

Full Length Research Paper

Impact of halophytic compost on growth and yield characteristics of *Vigna radiata* L.

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Accepted 24 May, 2013

Soil fertility is a dynamic concept influenced by climate and cultural practices. Soil organic matter whether fresh or composted plays a vital role in maintaining nutrient availability and thus plant productivity. Field experiments were conducted to evaluate the effects of halophytic herbs which are normally available in coastal areas on growth and yield characteristics of *Vigna radiata* L. From the results, it is observed that among nine treatments given, the application of *Suaeda* compost in combination with farmyard manure (FYM) and phosphate solubilizing bacteria (T₉) significantly increased the growth and yield characteristics of *V. radiata* in salt affected agricultural land at coastal area.

Key words: Halophyte, compost, farmyard manure, *Vigna radiata*.

INTRODUCTION

Organic compost is a very important method of providing the plants with their nutritional requirements without having an undesirable impact on the environment (Adeoye et al., 2011). There has been much discussion on the effect of organic fertilizer and waste compost from pig manure, farmyard manure (FYM), crop residues and ashes on soil properties and crop quality (Abdel-Rahman, 2009; Siavoshi et al., 2011). However, little research has been done on the effect of halophytic compost (compost prepared by using leaves, stem and root of halophytes after decomposition) in relation to plant growth.

Legume (*Vigna radiata* L.) which belongs to the family Leguminosae is commonly known as mungbean or green gram. Its seeds contain 24.2% protein, 1.3% fat and 60.4% carbohydrates (Considine, 1982). The area under pulse cultivation in India is around 24.36 million ha with a production of 14.52 million tones of which mungbean occupies an area of 3 million ha accounting for 14% of total pulses area and 7% of total production (Singh et al., 2004).

Mangrove forest has an important ecological and socio-economic value to man (Agoramoorthy et al., 2008). In India, Tamil Nadu has a coastline of 950 km. Extensive mangrove wetlands are located in Pichavaram of Cuddalore district and Muthupet of Thanjavur district. The Pichavaram mangrove wetland is located in the northern extreme of the Cauvery delta, near the mouth of River Coleroon. Its total area is about 1350 ha and 13 true mangrove species and 20 species of halophytic herbs and shrubs occur naturally in this salt marsh habitat.

Cuevas (1997) recorded the nutrient values of halophytes and observed that nutrient content in halophytes were higher when compared to green manures (glycophytes), while obtained from some species such as *Crotalaria juncea*, *Sesbania aculeate*, *Cyamopsis tetragonoloba* and *Vigna catajung*. However, halophytes accumulate NaCl in their tissues. The present work is based on the concept that, when halophytes are subjected to composting, it is possible that NaCl content present in the tissues will degrade during

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Table 1. Compost treatments and their concentrations.

Treatment	Compost application
T ₀	Unmanured
T ₁	<i>Ipomoea</i> compost 6.25 t ha ⁻¹
T ₂	<i>Sesuvium</i> compost 6.25 t ha ⁻¹
T ₃	<i>Suaeda</i> compost 6.25 t ha ⁻¹
T ₄	<i>Ipomoea</i> compost 3.13 t ha ⁻¹ + FYM 3.13 t ha ⁻¹
T ₅	<i>Sesuvium</i> compost 3.13 t ha ⁻¹ + FYM 3.13 t ha ⁻¹
T ₆	<i>Suaeda</i> compost 3.13 t ha ⁻¹ + FYM 3.13 t ha ⁻¹
T ₇	<i>Ipomoea</i> compost 3.13 t ha ⁻¹ + FYM 3.13 t ha ⁻¹ + phosphobacteria 2 kg ha ⁻¹
T ₈	<i>Sesuvium</i> compost 3.13 t ha ⁻¹ + FYM 3.13 t ha ⁻¹ + phosphobacteria 2 kg ha ⁻¹
T ₉	<i>Suaeda</i> compost 3.13 t ha ⁻¹ + FYM 3.13 t ha ⁻¹ + phosphobacteria 2 kg ha ⁻¹

Table 2. Physicochemical properties of the experimental soil.

Property	Value
A. Physical properties	
Coarse sand (%)	48.86
Fine sand (%)	34.25
Silt (%)	5.58
Clay (%)	10.26
Textural class	Sandy
B. Chemical analysis	
Available N (kg ha ⁻¹)	144.8
Available P ₂ O ₅ (kg ha ⁻¹)	4.85
Available K (kg ha ⁻¹)	156.7
Organic carbon (%)	0.32
Organic matter (%)	0.55
Soil reaction (pH)	7.89
Electrical conductivity (d sm ⁻¹)	1.36

decomposition. Na⁺ in NaCl may chelate with the organic acids produced during decomposition and release the Cl⁻ resulting in the reduction of NaCl content in the plant tissues. Watson (2003) also stated that leaching the compost with water reduce the concentration of soluble salts.

The objectives of this study were to determine the influence of the different halophytic compost in combination with FYM and phosphate solubilizing bacteria on the growth and yield characteristics of *V. radiata* cultivated along the coastal area agricultural soils.

MATERIALS AND METHODS

In the present study, salt marsh halophytes such as *Suaeda maritima* (L.) Dumort., *Sesuvium portulacastrum* L. and *Ipomoea pes-caprae* (L.) Sweet. were used for preparation of composts.

Experimental site

The experiment was carried out at Nadarajapuram village near

Pichavaram Mangrove Forest, 12 km away from Annamalai University. The experimental field is situated at 11° 21' N latitude and 79° 50' E longitude at an altitude of above 5.525 m mean sea level. The experiment outline was entirely randomized block design, with three repetitions. The experiment consists of nine treatments besides control as shown in Table 1.

