Mysore J. Agric. Sci., 56 (3) : 112-122 (2022)

Comparative Efficacy of Farmyard Manure and Vermicompost on Reproductive Potential of Lucerne (*Medicago sativa* L. cv. Ek Sali) Grown under NaCl Stress

JAHANGIRR AHMAD MAGRAY AND D. P. SHARMA
Department of Botany, Government Model Science College, Jiwaji University, Gwalior - 474 002
e-Mail : magray420@gmail.com

AUTHORS CONTRIBUTION

JAHANGIRR AHMAD MAGRAY & D. P. SHARMA :
Both the authors have contributed to designing, acquisition, analysis, interpretation of data, drafting the article and revising it critically

Corresponding Author:
JAHANGIRR AHMAD MAGRAY
Department of Botany, Government Model Science College, Jiwaji University, Gwalior

Received : July 2022
Accepted : August 2022

ABSTRACT

Salt stress is one of the serious abiotic factors endangering global agricultural output, and it is expected to worsen as a result of climate change. The purpose of this study is to mitigate the impact of salt stress and improve the reproductive capacity of lucerne by using farmyard manure (FYM) and vermicompost (VC), the two popular organic fertilizers. Lucerne seeds were planted in a completely randomized design (CRD) in pots containing soil supplemented separately with varied quantities (5, 10, 15, 20 and 25 per cent w/w) of FYM and VC. At 30th day after germination (DAG) when the plants had achieved enough strength to endure the stress, they were treated with 0, 10, 20, 50, 100, 200 and 500 mM of NaCl solutions for 45 days. Plants were harvested at 90th day after germination and the number of inflorescences / plant (NI), number of seeds / plant (NS) and seed yield g / plant (SY) were recorded. The data revealed that there was an increase in NI, NS and SY in both the FYM and VC soil amendments with lower doses of 0, 10, 20 and 50mM salt. The plants failed to survive at 500mM NaCl and perished after very first application of the salt. For FYM fertilization, the peaks 76 / plant, 3481 / plant and 10.54 g/plant, respectively of NI, NS and SY were observed at 50mM NaCl with 15 per cent FYM whereas the peaks of 68 / plant, 3208 / plant and 9.71g / plant of NI, NS and SY were observed at the same level of NaCl (50 mM) with 15 per cent VC. Comparatively, the FYM was found to be more effective in enhancing the seed yield than VC. The progeny seeds (R_1) obtained from the plants raised on the soil amended with FYM and VC and treated with various levels of NaCl revealed their germination in the range of 81.67 ± 6.02 to 91.33 ± 1.52 per cent against the 83.33±3.05 per cent of control (R_0) whereas, the radicle length ranged from 3.6 ± 0.30 to 4.2 ± 0.36cm without showing any statistical difference over the radicle length (3.84 ± 0.32cm) of control. It can be inferred from our data that there is a wide range of salt tolerance in the germplasm of this lucerne cultivar that may be used in breeding to increase salt tolerance in its salt-sensitive species.

Keywords : Salinity stress, Reproductive potential of lucerne, Seed yield, Farmyard manure, Vermicompost, Germination

SOIL salinity is a major abiotic stress seriously threatening the plant growth and food security (Roy *et al.*, 2011). Several workers have raised the issue that in future days, salt affected agriculture will expand as a consequence of both the climate change and poor land management (Daliakopoulos *et al.*, 2016). Salinity affects 20 per cent of global cultivable land and further increasing due to climate change and anthropogenic activities (Arora and Dagar, 2019). Salinity is expected to affect more than half of all arable areas by the year 2050 (Flowers and Yeo, 1995). Salinity depletes the natural resources of the soil, endangers plant development and affects the agricultural productivity (Ren *et al.*, 2019 and Zörb *et al.*, 2019). Salinity is a key concern causing the decreased yield in commercially important plants (Ivushkin *et al.*, 2019). It may interfere with pollination, reducing seed-set and grain output (Mass, 1986). Many crops, including wheat, barley, bean, rice, and cotton, have experienced yield reductions due to salt stress (Keating and Fisher, 1985). Salinity impairs the seedling establishment, plant growth and causes poor reproductive development consequently decreasing the yield and product quality (Turan *et al*., 2009 and Ahmad *et al.,* 2013). Salinity alters the cell structure, membrane functions and damages the photosynthetic machinery. It increases the reactive oxygen species (ROS) production, decreases the enzymatic activity and limits the growth and yield of crops (Wang *et al*. 2001; Pasapula *et al*., 2011 and Hasanuzzaman *et al*., 2014). Tolerance of plant to salinity is a polygenic function governed by many genetic factors (Arzaniand Asharaf, 2016). Halophytes are naturally adopted to high salinity which can grow and reproduce under saline conditions (Flowers and Clomer, 2008) but most of the halophytes are unsuitable as food or feed with their poor yields (Shabala, 2013). Most of the flowering plants reproduce through their seeds. Seed and its germination is the first stage in the life history of a plant affecting the ecesis (Pathak *et al*., 1978). Seed health is affected by several factors *viz*. plant genotype, nutrient supply and abiotic stress. Seed health is directly related to seed germination capacity. Seed weight is a good indicator of seed health. Thus, the number of seeds produced by a plant and their germination determine the reproductive potential of plants.

Chemical amendments of gypsum and organic materials have been used to reduce salinity in crop lands in many countries (Amezketa, 2006). The growing interest in mitigating the global soil salinity threat to several crop plants, drew our attention to carry out this research work to diminish salt stress using two different manures *i.e.,* farmyard manure (FYM) and vermicompost (VC). These organic manures improves the soil aeration and water holding capacity (Hillel, 1980 and Sanchez, 1990) and promote microorganisms in the soil that make plant nutrients easily available, resulting in increased yield and improved plant quality (Choudhary, 1995). Furthermore, organic matter influences the chemical behaviour of various metals in soils through its active groups (flavonic and humic acids), which have the capacity to retain metals in complex and chelate forms. Organic manure contributes directly to plant growth by providing all essential macro and micronutrients in accessible forms during mineralization, hence increasing the physical and physiological qualities of soils. In this study an attempt was made to find out the possible proportions of these manures in soil that will provide a better reproductive potential in lucerne.

