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Application of an organic halophytic manure on yield characteristics of *Arachis hypogaea* Linn.

Veluchamy Balakrishnan[1], Krishnamoorthy Venkatesan[2], Kolundu Sanjiviraja[3], Anbazhagan Indrajith[3] and Konganapuram Chellappan Ravindran[3, *]

[1]Department of Biotechnology,K.S.Rangasamy College of Technology,Tiruchengode-637 215, Tamilnadu, INDIA
[2]Regional Research Institute of Unani Medicine, Royapuram, Chennai - 600 013, Tamilnadu, INDIA
[3] Department of Botany, Faculty of Science,Annamalai University,Annamalainagar-608 002, Tamilnadu, INDIA
E-mails:(palanivbalu@rediffmail.com (V.Balakrishnan), drkc_ravi@rediffmail.com (K.C.Ravindran[*]), [*]Corresponding Author)

Abstract

As an alternative to chemical fertilizer, biocompost has been identified to increase the yield characteristics of *Arachis hypogaea* Linn. for sustainable agriculture. The objective of this field study was to evaluate the effect of three different types of halophytic composts in combination with farmyard manure (FYM) and phosphate solubilising bacteria (*Bacillus megaterium*) on yield characteristics such as number of pods per plant, fresh pod weight, dry pod weight , pod yield, haulm yield, shelling percentage and hundred kernel weight. From the results it was is observed that among nine treatments given, the application of *Suaeda* compost in combination with FYM and phosphate solubilising bacteria (T_9) significantly increased the yield characteristics in *Arachis hypogaea* cultivated in coastal saline soil. The resulting halophytic compost improves the quality and fertility of the saline soil.

*Keywords: Arachis hypogaea,*compost,dry weight, haulm yield, phosphate solubilising bactetria

1. Introduction

Shashidhar (1986) reported higher grain yield in finger millet by using horse gram and cowpea as green manuring. *Sesbania rostrata* , a green manure plant, increased the grain and straw yields in ratoon rice (Kumaresan and Rangasamy, 1997) while Muneshwar *et al.* (2001) have shown that combined application of farmyard manure and green manure increased yield content in wheat. Recently, Prasad *et al.* (2002) reported that application of green manures in groundnut increased pod yield by 40% and haulm yield 8.5% and shelling percentage.

The beneficial effect of farmyard manure on sunflower seed yield was reported by Mathers and Stewart (1982). Farmyard manure not only supplied nutrients but also improved soil conditions to produce higher yields (Jagdev and Singh, 2000). Narayanamma *et al.* (1982) and Suryanarayana Reddy (1991) have reported application FYM increased the 10% shelling percentage, 100 kernel weight 32 %, numbers of pods and pod yield per plant in groundnut crop.

Many research studies have shown that combined inoculation with *Rhizobium* and phosphate solubilising micro-organisms increased the yield as well as nitrogen fixing capacity of pulses (Tyagi *et al*., 2002). Gopalaswamy *et al.* (1997) reported that biofertilizer inoculation promoted early tillering and reproductive growth of rice and significantly increased grain-filling percentage and grain weight per plant. Balasubramanian and Palaniappan (1994) reported that use of microbial inoculants in combination with FYM favoured groundnut production. Application of biofertilizer increased the flower weight, number of flowers and yield per plant in China aster when compared with control (Kumar *et al*., 2003). Singh and Pareek (2003) also reported that application of biofertilizer increased the number of pods, number of seeds and Stover yield in mungbean.

The objective of this investigation was to determine the application of the different halophytic compost in combination with FYM and phosphobacteria on the yield characteristics of *Arachis hypogaea* Linn cultivated along the coastal agriculture area of Cuddalore district, South India.

2. Materials and methods

2.1. Experimental site. The experiment was carried at the Thandavaraya Sozhaganpettai 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 5.25 m mean sea level. The experimental outline was an entirely randomized block design, with three replications.

