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OPTIMIZATION OF HALOPHYTIC COMPOST ALONG WITH FARMYARD MANURE AND *RHIZOBIUM* ON GROWTH OF *VIGNA MUNGO* L.

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Abstract

Across the larger part of the world excess and unsustainable use of chemical fertilizers had lead to several issues of environmental pollution and land degradation. The utilization of organic compost as alternatives to reduce the use of chemical fertilizers is considered a good agricultural practice. However the effect of organic compost on growth parameters of plant depends upon its chemical composition. The goal of this endeavour is to find out optimization of a variety of halophytic compost in tandem on the developmental patterns of black gram (*Vigna mungo* L.). All the halophytic compost amended soils showed positive effect on growth parameters of black gram, although at the end of the experimental period growth parameters of black gram such as plant height, number of compound leaves, leaf area, number of branches, fresh and dry weight of plant ,number of root nodules, fresh and dry weight of root nodules increased more significantly in the treatment *Suaeda maritima* compost @ 6.25 t h^{-1} + farmyard manure @ 3.13 t h^{-1} + *Rhizobium* @ 2kg h^{-1} treated soils when compared to other halophytic compost and control.

Keywords **:** Halophytes, Compost, *Vigna mungo*, *Rhizobium,* Growth

Introduction

Organic farming nowadays is generating curiosity among researchers and common masses too amid greater health consciousness and pollution restraints. But unnecessary utilization of pesticides and chemical supplements leaves a negative affect not only on the soil bio-data but also affects quantity cum quality yield and man's wellbeing, yet it has also put excruciating encumber on farmers (Ramesh *et al.*, 2005; Littlefield-Wyer *et al.*, 2008; Yasmin and D'Souza, 2010; Damalas and Eleftherohorinos, 2011; Rivera-Becerril *et al.*, 2017). Using of inorganic fertilizers results in salty accrual the earth's niche and with the result crop plants use supplementary energy to uptake the water from the water table below, which may lead to little yield or complete shriveling of plant (Liu *et al.*, 2014). A number of studies from time and again established that continued utilization of inorganic supplemental fertilizers diminishes crop yield as of increase in soil pH, Reduction of earth's soil texture, chemical characteristics combined with deficiency of suitable micronutrients in these inorganic supplements (Gliesman and Engles 1998; Ghimire *et al.*, 2017). Organic supplication by utilization of animal manure has been adopted as a principle methodology to move towards a goal of sustainable agriculture particularly in the areas where soil is poor in nutrients which are of organic nature (Chiti *et al.*, 2012). It is notable that organic fertilizers boost farm richness and supplicate long term nutrients by slow decomposition (Zhou *et al.*, 2016; Angin et al; 2017). Utilizing of organic fertilizers upgrades quantity of N, P, K and other essential nutrients which play an imperative role in growth and development of the crops (Palm *et al.*, 2001). Organic fertilizers are rich in soil supplement sources and give prime amount of nutrients to the crop and prevent the nutrient imbalance (Blay *et al.*, 2002). Organic manures have the ability to reduce the soil pH and enhance the electrical conductivity whilst increase in ionic profile of the farms and also bio-nutrient absorption (Davarnejad *et al.*, 2002). However fewer studies exist regarding impact of halophytic compost, which is obtained by the utilization of halophytic biomass after decomposition when compared to plant height.

Black gram is cosmopolitan in distribution, placed in family Fabaceae by taxonomists and gains substantial importance as claims are made that it can act as main food for developing world. The total land area under pulses around world amounts to almost about 211.027million acres with annual yield of 87.40 million tonnes at 409.2 kg /acre. India, with greater than 71.66 million acres pulses cultivation area and occupies first position both in terms of area and yield i.e. 34 and 26 percent respectively. Preceding two years 2020 i.e. 2017-18 the country's productivity at 334 kg/acre with a substantial increase over eleventh year plan 264.8 kg/acre to 298 kg /acre in twelfth plan. Since 2015-16 there has been considerable increase in cultivation of black gram and this momental shift has been covered quite comprehensively. In the year 2017-18 the legume was cultivated on an area of greater than 50 hundred thousand hectares with an annual yield touching 35 hundred thousand tonnes. In Tamil Nadu black gram is cultivated in 4.06 lakh hectares with production of 3.01 lakh tonnes (Rajender and Tiwari 2018). *Rhizobium* the N- fixating symbiotic microorganism from Rhizobiaceae family and has an ability of fixing at 40 kg/acre in leguminous plants and this is the reason that it is quite frequently suggested for all pulses bearing crops except *Parasponia*, a non-legume (Saikia and Jain, 2007). Being leguminous plant black gram has the innate nature of fixing Nitorgen from atmosphere in relationship with a soil inhabiting bacterium *Rhizobium* through symbiosis. Legume *Rhizobium* interactions are inimitable as they fulfill three fourths of total nitrogen supplements of legumes.

