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STUDY OF SOIL AND AGRONOMIC TRAITS IN MUNGBEANGENOTYPES UNDER SALINE WATER IRRIGATION IN SEMI-ARID REGIONS OF HARYANA

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Abstract: Mungbean is an ecologically important legume, but its productivity is often affected by its susceptibility to salinity stress. To address this challenge, it is crucial to identify and screen varieties that demonstrate strong performance under saline conditions. This study, conducted during the *Kharif* 2022atCCSHAU, Hisar, aimed to evaluate sixteen mungbean varieties under saline irrigation (EC 5.0 dS/m). Seeds were sown on April 11, 2022, in a randomized block design with three replications. Results showed significant yield variations among genotypes. IPM02-3 (check) had the highest yield **(**4.84 q/ha), followed byPMS-9 (4.67 q/ha)**,** whilePMS-15 (2.73 q/ha) had the lowest. IPM02-3 (check) also exhibited the tallest plants (59.30 cm), longest pods (9.04 cm), most pods per plant (27.30), and highest seeds per pod (9.48)**.** The mean soil salinity **(**$EC_{1:2}$**)** at harvest was1.11 dS/m**.** Identifying salt-tolerant varieties likeIPM02-3 (check) can help in improving mung bean cultivation under saline conditions.

Keywords: Genotypes, Saline water, Seed yield, Yield attributes

INTRODUCTION

Pulses are a vital crop category, offering high-quality proteins that complement cereal-based diets, particularly for the country's predominantly vegetarian population (Kumar *et al*., 2022 and 2023). In India, the area under pulses was 28.9 million hectares during the 2022-23 period, yielding a total production of 26.06 million tonnes and an average yield of 902kg per hectare. Green gram (*Vigna radiata* (L.) is an important indigenous pulse crops of South and Southeast Asia. It is a rich source of protein, containing 24%, and adds essential variety to the cereal-based diets of low-income populations. As per scientific data, its 100 g weight, provides 94 mg of vitamin A, 7.3 mg of iron, 124 mg of calcium, 3 mg of zinc, and 549 mg of folate (Kumar *et al*., 2023). In addition to being a valuable protein source for humans, green gram enhances soil fertility through its ability to fix atmospheric nitrogen. Its short growth cycle also makes it an excellent fit within various cropping systems. Various biotic and abiotic factors affect the mungbean production potential, with salt stress being a major challenge that poses serious threats to its productivity. To address this challenge, it is crucial to screen and identify varieties that demonstrate strong performance under saline conditions.

Salinity-induced soil degradation is a significant obstacle to the effective utilization of land and water resources. This challenge is not confined to India but is a global issue, with approximately 950 million hectares of land worldwide affected by salt-impacted soils, including 397 million hectares of saline soils and 434 million hectares of sodic soils. In India, 6.74 million hectares are affected, with 3.78 million hectares classified as sodic and 2.96 million hectares as saline. (Mandal, *et al*., 2011). Due to water scarcity and unpredictable rainfall, farmers often resort to irrigate crops with poor-quality water. As water resources continue to deplete, this challenge is likely to intensify. Therefore, it is crucial to develop strategies for effectively using poor-quality water in crop production (Rani *et al*., 2020). Among the various scientific approaches to utilizing poor-quality water for crop production, identifying genotypes that perform well under challenging conditions is of paramount importance. Evaluating varietal performance and recommending suitable varieties for specific regions is a straightforward and effective strategy for ensuring successful crop production in these challenging areas. This study focuses on the varietal evaluation of mungbean to achieve objective.

MATERIALS AND METHODS

The experiment was conducted at during *kharif* 2022 at Soil Science Research Farm area, Chaudhary Charan Singh Haryana Agricultural University (CCSHAU), Hisar, India. It is situated in the sub-tropics at 29º 10´N latitude, 75 º 46´E longitudes at an elevation of 215.2 meters above mean sea level.