2.2. Compost preparation. After a detailed survey, three fast growing and dominant halophytes such as *Suaeda maritima* (L.) Dumort., *Sesuvium portulacastrum* L. and *Ipomoea pes-caprae* (L.) Sweet were identified for making compost. Well - decomposed FYM was mixed with the halophytic compost. Phosphobacteria (*Bacillus megaterium* var. *phosphaticum*) were obtained from the Department of Agricultural Microbiology, Faculty of Agriculture, Annamalai University, India. Three months growth of healthy halophytes were harvested from the nursery and used for compost preparation. The plant materials as well as rice straw were chopped well. The fungus *Pleurotus sajor-caju* (Fr.) Singer was added to the compost heap to enhance decomposition. The amount of activator used was usually 1% of the total weight of the substrates (Cuevas, 1997). By the end of the third month the compost was ready for use. The soil nutrients nitrogen (Subbaiah and Asija, 1959), phosphorus (Olsen *et al*., 1954) and potassium (Jackson, 1973) were analyzed before starting the experiment.. Nutrients status of composts is given in Table 1.

2.3. Treatment of composts

The different halophytic compost treatments used in present study are given in Table 1

Table 1. 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)	mg/g fr. wt. Before composting		After composting		Percentage of reduction	
													Na	Cl	Na	Cl	Na	Cl
T_1. *Ipomoea* compost 6.25 t ha^{-1}	7.1	54.00	1.80	30.00	0.68	1.46	1760	1340	8.02	10176	31.69	160	24	18.0	10	9.0	41.7	50.0
T_2. *Sesuvium* compost 6.25 t ha^{-1}	7.3	50.20	1.84	27.28	0.71	1.52	1820	1426	8.28	10194	31.76	174	22	16.5	9.0	8.0	40.9	48.5
T_3. *Suaeda* compost 6.25 t ha^{-1}	7.2	47.35	1.92	24.66	0.74	1.61	1958	1554	8.59	10296	32.62	193	20	15.0	7.5	6.6	37.5	44.0
T_4. *Ipomoea* compost 3.13 t ha^{-1} + farmyard manure 3.13 t ha^{-1}	7.0	46.62	2.70	17.26	1.28	1.96	3260	2640	10.49	10598	34.80	370	-	-	4.5	4.2	-	-
T_5. *Sesuvium* compost 3.13 t ha^{-1} + farmyard manure 3.13 t ha^{-1}	6.9	45.59	2.74	16.64	1.31	2.02	3320	2726	10.75	10616	34.90	403	-	-	3.8	3.5	-	-
T_6. *Suaeda* compost 3.13 t ha^{-1} + farmyard manure 3.13 t ha^{-1}	6.9	43.62	2.82	15.47	1.34	2.11	3458	2854	11.06	10718	35.73	580	-	-	2.9	2.6	-	-
T_7. *Ipomoea* compost 3.13 t ha^{-1} + farmyard manure 3.13 t ha^{-1} + phosphobacteria 2 kg ha^{-1}	6.6	40.72	2.71	15.02	1.29	1.98	3274	2646	11.52	10610	35.20	384	-	-	1.6	1.4	-	-
T_8. *Sesuvium* compost 3.13 t ha^{-1} + farmyard manure 3.13 t ha^{-1} + phosphobacteria 2 kg ha^{-1}	6.7	40.61	2.80	14.50	1.32	2.05	3336	2736	11.78	10627	35.30	426	-	-	1.1	0.9	-	-
T_9. *Suaeda* compost 3.13 t ha^{-1} + farmyard manure 3.13 t ha^{-1} + phosphobacteria 2 kg ha^{-1}	6.5	40.15	2.83	14.18	1.35	2.14	3474	2865	12.09	10733	35.80	595	-	-	0.8	0.5	-	-

2.4. Field preparation

The physico –chemical characteristics of the experimental soil are given in table 2.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. Discrete channels were laid to facilitate individual irrigation to plots . VRI-2 groundnut variety was used as experimental plant. The groundnut seeds were sown by dibbling two to three seeds per hill at a depth of 3 to 5 cm and spacing of 30 × 10 cm. Plant samples were harvested for experimental purpose at intervals of 20, 40, 60, 80 days and harvest stage. 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.