Halophytes are the salt cherishing plants which complete growth period in high saline environment.

Halophytes are abundantly found in coastal saline arid, semi arid soil, having more evaporation than precipitation. (Cuevas, 1997) recorded the nuturious content of halophytes and came to a conclusion that nutrient contents in salt cherishing plants are higher in comparison to low salt content adaptable plants while obtained from some plants like brown hemp, Prickly sesban, lond bean and catjang. Nonetheless, halophytes have an intrinsic ability to amass common salt in their cells. The present endeavor has a basis in the idea that whilst halophytes are subjected to composting, it is quite probable that NaCl content present in the cells will demean after decaying. Na^+ cation in NaCl may coordinate with the ligands (organic acids) produced after decomposition and discharge the Cl^- anion, as a consequence reduction of NaCl levels. Decay quashes the constuience of NaCl present in the crop plant tissues. Watson (2003) likewise has concluded that quantifying compost with water may diminish concentration of common salts.

The goal of this endeavor is to work out optimization of a variety of halophytic compost in tandem with organic manure and *Rhizobium* on the developmental patterns of black matpe bean.

Materials and Methods

Experimental Site

The aim of this endeavour was to assess optimization of halophytic compost along with farmyard manure and *Rhizobium* on growth of *Vigna mungo* L. The field experiment was conducted at Experimental farm, Faculty of Agriculture, Department of Agronomy, Annamalai Nagar, Tamil Nadu India, during June-October (Kharif) 2019. The experimental farm is physically located at and with coordinates of 11° 24' N Latitude and 79° 44' E Longitude at an elevation of +5.79 M above sea level. The weather at Annamai Nagar is moderately warm with some amount of rain fall. The maximum temperature at 29.3 ºC to 35.2 ºC with mean of 32.82 ºC. The relative humidity ranges from 81 to 96 percent with a mean of 85.78 percent and crop received at rain fall of 98.44 mm. The experimental design was sketched out entirely randomized block design.

Compost Preparation

Two quite rapidly growing as pioneers (halophytes) i.e. *Suaeda maritima* (L.) Dumort., and *Sesuvium portulacastrum* L. were selected for test design of preparation of organic compost after a detailed survey. The festering farmyard manure was collected from Dairy farm which was later on crumbled with contents of compost and was served in to the test fields as per the treatment schedule. *Rhizobium* was obtained from Department of Microbiology, Faculty of Agriculture, Annamalai university, India. Deliquescent and healthy halophytes were obtained from nursery and used for preparation of compost. The plant materials and in addition to that paddy stalks were lacerated homogenously. The lacerated substances were packed loosely in compost pit as long as improved aeration within the heap could be guaranteed. Owing to the well packed nature of materials no heavy weights were used and to increase aeration punched bamboo trunks were fixed flat and perpendicularly systematically improving air passage through the heap. Cellulolytic fungus (*Trichoderma harzianum*) which acts as activator was spread out onto the contents of compost during pilling. The quantity of activator put into use was 1% of the total weight of the substrate (Cuevas, 1997). The mound was enclosed entirely with white plastic sheets. Temperature was retained at 50°C or greater and was turned over every 5-7 days for the first two consecutive weeks and after that once after simultaneously weeks. Turning over also increased aeration cum decomposition and the compost was ready at the commencement of third month dark brown in color felling flaky in nature with earthly aroma.

Table 1 : Physico-chemical characteristics of the experimental field before installation of experiment

Soil characteristics of the experimental field	
Properties	**Value**
A. **Physical properties**	
Coarse sand (%)	49.83
Silt (%)	18.20
Clay (%)	16.68
Textural class	Sandy loam
B. **Chemical properties**	
Electrical conductivity(dsm^{-1})	0.912
pH	7.82
Organic carbon (%)	0.40
Organic matter (%)	0.54
Available Nitrogen (Kg ha^{-1})	143.8
Available Phosphorus (Kg ha^{-1})	21.9
Available Potassium (Kg ha^{-1})	40
Available Zinc (Kg ha^{-1})	4.8

Table 2 : Nutrient contents of different halophytic compost at maturity period (90 days)