Lucerne (*Medicago sativa*) also called as alfalfa is cultivated across all areas of globe as a green fodder for cattle, especially milk yielding domestic animals *viz*., Cows, buffaloes and others. Plant is best known for its high nutritive value and digestibility. This paper deals with the reproductive development of lucerne (*Medicago sativa* L. cv. Ek Sali) under different levels of NaCl when grown on the soil amended with different levels of farmyard manure (FYM) and vermicompost (VC) the two organic fertilizers.

Our hypothesis was that amendment of soil with FYM and VC in adjunction with salinity doses could minimize the salt stress and improve reproductive potential of lucerne.

Material and Methods

Experimental Design, Preparation of Pots and Seed Sowing

This experiment was carried out at Government Model Science College, Gwalior, Madhya Pradesh, India ($26^0 11' 38''$N and $78^0 10' 23''$E) during Winter season of 2020-21. The soil used in experiment was dug out from the college campus after removing the litter and the 10cm of top layer. The pebbles were separated and the crumbs were broken down. The soil was passed through 0.5cm sieve. Experiment was comprised of three different sets: 1) 5 sets of soils each amended and thoroughly mixed with 5, 10, 15, 20 and 25 per cent Farmyard manure (w/w), 2) 5 sets of the soils amended with 5, 10, 15, 20 and 25 per cent Vermicompost (w/w), 3) Control of 20 pots without adding any manure. Black polythene bags of 16" × 12" size were taken and each was filled with 3.5 kg of soil amended with respective ratios of FYM and VC. Pots were positioned in a completely random pattern

(CRD) in open lawn of the college. Soil was irrigated with 100ml of distilled water before seed sowing. Seeds of Ek Sali, a popular cultivar of lucerne (*Medicago sativa* L.) marketed by Gujarat based company (Narayani seeds of Shah Bhupendra Kumar Ramniklal, Ahmedabad) in India, were procured from the company outlet of old Delhi seed market and were sown 0.5 cm deep over a week time between 21st-27th December of 2020.

After the germination, plants were irrigated with distilled water on alternate day for 30 days. Seven doses of 0, 10, 20, 50, 100, 200 and 500mM NaCl were selected and three replicates were taken for each salt dose. Each salt dose was dissolved into 100ml distilled water and the salt treatment was initiated 30 days after germination (DAG) with minimal 2mM NaCl dose when the plants were strong enough to endure salt stress and progressively increased over two weeks until it achieved the desired salt concentrations. The plants were irrigated for 45 days with the respective salt solutions three times a week and also irrigated on each alternate day with distilled water to remove the excess amount of salt accumulated by successive doses while control was irrigated with distilled water only. The plants were harvested at the end of March (90 DAG Approx.). The appropriate ripe and dried pods were removed from plants in several pickings and seeds were collected in a glass pertri-plate of 6cm size by hand-breaking the pods.

The reproductive potential of lucerne was studied by recording the number of inflorescences/plant (NI), Number of seeds/plant (NS) and Seed yield (g)/plant (SY). Seed weight was measured by using single pan electronic balance. The number of seeds produced by a plant was determined by taking the weight of 1000 seeds randomly selected then calculating the total number of seeds on proportionate basis of total seed weight for each salinity treatment and the soil amendment.

Seed Germination

The germination responses of progeny seeds (R_1) were compared to the control (R_0) seeds by the standard protocol of ISTA (1985). The germination test was performed at room temperature (34.3±5.2^{0}C). Lots of 100 seeds were taken in three replicates for each dose of salinity and each soil amendment type and were placed in 150×10 mm sized petri-plates on double layer of Whatman filter paper No. 1 duly moistened with 10ml of distilled water on 1st and 5th day. Final germination percentage was calculated and the length of radicle was measured at nine days after planting.

Statistical Analysis

The data of reproductive potential *viz.,* NI, NS and SY and germination obtained were expressed in terms of their mean values and were tested for analysis of variance (ANOVA) by using SPSS software version 24. The Duncan's multiple range tests were used to establish the significance at $P<0.01$.

Results and Discussion

Number of Inflorescen ces (NI)

Reproductive potential of lucerne (*Medicago sativa* L. cv. Ek Sali) under various levels of salinity when grown on the soil amended with farmyard manure (FYM) is shown in the Table 1. Data reveals that the number of inflorescences (NI) were successively increased with the increasing doses of NaCl up to 50mM then started to decrease with most of the FYM amendments. For 5, 10, 15 and 20 per cent FYM soil amendments, the highest number (58, 68, 76 and 72/ plant) of inflorescences were recorded at 50mM salinity. The numbers of inflorescences (68 and 76/ plant) obtained under 50mM salinity in the plants grown with 10 and 15 per cent FYM significantly ($P<0.01$) increased over the control (40/plant). The overall peak (76/plant) of NI was found at 50mM NaCl with 15 per cent FYM amongst all the salt treatments and for all the FYM amendments. 500mM dose of NaCl was found to be lethal and plant failed to survive after very first application of salt dose in all formulations of FYM. The data recorded in Table 2 reveals the reproductive potential of lucerne under various levels of salt stress when grown on the soil amended with vermicompost (VC). Data reveals that there was a successive increase in the number of inflorescences/

TABLE 1

Reproductive potential of lucerne (*Medicagosativa* L. cv. Ek Sali) under NaCl stress with FYM as soil amendment