Table 2. Physico-chemical properties of the experimental soil

Properties	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_2O_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 (dS m^{-1})	1.36

2.5. Yield analysis

Yield characteristics such as the number of pods, fresh pod weight, dry pod weight, pod yield, haulm yield, shelling percentage and hundred kernel weights were estimated immediately after removing the plants from the experimental plots. The dry pod weight was determined after they had been dried at 80◦ C for 24 hour.

2.6.Economic analysis

Return ha^{-1} was calculated by subtracting the cost of cultivation from the gross return. The return per rupee invested was calculated as follows in Table 3.

$$\text{Return per rupee invested (Benefit cost ratio)} = \frac{\text{Gross return (Rs. ha}^{-1})}{\text{Cost of cultivation (Rs. ha}^{-1})}$$

2.7. Statistical analysis

The results were analyzed 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 $p < 0.05$.

3. Results

All the halophytic compost treated plants showed a significant increase in number of pods per plant. The number of pods per plant was increased by 6 %, fresh pod weight by 7 %, dry pod weight by 2.59 %, pod yield by 8.76 %, haulm yield by 1.42 %, the shelling percentage was increased to 2.54 %, a marked increase in hundred kernel weight of 10 % were observed in *Suaeda* compost alone treated soil (T_3). The number of pods per plant was increased 14 % , fresh pod weight by 18 %, the dry pod weight by 7.20 %, pod yield by 24.08 %, the haulm yield by 5.12 %, shelling percentage by 5.22 % and hundred kernel weight by 23 % in *Suaeda* compost plus FYM treated soil (T_6). The number of pods per plant was increased by 25 %, fresh pod weight 35 %, dry pod weight by 15.40 %, pod yield by 44.52 %, haulm yield was significantly increased by 9.91 %, shelling percentage increased by 11.20 % and hundred kernel weight by 40 % in *Suaeda* compost + FYM and phosphobacteria treated soil (T_9) when compared to other compost treated soil and control (Figures 1 to 7). Details of the cost of cultivation and net return per rupee invested are furnished in Table 3. Combined application of halophytic compost, FYM and phosphobacteria resulted in higher net returns. The maximum net returns of Rs. 22,615 ha^{-1} over unsubstituted control was obtained from T_9 treatment which was followed by T_8 (Rs. 19,293 ha^{-1}) and T_7 (Rs. 17,090 ha^{-1}).

Table 3. Application of halophytic compost on groundnut Economics of cultivation

Treatments	Pod yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Gross income (Rs. ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Net income (Rs. ha^{-1})	Return per rupee invested (B:C ratio)
Control	1370	3767	21,717	15,000	6,717	1.44
T_1	1395	3778	25,328	17,000	8,328	1.48
T_2	1435	3796	26,196	17,000	9,196	1.54
T_3	1490	3820	27,420	17,000	10,420	1.61
T_4	1530	3866	30,341	18,200	12,141	1.67
T_5	1600	3880	31,755	18,200	13,555	1.74
T_6	1700	3960	33,935	18,200	15,735	1.86
T_7	1760	4040	35,490	18,400	17,090	1.93
T_8	1850	4083	37,693	18,400	19,293	2.05
T_9	1980	4140	41,015	18,400	22,615	2.21