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Figure 1 shows the mean monthly data during the cropping season. The sixteengenotypes were investigated to compare and evaluate the tolerance against salinity stress. Seeds of sixteen mung bean genotypes *i.e* PMS-14, PMS-13, PMS-10, PMD-9, PMS-12, Pusa Vishal (check), PMD-8, PMS-9, Virat (IPM205-7)-check, PMD-10, Pusa-9531 (check), PMD-7, PMS-15, PMS-11, IPM02-3 (check), and PMS-8 were sown on 11-04-2022 in randomized block design with three replications. All the packages and practices of mung bean crop were followed according to the recommendations of CCSHAU. The fertilizer dose consists of nitrogen, phosphorus and potassium application were applied *via* urea, DAP and MOP. All fertilizers were applied as basal*i.e.* at the time of sowing. Mungbean seed were sown at 25x10 cm spacing. Two post sowing irrigation of saline water with ECiw 5.0 dS/m were applied. The crop was harvested on 21-06-2022. Data collected during the study were statistically analyzed by using OPSTAT software (Sheoran *et al*., 1998), developed by Agricultural Statistics Department of CCS Haryana Agricultural University. All significance tests were conducted at the 5% level of significance.

RESULTS AND DISCUSSION

Plant population: The population of sixteen genotypes ranged from 8 to 11 plants per meter row length at maturity. The results (Table 1) indicated that plant population was not significantly affected by saline water irrigation. Although some numerical variations were observed, all genotypes maintained a similar plant count at maturity, suggesting that plant population remains relatively unaffected by salinity stress. The further explanation is that, mungbean were sown after applying a good quality irrigation water so the germination was not affected, which help in maintaining a uniform plant stand.

Plant height: The plant height at maturity was not significantly affected by saline water application (Table 1). The height ranged from 47.2 cm to 59.3 cm, with the tallest plant observed in genotype IPM02-3 (59.3 cm) and the shortest in genotype PMD-9 (47.2 cm). Although variations in plant height were exhibited among the genotypes, they were not statistically significant, indicating similar growth responses to saline conditions. This uniformity suggests that all genotypes adapted in a comparable manner to the saline environment in terms of vertical growth. The results are in line of work with Sehrawat *et al*., 2015a and Sehrawat *et al*., 2015b.

Days to flowering: The number of days taken by mungbean to reach flowering under saline water irrigation ranged from 35 to 38 days (Table 1). These variations depend on genotype, salinity levels, and environmental conditions. Generally, saline water stress can delay flowering due to osmotic stress, ion toxicity, and reduced nutrient uptake. Among the sixteen genotypes tested, numerical variations were observed in days to flowering. Although results did not vary significantly but numerical variations may be exhibited. The genotype that showed the maximum delay may be the most sensitive to salinity, while the one that flowered earliest may exhibit greater tolerance. Here, genotypes PMS-13, Pusa 9531 (check), PMD-7, and PMS-15 took a comparatively longer duration (38 days) to flower, indicating similar sensitivity to salt stress. In contrast, PMS-9, IPM02-3 (check), and PMS-8 flowered earlier (35 days), suggesting a slight tolerance to salinity. The findings are accordance with that of Sewhag *et al*., 2024.

Days to maturity: The maturity duration (Table 1) varied significantly among different genotypes, ranging from 55 to 59 days. In general, increased soil salinity accelerates the maturation process compared to non-stress conditions. However, maturity duration also depends on genotype and other environmental factors. Among the tested genotypes, IPM02-3 (check) and PMS-9matured the earliest, taking55 days, while Pusa 9531 (check), PMD-7, and PMS-15 took the longest, requiring 59 days to reach maturity.

Table 1. Growth and phenology of different mungbean varieties undersaline water irrigation

Genotypes	Plant pop/mrl	Plant height at maturity (cm)	Days to flowering	Days to maturity
PMS-14	9.67	53.2	38	58
PMS-13	10.7	47.9	37	57
PMS-10	10.7	52.0	34	56
PMD-9	9.67	47.2	37	58
PMS-12	9.67	49.4	37	57
Pusa Vishal (check)	8.67	51.3	37	57
PMD-8	8.33	50.6	37	56
PMS-9	8.33	47.8	35	55
Virat (IPM205-7)-check	8.33	59.2	36	56
PMD-10	9.33	48.9	37	57
Pusa 9531 (check)	9.33	49.3	38	59
PMD-7	9.67	51.7	38	59
PMS-15	9.67	49.0	38	59