NaCl (mM)	Farmyard Manure														
	5 %			10 %			15 %			20 %			25 %		
	NI	NS	SY (g)	NI	NS	SY (g)	NI	NS	SY (g)	NI	NS	SY (g)	NI	NS	SY (g)
Control	40 [a]	2090 [a]	6.33 [a]	40 [a]	2090 [a]	6.33 [a]	40 [a]	2090 [a]	6.33 [a]	40 [a]	2090 [a]	6.33 [a]	40 [a]	2090 [a]	6.33 [a]
0	50 [a]	2483 [ab]	7.52 [ab]	53 [ab]	2527 [abc]	7.72 [abc]	55 [ab]	2713 [b]	8.22 [b]	55 [a]	2699 [bc]	8.17 [bc]	52 [a]	2583 [bc]	7.82 [bc]
10	52 [a]	2696 [b]	8.17 [b]	56 [ab]	2816 [bc]	8.52 [bc]	60 [ab]	2879 [bc]	8.72 [bc]	60 [a]	2721 [bc]	8.24 [bc]	56 [a]	2680 [bcd]	8.11 [bcd]
20	58 [a]	2840 [b]	8.6 [b]	62 [ab]	3021 [cd]	9.15 [cd]	65 [ab]	3174 [cd]	9.61 [cd]	63 [a]	3131 [cd]	9.48 [cd]	60 [a]	3101 [d]	9.39 [d]
50	58 [a]	2800 [b]	8.47 [b]	68 [b]	3344 [d]	10.13 [d]	76 [b]	3481 [d]	10.54 [d]	72 [a]	3397 [d]	10.29 [d]	58 [a]	3000 [cd]	9.08 [cd]
100	58 [a]	2704 [b]	8.19 [b]	60 [ab]	2771 [bc]	8.39 [bc]	65 [ab]	2848 [bc]	8.63 [bc]	61 [a]	2707 [bc]	8.23 [bc]	57 [a]	2541 [b]	7.7 [b]
200	49 [a]	2384 [ab]	7.22 [ab]	50 [ab]	2438 [ab]	7.38 [ab]	53 [ab]	2602 [b]	7.88 [b]	51 [a]	2481 [ab]	7.48 [ab]	48 [a]	2419 [ab]	7.32 [ab]
500	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L

NI: Number of inflorescence per plant; NS: Number of seeds per plant; SY: Seed yield (g) per plant; L= Lethal, FYM= Farmyard manure
Value showing dissimilar letters are significant at P<0.01

TABLE 2

Reproductive potential of lucerne (*Medicago sativa* L. cv. Ek Sali) under NaCl stress and grown on soil amended with VC

NaCl (mM)	Vermic Compost														
	5 %			10 %			15 %			20 %			25 %		
	NI	NS	SY (g)	NI	NS	SY (g)	NI	NS	SY (g)	NI	NS	SY (g)	NI	NS	SY (g)
Control	40 [a]	2090 [a]	6.33 [a]	40 [a]	2090 [a]	6.33 [a]	40 [a]	2090 [a]	6.33 [a]	40 [a]	2090 [a]	6.33 [a]	40 [a]	2090 [a]	6.33 [a]
0	47 [a]	2206 [a]	6.64 [ab]	49 [a]	2284 [ab]	6.97 [ab]	51 [ab]	2407 [ab]	7.29 [ab]	50 [a]	2290 [ab]	6.93 [ab]	44 [a]	2165 [a]	6.56 [a]
10	47 [a]	2448 [a]	7.41 [ab]	52 [a]	2593 [b]	7.85 [b]	55 [ab]	2710 [bc]	8.21 [bc]	50 [a]	2612 [bcd]	7.91 [bcd]	50 [a]	2526 [ab]	7.65 [ab]
20	55 [a]	2640 [a]	7.99 [b]	56 [a]	2694 [b]	8.16 [b]	57 [ab]	3009 [cd]	9.11 [cd]	54 [a]	2894 [cd]	8.76 [cd]	53 [a]	2762 [b]	8.36 [b]
50	53 [a]	2600 [a]	7.86 [ab]	52 [a]	2636 [b]	7.97 [b]	68 [b]	3208 [d]	9.71 [d]	57 [a]	3010 [d]	9.12 [d]	56 [a]	2919 [b]	8.83 [b]
100	49 [a]	2557 [a]	7.74 [ab]	51 [a]	2631 [b]	7.97 [b]	53 [ab]	2698 [bc]	8.17 [bc]	53 [a]	2478 [abc]	7.5 [abc]	51 [a]	2294 [a]	6.95 [a]
200	43 [a]	2192 [a]	6.61 [ab]	46 [a]	2304 [ab]	6.98 [ab]	47 [ab]	2358 [ab]	7.14 [ab]	44 [a]	2206 [ab]	6.68 [ab]	42 [a]	2117 [a]	6.41 [a]
500	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L

NI: Number of inflorescence per plant; NS: Number of seeds per plant; SY: Seed yield (g) per plant; L= Lethal, FYM= Farmyard manure
Value showing dissimilar letters are significant at P<0.01

plant with increasing doses of NaCl up to 20mM salt in the plants raised with 5 and 10 per cent VC additions whereas, it was found to be increased up to 50mM NaCl for 15, 20 and 25 per cent VC amendments then started to decline. However, there was no significant (P<0.01) difference statistically found between the treatments and the control except the peak (68/plant) which was recorded at 50mM salinity and 15 per cent VC amendment. The dose of 500mM was found to be lethal for all the VC amendments.

Number of Seeds/Plant (NS)

The Table 1 reveals that for all the FYM soil amendments the number of seeds/plant (NS) were also increased with various levels of salinity when compared to the control. For 5 and 25 per cent FYM soil amendments, highest number (2840 and 3101/plant) of seeds with significant increase (P<0.01) over the control were recorded at 20mM NaCl. In other cases (10, 15 and 20 per cent) of FYM amendments, highest number (3344, 3481 and 3397/plant) of seeds with significant increase (P<0.01) over the control were produced at 50mM NaCl. The overall peak (3481/plant) of number of seeds was recorded at 50mM of salinity that for 15 per cent FYM amongst all NaCl doses and FYM additions. The Table 2 shows that the numbers of seeds produced were successively increased with the increasing doses of NaCl up to 20mM when plants were grown with 5 and 10 per cent VC. For 5 per cent VC amendment, the number of seeds were recorded as 2206, 2448 and 2640/plant, respectively at 0, 10 and 20mM NaCl, but without significant (P<0.01) difference when compared to the control (2090/plant). However, the number of seeds 2593 and 2694, 2636 and 2631/plant produced respectively at 10, 20, 50 and 100mM NaCl for 10 per cent VC revealed a significant (P<0.01) increase over the control (2090/plant). For the higher orders (15, 20 and 25 per cent) of VC amendments, the numbers of seeds produced were found to increase up to 50mM salt dose and then started to decrease. The best results 2710, 3009 and 3208/plant of seed production were observed at 10, 20 and 50mM NaCl against the control (2090/plant) that for 15 per cent VC amongst all soil–VC formulations. The overall peak (3208/plant) of number of seeds produced was registered for 15 per cent VC at 50mM NaCl amongst all salt doses and VC amendments (Table 2).