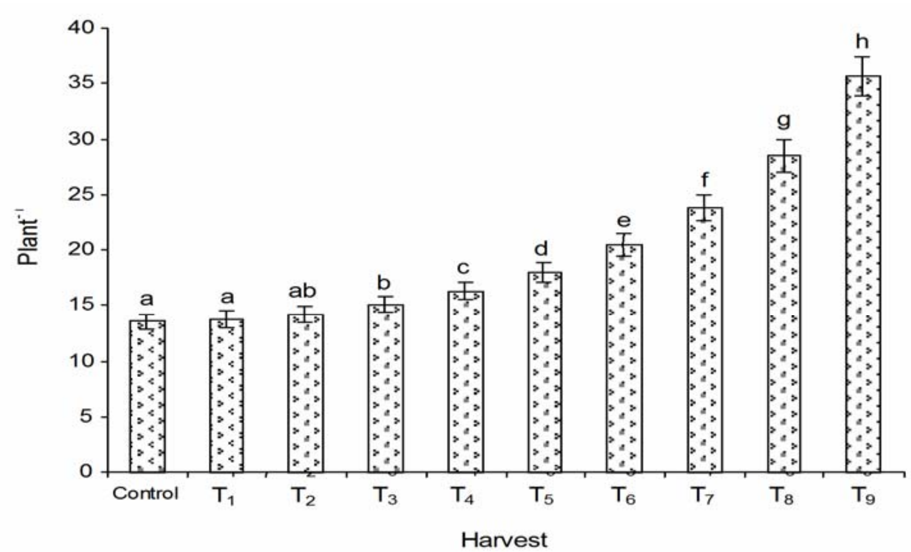

Fig. 1

Figure 1. Effect of different halophytic compost application on number of pods per plant in *Arachis hypogaea.* Values shown are mean ± S.E. for three replicate experiments. Different letters above bars indicates a significant difference at $p < 0.05$ according to Duncan's multiple range test.

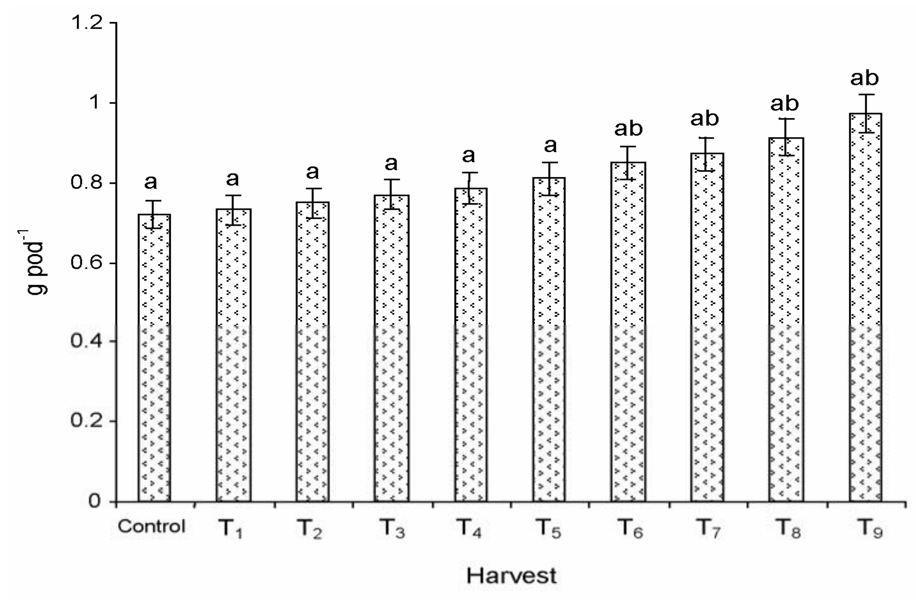

Fig. 2

Figure 2. Effect of different halophytic compost application on fresh weight of pod in *Arachis hypogaea.* Values shown are mean ± S.E. for three replicate experiments. Different letters above bars indicates a significant difference at $p < 0.05$ according to Duncan's multiple range test.