Treatments	pH	C	N	C:N Ratio	P (%)	K (%)	Ca (ppm)	Mg (ppm)	Zn (ppm)	Fe (ppm)	Mn (ppm)	Cu (ppm)	Before Composting		After Composting		Percentage of reduction	
													Na	Cl	Na	Cl	Na	Cl
T1	7.2	49.21	1.85	26.20	0.73	1.54	1824	1430	8.30	10,197	31.80	177	21.0	15.2	8.5	7.3	40.5	48.0
T2	7.1	46.72	1.93	23.5	0.76	1.63	1962	1558	8.62	10,299	32.66	196	19.0	14.3	6.9	6.2	36.3	43.3
T3	6.9	44.59	2.75	15.30	1.33	2.05	3324	2730	10.77	10,619	34.94	406	.....	.....	.....	.....	.....	.....
T4	6.8	42.62	2.83	14.23	1.36	2.14	3462	2858	11.09	10,721	35.77	583	.....	.....	.....	.....	.....	.....
T5	6.7	39.95	2.81	13.27	1.34	2.08	3340	2740	11.80	10,630	35.34	429	.....	.....	.....	.....	.....	.....
T6	6.4	39.40	2.91	13.10	1.37	2.17	3476	2869	12.12	10,736	35.84	598	.....	.....	.....	.....	.....	.....

Treatments

Compost treatments and their concentrations

Table 3

Treatments	Compost Application
T0	Control (Without compost)
T1	*Sesuvium portulacastrum* compost @ 6.25 t ha^{-1}
T2	*Suaeda maritima* compost @ 6.25 t ha^{-1}
T3	*Sesuvium portulacastrum* compost @ 6.25 t ha^{-1} + Farmyard manure @ 3.13 t h^{-1}
T4	*Suaeda maritima* compost @ 6.25 t ha^{-1} + Farmyard manure @ 3.13 t h^{-1}
T5	*Sesuvium portulacastrum* compost @ 6.25 t ha^{-1}+ Farmyard manure @ 3.13 th^{-1} + *Rhizobium* @ 2 kg ha^{-1}
T6	*Suaeda maritima* compost @ 6.25 t ha^{-1}+ Farmyard manure @ 3.13 th^{-1} + *Rhizobium* @ 2kg ha^{-1}

Field Preparation

The land was prepared after ploughing twice with bullock drawn mould board followed harrowing by using cultivator-tractor and the whole plot was levelled with leveler, individual plots were made manually as per experimental sketch. Channels were laid to facilitate irrigation to plots individually. ADT 5 black gram variety was purchased from Rice research institute Tamil Nadu Agricultural Agriculture University, Rice Research Institute, Aduthurai, Thanjavur District and was used for experimental study. The black gram seeds were sown by dibbing 3 to 5 seeds per hill at a depth of 3 to 5 cm and spacing of 30 x 10 cm. Plant samples were harvested for experimental purpose at an interval of 15, 30, 45, 60 days and harvest stage. The matured crop was harvested by leaving the border rows by hand pulling. Six treatments were used in randomized block. The amendment doses were determined totally based on the recommendation of Department of Agronomy, Tamil Nadu Agriculture University, Coimbatore Tamil Nadu India.

Growth analysis

Growth analysis such as shoot length, number of trifoliar leaves, and number of branches, leaf area, nodules, rood nodules weight and plant weight were measured immediately after removing the plants from experimental plots. The dry weight of plants and root nodules were determined after they had been dried at 80ºC for 24 hours.

Soil analysis

The pH of the soil was worked out in the ratio 1:2:5 (soil and water suspension) by using pH meter. Conductivity (EC) was measured in the ratio 1:2:5 (soil and water suspension) by using Elico-conductivity meter.

Statistical analysis

The results were analyzed by helping out ANOVA and the group means were compared by Duncan's Multiple Range Test (Duncan, 1957). Values are considered statistically important when $p<0.05$.

Results and Discussion

Properties of the halophytic compost

Initially an experiment was carried out to find out whether the process of decomposition of halophytes reduces the NaCl concentration in the compost. From the results it was concluded that after 90 days completion of composite prepration, NaCl concentration in the composite was drastically reduced to 40.5 Na^+ and 48.0 Cl^- in *Sesuvium portulacastrum* compost and 36.3 % Na^+ and 43.3% Cl^- in *Suaeda maritima* compost. It also was observed from the studies at the end of decomposition *Suaeda maritima* compost in combination with farmyard manure and *Rhizobium* gaining higher nutrient contents when compared to other halophytic composts. Nutrients such as N, P, K Ca, Mg and micronutrients were found higher in *Suaeda maritima* compost in combination with farmyard manure and *Rhizobium*. The reduction in pH and EC was noticed in *Suaeda maritima* compost along with Farmyard manure and *Rhizobium* compost.