Seed Yield (g)/Plant (SY)

Seed yield (g) was also found to increase with increasing doses of salt up to 20mM for 5 and 25 per cent FYM formulations and then started to decrease. In other cases (10, 15 and 20 per cent) of FYM amendments, the seed yield successively increased up to 50mM NaCl. However, all treatments of NaCl with all FYM doses were found to enhance the seed yield when compared to the control (Table 1). Seed yields of 8.17, 8.60, 8.47 and 8.19g/plant were significantly (p<0.01) increased respectively at 10, 20, 50 and 100mM saltdoses against the control (6.33g/plant) for 5 per cent FYM. Seed yields of 8.52, 9.15, 10.13 and 8.39g/plant were also significantly (P<0.01) increased respectively at 10, 20, 50 and 100mM NaCl for 10 per cent FYM over the 6.33g yield of the control. When compared to the control, significant (P<0.01) increase in the seed yields were also registered at 10, 20, 50 and 100mM NaCl for 15, 20 and 25 per cent of FYM soil amendments (Table 1). However, the peak (10.54g/plant) of seed yield was recorded at 50mM NaCl and that for 15 per cent FYM amongst all salinity treatments and FYM amendments (Table 1 and Fig. 1). Seed yield (g) also increased with various salinity treatments for all VC amendments (Table 2 and Fig. 2). Data reveals that there was a significant

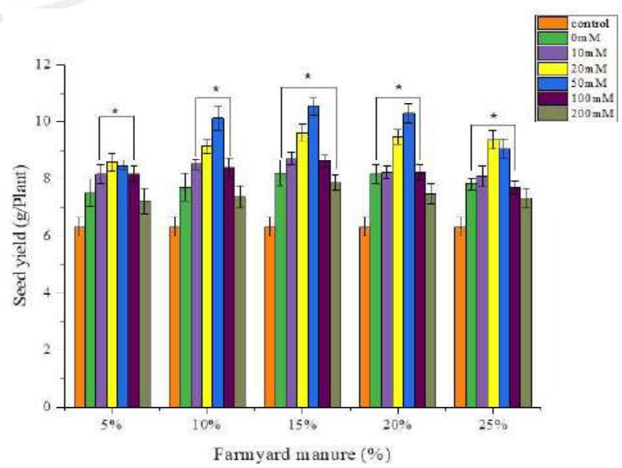

Fig. 1 : Seed yield (g/plant) of lucerne (*Medicago sativa* L. cv. Ek Sali) under NaCl stress with soil amendment of FYM Vertical bars indicate ±SE; * indicate significant at P<0.01

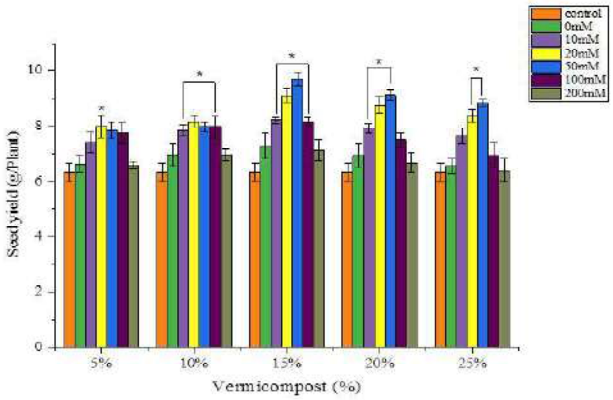

Fig. 2 : Seed yield (g/plant) of lucerne (*Medicago sativa* L. cv. Ek Sali) under NaCl stress with soil amendment of VC Vertical bars indicate ± SE; * indicate significant at P<0.01

(P<0.01) increase in the seed yield at 10, 20 and 50mM salt for 10 per cent VC amendment and respectively recorded as 7.85, 8.16 and 7.97g/plant over the 6.33g/plant yield of the control. A significant (P<0.01) increase in the seed yield of 8.21, 9.11, 9.71 and 8.17g/plant was also registered at 10, 20, 50 and 100mM NaCl in the plants raised with 15 per cent VC when compared to the control (6.33g/plant). Seed yield of 7.91, 8.76 and 9.12g/plant, respectively at 10, 20 and 50mM salinity also significantly (P<0.01) increased for 20 per cent VC against the control (6.33g/plant). Overall peak (9.71g/plant) of seed yield was observed for 15 per cent VC at 50mM NaCl for all salt doses and VC amendments.

Germination of Progeny Seeds

Germination of progeny seeds obtained from the plants raised under salt stress on the soil amended with FYM and VC is shown in Table 3. The progeny seeds obtained under various levels of salt stress with 5 per cent FYM revealed the germination in the range of 81.67±6.02 - 90.33±0.57 per cent whereas, 84.67 ± 3.78 - 90.00 ± 2.00 per cent germination was recorded in the seeds harvested with 10 per cent FYM fertilization and different levels of salt application. Similar trends of germination were recorded in the seeds obtained from the plants cultivated with 15, 20 and 25 per cent FYM where, 83.67 ± 7.23 - 89.00 ± 5.29, 85.33 ± 4.50 - 89.67 ± 3.00 and 82.67 ± 3.51 - 90.67 ± 4.16 per cent germinated seeds were respectively recorded against 83.33 ± 3.05 per cent

TABLE 3

Germination (%) of progeny seeds (R_1) obtained from plants raised under salt stress with soil amendment of FYM and VC