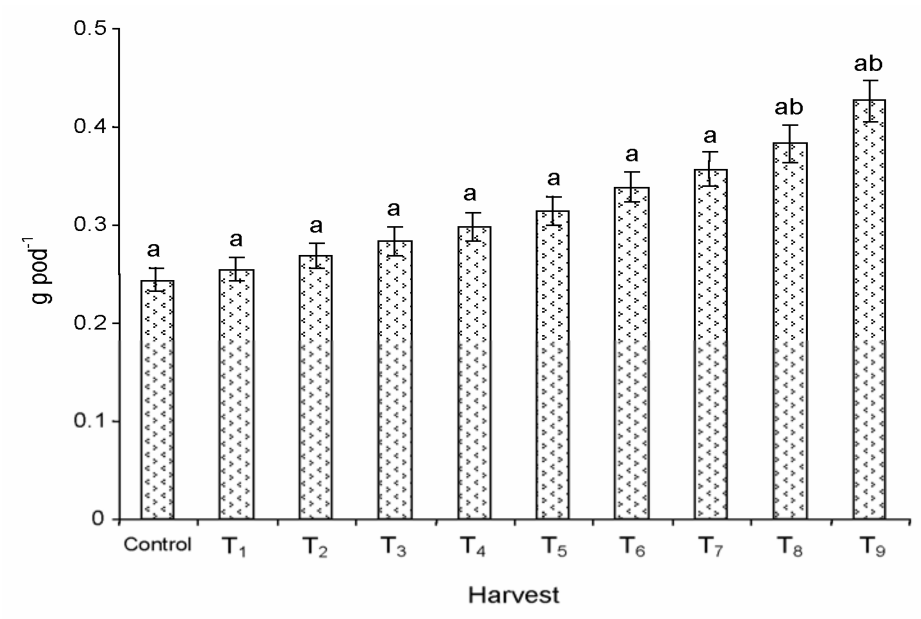

Fig. 3

Figure 3. Effect of different halophytic compost application on dry weight of pod in *Arachis hypogaea.* Values shown are mean ± S.E. for three replicate experiments. Different letters above bars indicates a significant difference at $p < 0.05$ according to Duncan's multiple range test.

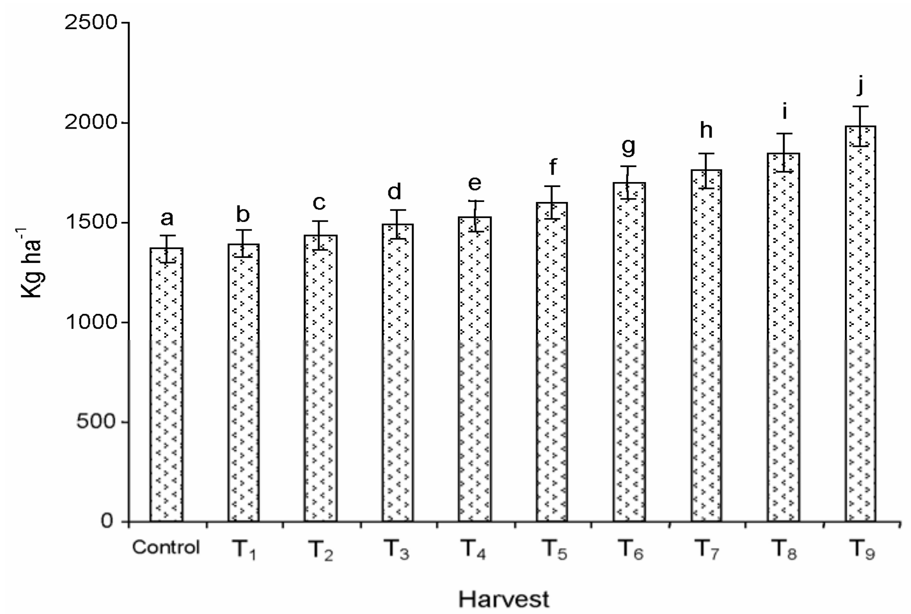

Fig. 4

Figure 4. Effect of different halophytic compost application on pod yield in *Arachis hypogaea.* Values shown are mean ± S.E. for three replicate experiments. Different letters above bars indicates a significant difference at $p < 0.05$ according to Duncan's multiple range test.