Effect of halophytic compost on biomass of *Vigna mungo* L.

The maximum improvement in the plant height with treatment *Suaeda maritima* compost @ 6.25 t h^{-1} + Farmyard manure @ 3.13 t h^{-1} + *Rhizobium* @ 2kg ha^{-1} was reflected over control (T_0). Other treatments were also significantly effective over control, however their level of effectiveness were lesser than treatment *Suaeda maritima* compost @ 6.25t

h^{-1} + Farmyard manure @ 3.13t h^{-1} + *Rhizobium* @ 2kg ha^{-1} (Table 4). Significantly higher number of branches were recorded in treatment *Suaeda maritima* compost @ 6.25 t h^{-1} + Farmyard manure @ 3.13 t h^{-1} + *Rhizobium* @ 2kg ha^{-1} treated sound plots as compared to untreated control. Other treatment treated plots also gained considerable improvement but their level were ranked after treatment *Suaeda maritima* @ 6.25 t h^{-1} + Farmyard manure @ t h^{-1} + *Rhizobium* @ 2kg ha^{-1} (Table 5). Similarly maximum number of leaves plant^{-1} were recorded in beds that received the consortia of treatment *Suaeda maritima* compost @ 6.25 t h^{-1} + Farmyard manure @ t h^{-1} + *Rhizobium* @ 2kg ha^{-1} when compared to control. Incorporation of the other treatments also registered improvement in number of vegetation plant^{-1} over control. But their improvement quantum was lesser than treatment *Suaeda maritima* compost @ 6.25 t h^{-1} + Farmyard manure @ t h^{-1} + *Rhizobium* @ 2kg ha^{-1} (Table 6). Likewise leaf area plant^{-1} was greatly influenced in all scheduled treatments. But application of treatment *Suaeda maritima* compost 6.25 @ t h^{-1} + Farmyard manure 3.13 @ t h^{-1} + *Rhizobium* @ 2kg ha^{-1} markedly improved the leaf area plant^{-1} when compared to control. Besides, other treatments exhibited the appreciable improvement in leaf area plant^{-1}. But their improvement were once at par among the treatment *Suaeda maritima* compost @ t h^{-1} + Farmyard manure @ 3.13 t h^{-1} + *Rhizobium* @ 2kg ha^{-1} (Table 7). The fresh and dry weight of the plant were increased progressively at successive observations with the advancement of crop age and were significantly affected by different treatments. The maximum fresh and dry weight of the plant were recorded in treatment *Suaeda maritima* compost @ 6.25 t h^{-1} + Farmyard manure @ 3.13 th^{-1} + *Rhizobium* @ 2kg ha^{-1}. Which were superior to the rest of the treatments. While minimum fresh and dry weights of the plants were observed in control (Table 8 and 9).

Application of treatment *Suaeda maritima* compost @ 6.25 t h^{-1} + Farmyard manure @ 3.13 t h^{-1} + *Rhizobium* @ 2kg ha^{-1} significantly enhanced the number of root nodules plant^{-1} over control. A wide range of other treatments also assured marked enhancement in the number of root nodules plant^{-1}, but lesser than treatment *Suaeda maritima* compost @ 6.25 t h^{-1} + Farmyard manure @ 3.13 t h^{-1} + *Rhizobium* @ 2kg ha^{-1} . Similarly the fresh and dry weight of root nodules were significantly higher in treatment *Suaeda maritima* compost @ 6.25 t h^{-1} + Farmyard manure @ 3.13 t h^{-1} + *Rhizobium* @ 2kg ha^{-1} over control. Other treatments also exhibited the appreciable improvement in fresh and dry weight of root nodules plant^{-1} but their improvement were lesser among the treatment *Suaeda maritima* compost @ 6.25 t h^{-1} + Farmyard manure @ 3.13 t h^{-1} + *Rhizobium* @ 2kg ha^{-1}. The decline was noted in nodule number, fresh and dry weight of root nodules at 60 days. This was mainly due to decay of nodular tissue at pod formation (Table 10, 11 and 12).

