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Analysis of Biological Parameters of Mung Bean Plant Nodulation under Different Soil Conditions

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Abstract: Mung bean is a very important crop in Uzbekistan in both socio-economic and nutritional terms. Uzbekistan the legumes are grown mostly in rain-fed areas of marginal lands where soil fertility and native rhizobial populations are low. Unfortunately, it is highly sensitive towards climate variability and environmental stress factors. Salinity stress is highly prevailing factor at global level which drastically limiting mungbean production. Mung bean production is often curtailed by various biotic and abiotic factors which significantly limit its yield and quality. The goal of our experiment was to observe the differences in the fertility of plants in different regions of Uzbekistan. For this, mung bean plants of the same variety were grown on soil samples from 12 regions for 40 days. The result is Fergana Djizzax and Andijan regions of Uzbekistan have the highest biometric parametres.

Keywords: legume, nodules, saline soil, arid soil, dry resistant, tolerant, salt lands, soil toxicity.

INTRODUCTION

Agriculture sector contributes towards one third share in global gross domestic products. However, with the increasing trend in human population, world's population has been estimated to rise upto 9.5 billion by 2050, leading to high food demand. Besides availability of limited fertile land, urbanisation, unexpected weather events connected to climate change, abiotic and biotic stresses are the major constraints for the production of several crops.

Legumes play a significant role in the transformation of the globalfood system as they provide a plant-based source of dietary proteins andother essential micronutrients. Furthermore, legumes' capacity to fix atmospheric nitrogen is crucial for the sustainability of agriculture. Legumes are of crucial importance for rural households inEthiopia as they cover almost thirteen percent of the cultivated area(Rashid, *et al*., 2010; CSA 2016). Legumes are an essential facet of Ethiopian subsistence farming serving as a source of protein and cash income(Rashid, *et al*., 2010). The most common pulses produced in Ethiopia include faba bean, haricot bean, grass pea, field pea, chickpea, lentils,and mung bean.

Mung bean (Vigna radiata (L.) Wilczek) is a widely cultivated crop on the Asian continent. It has good adaptability to tropical climate conditions and its grain has high nutritional value (Du*et al*., 2018; Yi-Shen, *et al*., 2018) The global mungbean cultivated area is approximately 7.3 million hectares with an average yield of 721 kg ha−1 (Nair and Schreinemachers, 2020). This crop has a strategic position in Asian countries for its nutritional security, being rich in carbohydrates, proteins, vitamins and minerals. In Pakistan, the total area under cultivation of mungbean is approximately 302,000 hectare with a production of 264,000 tonne (Economic Survey of Pakistan, 2021–2022).

Studies on microbial community of legume root nodules haveshown the presence of several non-rhizobial bacteria (NRB)genera (Leite, *et al*., 2009, 2017; Martínez-Hidalgo and Hirsch,2017; Hakim, *et al*., 2018). Until recently, it was thought thatlegume nodules were only inhabited by rhizobia, according tothe plant trait regarding host specificity. However, recent studieshave shown a different picture where nodules from several legume species have a great diversity of microorganisms (Aserse, *et al*., 2013; De Meyer, *et al*., 2015; Leite, *et al*., 2017; MartínezHidalgo and Hirsch, 2017; Trabelsi, *et al*., 2017; Cardoso, *et al*.,2018; Zhang, *et al*., 2018). Hence, the microbial community structure and the role of most NRB in the plant/rhizobia symbiotic relationship are still poorly understood. The evaluation of nodule microbial community composition is a potent tool which enables selecting beneficial microorganisms to improve plant development. Furthermore, this knowledge can assist in the development of multi-organism biological products aiming to increase grain yield. Several studies have focused on the possible benefits to cultivated plant by atmospheric N fixation (De Meyer, *et al*., 2015; Andrews and Andrews, 2017), biocontrol activity (Berg, *et al*., 2017), or plant growth promotion (Tariq, *et al*., 2014), among others.