Compost preparation

Three fast growing and dominant halophytic herbs such as *S. maritima* (L.) Dumort., *S. portulacastrum* L. and *I. pes-caprae* (L.) Sweet were selected for making compost. Well decomposed FYM was mixed with halophytic compost. Phosphobacteria (*Bacillus megatherium* var. Phosphaticum) were obtained from the Department of Agricultural Microbiology, Faculty of Agriculture, Annamalai University, India. Three months of healthy halophytes were harvested from nursery and used for preparation of compost. The plant materials as well as rice straw were chopped well. The substrates were piled loosely in a compost pit and bulky in nature which provide better aeration within the heap. The material was too compact and no heavy weights were put on top. Aeration was provided by placing perforated bamboo trunks horizontally and vertically at regular intervals, to carry air through the compost heap. The fungus *Pleurotus sajor-caju* (Fr.) Singer, was added to the compost heap for best decomposition. The amount of activator used was usually 1% of the total weight of the substrates (Cuevas, 1997). Heat was maintained at 50°C or higher and the heap was turned over every 5 to 7 days for the first 2 weeks and thereafter once in every 2 weeks. Turning over the pile provided adequate aeration and evened up the rate of decomposition throughout the pile. By the end of the 3rd month, the compost was ready for use. It was dark brown, crumbly and had an earthy aroma. The physicochemical characteristics of the experimental soil and the nutrient contents of the selected halophytic compost are presented in Tables 2 and 3.

Field preparation

The field was ploughed with tractor drawn disc plough followed by a thorough harrowing to break the clods. The field was properly leveled and each plot (5 × 4 m size) was earmarked with raised bunds all around to minimize the movement of nutrient. Channels were laid to facilitate irrigation to plots individually. *V. radiata* (Vamban-2) variety was used as experimental plant. The seeds were sown by dibbling 2 to 3 seeds per hill at a depth of 3 to 5 cm and spacing of 15 × 10 cm. Plant samples were harvested for experimental purpose at an interval of 20, 40 and 60 days and

Table 3. Nutrient contents of different halophytic compost at maturity period (90 days).

Treatment	pH	C (%)	N (%)	C:N ratio	P (%)	K (%)	Ca (ppm)	Mg (ppm)	Zn (ppm)	Fe (ppm)	Mn (ppm)	Cu (ppm)	mg/g.fr.wt				Percentage of reduction	
													Before composting		After composting		Na	Cl
													Na	Cl	Na	Cl		
T ₁	7.1	54.00	1.80	30.00	0.68	1.46	1760	1340	8.02	10,176	31.69	160	24	18.0	10	9.0	41.7	50.0
T ₂	7.3	50.20	1.84	27.28	0.71	1.52	1820	1426	8.28	10,194	31.76	174	22	16.5	9.0	8.0	40.9	48.5
T ₃	7.2	47.35	1.92	24.66	0.74	1.61	1958	1554	8.59	10,296	32.62	193	20	15.0	7.5	6.6	37.5	44.0
T ₄	7.0	46.62	2.70	17.26	1.28	1.96	3260	2640	10.49	10,598	34.80	370	-	-	4.5	4.2	-	-
T ₅	6.9	45.59	2.74	16.64	1.31	2.02	3320	2726	10.75	10,616	34.90	403	-	-	3.8	3.5	-	-
T ₆	6.9	43.62	2.82	15.47	1.34	2.11	3458	2854	11.06	10,718	35.73	580	-	-	2.9	2.6	-	-
T ₇	6.6	40.72	2.71	15.02	1.29	1.98	3274	2646	11.52	10,610	35.20	384	-	-	1.6	1.4	-	-
T ₈	6.7	40.61	2.80	14.50	1.32	2.05	3336	2736	11.78	10,627	35.30	426	-	-	1.1	0.9	-	-
T ₉	6.5	40.15	2.83	14.18	1.35	2.14	3474	2865	12.09	10,733	35.80	595	-	-	0.8	0.5	-	-

harvest stage. Always fully expanded second and third leaves of the plants were used for experiments. The matured crop was harvested by leaving the border rows by hand pulling.

Growth analysis

Growth parameters such as shoot length, total number of leaves, fresh weight and total number of nodules were measured immediately after removing the plants from the experimental plots. Leaf area was calculated by using Licor 3100 leaf area meter (LICOR, Model LI-3100, Lincoln, USA). The dry weight of plants was determined after they had been dried at 80°C for 24 h.

Analysis of yield characteristics

The total number of pod and 100 seed weight were measured immediately after removing the plants from experimental plots. The dry weight of pod was determined after they had been dried at 80°C for 24 h.

Soil analysis

The pH of the soil was determined in the ratio 1:2.5 (soil

and water suspension) by using pH meter. The electrical conductivity (EC) was measured in the ratio 1:2.5 (soil and water suspension) by using Elico - conductivity meter. The available sodium was estimated by using flame photometer method (Standford and English, 1949). The available chloride content was estimated by using Mohr's titration method (Jackson, 1973).

Statistical analysis

The results were analyzed by using analysis of variance (ANOVA) and the group means were compared by Duncan's multiple range test (Duncan, 1957). Values are considered statistically significant when $p > 0.05$.

RESULTS

Characteristics of halophytic compost

The experiment was carried out to find out whether the process of decomposition of halophytes reduces the NaCl concentration in the compost. From Table 3, it is concluded that NaCl concentration are drastically reduced, when these

halophytes are subjected to under decomposition. It was also observed from the studies, at the end of decomposition, *Suaeda* compost in combination with FYM and phosphobacteria gaining higher nutrient contents when compared to other halophytic composts. Nutrients such as N, P, K, Ca, Mg and micronutrients were higher in *Suaeda* compost in combination with FYM and phosphobacteria compost. The reduction in pH, organic carbon and C:N ratio was also noticed in *Suaeda* compost in combination with FYM and phosphobacteria compost.