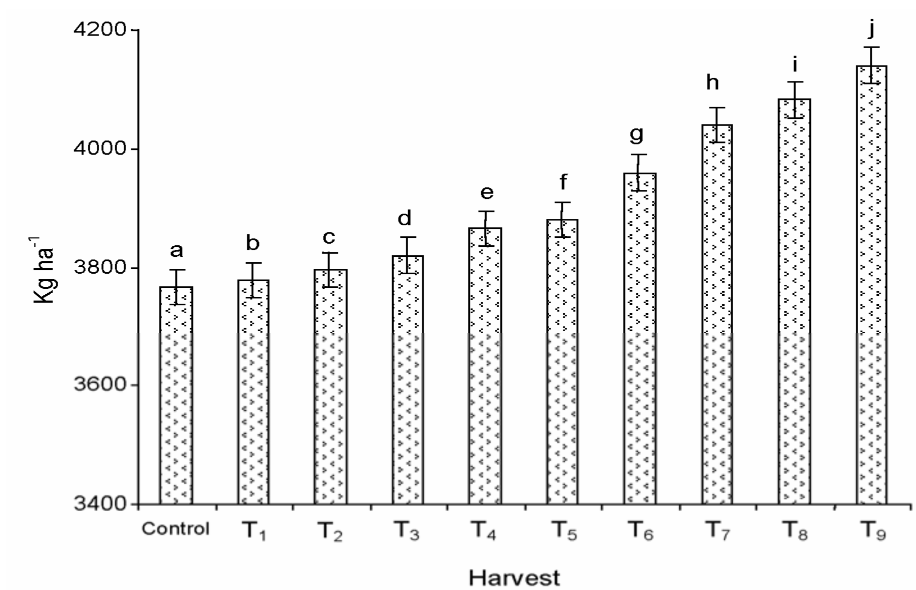

Fig. 5

Figure 5. Effect of different halophytic compost application on haulm yield in *Arachis hypogaea.* Values shown are mean ± S.E. for three replicate experiments. Different letters above bars indicates a significant difference at $p < 0.05$ according to Duncan's multiple range test.

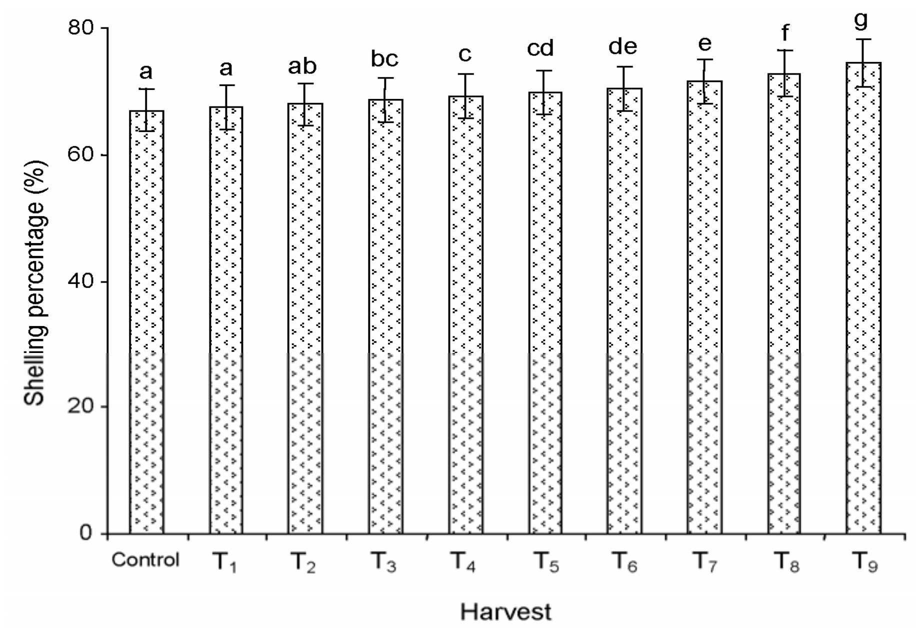

Fig. 6

Figure 6. Effect of different halophytic compost application on shelling percentage in *Arachis hypogaea*. Values shown are mean ± S.E. for three replicate experiments. Different letters above bars indicates a significant difference at $p < 0.05$ according to Duncan's multiple range test.