NaCl (mM)	FYM					VC				
	5 %	10 %	15 %	20 %	25 %	5 %	10 %	15 %	20 %	25 %
Control (R_0)	83.33 ± 3.05	83.33 ± 3.05	83.33 ± 3.05	83.33 ± 3.05	83.33 ± 3.05	83.33 ± 3.05	83.33 ± 3.05	83.33 ± 3.05	83.33 ± 3.05	83.33 ± 3.05
0	83.67 NS ± 8.73	85.67 NS ± 4.04	84.67 NS ± 5.50	88.33 NS ± 4.04	82.67 NS ± 3.51	82.33 NS ± 6.50	83.67 NS ± 4.04	87.33 NS ± 6.50	84.33 NS ± 6.02	86.67 NS ± 0.57
10	81.67 NS ± 6.02	84.67 NS ± 3.78	83.67 NS ± 7.23	85.33 NS ± 4.50	83.33 NS ± 3.51	87.00 NS ± 8.71	88.00 NS ± 6.00	88.67 NS ± 0.57	91.00 NS ± 2.64	86.00 NS ± 3.60
20	90.00 NS ± 1.00	86.33 NS ± 8.50	87.33 NS ± 6.50	85.67 NS ± 3.78	90.67 NS ± 4.16	85.67 NS ± 2.88	89.67 NS ± 2.08	90.00 NS ± 6.08	88.67 NS ± 6.02	86.67 NS ± 4.61
50	84.67 NS ± 3.05	88.67 NS ± 1.52	89.00 NS ± 5.29	88.33 NS ± 6.11	84.67 NS ± 5.03	88.66 NS ± 3.51	85.00 NS ± 9.53	88.67 NS ± 1.52	87.33 NS ± 2.51	91.00 NS ± 3.00
100	86.00 NS ± 7.81	88.00 NS ± 8.18	87.67 NS ± 0.57	89.00 NS ± 4.00	85.33 NS ± 3.05	91.33 NS ± 1.52	86.67 NS ± 3.78	86.00 NS ± 1.00	87.33 NS ± 5.13	87.00 NS ± 4.58
200	90.33 NS ± 0.57	90.00 NS ± 2.00	86.67 NS ± 1.52	89.67 NS ± 3.00	87.67 NS ± 7.09	84.00 NS ± 5.00	82.33 NS ± 3.21	87.00 NS ± 5.19	86.33 NS ± 7.02	84.00 NS ± 3.60

Mean±SD; NS=Non Significant at P<0.01

germination of the control. The lowest germination (81.67 ± 6.02%) was recorded in the seeds obtained from 5 per cent FYM with10mM NaCl whereas, the overall peak (90.67 ± 4.16%) was observed in the seeds obtained under 20mM salt with 25 per cent FYM amongst all FYM and salinity treatments. Number of progeny seeds obtained under various levels of salt stress and VC revealed that 82.33 ± 6.50 - 91.33 ± 1.52 for 5 per cent, 82.33 ± 3.21 - 89.67 ± 2.08 for 10 per cent, 86.00 ± 1.00 - 90.00 ± 6.08 for 15 per cent, 84.33 ± 6.02 - 91.00 ± 2.64 for 20 per cent and 84.00 ± 3.60 - 91.00 ± 3.00 per cent germination for 25 per cent vermicompost fertilization (Table 3). Most of the values of germinated seeds were recorded in the general range of 82.33 ± 6.50 - 91.33 ± 1.52 per cent. The lowest germination (82.33 ± 6.50%) was recorded in the seeds obtained with 5 per cent VC fertilization and with 00mM salt whereas, the highest (91.33 ± 1.52%) germination was observed in the seeds produced under 100mM salt and with 5 per cent VC manure. Statistically, there was no significant difference in the germinated seeds between those obtained from different sets of VC fertilization and under different salt levels when compared with the control.

Radicle lengths ranged between 3.6 ± 0.30 - 4.10 ± 0.45 cm, 3.7 ± 0.36 - 4.1 ± 0.52 cm, 3.7 ± 0.55 - 3.9 ± 0.17 cm, 3.7 ± 0.43 - 4.1 ± 0.52 cm and 3.6 ± 0.30 - 3.9 ± 0.26 cm in the seeds, respectively obtained with 5, 10, 15, 20 and 25 per cent FYM under various levels of salt stress. Almost similar ranges of radicle lengths were recorded in the seeds harvested with various formulations of VC and NaCl levels (Table 4). Seed germination data does not reveal any statistical difference in the progeny seeds obtained from different sets of FYM and VC fertilizations under various levels of salt stress when compared with the seeds produced by the control plants.

The overall germination was recorded as 81.67 ± 6.02 - 90.67 ± 4.16 per cent in the progeny seeds obtained from the plants for all FYM and 82.33 ± 6.50 -91.33 ± 1.52 per cent for all VC fertilization under different levels of NaCl treatments. In either of the two cases, none of the seed germination of progeny seeds showed

TABLE 4

Radicle length (cm) of progeny seeds (R_1) obtained from plants raised under salt stress with soil amendment of FYM and VC