In the present study it was seen that impact of halophytic compost enhanced the growth parameters in *Vigna mungo* L. when compared to control. Among six treatments *Suaeda maritima* compost, farmyard manure and *Rhizobium* enhanced the overall growth when compared with other treatments and untreated soil. The present observation regarding the biomass of the plant were in agreement with other several findings that the effect of organics such as organic and bioorganic fertilizers enhanced the plant height in pigeon pea (Ansari and Mahmood, 2017), leaf area in black gram with bio fertilizers (Javid *et al.*, 2003). Total number of root nodules in *Vigna mungo* L. with farmyard manure, pseudomonas, bacillus and *Rhizobium* (Hassan and Ram, 2015). Number of other studies have also pointed out that the application of halophytic powder used as bio fertilizer increased the height of wheat plant (Hassan *et al.*, 2018), number of foliage in coriander with poultry manure (Ahmad *et al.*, 2017), fresh and dry weight of root nodules with administering of halophytic compost and PO^{-}_{4} solubilising bacteria (Ravindran *et al.*, 2007a). Delijooye Tohidi *et al.*, 2013 reported that the use of organic compounds such as municipal solid waste compost and tea compost along with garden soil in the medium increased the number of leaves in *Bellis perennis*. Hashemabadi *et al.*, 2012 demonstrated the different methods of applying bio fertilizers increased the fresh and dry weight of marigold (*Tagetes erecta* L.). Shanmugam and Verraouthran (2000) stated that administering of organic manures and bio fertilizers, enthused the growth of plants with increased number of tillage's and broader leaves in paddy plants that could be the likely rationale for the increased foilage area. Khosro (2010) reported that the bio fertilizers and organic manure had a significant effect on nodule number and nodule activity. Togay *et al.* (2008) reported that plants inoculated with *Rhizobium* spp. increased the number of root nodules in chick pea. Balakrishan *et al.* (2010) observed that application of halophytic compost increased the fresh and dry weight, leaf area, number of trifoilage leaves, branches and nodules plant^{-1} in *Vigna radiata* L.

Impact of halophytic compost on soil properties

All the treatments reduced the pH than control. Among the treatments *Suaeda maritima* compost @ 6.25 t h^{-1} + Farmyard manure @ 3.13 t h^{-1} + *Rhizobium* @ 2kg ha^{-1} recorded the minimum reduction in pH when compared to other treatments and unamended soil. However application of treatment *Suaeda maritima* compost @ 6.25 t h^{-1} + Farmyard manure @ 3.13 t h^{-1} + *Rhizobium* @ 2kg ha^{-1} recorded minimum reduction in EC over control. Incorporation of other treatments also showed reduction in EC over control. But there improvement in reduction of EC was ranked after treatment T6 (Table 13 and 14). In the present study application of *Suaeda maritima* compost in combination with farmyard manure and *Rhizobium* showed lower pH and EC in compost treated soil at harvest stage. This might may be due to the production of organic acids during decomposition of organic compost in soil (Das and Singh, 2013). It has been indicated that soil pH and EC gradually decreased with the increase of incubation time in amended soils (Sanjay Roy and Abdul Kashem 2014). The same results were also obtained by (Ravindran *et al.*, 2007b), who reported that impact of halophytic compost along with farmyard manure and Phospho solubilising bacteria reduces soil pH and EC.

Conclusion

It can be deduced that mixed administering of *Suaeda maritima* compost @ 6.25 t h^{-1} + Farmyard manure @ 3.13 t h^{-1} + *Rhizobium* @ 2kg t h^{-1} showed increased effect on plant growth. Other supplementary treatments also gave promising results over control. However, their impacts were lesser than treatment *Suaeda maritima* compost @ 6.25 t h^{-1} + Farmyard manure @ 3.13 t h^{-1} + *Rhizobium* @ 2kg t h^{-1} treated plots. Likewise, soil physico- chemical properties were also found to be influenced. But a significant reduction in ph and EC were recorded in the *Suaeda maritima* compost @ 6.25 t h^{-1} + Farmyard manure @ 3.13 t h^{-1} + *Rhizobium* @ 2kg t h^{-1} treated plots as compared to control.

Therefore based on these findings it can be concluded that not only inorganic supplements can have a say on the plant development, but also the consortium of halophytic compost could also achieve the excellent results under better systematic methods.

Table-4: Effect of different halophytic compost application on plant height in *Vigna mungo* L. Values shown are mean ± S.E. for three replicate experiments.