PMS-11	8.67	52.6	37	57
IPM02-3 (check)	10.7	59.3	35	55
PMS-8	9.33	54.2	35	56
C.D. (p=0.05)	**NS**	**NS**	**NS**	**2.73**

Pods per plant: The number of pods per plant in mungbean genotypes varied significantly under saline water irrigation (Table 2), indicating that some genotypes perform better in pod formation under salt stress. The number of pods ranged from 18.0 to 27.3, with IPM02 (check) recording the highest (27.3 pods/plant) and PMS-15 the lowest (18.0 pods/plant). This variation may reflect an adaptive response to saline conditions, enabling certain genotypes to maintain pod production despite the stress. This trait plays a crucial role in determining the overall seed production capacity of the genotypes. Katiyar *et al.*, (2019) also reported the similar findings in mungbean.

Seeds per pod: The number of seeds per pod in mungbean genotypes varied significantly under salt stress, ranging from 8.03 in Pusa 9531 (check) to 9.48 in IPM02-3 (check). This trait is a crucial yield-determining factor, and the observed variations suggest that some genotypes are better adapted to saline conditions by producing a higher number of seeds per pod, while others are more susceptible to stress. The highest seed count recorded in IPM02-3 (check) (9.48 seeds per pod) suggests ahigher tolerance to salinity, possibly due to biochemical and physiological mechanisms such asion regulation, osmotic adjustment, and improved nutrient uptake (Ahmed, 2009). These mechanisms enable better reproductive success under stress by maintaining cellular balance and sustaining metabolic functions. In contrast, Pusa 9531 (check), which produced the lowest seed count (8.03 seeds per pod), appears to be more sensitive to salt stress. The reduced seed set could be attributed to impaired fertilization, reduced assimilate supply, or disruptions in hormonal signaling caused by salinity.

100 seed weight: The weight of 100 seeds varied from 3.79 g (PMS-15) to 4.44 g (IPM02-3 check), demonstrating significant variation under salt stress conditions (Table 2). This yield-related trait indicates that genotypes respond differently to salinity, with some maintaining heavier seeds than others, reflecting their varying degrees of tolerance. Among the tested genotypes, IPM02-3 (check) recorded the highest seed weight (4.44 g), suggesting it possesses adaptive mechanisms that enhance tolerance to saline water, thereby supporting better seed development in terms of both size and quantity. In contrast, genotypes with lower seed weight may have a reduced ability to withstand salt stress, leading to diminished seed size. These findings align with the research of Ahmed (2009) and Katiyar et al. (2019), which also highlight the role of salt tolerance mechanisms in maintaining seed weight under stress conditions.

Pod length: Pod length in mungbean varied significantly depending on the genotype's tolerance to salt stress (Table 2), ranging from7.67 cm (PMS-15) to 9.04 cm (IPM02-3). Higher-yielding genotypes tended to exhibit longer pod lengths compared to those with shorter pods, suggesting that this trait plays a crucial role in overall productivity. Similar to other yield-attributing traits—such as pods per plant, seeds per pod, and 100-seed weight - pod length also showed significant variation under saline conditions. This highlights the differential impact of saline water irrigation on pod development, reflecting the genotypic differences in salinity tolerance. Similar findings were reported by Sherawat *et al.*, 2015a and 2015b.

Seed yield: Saline water irrigation significantly impacted the seed yield of the sixteen tested mungbean genotypes, reflecting their varying abilities to reproduce and perform under stress conditions (Table 2). Among them, IPM02-3 check recorded the highest seed yield (4.84 q/ha), demonstrating its resilience and effective adaptation mechanisms to salinity stress. This higher yield can be attributed to the cumulative effect of multiple yield-attributing traits, which also showed superior values in salt-tolerant genotypes. Their ability to maintain reproductive efficiency and overall plant health despite saline conditions contributes to their enhanced performance. In contrast, PMS-15 and Pusa 9531 (check) exhibited lower seed yields, primarily due to reduced performance in key yield traits such as pods per plant, pod length, and 100-seed weight. The positive correlation between higher seed yield and favorable yield-attributing traits underscores their importance in mitigating the adverse effects of salinity stress. Genotypes with greater pod counts and higher seed weights are better equipped to sustain productivity, highlighting the role of effective stress tolerance mechanisms in achieving optimal yields under saline conditions. These results are in accordance with the findings of Sehrawat *et al.*, 2019 and Somta P & Srinives P, 2007.