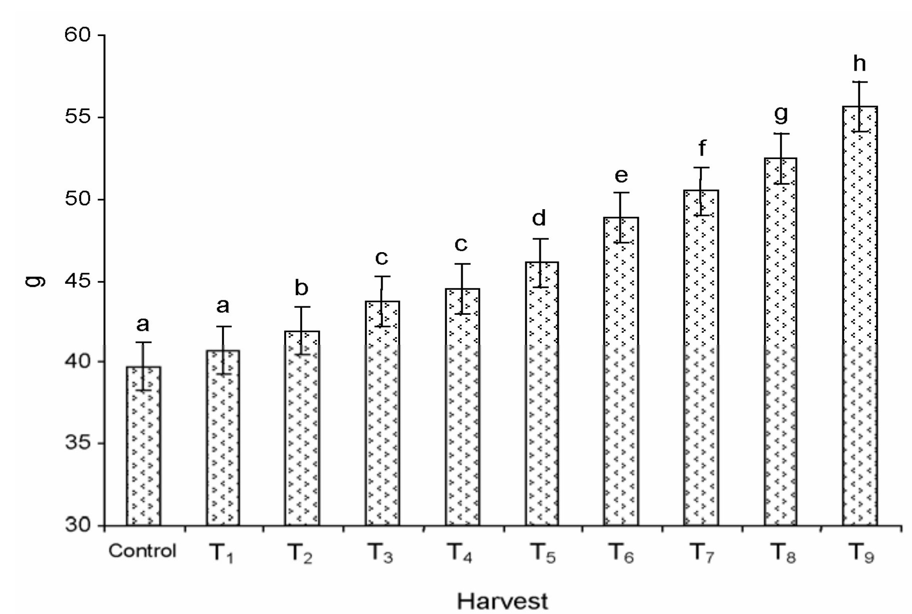

Fig. 7

Figure 7. Effect of different halophytic compost application on 100 kernel weight in *Arachis hypogaea*. Values shown are mean ± S.E. for three replicate experiments. Different letters above bars indicates a significant difference at $p < 0.05$ according to Duncan's multiple range test.

4. Discussion

Present study, application of halophytic compost has increased yield characteristics in *Arachis hypogaea* when compared to its control. Among 9 halophytic compost treatments T_9 compost (*Suaeda* compost + FYM + phosphobacteria) increased the overall yield when compared to other treatments and control.

These observations are in agreement with earlier findings that consider the application of organic manures increased the yield parameters to 21 per cent in number of pods, 10.5 per cent in shelling percentage and 37% in hundred kernel weight in groundnut with farmyard manure (Narayanamma *et al*., 1982; Suryanarayana Reddy, 1991; Balakrishnan *et al*., 2009) or 40% in pod yield and 8.5% per cent in haulm yield in groundnut with green manure (Prasad *et al*., 2002).

Application of green manure also stimulated the grain yield in finger millet (Shashidhar, 1986), in rice (Kumaresan and Rangasamy, 1997) in rice with coirpith and FYM (Parasuraman and Mani, 2003), wheat with FYM (Muneshwar *et al*., 2001), rice and wheat with crop residue (Das *et al*., 2003), number of pods in mungbean with biofertilizer (Singh and Pareek, 2003), in *Vicia sativa* with organic manure (Gomaa *et al*., 2002), fenugreek with organic manure (Khiriya and Singh, 2003) fresh and dry weight of pod in groundnut with FYM (Suryanarana Reddy, 1991), seed yield in sunflower with FYM (Mathers and Stewart, 1982) and senna with FYM (Ramamoorthy *et al*., 2003).

