Cultivation of potato on abiotic stress-affected soils of India

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Potato (*Solanum tuberosum* L.) is the third most important food crop in the world after rice and wheat. It is relatively sensitive to abiotic stress of excessive salt content in the soil. However, comparatively little work has been done with respect to abiotic stress of soil salinity on potato. Scientific evidences show that electrical conductivity (EC) above threshold levels can reduce potato tuber yield. EC of 2.5, 3.8 and 5.9 dS/m of soil-saturated paste extract may reduce potato yield by 10%, 25% and 50% respectively[1]. Studies indicate little reduction in total tuber yields over high pH range, but the incidence and severity of scab lesions decline as the pH increases above 8.5 and marketable yields after grade-out to scab are the highest at pH 9.0. The economics of this type of pH change and its impact on subsequent crops need to be considered[2]. In addition, high exchangeable sodium percentage (ESP) in root zone may have toxicity symptoms in potato crop.

Potential yield reduction of 10%, 25% and 50% was observed by applying saline irrigation water having salt concentration of 1.2, 2.5 and 3.9 dS/m respectively[3]. This might be one of the reasons that most of the area under potato cultivation in many countries is on soil that does not show abiotic stress. But exceptions include countries in South and Southeast Asia, where coastal or inland salinity is more common, however potato is cultivated on these lands[4]. Farmers are able to achieve marginal yields with locally available varieties on these soils. The salt-tolerant varieties and advanced cultivation techniques for cultivation of potatoes on abiotic stress-affected soils are rarely available for the farmers.

Though potato is sensitive to excess salt content of soil, the farmers' effort to cultivate potato in salt-affected soils shows the possibility of cultivation of this crop in such soils. Most of the presently available varieties show constraints for cultivation on abiotic stress-affected soils like alkaline, saline, sodic and saline sodic soils. Worldwide potato research is more focused on developing disease and pest-resistant, high-yielding and early-maturing varieties. ICAR-Central Potato Research Institute (CPRI), Shimla is responsible for the overall research related to potato in the country. The Institute has developed and released many varieties of potatoes with the objectives of high yield, early maturity and resistance to diseases and pests. But there is hardly any variety developed to tolerate abiotic stress of excess salt content in the soil. To meet the demand of potato for home consumption and livelihood, farmers are forced to cultivate the existing varieties developed for non-saline soils in some pockets of salt-affected soils in the country. The major area of salt-affected soils is distributed in important potato-growing states of the country like Gujarat (2.22 m ha), Uttar Pradesh (1.37 m ha) and West Bengal (0.44 m ha).

Soil salinity is believed to be mainly responsible for low land use as well as cropping intensity[5]. Salt-affected soils contain excessive concentration of either soluble salts or exchangeable sodium, or both. Depending upon the physico-chemical properties, these soils are classified into saline, sodic and saline–sodic. The area under salt-affected soils in India is 6.73 m ha (Table 1)[6]. It is projected that by 2050 the area under salt-affected soils will be 20 m ha compared to the current estimate[7] of 6.73 m ha. Most of the salt-affected areas have saline groundwater which is used for irrigation and may lead to further degradation of soils. Among the presently reported saline areas, the area underlain by saline groundwater (with EC > 4 dS/m) in Rajasthan, Gujarat, Haryana, Karnataka, Punjab and Uttar Pradesh is 1.41, 0.24, 0.11, 0.09, 0.03 and 0.01 lakh sq. km respectively[8].

The gene pool of potato is large and may provide valuable source of genetic diversity for developing salt-tolerant varieties. The International Potato Center (CIP) Lima, Peru maintains a huge collection of potatoes, including more than 7000 accessions of native, wild and improved varieties. The gene bank of CIP may provide potential material for developing salt-tolerant potato varieties for Indian conditions. Researchers in Asian countries have used the genetic resource of CIP and released a few potato varieties for cultivation in saline areas[9,10]. Fifteen salt-tolerant CIP genotypes, along with BARI Alu 7 (Diamant) and one local variety (Dohazari sada) were evaluated to screen those suitable for cultivation in saline areas of Bangladesh. It was reported that the genotype CIP-112 gave the highest yield (21.07 t/ha) and CIP-102 was comparatively less affected by soil salinity compared to other genotypes[9]. Such genotypes have high potential for breeding and developing salt-tolerant varieties under Indian conditions.

Recently, CPRI has projected that India will have to produce 56.15 and 124.88 million tonnes of potato during the years 2025 and 2050 respectively to meet the future demands[11]. Considering more or less stagnant cultivable land and impending food insecurity threat, India will have to strive hard to increase potato production. The country has about 46% (141.4 m ha) of the total geographical area as net sown area. Further increase in cultivable area is likely to cause huge environmental damage[11]. Thus, existing agricultural lands need to be utilized effectively and sustainably to meet the future demands.

One way to boost the potato production is providing farmers with salinity-tolerant varieties and improved techniques of cultivation. Major emphasis of

Table 1. Extent and distribution of salt-affected soils in India[6]

State	Area (m ha)
Andhra Pradesh	0.27
Andaman & Nicobar Islands	0.08
Bihar	0.15
Gujarat	2.22
Haryana	0.23
Karnataka	0.15
Kerala	0.02
Madhya Pradesh	0.14
Maharashtra	0.61
Odisha	0.15
Punjab	0.15
Rajasthan	0.38
Tamil Nadu	0.37
Uttar Pradesh	1.37
West Bengal	0.44
Total	6.73

the present research is on enhancing potato production through high-yielding, disease- and pest-resistant and early-maturing varieties. The National Agricultural Research System (NARS) of India needs collaborative research and extension efforts for development of potato varieties and cultivation techniques for abiotic stress-affected saline soils. This may help in increasing potato production and improving livelihood of rural people.

CIP has also recognized the need for potato research in Asia and emphasized on 'agile potato for Asia' in its strategy and Corporate Plan 2014 (ref. 12). The proposed research in India through NARS for cultivation of potato crop on salt-affected soils will not only assist CIP's research programmes in India, but also increase potato production and productivity. Farmers are already cultivating potato in some pockets of salt-affected soils. The local knowledge of farmers, and collaboration between different organizations and NARS will help in successfully meeting the future potato requirements of the country.

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