Impact of halophytic compost on the biomass of *Vigna radiata*

In the present study, shoot length was increased due to application of halophytic compost. Application of *Suaeda* compost in combination of FYM and phosphobacteria (T₉) resulted in significant increase in shoot length throughout the study period. After 60 days of treatment when compared to control seedlings (unmanured soil)

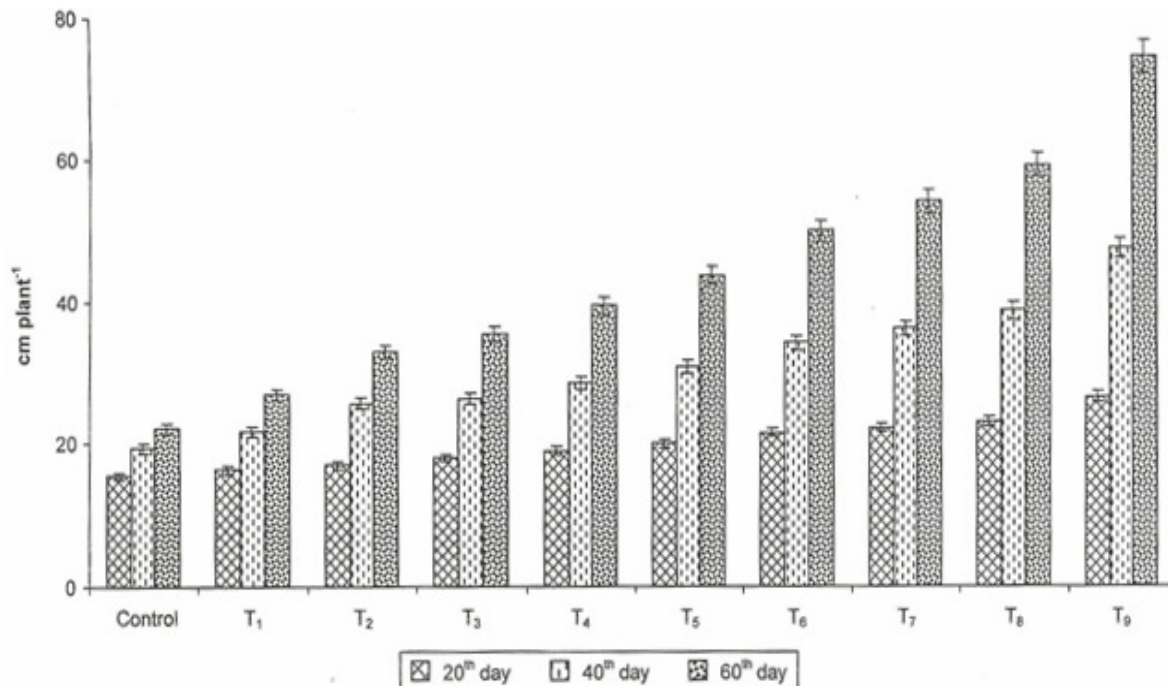


Figure 1. Effect of halophytic compost on shoot length in *V. radiata*. Values shown are mean \pm SE for three replicate experiments.

and other compost the shoot length increased to 57% in T₉ compost (Figure 1) followed by 53% in Sesuvium + FYM + phosphobacteria (T₈) and 49% in Ipomoea + FYM + phosphobacteria (T₇).

The total number of leaves per plant (Figure 2) was significantly increased in all the treatments. The maximum number leaves were recorded in T₉ treatment (50%) than T₈ (44.4%) and T₇ (42.6%) when compared to control and other treatments such as T₆, T₅, T₄, T₃, T₂, and T₁.

Halophytic composts generally increased fresh and dry weight of the seedlings after 60 days of compost treatment. Maximum fresh weight 47% (Figure 3) and dry weight 41% (Figure 4) was recorded in *Suaeda* + FYM + Phosphobacteria (T₉) when compared to control and T₈, T₇, T₆, T₅, T₄, T₃, T₂, and T₁ treatments.

When compared to control and other composts the maximum increase in leaf area (Figure 5) was observed to 50% in T₉ compost, 43.8% in T₈ compost 41% in T₇ compost, respectively.

Application of *Suaeda* composts along with FYM and phosphobacteria (T₉) recorded maximum 91% in total number of root nodules when compared to control and other composts (Figure 6).

Effect of halophytic compost on yield

In the present study, *V. radiata* seedlings grown under different halophytic compost showed significant increase

in number of pods per plant, dry weight of pods and hundred seed weight after 60 days of cultivation. The number of pods per plant increased up to maximum 98.2% in T₉ compost (Figure 7). Similarly, dry weight of pods (58%) was increased in T₉ treatments (Figure 8). Marked increase in 100 seed weight was also observed in plots cultivated with T₉ compost (Figure 9) after 60 days of cultivation. T₉ compost recorded maximum of 66.58% than T₈ compost (56.08%) and T₇ compost (48.18%) when compared to control and other composts treatments.

Effects on halophytic compost on soil properties

The results from the present study also indicated that the halophytic compost treated soil significantly decreased the pH of the soil (Table 3). The pH was reduced to 1.74% in *Suaeda* compost alone treated soil, 3.5% in *Suaeda* compost + FYM treated soil and 5.95% in *Suaeda* compost + FYM and phosphobacteria treated soil when compared to other compost treated soil and unmanured soil during harvest stage.

DISCUSSION

In the present study, it is observed that application of halophytic composts increased growth characteristics in *V. radiata* when compared to its control. Among nine