Anburani *et al*. (2003) stated that readily available nitrogen from the application of FYM and biofertilizer may be the prime factor for the increased fruit weight, length and girth in brinjal. The residual effect of FYM was also found significant on the grain yield of mungbean in wheat-mungbean crop sequence by Sharma (1981). Increasing yield parameters in *Sorghum* due to application organics was attributed to the supply of essential nutrients by continuous mineralization of organic manures, enhanced inherent nutrient supplying capacity of the soil and its favorable effect on the soil physical and biological properties of soil (Hati *et al*., 2001).

Enhancement of yield parameters due to soil application of certain organic manures (enriched bio-digested slurry) and biofertilizer (phosphobacteria) might result from the phosphobacteria which are capable of mobilizing insoluble phosphorus and making it available to crops (Marimuthu *et al*., 2003). Rao and Shaktawat (2002) suggested that FYM and poultry manure increase yield attributes in groundnut due to improvement in rhizosphere environment. From an agricultural point of view, a cost/benefit analysis of halophytic (*Suaeda* compost + FYM with phosphobacteria (T_9)) compost application should also be conducted. T_9 compost application considerably increased the gross return over unsubstituted control. The higher increase in gross return was mainly due to the combined effects of increased uptake of nutrients in plants, available nutrients, microbial population and soil enzymatic activities which leads to higher pod, haulm and hundred kernel weight yields.

In the present study, the halophytic composts increased the yield characters significantly in *Arachis hypogaea*. This may be due to the accelerated mobility of photosynthates from the source to sink as influenced by the growth hormone synthesized due to the organic sources.

5. Conclusion

When compared to control, yield parameters such as number of pods, pod yield, shelling percentage, haulm yield, hundred kernel weight, fresh and dry weight were increased in compost treated field, especially with T_9 treatment. Increased yield parameters in the present study may be associated with the 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.

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Biographical notes

Dr. Veluchamy Balakrishnan is an Assistant Professor in the Department of Biotechnology, K.S.Rangasamy College of Technology, Tiruchengode, Tamilnadu State, India. His research area interest is Environmental conservation of natural ecosystem, Conservation of Mangroves. He is presently supervising six Ph.D Research Scholars in Anna University-Coimbatore and Bharathiar University, Coimbatore, Tamilnadu State. He has produced 18 M.Phil, Research Scholars in the disciplines of Botany, Biotechnology, Biochemistry and Environmental science. He has published five National Journals and 34 International Journals and attended more than 18 conferences. He is awarded 12 honours, fellowship and rank in the academic including Young Scientist Fellowship Award from Tamilnadu State Council for Science and Technology.

Dr. Krishnamoorthy Venkatesan is working as a senior scientific assistant in Botany, Regional Research Institute of Unani Medicine, Royapuram, Chennai, and Tamilnadu, India.

Kolundu Sanjiviraja is working as a Ph.D Research Scholar in Annamalai University, Annamalainagr, India.

Anbazhagan Indrajith is working as a Ph.D Research Scholar in Annamalai University, Annamalainagr,India.

Prof. Konganapuram Chellappan Ravindran is working as a Reader in Botany, Faculty of Science, Annamalainagar, Tamilnadu, India.He got his Doctoral degree from Maduarai Kamaraj University , Maduari under the Supervision of Dr.G.Kulandaivelu. He has produced three Ph.D.Research Scholars and presently supervising two Ph.D Research Scholars in the area of saline Soil reclamation in Tsunami affected soils. His area of Specialization is Light intensities in spices plants, UV-B radiation on Leguminous plants. He has produced 14 M.Phil research Scholars in the field of Botany.

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