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REVIEW ARTICLE

Impact of Waste Citrus Fruits Peel in Alleviation of Injurious Effects of Salinity in Mungbean for Enhanced Production

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ABSTRACT
Soil salinity is a major global concern in present era of climate change. Its implications on agricultural practices are continuously threatening global food security and nutrition. Mungbean have significant food value, economic, agricultural and pharmacological importance and an emerging functional food. But performance, survival and production of this crop is severely inhibited on saline soil. Application of agro-industrial waste exerts significant impact to alleviate adverse effects of salinity. Fruit peel waste that are one of the leading causes of environmental pollution, could be better utilized as natural source of bioactive compounds, plant growth nutrients and antioxidants as an alternative approach to enhance salinity tolerance in mungbean for stable yield production on salt affected soil.
Keywords: *Mungbean, Salinity stress, Citrus fruits peel, Salinity tolerance, Improved Production*

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INTRODUCTION

Mungbean is a short duration crop that is cultivated after harvesting of dry season crops such as wheat, lentil and mustard). It can fix atmospheric nitrogen and a good source of easily digestible protein, fiber, antioxidants and minerals. A small portion of fixed nitrogen is also utilized by the succeeding non-legume crops. Mungbean is a cheap source of protein, particularly, in the regions where meat is not available or affordable. This valuable crop has persistent civilization for 4,500 years ago as recorded from its historical background. However, the routes of migration and widespread cultivation have still ambiguity. Recent study reveals that the use of cutting-edge genomic techniques to map out the evolutionary trajectory of the mung bean [1]. This study utilized mungbean seeds from 3 seed banks as 1) The World Vegetable Center (Taiwan), 2) The Australian Diversity Panel, and 3) the Vavilov Institute of Plant Industry (Russia). Research carried out on evolution and expansion of mungbean explored a different path of cultivation and various factors that influence its expansion. Mung bean's unique trajectory has been shaped particularly by various farming practices and divergent climatic conditions not solely due to deliberate human cultivation choices. Beside this, evolution of mungbean was not exclusively driven by human activity via domestication. It was intricately intertwined with the mung bean's adaptation towards encountering diverse climatic conditions [1]. Studies on genetic evidences demonstrated that initially this crop spread from South Asia to Southeast Asia, and then to the Central Asia including Russia, Mongolia, Western China, Afghanistan, and Iran. Later on, the mungbean spread to the rest parts of China and Southeast Asia including Indonesia, Cambodia, Vietnam, Taiwan, Thailand, and the Philippines [1].
Mungbean is an important pulse crop in terms of food value, economic and pharmacological importance and an emerging functional food to treat human illnesses along with its beneficial role in biological nitrogen fixation and soil fertility [2, 3]. It is a good source of easily digestible protein, fiber, antioxidants, minerals and bioactive chemical compounds (secondary metabolites) [3]. Mungbean seeds can be

consumed as whole or split, as sprout, soup, daal or khichadi. This crop can be considered as an important component of balanced diet. But the average grain yield of mungbean in farmer's field is very low due to lack of quality seed, climate resilience and inappropriate agronomic management practices followed by the farmers. Beside this, establishment of this important crop and grain yield is also affected by sowing date due to variability in weather factors, particularly the rainfall patterns and its amount [4]. Hence, there is a gap between its demand and supply resulting in high selling prices.

SALINITY STRESS AND MUNGBEAN

Climate change has become a serious global problem. Its implications on agricultural practices are continuously threatening the global food security [5-7]. Several biotic and abiotic stress factors existing in the environment either individually or in combination exert deleterious effects on the morpho-physiological characteristics, and reproductive ability of the plants via altered cellular signaling and molecular mechanisms regulating plant growth and development. This further reduces the plasticity and adaptation of the crop plants to changing climates, which finally results in loss of quantity and quality of the produce. Among these factors, salinity stress is a major concern in current scenario of climate change that severely restricts performance and production of agricultural important crops including mungbean which is highly sensitive towards salinity [8, 9]. Soil area affected by salinity is increasing due to global warming, high temperatures, and rising sea levels. High soil salinity turns nearly about 6% (800 million ha) of worldwide fertile land into unarable land. Naturally, salt stress is the most important stress factor that leads to an imbalance in the Earth's climatic conditions. It also has destructive effects on plant growth, physiological and biochemical processes as well as molecular mechanisms regulating various cellular processes necessary for plant development, adaptability and survival under changing climatic conditions. Salt stress causes reduction of crop production in about 20% of irrigated land worldwide that results in annual losses of approximately $12 billion worldwide. Moreover, nearly 50% of the arable land will be lost due to salinity by the mid-twenty-first century [10].