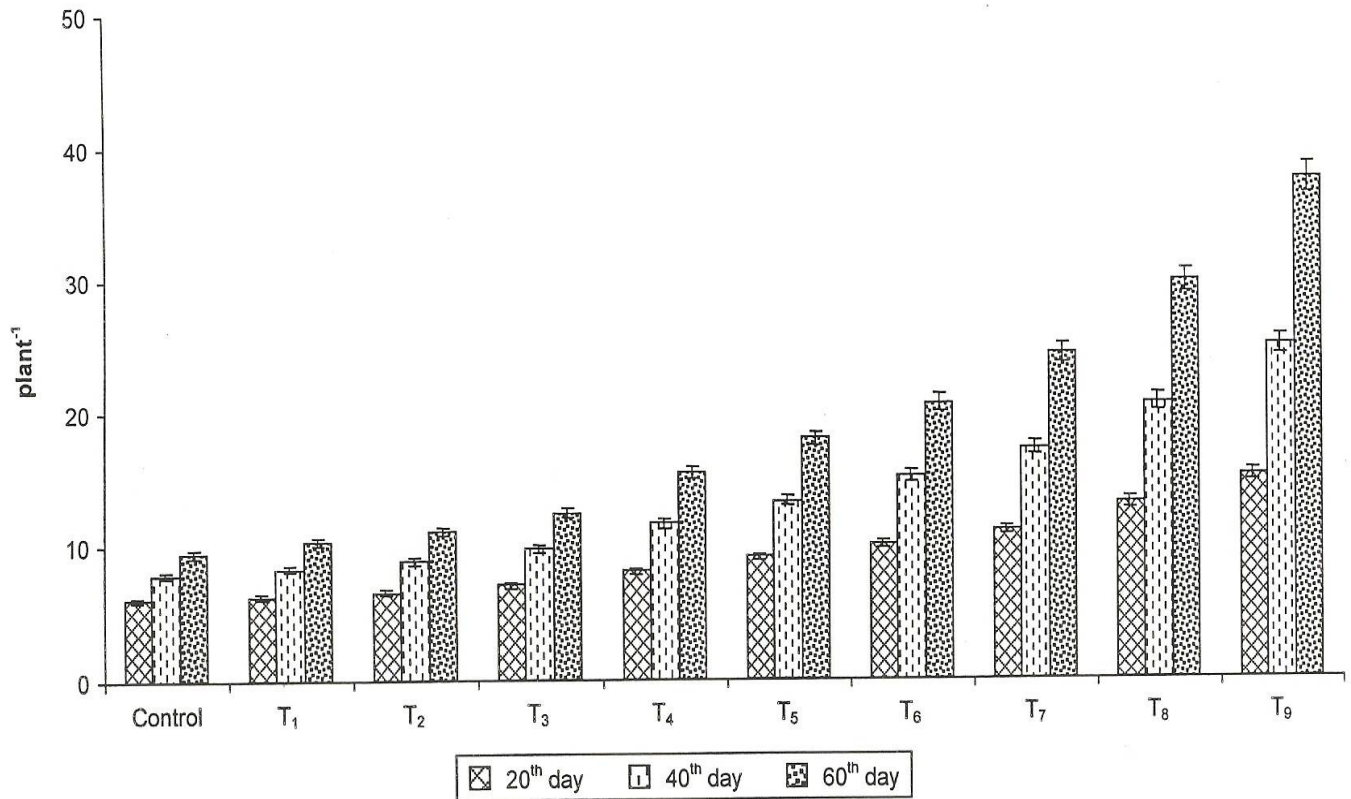


Figure 2. Effect of halophytic compost on total number of leaves in *V. radiata*. Values shown are mean \pm SE for three replicate experiments.

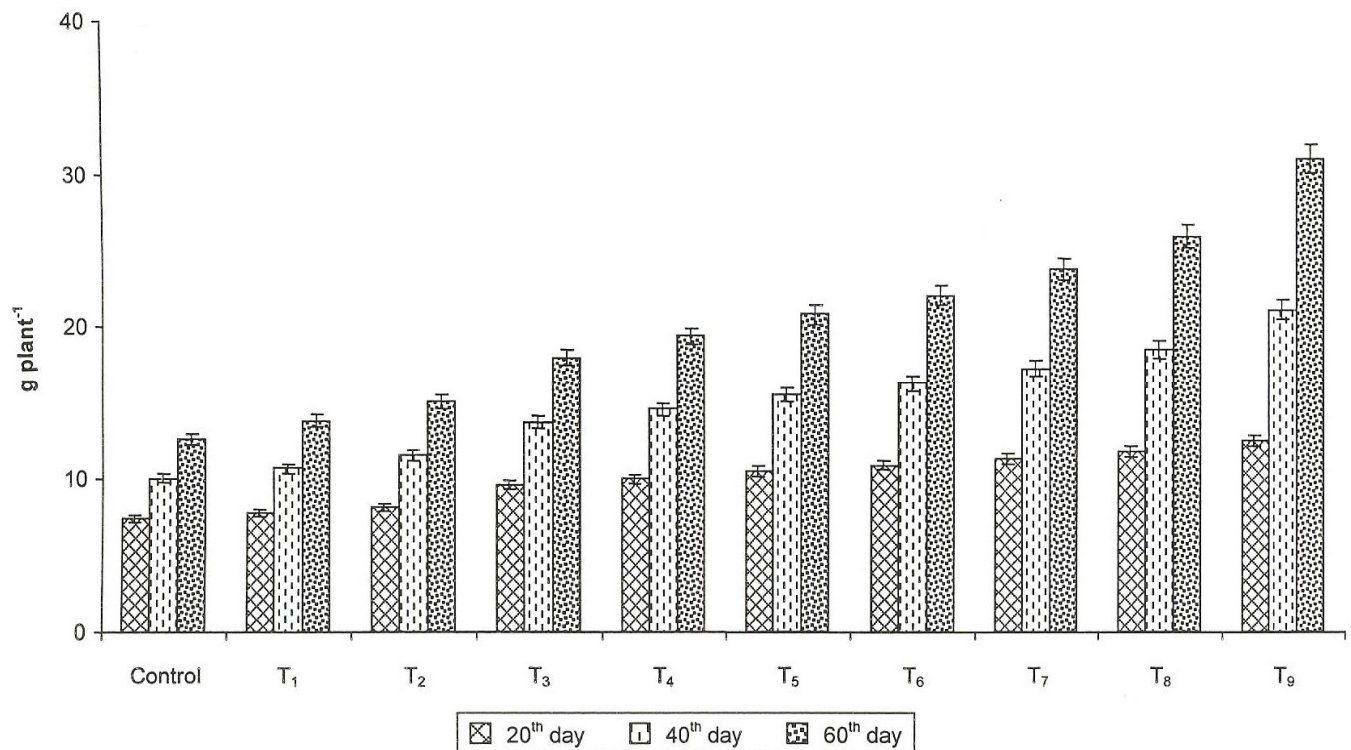


Figure 3. Effect of halophytic compost on fresh weight in *V. radiata*. Values shown are mean \pm SE for three replicate experiments.