Treatment	cm plant^{-1}			
	15th DAS	30th DAS	45th DAS	60th DAS
Untreated check; no organic input	5.23±0.260	6.96±0.176	9.26±0.176	10.8±0.173
Sesuvium portulacastrum compost @ 6.25 t ha^{-1}	6.43±0.328	10.43±0.202	17.80±0.230	24.26±0.233
Suaeda maritima compost@ 6.25 t ha^{-1}	6.86±0.290	11.26±0.176	19.63±0.145	26.93±0.202
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	7.40±0.173	12.43±0.145	23.63±0.145	33.80±0.230
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	8.23±0.145	13.73±0.145	26.46±0.176	37.93±0.202
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure 3.13 t ha^{-1} + *Rhizobium* @ 2kg ha^{-1}	8.93±0.202	16.26±0.176	31.23±0.088	45.26±0.176
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @3.13 t ha^{-1} + *Rhizobium* @ *2kg* ha^{-1}	9.76±0.176	17.80±0.173	35.60±0.173	52.43±0.145

Table-5: Effect of different halophytic compost application on total number of branches in *Vigna mungo* L. Values shown are mean ± S.E. for three replicate experiments.

Treatment	Plant^{-1}			
	15th DAS	30th DAS	45th DAS	60th DAS
Untreated check; no organic input	2.34±0.333	4.0±0.333	6.66±0.333	8.0±1.154
Sesuvium portulacastrum compost @ 6.25 t ha^{-1}	2.72±0.333	5.0±0.577	8.31±0.333	11.0±1.732
Suaeda maritima compost@ 6.25 t ha^{-1}	3.0±0.333	5.74±0.333	9.59±0.666	13.0±1.154
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	3.34±0.333	6.36±0.333	11.35±0.881	15.66±0.881
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	3.66±0.577	8.0±0.577	13.70±1.201	18.71±0.881
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure 3.13 t ha^{-1} + *Rhizobium* @ 2kg ha^{-1}	4.0±0.881	10.32±0.577	17.0±1.154	20.0±1.732
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @3.13 t ha^{-1} + *Rhizobium* @ *2kg* ha^{-1}	4.68±0.333	12.0±0.577	20.75±0.881	25.64±1.201

Table 6: Effect of different halophytic compost application on total number of compound leaves in *Vigna mungo* L. Values shown are mean ± S.E. for three replicate experiments.

Treatment	Plant^{-1}			
	15th DAS	30th DAS	45th DAS	60th DAS
Untreated check; no organic input	3.36±0.33	5.65±0.33	9.33±1.45	10.60±0.88
Sesuvium portulacastrum compost @ 6.25 t ha^{-1}	4.66±0.33	7.66±0.88	13.71±1.20	16.0±1.15
Suaeda maritima compost@ 6.25 t ha^{-1}	5.29±0.66	8.39±1.20	15.66±2.33	18.66±2.33
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	5.68±0.33	9.70±0.66	18.31±1.45	21.59±1.45
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	6.33±0.33	11.34±1.45	22.67±2.33	26.29±1.45
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure 3.13 t ha^{-1} + *Rhizobium* @ 2kg ha^{-1}	7.0±0.57	13.62±1.45	27.73±1.76	31.66±1.45
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @3.13 t ha^{-1} + *Rhizobium* @ *2kg* ha^{-1}	8.0±0.57	18.0±1.73	34.0±2.30	38.38±1.45

Table 7: Effect of different halophytic compost application on leaf area index (LAI) in *Vigna mungo* L. Values shown are mean ± S.E. for three replicate experiments.

Treatment	Cm^2 Plant^{-1}			
	15th DAS	30th DAS	45th DAS	60th DAS
Untreated check; no organic input	0.224±0.001	0.424±0.001	0.704±0.001	0.944±0.001
Sesuvium portulacastrum compost @ 6.25 t ha^{-1}	0.265±0.002	0.582±0.002	1.12±0.023	1.61±0.011
Suaeda maritima compost@ 6.25 t ha^{-1}	0.288±0.001	0.622±0.001	1.18±0.017	1.78±0.017
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	0.322±0.001	0.720±0.001	1.38±0.023	2.14±0.023
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	0.335±0.002	0.768±0.001	1.64±0.017	2.62±0.023
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure 3.13 t ha^{-1} + *Rhizobium* @ 2kg ha^{-1}	0.355±0.001	0.935±0.001	1.92±0.023	3.28±0.017
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @3.13 t ha^{-1} + *Rhizobium* @ *2kg* ha^{-1}	0.378±0.001	1.02±0.023	2.29±0.017	3.98±0.011

Table 8: Effect of different halophytic compost application on fresh weight of plant in *Vigna mungo* L. Values shown are mean ± S.E. for three replicate experiments.