Salinity in the soil causes ionic toxicity, osmotic stress and nutrients deficit in plants that adversely affects the root growth and reduces the ability of plants to absorb water and other essential nutrients from the soil [11, 12]. Accumulation of harmful ions such as sodium and chlorine in leaves under salinity stress, while disrupting the distribution of ions among plant tissues, has negative effects on the crop growth by disrupting other physiological processes such as chlorophyll stability, photosynthetic system efficiency, antioxidant enzyme activity, and leads to reduction in the plant height, dry weight, flower, fruit drop and economic yield reduction [13]. These effects cause delayed plants growth that ultimately leads to plants death. In addition, salt stress leads to membrane damage and stomatal closure, which results in reduced carbon dioxide uptake, hydrolase activity, and increased lipid peroxidation levels. These effects stimulate generation and accumulation of several reactive oxygen species (O^{2-}, H_2O_2, and OH^-) that further results in oxidative damage to the cell membranes, DNA, proteins, and lipids. Simultaneously, it causes accumulation of malondialdehyde (MDA), which causes disruption of various biochemical and metabolic processes in crop plants [14, 15].

PROMISING BASIS OF SALINITY TOLERANCE IN MUNGBEAN

Crops generally display diverse physiological, morphological, biochemical, and molecular responses under stressed conditions [16]. Mungbean has inherent intrinsic tolerance mechanisms against many stresses prevailing in the environment. Plant's antioxidant defense system is an effective strategy to reduce oxidative damage under saline environment. This includes enzymatic antioxidants (SOD, POD, CAT, APX, and GR) and non-enzymatic antioxidants (some low-molecular-weight compounds; flavonoids, carotenoid, AsA, or GSH). These antioxidants regulate different metabolic processes in cells and acting as cofactors for different enzymes that collectively affect plant growth and development under diverse climatic conditions [17]. The antioxidant defense system effectively eliminates the ROS and tries to maintain appropriate equilibrium within the cells. The intracellular ion homeostasis particularly, the K^+/Na^+ ratio, synthesis and accumulation of compatible solutes (proline and betaine) are two equally important strategies to contribute salt tolerance [14]. Beside this, various water and soil reclamation strategies have been recorded to manage soil salinity. However, identification or development of salt tolerant crop genotype is more efficient approach for enhanced production [18]. Intensive phenotypic diversification among regional mungbean accessions could be utilized as an invaluable genetic resource for genetic improvement of this valuable crop in the future. Recently, various bio-stimulants (plant growth regulators; PGRs, plant growth promoting microbes; PGPBs and AMF) have been reported that can effectively mitigate the adverse effects of salinity which could be applied as a cost-effective approach for improved crop production on saline soil [19, 20].

WASTE FRUITS PEEL MEDIATED SALT TOLERANCE

Application of agro-industrial waste as fruits peel exerts significant impact to alleviate adverse effects of salinity [21]. Fruit peels are the waste materials that are produced by fruit processing in various agro-industries. These wastes are considered excellent mediums for microbial spoilage, causing environmental pollution. Peels play a critical role in protecting fruit parenchyma from pathogenic microorganisms since they have antimicrobial properties and contain prominent levels of antioxidants. Many fruit wastes contained more phytochemicals and nutritional components than fruit pulp [22]. Recently, exploiting these wastes as a by-product for many industries has gained great interest because of the high quality of their products and their economic attractiveness.

Waste fruits peel is recognized as a rich source of phytochemicals (phenolic compounds, flavonoids), nutritional ingredients (proteins, vitamins, dietary fiber, essential amino acids, particularly tryptophan, and polyunsaturated fatty acids) and antioxidants having industrial, agricultural and pharmacological significance [23-25]. This waste can be efficiently used as a plant growth-promoting substance either for foliar or soil applications in ameliorating the negative impacts of salinity stress [26-28]. Waste citrus fruits peel constitutes enormous bio-active compounds that supports the growth of beneficial microbes either they have industrial significance or agricultural importance [24, 25]. Addition of waste citrus peels and beneficial microbes significantly helps in reducing salinity stress in plants by several mechanisms which favors healthy plant growth and development resulting in higher yield production and good quality of produce. Different agro-industrial wastes have been used for energy recovery, producing flavor and fragrance as food supplementation, cleaning supplies for household materials and as livestock feed [29, 30]. Beside these benefits, the fruit peel waste can be used as organic fertilizer to improve soil fertility that may results in higher yield production of crop plants under stressed conditions [28, 31-33]. In addition, citrus waste-based biofertilizer has powerful antibacterial characteristics and removes harmful heavy metals from soil because of its high pH and lignocellulose content [34]. Positive impacts of citrus fruits peel in enhancing salinity tolerance in plants are depicted in Figure 1. Therefore, the fruit peel waste that are one of the leading causes of environmental pollution, could be better utilized as natural source of plant growth nutrients and antioxidants as an alternative approach to generate or enhance salinity stress tolerance in plants for stable yield production on salt affected soil.