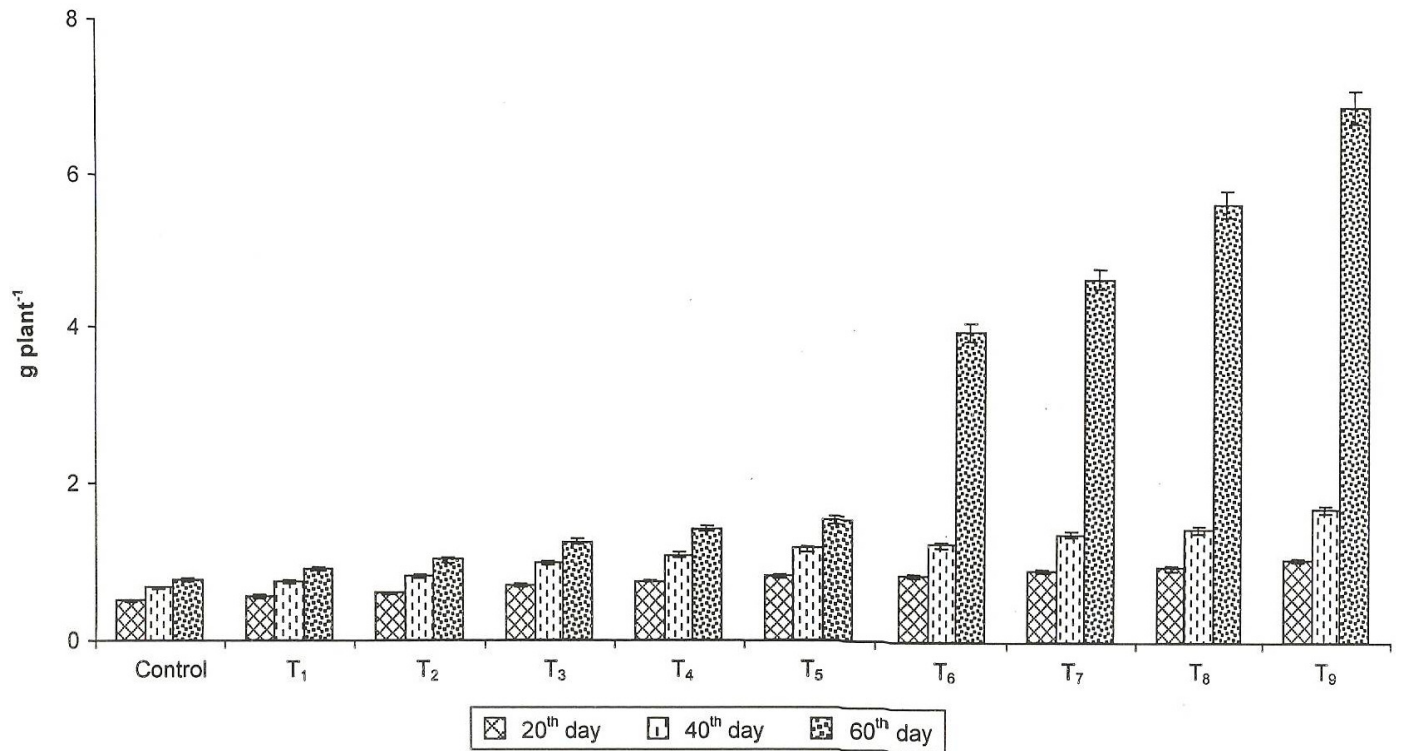


Figure 4. Effect of halophytic compost on dry weight in *V. radiata*. Values shown are mean \pm SE for three replicate experiments.

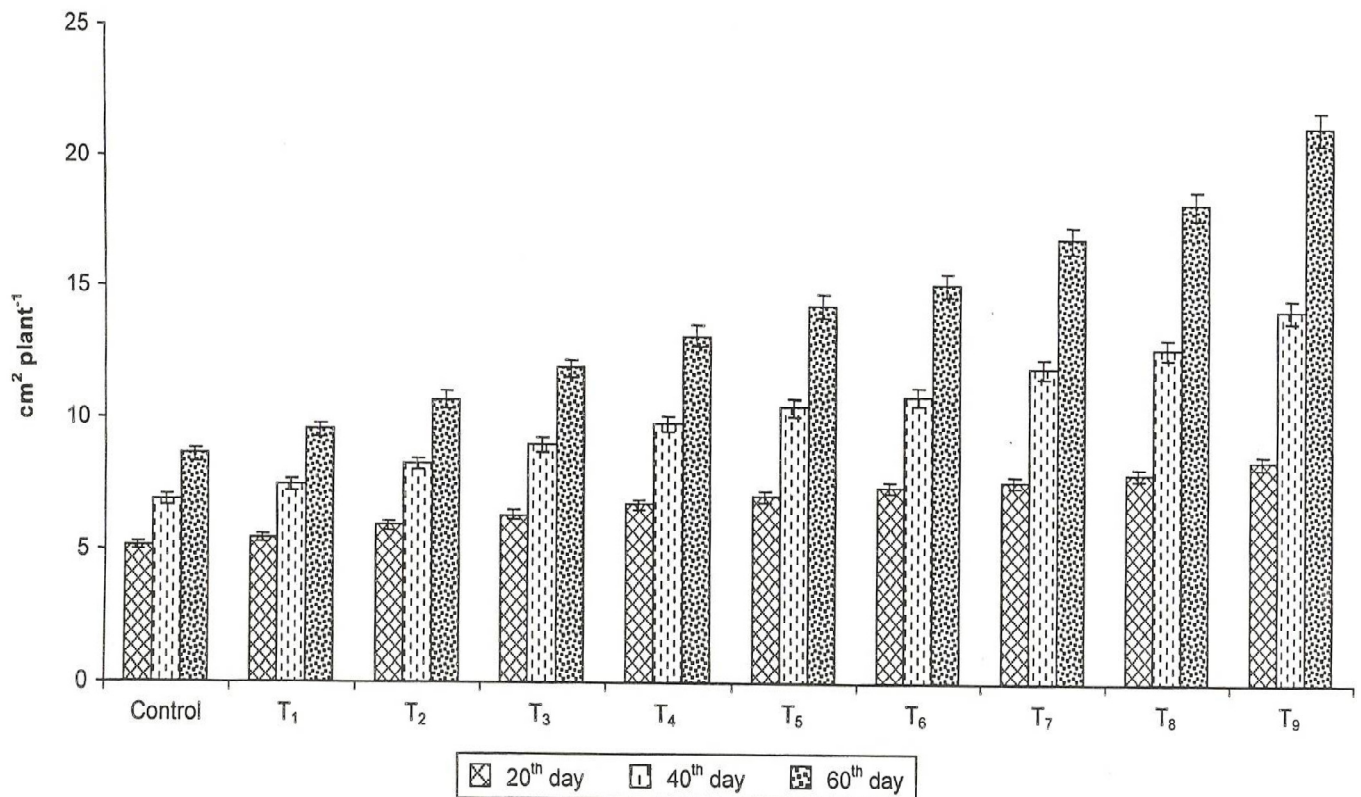


Figure 5. Effect of halophytic compost on leaf area in *V. radiata*. Values shown are mean \pm SE for three replicate experiments.