Treatment	g Plant^{-1}			
	15th DAS	30th DAS	45th DAS	60th DAS
Untreated check; no organic input	1.50±0.023	4.28±0.028	8.48±0.017	15.28±0.017
Sesuvium portulacastrum compost @ 6.25 t ha^{-1}	2.08±0.023	6.22±0.023	13.36±0.023	25.22±0.017
Suaeda maritima compost@ 6.25 t ha^{-1}	2.22±0.017	6.84±0.017	14.22±0.023	27.28±0.017
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	2.38±0.017	7.32±0.023	16.88±0.023	32.98±0.017
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	2.48±0.011	8.18±0.017	19.98±0.011	38.29±0.028
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure 3.13 t ha^{-1} + *Rhizobium* @ 2kg ha^{-1}	2.68±0.017	9.78±0.017	24.22±0.023	47.52±0.023
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @3.13 t ha^{-1} + *Rhizobium @ 2kg* ha^{-1}	2.84±0.017	11.48±0.011	29.12±0.017	58.23±0.017

Table 9 : Effect of different halophytic compost application on dry weight of plant in *Vigna mungo* L. Values shown are mean ± S.E. for three replicate experiments.

Treatment	g Plant^{-1}				
	15th DAS	30th DAS	45th DAS	60th DAS	HARVEST
Untreated check; no organic input	0.602±0.002	1.63±0.011	2.62±0.037	4.72±0.023	0.602±0.002
Sesuvium portulacastrum compost @ 6.25 t ha^{-1}	0.640±0.003	1.92±0.023	4.14±0.041	7.81±0.011	0.640±0.003
Suaeda maritima compost@ 6.25 t ha^{-1}	0.682±0.003	2.12±0.011	4.40±0.011	8.66±0.017	0.682±0.003
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	0.732±0.003	2.27±0.017	5.22±0.011	10.20±0.143	0.732±0.003
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	0.766±0.006	2.53±0.028	6.15±0.017	11.82±0.005	0.766±0.006
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure 3.13 t ha^{-1} + *Rhizobium* @ 2kg ha^{-1}	0.826±0.002	3.03±0.011	7.46±0.041	14.72±0.017	0.826±0.002
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @3.13 t ha^{-1} + *Rhizobium @ 2kg* ha^{-1}	0.878±0.003	3.54±0.017	9.02±0.026	18.04±0.011	0.878±0.003

Table-10: Effect of different halophytic compost application on total number of root nodules in*Vigna mungo* L. Values shown are mean ± S.E. for three replicate experiments.

Treatment	Root Nodules Plant^{-1}			
	15th DAS	30th DAS	45th DAS	60th DAS
Untreated check; no organic input	3.66±0.333	4.34±0.333	8.67±0.881	7.28±0.801
Sesuvium portulacastrum compost @ 6.25 t ha^{-1}	4.0±0.577	7.0±0.577	13.0±1.154	10.66±1.201
Suaeda maritima compost@ 6.25 t ha^{-1}	4.35±0.333	8.33±0.333	15.69±1.763	12.36±1.452
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	5.0±0.577	10.62±0.666	20.28±1.452	16.0±1.732
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	5.70±0.333	13.33±1.452	25.66±1.201	21.0±1.154
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure 3.13 t ha^{-1} + *Rhizobium* @ 2kg ha^{-1}	6.32±0.333	16.71±1.452	31.38±1.763	26.72±0.881
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @3.13 t ha^{-1} + *Rhizobium @ 2kg* ha^{-1}	7.0±0.577	20.0±1.732	40.69±1.763	35.0±1.732

Table 11: Effect of different halophytic compost application on fresh weight of root nodules in *Vigna mungo* L. Values shown are mean ± S.E. for three replicate experiments.