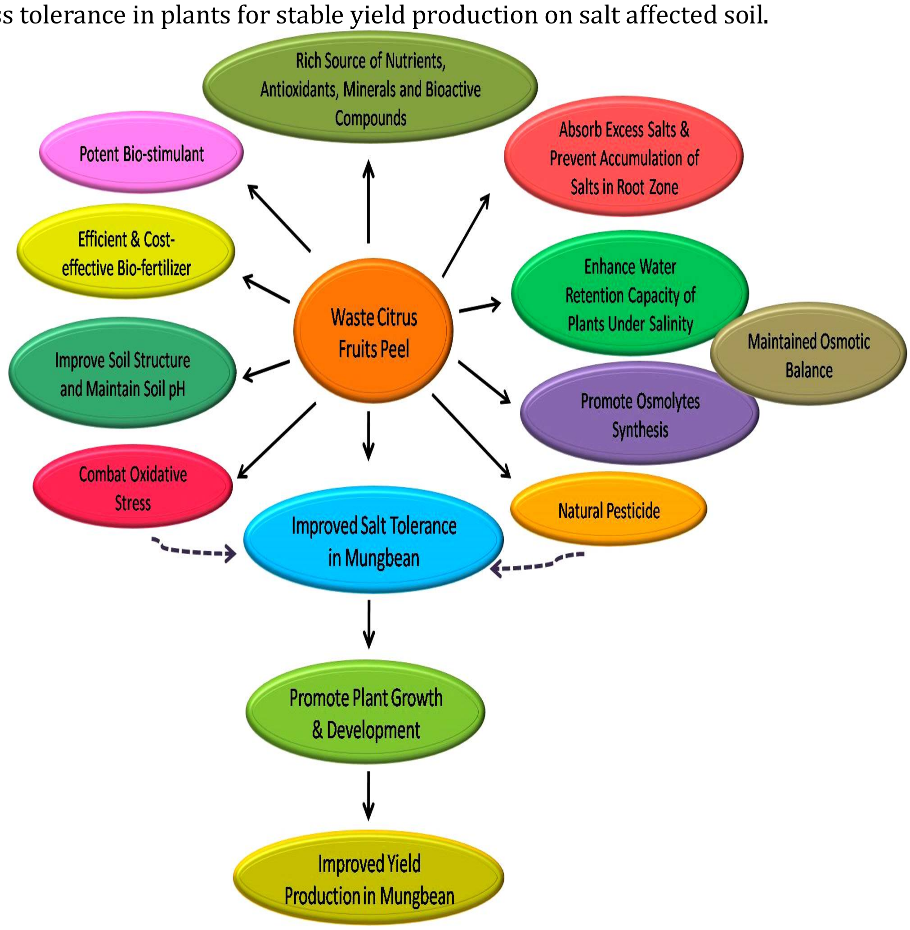

Figure 1: Positive impacts of waste citrus fruits peel in salt tolerance in mungbean.

CONCLUSIONS AND FUTURE ASPECTS

In current era of global climate change, salinity is one of the major abiotic stresses limiting agricultural productivity of almost all crops. Mungbean have unconditional importance in global food security as it provides essential dietary protein, carbohydrate, vitamins, and minerals, cheaply to the poorest of the poor. But production of this valuable crop is severely affected due to continuous increase in salinity of arable land (1-2% annually). Therefore, it seems very difficult to follow the existing management practices for saline soil to obtain higher grain yield. Climatic variations also emphasize the farmers to use mungbean mainly as a grain or green manure crop. Addition of waste citrus peels to the soil helps in growth of beneficial microbes. Application of waste citrus fruits peel either alone or along with good microbial species in root zone significantly helps in reducing salinity stress in plants by several mechanisms which favors healthy plant growth and development. Hence, waste citrus fruits peel could be more efficient and cost effective alternate to manage soil salinity and to enhance crop performance under salinity that ensures good quality of produce and improved yield production in salinity prone area.

CONFLICTS OF INTERESTS

The authors declare do not declare any conflict of interest.

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