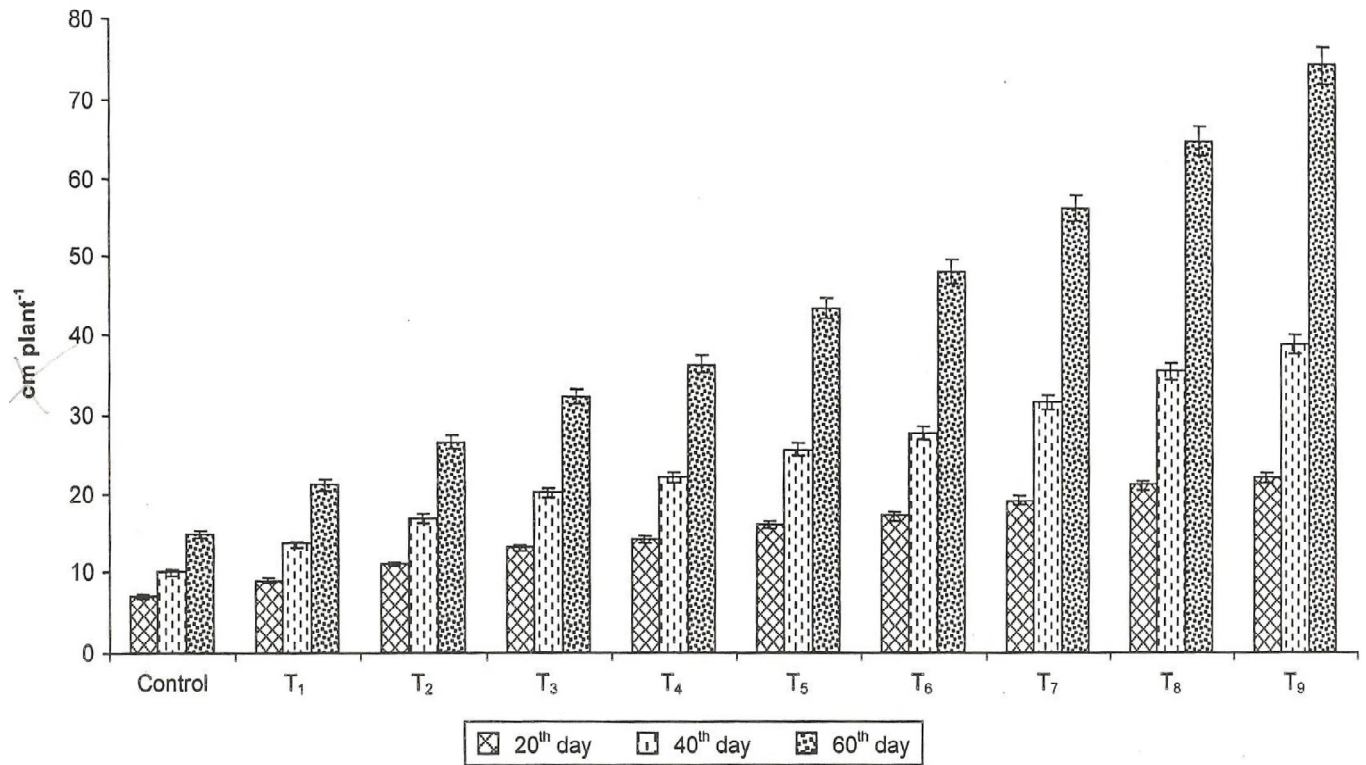


Figure 6. Effect of halophytic compost on total number of root nodules in *V. radiata*. Values shown are mean \pm SE for three replicate experiments.