Table 2. Yield and yield attributes of different mungbean genotypes under saline water irrigation

Genotypes	**Pods/plant**	**Seeds/pod**	**100 seed weight (g)**	**Pod length (cm)**	**Seed yield (q/ha)**
PMS-14	19.3	8.67	3.95	8.05	2.97

PMS-13	21.0	9.31	3.96	8.19	3.06
PMS-10	24.8	9.33	4.41	8.82	4.45
PMD-9	21.0	9.04	4.07	8.22	3.20
PMS-12	21.6	9.04	4.21	8.33	3.57
Pusa Vishal (check)	22.2	9.11	4.26	8.36	3.62
PMD-8	21.4	9.03	4.15	8.25	3.25
PMS-9	25.3	9.44	4.43	8.86	4.67
Virat (IPM205-7)-check	24.0	9.22	4.33	8.53	4.04
PMD-10	22.7	9.19	4.13	8.41	3.87
Pusa 9531 (check)	19.3	8.03	3.84	7.74	2.77
PMD-7	18.2	8.67	3.84	8.04	2.82
PMS-15	18.0	8.33	3.79	7.67	2.73
PMS-11	22.2	9.30	4.28	8.35	3.65
IPM02-3 (check)	27.3	9.48	4.44	9.04	4.84
PMS-8	24.6	9.26	4.38	8.54	4.26
C.D. (p=0.05)	**5.66**	**1.04**	**0.32**	**0.88**	**0.663**

Soil properties: The various soil properties, including electrical conductivity (EC), pH, and available nitrogen, phosphorus, and potassium, were not significantly affected by different genotypes under saline conditions (Table 3). After the harvest of mungbean, the soil's electrical conductivity (1:2) ranged from 0.86 to 1.44 dS/m, while the pH varied between 8.01 and 8.17. The available nitrogen content in the soil ranged from 177.5 to 181.5 kg/ha, available phosphorus from 20.02 to 21.78 kg/ha, and available potassium from 311 to 318.54 kg/ha. Although the variations in soil properties among genotypes were statistically insignificant, minor numerical differences were observed.

Table 3. Soil properties under different mungbean varieties irrigated with saline water

S. No	Genotypes	EC	pH	Available N	Available P	Available K
1	PMS-14	1.31	8.11	180.2	21.78	312.28
2	PMS-13	0.92	8.14	179.5	21.08	315.64
3	PMS-10	0.88	8.09	180.7	21.05	316.4
4	PMD-9	1.24	8.11	180.1	21.15	314.57
5	PMS-12	1.21	8.20	178.6	20.41	312.6
6	Pusa Vishal (check)	1.09	8.11	177.5	20.02	311.00
7	PMD-8	1.19	8.01	179.42	20.89	316.55
8	PMS-9	0.91	8.03	180.3	20.74	317.67
9	Virat (IPM205-7)-check	1.01	8.08	179.6	20.38	313.27
10	PMD-10	1.06	8.15	178.6	20.67	315.68
11	Pusa 9531 (check)	1.41	8.12	180.5	20.19	312.55
12	PMD-7	1.35	8.01	181.0	20.76	314.87
13	PMS-15	1.44	8.03	179.2	20.07	316.66
14	PMS-11	0.98	8.11	180.5	21.23	316.45
15	IPM02-3 (check)	0.86	8.15	181.5	21.31	318.54
16	PMS-8	0.95	8.17	181.2	21.24	316.24
	C.D. (p=0.05)	NS	NS	NS	NS	NS

CONCLUSION

Based on the results, it is concluded that among the sixteen tested genotypes under saline water conditions, IPM02-3 exhibited the best performance in terms of yield attributes and seed yield, followed by PMS-9, while the lowest seed yield was recorded for the PMS-15 genotype. In the sandy loam regions of Haryana, where saline irrigation water has an EC of 5 dS/m, the mungbean genotype IPM02-3 check can achieve a yield of 4.84 q/ha. Additionally, exploring new techniques and strategies to enhance pulse production under stress conditions remains crucial.

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