ABSTRACT

Lithium is used to manufacture lithium ion batteries predominantly worldwide. Recycling of lithium is not preferred both in developed and developing countries due to economical and easy availability of lithium from virgin mining sources. That is why lithium becomes an emerging pollutant of today as a result of not being recycled. Geochemically it is exceptionally mobile element. Its mobility causes high risk for environmental health and safety. Lithium is non-essential element for organisms. It is among the alkali metals which can significantly reduce the plant growth and yield. Food insecurity is a major issue of rapidly increasing population. Environmental pollution is a key agent to decrease in crop production. Limited information is available for lithium toxicity and its control.Objectives of the present study were to i) isolate, screen and identify lithium resistant bacteria from soil .ii) find effect of lithium on germination of selected crops and role of lithium resistant bacteria in germination.iii) determine the effects of different concentrations of lithium and inoculation of lithium resistant bacteria on the growth and yield of selected crops. iv) explore the role of different concentrations of lithium and application of lithium resistant bacteria on some physiological parameters of three economically important selected crops.

Lithium resistant bacteria were isolated from soil by serial dilution method. The capability of bacteria for lithium resistance was assessed by examining the bacterial growth on nutrient broth modified with the different levels of lithium. The screened bacterial strain was identified on morphological and biochemical properties.In total 69 isolates were obtained, 23 of them were tolerated lithium at 100 ppm, 17 isolates showed growth upto 175 ppm lithium concentration, 28 isolates were appeared at 225ppm concentration of lithium and only one isolate was able to tolerate 400ppm lithium concentration. It was labelled as umerA.Morphological and biochemical studies showed, it was rod shaped, Gram positive and capable to produce IAA at 24±2 µgm/ml concentration. This strain was identified as *Bacillus velezensis* by using 16S rRNA analysis. This isolate was maintained and used for further experimentation.

Vignaradiate(L.) R. Wilczek(mung bean)*Sorghum vulgare*Pers.(sorghum), and*Triticumaestivum*L. (wheat) are three major agriculture crops in the world, especially in the arid and semi-arid regions and also in Pakistan.These were selected in the present study. A randomized complete block deign (RCBD) was used. Five lithium concentrations (0, 50, 100, 150 and 200 ppm) and the same set of five concentrations for bacterial inoculums treated seeds of crops were prepared by following standard germination protocol. Germination percentage, germination index, and seedling vigour index were measured. Their germination and seedling vigor was significantly reduced due to lithium stress. It wasfound that the lithium stress significantly reduced the germination percentage, germination index as well as the seedling vigor index as compared to the control plants across all the three species. While, the plants were exposed to simultaneous treatments of lithium and *Bacillus velezensis* showed a significant increase in the studied parameters as compared to thoseof lithium treated. Further, there was a significant and positive relationship between the seedling vigor index and germination percentage.

The pot experiments were conducted following the factorial experiment in a completely randomized design. There were six replicate pots per treatment and total of five treatments for lithium (0, 50, 100, 150 and 200 ppm which were labelled as T0, T1, T2, T3, T4) and five treatments for lithium and bacterial inoculations were applied and labelled as T0SB, T1SB, T2SB, T3SB, T4SB for each selected crop. The parameters for growth of plantswere measured. While the physiological parameters included the leaf area based maximum rate of photosynthesis, maximum stomatal conductance, rate of maximum transpiration using infra red gas analyzer were noted. The chlorophyll contents were measured using spectrophotometer. After final harvest, length of roots and shoots, fresh and dry mass of roots and shoots, and grain yield were estimated. Lithium concentration was measured by flame photometer in root, shoot and grains.

The results of present study provide novel finding that lithium can reduce the growth and physiological performance of mung bean but this reduction can be significantly prevented by applying the lithium resistant bacteria.Mung bean is highly sensitive to the lithium while sorghum is susceptible.The analyses demonstrate that lithium can cause significant reduction in growth and yield of sorghum, although reduction can be compensated by applying lithium resistant

bacteria. Wheat is moderately sensitive to the lithium, when applied in the soil. As the significant reduction in the growth and yield were observed. There was compensation for the reduction of growth and yield due to lithium stress by applying lithium resistant bacteria. Such data can be useful for lithium remediation in agricultural crops. This study is suitable to understand the impact of lithium on the crops and also the utilization of microbes to ameliorate the lithium stress. This research is useful to overcome lithium's toxicity in plants in eco friendly ways. It is helpful to establish simple, economically viable solution to control the lithium pollution. Detailed research is required to investigate lithium pollution implications for animals, plants and human.