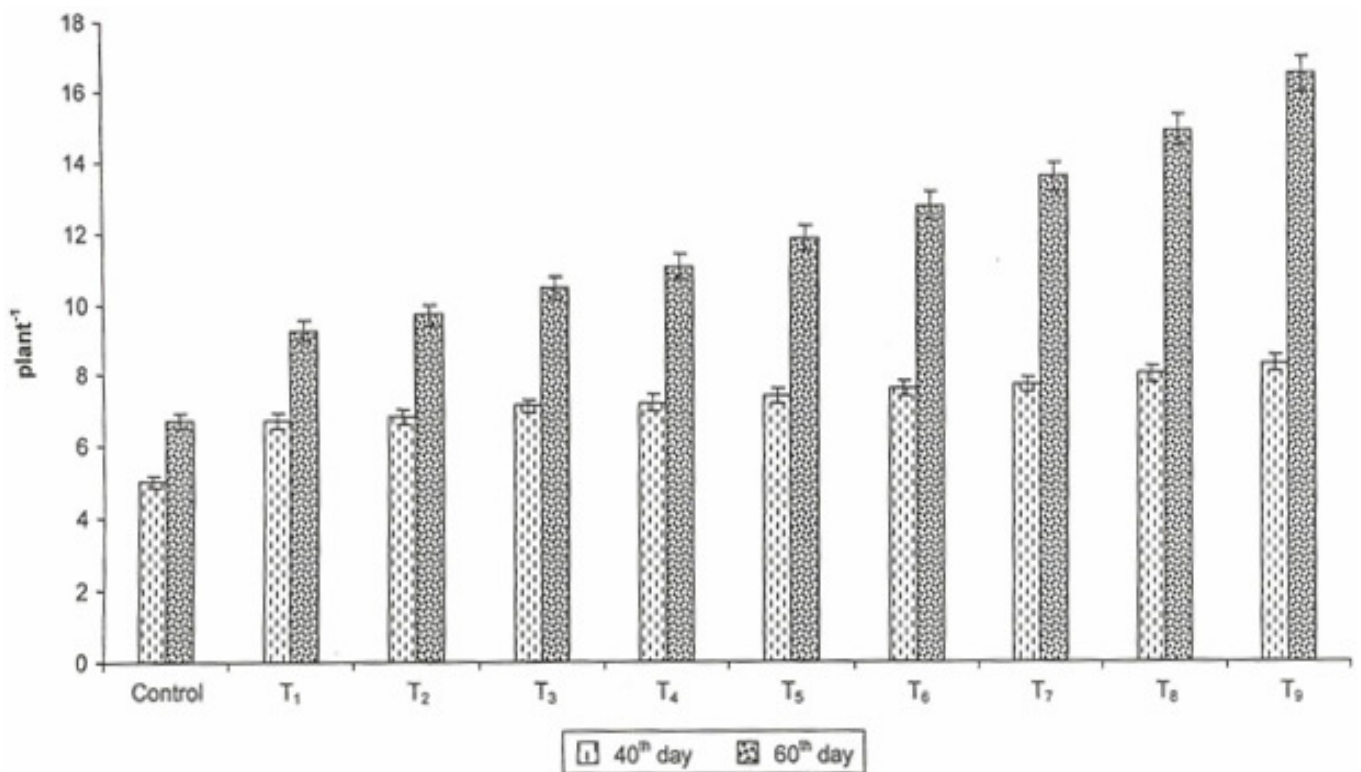


Figure 7. Effect of halophytic compost on number of pod in *V. radiata*. Values shown are mean \pm SE for three replicate experiments.

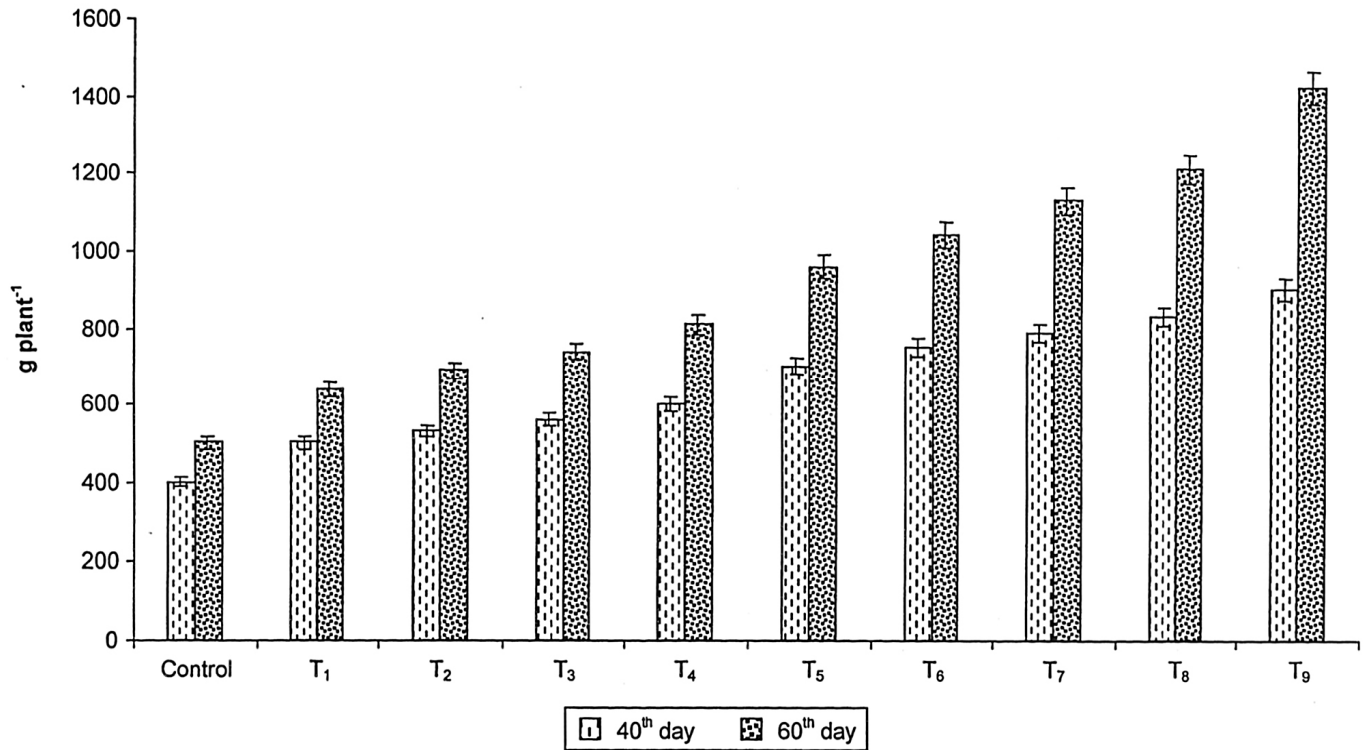


Figure 8. Effect of halophytic compost on dry weight of pod in *V. radiata*. Values shown are mean \pm SE for three replicate experiments.