Biofertilizers comprise of living or latent cells, which are applied either to soil, seed or seedlings for improving nutrients availability and uptake

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from soil (Fasusi, *et al*., 2021). Use of biofertilizers has currently emerged as cost effective and ecofriendly alternative than chemical-based fertilizers. Substantial progress has been achieved recently in development of effective biofertilizers for different crops. Microbes being phylogenetically diverse and multifaceted, interact with plants in different ways including symbiosis, parasitism, commensalism, amensalism and neutralism (Glick and Gamalaro, 2021). The growth of these microbes is dependent on plant photosynthesis and reciprocate by influencing plant growth, thereby collectively termed as plant microbiome (Wang, *et al*., 2008; Lebeis, *et al*., 2012; Klaus and Bulgarelli, 2015; Mu¨ller, *et al*., 2016; Zhang, *et al*., 2021).

Mung bean can adapt to a wide range of climatic conditions. The best environment is a tropical climate with temperatures ranging from 25 to 35 °C and with moderate precipitation between 400 and 550 mm, during its life cycle of 60–90 days [M.Singh, *et al*., 2017]. Mung bean is adaptable to various soil types and grows best on well-drained loamy to sandy loam soil. It cannot survive in alkaline and saline soil. The field should have adequate drainage and aeration. Soil quality is primarily important to support the activities of nitrogen-fixing bacteria which are harbored in the root nodules of mung bean forming a beneficiary symbiotic relationship [H.Arif, *et al*., 2014]. Applying well-composted farmyard manure is advised to enhance soil quality, increase the yield and enhance nutrient uptake. In addition to manure, the biocontrol agent *Trichoderma viridae* can be applied [M.Sood, *et al*., 2017]. Generally, a fertilizer mix containing nitrogen, phosphorus, and potassium is added to the soil before plowing. Sometimes, mung bean seeds can foster seed-borne fungal diseases, thus it is recommended to treat well-dried seeds with fungicides before sowing [M. Ayesha, *et al*., 2021]. It is also highly recommended to inoculate seeds with *Bradyrhizobium* strains and sometimes along with *Pseudomonas* strains which evidently promotes plant development and in turn increases the overall yield [V.O. Favero, *et al*., 2021].

Among the different diseases, anthracnose is a serious soil and seed-borne disease in mung beans caused by the hemibiotrophic fungal pathogen *Colletotrichum lindemuthianum* (Sacc. and Magn.) (*C. lindemuthianum*). The pathogen *C. lindemuthianum* affects severely to the mung bean and through its rapid spreading causes 20–100% yield loss (Singh, *et al*., 2022). The severity of the disease can aggressively spread to all parts of the plant (cotyledons, stem, leaves and pods), and it causes serious damage to the infected parts. The pathogen can also survive for a long term in the infected soil. This foliar disease occurrence is high in mung bean crop growing in high relative humidity and in impartial temperatures and cause maximum yield loss. Symptoms on the leaf shows pale brown lesions at the abaxial surface and spread to pods with depressed lesions. This disease develops black-red cankers on infected plant parts and become black ring with pink colored ooze in the centre on maturation.

All terrestrial plants are colonized by diverse, complex and interactive communities of microorganisms (Sasse, *et al*., 2018; Xiong, *et al*., 2021). The colonization of microbes on the plants can be either epiphytic, endophytic or rhizospheric (Rossmann, *et al*., 2017). The study of microbial communities inhabiting the diverse habitats and their collective contribution to plant growth development and protection has received intense interest over the last two decades. Various microorganisms present within the plant rhizosphere include procaryotic organisms i.e., bacteria and archaea, unicellular protozoa, multicellular eucaryotic nematodes and fungi, and viruses. Many of these microorganisms within the plant's microbiome play many vital roles in promoting the growth and development of agriculturally important crop plants (Bakker, *et al*., 2013; Bulgarelli, *et al*., 2013; Fasusi, *et al*., 2021). For screening of efficient beneficial microbial strains for use as biofertilizer, microorganisms isolated from the rhizosphere are screened for plant growth-promoting (PGP) traits along with effective . Various beneficial properties of PGP microbes for utilization as biofertilizer include decomposition of organic matter, enhancing nutrient availability, production of phytohormones and contribution towards mitigation of abiotic and biotic stresses (Lalitha, 2017; Sehrawat and Sindhu, 2019; Zhang, *et al*., 2021).