Treatment	mg Plant^{-1}			
	15th DAS	30th DAS	45th DAS	60th DAS
Untreated check; no organic input	7.28±0.063	9.78±0.017	14.80±0.011	13.47±0.011
Sesuvium portulacastrum compost @ 6.25 t ha^{-1}	8.38±0.047	12.58±0.032	20.98±0.017	18.64±0.017
Suaeda maritima compost@ 6.25 t ha^{-1}	9.12±0.047	13.78±0.011	23.38±0.017	20.05±0.023
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	9.85±0.043	15.98±0.017	27.78±0.011	23.45±0.017
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	10.59±0.011	18.38±0.023	32.58±0.017	27.92±0.011
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure 3.13 t ha^{-1} + *Rhizobium* @ 2kg ha^{-1}	11.33±0.023	22.18±0.023	40.18±0.017	34.84±0.017
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @3.13 t ha^{-1} + *Rhizobium @ 2kg* ha^{-1}	12.22±0.023	26.38±0.017	48.58±0.011	42.92±0.023

Table-12:. Effect of different halophytic compost application on dry weight of root nodules in *Vigna mungo* L. Values shown are mean ± S.E. for three replicate experiments.

Treatment	mg Plant^{-1}			
	15th DAS	30th DAS	45th DAS	60th DAS
Untreated check; no organic input	2.19±0.017	3.03±0.023	4.58±0.017	4.15±0.017
Sesuvium portulacastrum compost @ 6.25 t ha^{-1}	2.58±0.023	3.89±0.017	6.48±0.023	5.72±0.023
Suaeda maritima compost@ 6.25 t ha^{-1}	2.82±0.011	4.26±0.011	7.24±0.017	6.21±0.011
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	3.04±0.017	4.93±0.017	8.61±0.011	7.25±0.023
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	3.28±0.017	5.68±0.023	10.09±0.017	8.63±0.023
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure 3.13 t ha^{-1} + *Rhizobium* @ 2kg ha^{-1}	3.51±0.023	6.87±0.023	12.42±0.023	10.78±0.017
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @3.13 t ha^{-1} + *Rhizobium @ 2kg* ha^{-1}	3.78±0.017	8.17±0.017	15.05±0.017	13.29±0.017

Table 13: Effect of different halophytic application on soil pH. Values shown are mean ± S.E. for three replicate experiments.

Treatment	g Plant^{-1}				
	15th DAS	30th DAS	45th DAS	60th DAS	HARVEST
Untreated check; no organic input	7.82±0.017	7.80±0.017	7.77±0.11	7.74±0.017	7.67±0.023
Sesuvium portulacastrum compost @ 6.25 t ha^{-1}	7.76±0.023	7.64±0.017	7.55±0.017	7.32±0.023	7.12±0.023
Suaeda maritima compost@ 6.25 t ha^{-1}	7.75±0.023	7.62±0.023	7.52±0.017	7.28±0.017	7.06±0.017
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	7.74±0.017	7.59±0.011	7.48±0.023	7.23±0.017	6.97±0.011
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	7.73±0.011	7.55±0.023	7.43±0.017	7.17±0.011	6.89±0.017
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure 3.13 t ha^{-1} + *Rhizobium* @ 2kg ha^{-1}	7.72±0.011	7.50±0.017	7.37±0.011	7.10±0.017	6.76±0.028
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @3.13 t ha^{-1} + *Rhizobium @ 2kg* ha^{-1}	7.71±0.017	7.44±0.011	7.30±0.017	7.02±0.023	6.64±0.011

Table-14: Effect of different halophytic application on soil EC. Values shown are mean ± S.E. for three replicate experiments.

Treatment	Soil EC				
	15th DAS	30th DAS	45th DAS	60th DAS	HARVEST
Untreated check; no organic input	0.88±0.017	0.87±0.011	0.85±0.017	0.82±0.017	0.78±0.011
Sesuvium portulacastrum compost @ 6.25 t ha^{-1}	0.87±0.011	0.82±0.011	0.78±0.017	0.71±0.011	0.63±0.011
Suaeda maritima compost@ 6.25 t ha^{-1}	0.86±0.023	0.80±0.011	0.75±0.011	0.69±0.017	0.60±0.011
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	0.85±0.017	0.77±0.011	0.71±0.017	0.64±0.017	0.53±0.017
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @ 3.13 t ha^{-1}	0.84±0.011	0.74±0.017	0.67±0.023	0.58±0.017	0.46±0.023
Sesuvium portulacastrum compost @ 3.13 t ha^{-1} + farmyard manure 3.13 t ha^{-1} + *Rhizobium* @ 2kg ha^{-1}	0.83±0.017	0.70±0.011	0.62±0.023	0.51±0.011	0.36±0.011
Suaeda maritima compost @ 3.13 t ha^{-1} + farmyard manure @3.13 t ha^{-1} + *Rhizobium @ 2kg* ha^{-1}	0.84±0.011	0.66±0.017	0.57±0.011	0.42±0.017	0.26±0.017

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