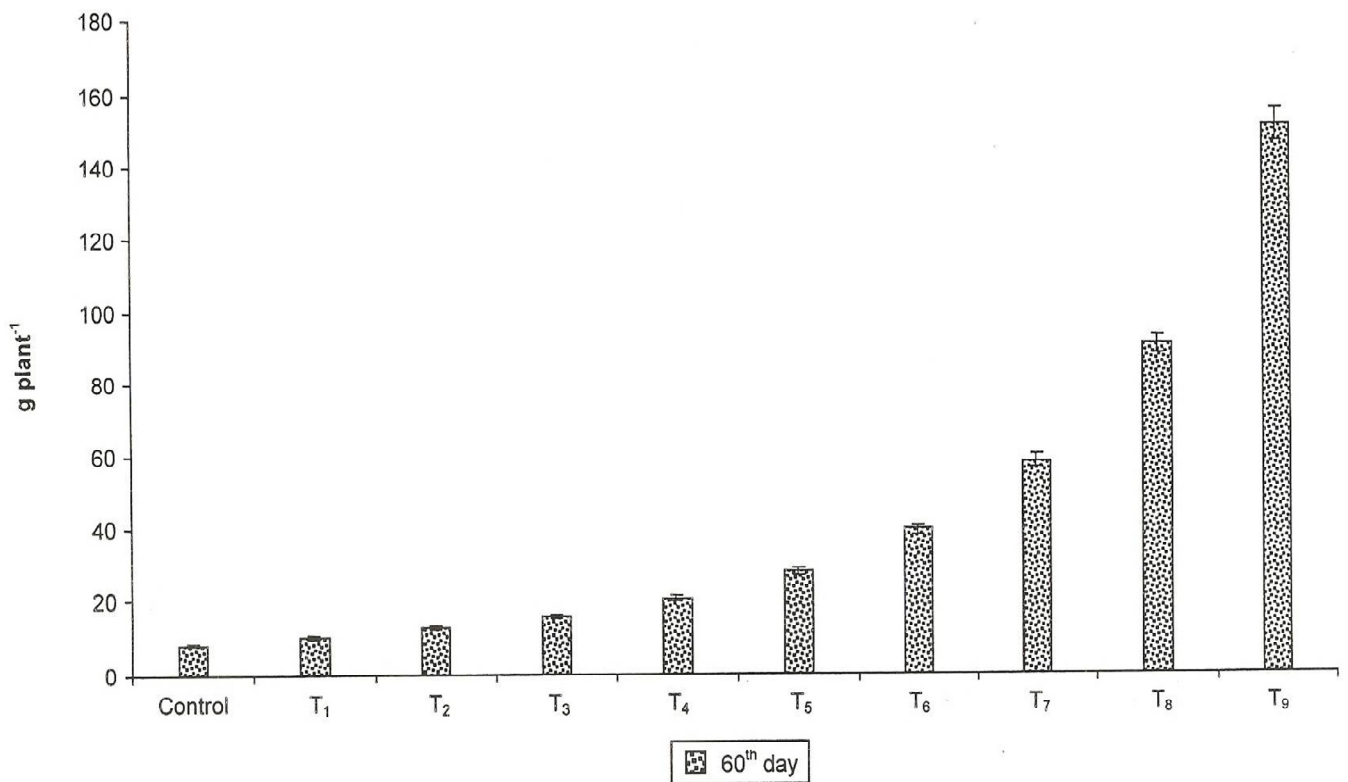


Figure 9. Effect of halophytic compost on hundred seed weight of pod in *V. radiata*. Values shown are mean \pm SE for three replicate experiments.

treatments, taken for study, T₉ compost (*Suaeda* compost + FYM and phosphobacteria) increased the overall growth when compared to control and other treatments. The present observations are in agreement with several findings that application of organics such as FYM and phosphobacteria manures increased the growth parameters to maximum of 40% in plant height in maize (Nanjundappa et al., 2000), 15% in number of leaves in China aster with biofertilizers (Kumar et al., 2003), 24% in leaf area in black gram with biofertilizers (Javid et al., 2003) and 41% in total number of root nodules in *Vicia sativa* with organic manures (Gomaa et al., 2002). Other studies also pointed out, that application of FYM and phosphate solubilizing bacteria increased the leaf area in maize (Nanjundappa et al., 2000). Karanatsidis and Berova (2009) found that application of organic N fertilizer to Pepper plants increased the plant height, leaf size and dry weight. Recently, Balakrishnan et al. (2010) observed that halophytic compost increased number of leaves, fresh and dry weight, and number of branches, leaf area, nodule number and yield in *Vigna mungo*.

In the present study, it is observed that application of halophytic compost significantly increased the growth characters mainly due to presence of higher nitrogen content, low C:N ratio and succulent nature of the compost. This has provided a sustained release of nutrient for the crop growth. In Chickpea, phosphobacter (*B. megatherium* Var. Phosphaticum) produced biotic substances that stimulated plant growth (Gaur, 1990). The positive effect of phosphate solubilizing bacteria enhanced root growth by synthesizing promoting substances, resulted in more nutrient uptake and decreased cell division and expansion (Thirumurugan et al., 1999).

In the present study, it is also observed that application of halophytic compost increased yield characteristics in *V. radiata* when compared to its control. Among nine halophytic compost treatments, T₉ compost (*Suaeda* compost + FYM + phosphobacteria) increased the overall yield when compared to other treatments and control. The present observations are in agreement with several findings that application of organic manures increased the yield parameters to 21% in number of pods, 10.5% in shelling percentage and 37% in hundred kernel weight in groundnut with FYM (Suryanarayana Reddy, 1991), 40% in pod yield and 8.5% in haulm yield in groundnut with green manure (Prasad et al., 2002). Application of composted rice residues also stimulated the grain yield in rice (El-kramany et al., 2010), snap bean with compost (Shehata et al., 2011), fenugreek with organic manure (Khiriya and Singh, 2003). Hati et al. (2001) observed that increasing yield parameters in *Sorghum* due to application of organics attributed to supply of essential nutrients by continuous mineralization of organic manures enhanced inherent nutrient supplying capacity of the soil and its favorable effect on soil physical and biological properties.

From the results, it was observed that halophytic compost decreased the soil pH. The present observations

were in accordance with several findings that application of various organic manures decreased the soil pH nearly 6.5% in poultry manure (Babu and Reddy, 2000) and 5% in FYM treated soil (Sharma et al., 1983). This may be attributed to the release of organic acids from manures which in turn would have reduced the pH by releasing hydrogen ions.

Similar to pH, soil EC was reduced in halophytic compost treated soil and it is evidenced by other studies that addition of organic manures, decreased the soil EC to 16% in biogas slurry (Gopal Reddy, 1997) and 18% in FYM (Sharma et al., 2001) treated soil. The dissolved ions in the soil from halophytic compost and FYM and phosphobacteria could be the reason for decreasing the EC of the soil in the present study. In the present study, it was observed that enhancement of growth parameters was mainly due to combined effect of halophytic composts, FYM and phosphobacteria which are capable of mobilizing the insoluble phosphorus and making it available to crops. The combined beneficial effect of organic manures leads to provide the proper availability of nutrients by releasing the requirement of crop demand and presence of higher nitrogen content, low C:N ratio and succulent nature of the halophytic compost which provided a sustained release of nutrients which leads to better growth.

Conclusion

Results of the present study indicate the feasibility of using halophytic composts in the coastal area to improve soil fertility and productivity. It is concluded that *Suaeda* compost + FYM and phosphobacteria could be used for soil fertility management and also contribute to increase growth and yield of *V. radiata* in coastal area without any toxic effect of salts.

ACKNOWLEDGEMENT

The authors wish to thank University Grants Commission, New Delhi, India for funding the project.

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