RESEARCH METHODOLOGY

The goal of our experiment was to observe the differences in the fertility of plants in different regions of Uzbekistan. For this, mung bean plants of the same variety were grown on soil samples from 12 regions for 40 days. The plants were placed in pots with 1 kg of soil and plant seeds were planted. "Durdona" mung bean variety was selected for the experiment. "Durdona" variety is a

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selection variety of the Research Institute of Cereals and Legumes in irrigated lands. Authors of the variety: Mannopova M, Siddikov R, Abdurakhimova Sh. Belongs to the Carneum group. Large-seeded, 1000 seeds weigh 520.0 g. The variety is tall, on average 66-75 cm. The height of the first pod on the stalk is 23-28 cm, suitable for mechanical harvesting. Vegetation period is 122 days on average. Average productivity: 36.6 s/ha. Resistant to drought and pod cracking. The protein content is 28.0%. Since 2011, it has been included in the State Register for planting on irrigated lands of our Republic. Mung bean seeds were soaked in water for 1 hour before planting, then 9-10 cm holes were dug in the pots and planted. Each pot contains 1 kg of medium moisture soil. Mung bean seeds were grown for 4 weeks at normal humidity after sowing.


Figure 1: Mung bean is growing in pots greenhouse conditions
Figure 2: Increase in root length mung bean seedlings

Table 1: Mung bean biometric parametres

Regions	pots	Length	Fresh weight	Dry weight
Fergana	1	25	1.2	0.6
	2	13	0.5	0.2
	3	19	0.4	0.2
Namangan	1	17	0.4	0.2
	2	12	0.2	0.1
	3	16	0.3	0.2
Sirdarya	1	27	1.8	0.8
	2	18	0.5	0.2
	3	17	0.5	0.1
Tashkent	1	24	1.2	0.5
	2	22	1.0	0.4
	3	18	0.7	0.3
Jizzax	1	23	0.7	0.3
	2	24	0.4	0.2
	3	21	0.6	0.3
Samarkand	1	24	0.5	0.2
	2	25	0.5	0.2
	3	25	0.5	0.3
Navoiy	1	18	0.4	0.2
	2	21	0.5	0.3
	3	19	0.4	0.2
Bukhara	1	19	0.3	0.1
	2	22	0.7	0.2
	3	17	0.3	0.1
Xorazm	1	15	0.3	0.2
	2	22	0.4	0.2
	3	32	0.7	0.2
Andijon	1	24	0.6	0.1

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	2	18	0.7	0.3
	3	17	0.5	0.2
Kashkadarya	1	22	0.5	0.1
	2	21	0.3	0.2
	3	19	0.4	0.2
Surxandarya	1	15	0.3	0.1
	2	27	0.5	0.1
	3	19	0.4	0.1

ANALYSIS AND RESULTS

After 4 weeks, the plants were removed from the pots and their biometric parameters were determined: plant height, root length, number of nodules, wet mass. After obtaining the biometric indicators, the soil where the plants were grown was taken and the amount of nutrients in the soil was analyzedand compared with the results of the preliminary analysis.

DISCUSSION

To our knowledge, salinity stress is highly prevailing factor at global level which drastically limiting mungbean production in Uzbekistan. The research aimed observe the differences in the fertility of plants in different regions of Uzbekistan.Our findings suggest that overall, all study participants had some limited understanding of fertility of plants and their importance growing of mung bean. One outstanding result is, Fergana Djizzax and Andijan regions of Uzbekistan have the highest biometric parametres.

CONCLUSION

Salinity stress drastically afected mung bean plants' growth, yield and ionic parameters under salinity stress. The results obtained from the experiment show that the "Durdona" mung bean variety was taller in the soils brought from the southern regions of our country than the plants in the soils brought from the rest of the regions. As the experiments lasted for 4 weeks, nodules were not formed on the plants. It was observed that the nodules appeared on the mung bean roots from the 5th week and unstressed conditions.

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