NaCl (mM)	FYM					VC				
	5 %	10 %	15 %	20 %	25 %	5 %	10 %	15 %	20 %	25 %
Control(R_0)	3.84 ± 0.32	3.84 ± 0.32	3.84 ± 0.32	3.84 ± 0.32	3.84 ± 0.32	3.84 ± 0.32	3.84 ± 0.32	3.84 ± 0.32	3.84 ± 0.32	3.84 ± 0.32
0	3.9 ^{NS} ± 0.36	3.8 ^{NS} ± 0.50	3.8 ^{NS} ± 0.60	4.0 ^{NS} ± 0.45	3.7 ^{NS} ± 0.43	3.9 ^{NS} ± 0.3	3.8 ^{NS} ± 0.52	3.9 ^{NS} ± 0.3	3.8 ^{NS} ± 0.2	4.2 ^{NS} ± 0.36
10	3.7 ^{NS} ± 0.65	3.9 ^{NS} ± 0.20	3.8 ^{NS} ± 0.60	3.7 ^{NS} ± 0.43	3.6 ^{NS} ± 0.30	4.2 ^{NS} ± 0.10	3.7 ^{NS} ± 0.43	3.9 ^{NS} ± 0.26	4.1 ^{NS} ± 0.45	3.9 ^{NS} ± 0.26
20	3.6 ^{NS} ± 0.30	3.7 ^{NS} ± 0.36	3.7 ^{NS} ± 0.55	3.8 ^{NS} ± 0.36	3.6 ^{NS} ± 0.30	3.8 ^{NS} ± 0.26	4.1 ^{NS} ± 0.34	3.8 ^{NS} ± 0.34	3.9 ^{NS} ± 0.1	3.8 ^{NS} ± 0.17
50	3.9 ^{NS} ± 0.30	3.9 ^{NS} ± 0.51	3.8 ^{NS} ± 0.30	3.7 ^{NS} ± 0.20	3.9 ^{NS} ± 0.26	3.8 ^{NS} ± 0.26	3.7 ^{NS} ± 0.45	4.1 ^{NS} ± 0.43	3.9 ^{NS} ± 0.26	3.7 ^{NS} ± 0.52
100	4.1 ^{NS} ± 0.45	3.9 ^{NS} ± 0.45	3.9 ^{NS} ± 0.17	3.9 ^{NS} ± 0.17	3.8 ^{NS} ± 0.30	4.1 ^{NS} ± 0.20	3.9 ^{NS} ± 0.40	3.9 ^{NS} ± 0.55	3.9 ^{NS} ± 0.43	3.8 ^{NS} ± 0.45
200	3.8 ^{NS} ± 0.10	4.1 ^{NS} ± 0.52	3.8 ^{NS} ± 0.36	4.1 ^{NS} ± 0.52	3.8 ^{NS} ± 0.26	3.8 ^{NS} ± 0.45	3.8 ^{NS} ± 0.52	3.9 ^{NS} ± 0.26	4.0 ^{NS} ± 0.3	3.9 ^{NS} ± 0.30

Mean±SD; NS=Non Significant at $P<0.01$

significant ($P<0.01$) differences against the control (83.33 ± 3.05%).

The radicle lengths of progeny seeds of plants raised on varied levels of FYM soil amendments and various NaCl treatments ranged between 3.6 ± 0.30 - 4.1 ± 0.52cm whereas, for those obtained from the plants grown on VC amended soil recorded between 3.7 ± 0.52 - 4.2 ± 0.36cm. None of the radicle lengths differed significantly.

Salt tolerance is a complex trait that requires a coordinated response of the plant to withstand the osmotic and ionic stress imposed by the salinity in plants. Salinity decreases the osmotic potential of the soil, which leads to decreased turgor pressure in root cells that leads to water loss (Julkowska and Testerink, 2015). One of the major responses of the plants is to close the stomata and reduce transpiration to minimize the water loss. Maintenance of turgor is also essential and this is achieved by decreasing the osmotic potential in the roots by the osmolytes in the tissues. This can be achieved by the synthesis of certain organic compounds or the accumulation of Na^+ and Cl^- in a cost effective manner (Munns *et al*., 2016). Plants adopt certain strategies to keep the ion concentrations low in the cytosol, especially in mesophylls. Certain plants exclude the ions from the root to the rhizosphere or retrieve from xylem parenchyma by specific ion transporters (Moller and Tester, 2007). Several workers have studied the seed yield under the salinity stress in different plants. In a study carried out by Hebbara *et al.* (2003), poor yields were recorded in different cultivars of sunflower under the salinity stress. In another study carried out in different cultivars of quinoa (*Chenopodium quinoa*), salt induced reduction in seed yield was averagely recorded as 29 per cent at 100 mM, 57 per cent at 200mM and 65 per cent at 300mM NaCl Salinity (Jaramillo *et al.,* 2021). In another study carried out by El-Sabagh *et al.* (2015), soybean has found to be a sensitive plant to salinity, significant decrease in seed yields have been recorded in the cultivars of the this plant when grown at 10mM NaCl over their control. Seed weights also significantly decreased at the same level of salinity when compared to their controls in this plant. Reduction in seed yield due to salinity stress has also been reported in soybean (Ghassemi-Golezani *et al*., 2010). Mahmoodzadeh (2008) and Tunçtürk *et al.* (2011) have also found that due to increasing salinity levels, yield and yield associated traits were reduced in Brassica cultivars while in another study in brassica, Chakraborty *et al.* (2016) showed that salinity treatment can reduce seed yield up to 90 per cent in cultivars like Varuna which is the best performing variety when cultivated under non-stressed environment. Contrary to the findings of these workers, in our study seed yield was found to increase with various levels of salt stress when the plants were cultivated with all the compositions of FYM and VC fertilization. The peaks of 10.54 and 9.71g/plant of seed yield were recorded at 50mM NaCl and 15 per cent FYM and VC, respectively. Although, after the higher doses (100 and 200mM) of the salt, a decreasing trend was observed in the seed yield and the 500mM dose was found to be lethal. A positive association between seed yield attributes and the salinity levels was found in our study that concurs with the study of Vadez *et al*. (2007) who reported in chickpea that seed yield under saline conditions was positively linked with both the number of pods and seeds produced by the salinized plants. In another study in chickpea, among the 55 chickpea genotypes cultivated in soil under 40mM NaCl, Turner *et al*. (2013) reported a 27-fold range in seed production.

Plants experience a water absorption problem due to salinity stress, which is connected to the osmotic effect. Plants also have reduced nutrient intake due to particular ion effects. When compost is applied to the soil, it creates a large amount of acid-forming compounds, which react with partially soluble salts in the soil and convert them to highly soluble salts. These highly soluble salts are leached away, improving soil characteristics. Still, the amount of improvement is proportional to the amount of compost used (Sarwar, 2005). In the present study the results of NI, NS and SY were more pronounced in FYM than VC which could be due to farmyard manures showing to improve the solubility and up take of P from sparingly soluble P compounds in soil and enhance the utilization of P from fertilizers, Organic compounds released during the decomposition of manures increase the availability of P from soil or fertilizers (Iymuremy and Dick, 1996 and Reddy *et al.,* 1999). In field experiment to study the effect of phosphorus and nitrogen fertilizers on fodder and seed yield oflucerne, both phosphorus and nitrogen enrichment increased the number of pods per raceme and seed output significantly, but had little effect on the number of seeds per pod or seed weight (Nayeand Khidir, 1995).

