated land in India, mostly in northeastern region (NER) where 95% soils are acidic, and nearly 65% soils are suffering from strong acidity (pH<5.5) (Sharma and Singh 2002; Kumar 2011; Kumar et al. 2012a,b). Amidst a multitude of fertility constraints, phosphorus and zinc deficiency frequently limits crop yield on these soils. Efficiency of applied P in acidic soils of NER is very low due to their high P-fixing capacity (Patiram et al. 1990), while application of Zn is traditionally minimal. High cost of these fertilizer-inputs, poor economic condition of farmers and their traditional apathy towards use of agro-chemicals usually limits the application of required doses of fertilizers in northeast India, which warrants alternative strategies to minimize the fertilizer requirement and improve its use efficiency. Seed priming (with water and nutrient solutions such as Zn and P) is one such technique which has been reported to reduce fertilizer requirement and increase crop yield in many regions of the world (Harris et al. 1999, 2007; Ajouri et al. 2004; Sekiya and Yano 2010). Since nutrients or nutrient sources are directly applied to seeds, many undesired interactions of applied nutrient with soil matrix (such as fixation of applied P) can be avoided through seed priming. This technique aims at giving a good start to the crop by improving its germination, seedling vigour, and initial root growth and proliferation. The improved seedling growth and root system in initial stage enables the plant to absorb nutrient and water more efficiently during its entire active-growth period, leading to a better yield and quality of crop.

Urines (human and cow urine) could also be considered as potential seed-priming agents, as they are rich in many plant nutrients including N, P and micronutrients (Heinonen-Tanski et al. 2007; Winker et al. 2009). Despite being long known as a rich source of plant nutrients, potential utility of urine (particularly human urine) as seed priming agent remains untried, although it has been tested as an alternative fertilizer in many studies (Richert Stintzing et al. 2002; Heinonen-Tanski and van Wijk-Sijbesma 2005; Heinonen-Tanski et al. 2007; Sridevi and Srinivasamurthy 2011). In this context, the present study was undertaken to evaluate the effects of seed priming with P, Zn, human and cow urine on maize yield in an acidic soil of northeast India.

MATERIALS AND METHODS

A field experiment with maize variety DA 61A as test crop was undertaken in an acid Alfisol (pH 4.7) of Meghalaya, Northeast India, with six treatments consisting of control (unprimed seed), priming with water, P solution (1% KH_2PO_4), Zn solution (1% $ZnSO_4.7H_2O$), human urine (2.5 times dilution) and cow urine (2.5 times dilution) replicated four times in a RBD. Before sowing, seeds were soaked in the priming agents for 16 h, and air-dried to reduce the moisture content. Sandy clay loam soil (Typic Hapludalf) of the experimental field had sand 68.8%, silt 7.3%, clay 23.9%, pH 4.7, available N 238 kg ha^{-1}, available P 7.7 kg ha^{-1}, available K 82.9 kg ha^{-1}, DTPA-Zn 0.53 mg kg^{-1}, hot water-extractable B 0.29 mg kg^{-1}, total

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acidity 3.76 meq $100g^{-1}$, ECEC 2.75 Cmol (p^+) kg^{-1}, Al saturation 63.3% and lime requirement 9.48 t ha^{-1}. No additional fertilizers were added to support the crop (to replicate the farmers' practice); however, recommended agronomic practices were followed. At harvest, grain yield was recorded and statistically analyzed using the SPSS version 16.0 statistical package (SPSS Inc., Chicago, USA). Significance of the treatments' effect was considered at 0.05 probability level (unless otherwise stated). The treatments' means were segregated using Duncan's Multiple Range Test. Relative yield was calculated assuming yield at control to be unity (1.0).

RESULTS AND DISCUSSION

Seed priming with P had highest increase in maize yield (relative yield 1.71) followed by human urine (1.45), cow urine (1.28) and Zn (1.24, P = 0.08) treatments, whereas hydro-priming proved ineffective (Table 1). In general, yields were low owing to poor fertility of soil and no nutrient supply through fertilizers; however, incremental yield might be due to better root growth and proliferation, leading to higher uptake of nutrients and water (Harris et al. 1999, 2007, 2008; Sekiya and Yano 2010). Crop did not respond to hydro-priming as sufficient moisture was available during crop growth period (*Kharif* season). However, the crop responded well to seed priming with P and Zn solutions as experimental soil was deficient in both the nutrients. Such positive responses of crop growth and yield due to seed priming with P and Zn have also been reported by Ajouri et al. (2004) Harris et al. (2007, 2008) and Sekiya and Yano (2010) in other regions; and the present results validate their effectiveness in acidic soil of northeast India as well. Since the yield improvement was solely due to seed priming (no fertilizer was added to soil), it might reduce fertilizer requirement for crop production in northeast India.

Table 1: Effect of seed priming with water, phosphorus, zinc, human and cow urine on maize yield

Treatments	Maize yield (t ha^{-1})	Relative yield
Control	0.75^{d}	1.00
Water	0.79^{cd}	1.05
Zinc	0.93^{bcd}	1.24
Phosphorus	1.28^{a}	1.71
Human urine	1.09^{b}	1.45
Cow urine	0.96^{bc}	1.28

Means with no letters in common are significantly different (P=0.05) by Duncan's multiple range test. (Zn priming effect was significantly higher over control at P = 0.08).

Yield improvement due to seed treatment with urine can be ascribed to the presence of a range of plant nutrients therein, including N, P, K and micronutrients (Schouw et al. 2002; Heinonen-Tanski et al. 2007), and hence proposed as an alternative fertilizer in crop production (Richert Stintzing et al. 2002; Heinonen-Tanski et al. 2007; Sridevi and Srinivasamurthy 2011). As the chemical composition of human urine depends on time of day, diet, climate, physical activity and body size (Sullivan and Grantham 1982), there is need to ascertain its appropriate concentration and treatment duration for a given set of urine-source, soil and crops in an area. Since the beneficial effect of seed priming with urine (particularly human urine) on crop yield is reported here for the first time, its potential utility as seed priming agent needs further testing.

It is concluded that seed priming with P, Zn, human and cow urine can potentially improve crop growth and yield on low-fertility acid soils of northeast India, and needs to be tested elsewhere through experimentations on different soils and crops.

CONCLUSION

Effect of seed priming with urine, phosphorus and zinc on maize yield in an acid Alfisol of Northeast India was evaluated. Treatments included seed priming (16 h) with Water, 1% KH_2PO_4, 1% $ZnSO_4.7H_2O$, 2.5 times diluted human and cow urine, along with a control (unprimed seed). Seed priming with P resulted in highest increase in yield (relative yield 1.71) followed by human urine (1.45), cow urine (1.28) and Zn (1.24) treatments, whereas hydro-priming proved ineffective. In general, yields were low owing to poor fertility of the soil and no nutrient supply through fertilizers. It was concluded that seed priming with P, Zn, human and cow urine could potentially improve crop growth and yield on low-fertility acid soils of northeast India.

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