Salinity stress at pod filling stage can cause a decrease in the mobilization of photosynthates into the grains thereby decreasing the grain weight (Sadeghipour, 2008). Reduction in grain yield under salt stress has also been reported in chickpea (Sohrabi *et al*., 2008). Salinity has also been identified as a major constraint to rice production worldwide (Ghosh *et al.,* 2016). The number of inflorescences and the seed yield started to decline at the higher (100 and 200mM) doses of salt, it may further decrease with increased level of salt until otherwise become lethal as happened in this case at 500mM salt. Thus the idea of reduction in grain filling when the plants are grown under higher levels of salt stress can be appreciated for this study also.

Seed germination studies in lucerne at the temperature 34.3 ± 5.2^{0}C under various levels of NaCl stress have been carried out by Magrayand Sharma (2022). In their study, a significant increase was recorded at 50mM NaCl stress when compared with the control. However, a significant decrease was observed at 500mM NaCl. But in the present study the progeny seeds obtained from the plants raised on the soil after various levels of FYM and VC fertilization and treated with different levels of NaCl does not reveal any significant difference in germination against the control.

The results can be exploited to set the guidelines for the production of seeds in alfalfa. It can be concluded that the low doses of 20 - 50mM NaCl coupled with the application of organic fertilizers especially 15 per cent FYM and VC in all experimental sets increases the seed production in central Indian environment when cultivated as a winter crop. Comparatively, FYM provides better reproductive potential than VC. It can also be inferred from our data that there is a wide range of salt tolerance in the germplasm of this (Ek Sali) lucerne cultivar that may be used in breeding to increase salt tolerance in its salt-sensitive species.

References

Ahmad, M., Shahzad, A., Iqbal, M., Asif, M. and Hirani, A. H., 2013, Morphological and molecular genetic variation in wheat for salinity tolerance at germination and early seedling stage. *Australian Journal of Crop Science*, **7**(1) : 66 - 74.

Amezketa, E., 2006, An integrated methodology for assessing soil salinization, a pre-condition for land desertification. *Journal of Arid Environments*, **67**(4) : 594 - 606.

Arora, S. and Dagar, J. C., 2019, Salinity tolerance indicators. In *Research developments in saline agriculture* (pp. 155 - 201). Springer, Singapore.

Arzani, A. and Ashraf, M., 2016, Smart engineering of genetic resources for enhanced salinity tolerance in crop plants. *Critical Reviews in Plant Sciences*, **35**(3) : 146 - 189.

Chakraborty, K., Sairam, R. K. and Bhaduri, D., 2016, Effects of different levels of soil salinity on yield attributes, accumulation of nitrogen and micronutrients in *Brassica* spp. *Journal of plant nutrition*, **39**(7) : 1026 - 1037.

Choudhary, M., Bailey, L. D., Grant, C. A. and Leisle, D., 1995, Effect of Zn on the concentration of Cd and Zn in plant tissue of two durum wheat lines. *Canadian Journal of Plant Science*, **75**(2) : 445 - 448.

Daliakopoulos, I. N., Tsanis, I. K., Koutroulis, A., Kourgialas, N. N., Varouchakis, A. E., Karatzas, G. P., and Ritsema, C. J., 2016, The threat of soil salinity : A European scale review. *Science of the total environment*, **573** : 727 - 739.

El-Sabagh, A., Sorour, S., Ueda, A. and Saneoka, H., 2015, Evaluation of salinity stress effects on seed yield and quality of three soybean cultivars. *Azarian Journal of Agriculture*.

FLOWERS, T. J. AND COLMER, T. D., 2008, Salinity tolerance in halophytes. *New Phytologist*, pp. : 945 - 963.

FLOWERS, T. J. AND YEO, A. R., 1995, Breeding for salinity resistance in crop plants : Where next?. *Functional Plant Biology*, **22**(6) : 875 - 884.

GHASSEMI-GOLEZANI, K., TAIFEH-NOORI, M., OUSTAN, S., MOGHADDAM, M. AND SEYYED-RAHMANI, S., 2010, Oil and protein accumulation in soybean grains under salinity stress. *Notulae Scientia Biologicae*, **2**(2) : 64 - 67.

GHOSH, B., MD, N. A. AND GANTAIT, S., 2016, Response of rice under salinity stress : A review update. Rice research: open access, pp. 1 - 8.

HASANUZZAMAN, M., NAHAR, K., ALAM, M., BHOWMIK, P. C., HOSSAIN, M., RAHMAN, M. M. AND FUJITA, M., 2014, Potential use of halophytes to remediate saline soils. *BioMed research international*.

HEBBARA, M., RAJAKUMAR, G. R., RAVISHANKAR, G. AND RAGHAVAIAH, C. V., 2003, Effect of salinity stress on seed yield through physiological parameters in sunflower genotypes. *Helia*, **26**(39) : 155 - 160.

HILLEL, D., 1980, Applications of soil physics. Academic Press, New York. *Applications of soil physics. Academic Press, New York.*

INTERNATIONAL SEED TESTING ASSOCIATION, 1985, International rules for seed testing, *Seed Sci. Technol.*, **13** : 307 - 513.

IVUSHKIN, K., BARTHOLOMEUS, H., BREGT, A. K., PULATOV, A., FRANCESCHINI, M. H., KRAMER, H. A ND FINKERS, R., 2019, UAV based soil salinity assessment of cropland. *Geoderma*, **338** : 502 - 512.

IYAMUREMYE, F. AND DICK, R. P., 1996, Organic amendments and phosphorus sorption by soils. *Advances in agronomy (USA).*

JARAMILLO ROMAN, V., VAN DE ZEDDE, R., PELLER, J., VISSER, R. G., VAN DER LINDEN, C. G. AND VAN LOO, E. N., 2021, High-resolution analysis of growth and transpiration of quinoa under saline conditions. *Frontiers in plant science*, pp. : 1627.

JULKOWSKA, M. M. AND TESTERINK, C., 2015, Tuning plant signaling and growth to survive salt. *Trends in plant science*, **20**(9) : 586 - 594.

KEATING, B. A. AND FISHER, M. J., 1985, Comparative tolerance of tropical grain legumes to salinity. *Australian journal of agricultural research*, **36**(3) : 373 - 383.

MAAS, E. V., 1986, Salt tolerance of plants. Apple Agric. Res. 1, 12-26. *World Journal of Agricultural Sciences*, **4**(3) : 351 - 358.

MAGRAY, J. A. AND SHARMA, D. P., 2022, Seed Germination in Lucerne (*Medicago sativa* L. cv. Ek Sali) under NaCl Stress at Winter and Summer Temperatures.

MAHMOODZADEH, H., 2008, Comparative study of tolerant and sensitive cultivars of Brassica napus in response to salt conditions. *Asian Journal of Plant Sciences*.

MOLLER, I. S. AND TESTER, M., 2007, Salinity tolerance of Arabidopsis : A good model for cereals?. *Trends in plant science*, **12**(12) : 534 - 540.

MUNNS, R., JAMES, R. A., GILLIHAM, M., FLOWERS, T. J. AND COLMER, T. D., 2016, Tissue tolerance: an essential but elusive trait for salt-tolerant crops. *Functional Plant Biology*, **43**(12) : 1103 - 1113.

NAYE, B. A. AND KHIDIR, M. O., 1995, Effect of seed rate and fertilizers on fodder and seed yield of Lucerne (*Medicago stiva* L.).

PASAPULA, V., SHEN, G., KUPPU, S., PAEZ VALENCIA, J., MENDOZA, M., HOU, P. AND PAYTON, P., 2011, Expression of an Arabidopsis vacuolar H+ pyrophosphatase gene (AVP1) in cotton improves drought and salt tolerance and increases fibre yield in the field conditions. *Plant biotechnology journal*, **9**(1) : 88 - 99.

PATHAK, R. S., ROY, R. D. AND RAI, P., 1978, Factor affecting the seed health and germination in *Heteropogon contortus* (L.) Beam. ex Roemand and Shult. *Environ. Physol. Ecol. Plants,* pp. : 279 - 302.

REDDY, D. D., RAO, A. S., REDDY, K. S. AND TAKKAR, P. N. (1999), Yield sustainability and phosphorus utilization in soybean–wheat system on Vertisols in response to integrated use of manure and fertilizer phosphorus. *Field crops research*, **62**(2-3) : 181 - 190.

REN, D., WEI, B., XU, X., ENGEL, B., LI, G., HUANG, Q. AND HUANG, G., 2019, Analyzing spatiotemporal characteristics of soil salinity in arid irrigated agro-ecosystems using integrated approaches. *Geoderma*, **356** : 113935.

ROY, S. J., TUCKER, E. J. AND TESTER, M., 2011, Genetic analysis of abiotic stress tolerance in crops. *Current opinion in plant biology*, **14**(3) : 232 - 239.

SADEGHIPOUR, O., 2008, Effect of with holding irrigation at different growth stages on yield and yield components of mungbean (*Vicia radiata* L.) varieties. *Amer.Eur. J. Agric. Environ. Sci.,* **4** : 590 - 594.

SANCHEZ, C.A., 1990, Soil testing and fertilization recommendations for crop production on organic soils in Florida. *Fla. Agr. Exp. Sta. Bull.,* **876** : 44.

SARWAR, G., 2005, *Use of compost for crop production in Pakistan.Ökologie und Umweltsicherung-Universität Kassel, Germany* (Doctoral dissertation, Ph.D. Dissertation).

SHABALA, S., 2013, Learning from halophytes: physiological basis and strategies to improve abiotic stress tolerance in crops. *Annals of botany*, **112**(7) : 1209 - 1221.

SOHRABI, Y., HEIDARI, G. AND ESMAILPOOR, B., 2008, Effect of salinity on growth and yield of desi and kabuli chickpea cultivars. *Pakistan Journal of Biological Sciences: PJBS*, **11**(4) : 664 - 667.

TUNÇTÜRK, M., TUNÇTÜRK, R., YILDIRIM, B. AND ÇIFTÇI, V., 2011, Changes of micronutrients, dry weight and plant development in canola (*Brassica napus* L.) cultivars under salt stress. *African Journal of Biotechnology*, **10**(19) : 3726 - 3730.

TURAN, M. A., ELKARIM, A. H. A., TABAN, N. AND TABAN, S. 2009, Effect of salt stress on growth, stomatal resistance, proline and chlorophyll concentrations on maize plant. *African Journal of Agricultural Research*, **4**(9) : 893 - 897.

TURNER, N. C., COLMER, T. D., QUEALY, J., PUSHPAVALLI, R., KRISHNAMURTHY, L., KAUR, J. AND VADEZ, V., 2013, Salinity tolerance and ion accumulation in chickpea (*Cicer arietinum* L.) subjected to salt stress. *Plant and Soil*, **365**(1) : 347 - 361.

VADEZ, V., KRISHNAMURTHY, L., SERRAJ, R., GAUR, P. M., UPADHYAYA, H. D., HOISINGTON, D. A. AND SIDDIQUE, K. H. M., 2007, Large variation in salinity tolerance in chickpea is explained by differences in sensitivity at the reproductive stage. *Field crops research*, **104**(1-3) : 123 - 129.

WANG, B., LÜTTGE, U. AND RATAJCZAK, R., 2001, Effects of salt treatment and osmotic stress on V ATPase and V PPase in leaves of the halophyte Suaeda salsa. *Journal of Experimental Botany*, **52**(365) : 2355 - 2365.

ZORB, C., GEILFUS, C. M. AND DIETZ, K. J., 2019, Salinity and crop yield. *Plant biology*, **21** : 31 - 38.