

Productive Zones for Commercial Cultivation of *Salicornia brachiata* in Some Estuarine Habitats of Andhra Pradesh, East Coast of India

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Abstract

Original Research Article

Salicornia brachiata is a halophyte belongs to family Amaranthaceae popularly known as sea asparagus used as vegetable, fodder, seeds of this plant yield high quality edible oil, seeds also sources for extraction of bio fuels. In recent years plants are commercially cultivating for extraction of green salt/salt. Godavari estuary supports the growth and development of *Salicornia* plant populations. In this present study suitable regions for commercial cultivation of *Salicornia brachiata* was identified through physico chemical and sediment analysis of some selected estuarine habitats such Vamsadhara estuary (Bhavanapadu), Gautami Godavari estuary (Kothapalem), Vainateyam Godavari estuary (Odalarevu), Vashista Godavari estuary (Biyyaputippa) and Krishna estuary (Sarlogondi) of Andhra Pradesh. Sediment samples were collected during the month of November 2024 in all study sites. Salinity of sediment samples were varied from 25 to 33 ppt in all five study sites, soil salinity increases with increased distance from the creek. pH of the sediment samples varied from 7.6 to 7.9 and minimum pH value was recorded in Sarlogondi Reserve Forest of Krishna estuary. Percentages of soil particles such as sand, silt and clay contents varied in the sediment samples. Sand particles in the sediments ranged from 12 to 16 %, silt varied from 47 to 60% and clay ranged from 27 to 40 % in all five study sites. Earlier results revealed that *Salicornia* populations prefer to grow in high saline regions where low percentages sand particles and high percentages of silt and clay particles in the sediment. Based on the obtained results in this present study it may be suggested that *Salicornia brachiata* can be cultivated in all above five study sites of estuarine regions of Andhra Pradesh.

Keywords: *Salicornia brachiata*, physico chemical and sediment analysis, productive zones, East Coast of India. AP.

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INTRODUCTION

Mangroves are evergreen tidal forests occurs in estuarine habitats between land and sea; these aquatic ecosystems are highly productive ecosystems on the earth which converting the litter into organic matter and finally food for the aquatic organisms and avian species. Mangrove forests comprise of three different groups of plant communities which occupies specific zones of their adaptability. Halophytes are salt tolerant mostly herbaceous plants grows in transitional zone between terrestrial plants and mangrove plants, while associated mangroves are existing in between mangroves and halophytic populations, mangroves occupy near to the creek or edge of the canals. Halophytes were utilized as food, fodder, fertilizer and applied in several medicinal formulations by local inhabitants. Halophytes are commercially valuable as their usage in bio saline agriculture as vegetables, extraction of edible oil and biofuels (Glenn *et al.*,1991 and Webner *et al.*,2007).

Species of halophytes are sources for detection of unique secondary metabolites which used as antimicrobial, antioxidant and anticancer agents. However, scientific information about the biological effects of halophytic plants is poorly documented. The genus *Salicornia* is one of the important halophytes commonly known as sea asparagus are cooked, pickled and fodder for livestock (Narasimha Rao,2014). *Salicornia* seeds are good sources for extraction of high-quality edible oils (Narasimha Rao *et al.*,2015), antimicrobial activity was reported in *Salicornia brachiata* (Prasanna Lakshmi *et al.*,2015). Along the coastal regions of Andhra Pradesh some perennial rivers merging with Bay of Bengal, and these estuarine habitats support the growth and development of halophytes especially *Salicornia*. Commercial cultivation of *Salicornia* (Fig.1) will reclaim the saline soils, further the waste saline infected lands turn into green fields and fertile lands. Cultivation of these plant species certainly generate the employment opportunities for local inhabitants. As a whole these

populations can act as sink for the carbon dioxide. Intrusion of salt water into agricultural lands is common problem in the recent years due to aquaculture and urbanization. So commercial cultivation of *Salicornia* will help the reclaim the saline soils further generate income through the cultivation of this species. *Salicornia* is an annual herb which completes its life cycle within 10 months.

Mangrove populations including halophytic vegetation of estuarine habitats of Andhra Pradesh were studied by several authors (Umamaheswara Rao and Narasimha Rao, 1988; Venkanna and Narasimha Rao, 1993; Narasimha Rao, 2008; Narasimha Rao and Subba Rangaiah, 2010; Narasimha Rao and Murthy, 2010a; 2010b; Narasimha Rao, 2012; Narasimha Rao *et al.*, 2012; Narasimha Rao, 2014, Narasimha Rao, 2018, 2020; Narasimha Rao and Lohitasyudu 2023). Several authors studied the ecological and experimental studies on the species *Salicornia brachiata* (Satish *et al.*, 1991; Narasimha Rao *et al.*, 2012; Narasimha Rao and Reddi, 2013, Narasimha Rao *et al.*, 2015; Narasimha Rao and Murthy, 2015; Prasanna Lakshmi *et al.*, 2015). In this present study an attempt was made to identify the potential regions for commercial cultivation of *Salicornia brachiata* in some estuarine habitats of Andhra Pradesh. Several mangrove and estuarine habitats are prevailing in coastal regions of Andhra Pradesh but some places such as estuarine habitats of Sarada and Varaha; mangrove habitats of Visakhapatnam are not suitable for *Salicornia* cultivation due to industrialization and anthropogenic activities. Physico chemical features and sediment analysis were conducted in selected stations during the month of November 2024 to identify the suitable regions for commercial cultivation of *Salicornia brachiata*.

MATERIALS AND METHODS

Estuarine regions of Vamsadhara, Gautami Godavari, Vainateyam, Vashista, Krishna were selected for this study. Mangroves of Godavari estuary distributed from Kakinada to Narasapur along with different branches of river Godavari. Distribution of *Salicornia brachiata* in relation to physico chemical features and composition of soil particles in Gautami Godavari estuary was studied earlier (Narasimha Rao and Murthy, 2015). In this present investigation physico chemical studies and soil particle composition were carried out in Vamsadhara estuary near Bhavanapadu (latitudes and longitudes are 18° 32' 73" N 84° 19' 80" E), Kotha palem (latitudes 16° 31' N and longitudes 82° 17' E) region of Gautami Godavari estuary, Vainateyam estuary near Odalarevu (latitudes and longitudes are 16° 25' 24" N and 81° 58' 14" E), Biyyaputippa (latitudes 16° 33' N and longitudes 81° 70'E) region of Vashista estuary and Sarlogondi Reserve Forest (latitudes 15° 55' N and longitudes 80° 42' E) region of Krishna estuary. Soil samples were collected during the month of November 2024 (post monsoon season) At each study site; soil samples were collected from waterfront to

barren zone or end of the mangrove forest. Depending upon the width of the forest from creek edge to barren zone, soil sample collections were collected at 15 M interval. Sampling size in different regions was varied due to width of the forest. Sediment samples from different regions of the intertidal region clearly shows the soil types and physico chemical features which support the growth and development of halophytes including *Salicornia*. Soil salinity and soil pH were measured by portable salinometer and pH meters respectively, Sediment analysis was done by the pipette method (Craver, 1971).

RESULTS AND DISCUSSION

Information collected on physico chemical parameters and soil or sediment analysis from five different areas in estuarine regions of Andhra Pradesh was presented in Tables 1 to 5. In all the five study sites soil salinity of sediment samples varied from 25 to 33 ppt salinity. (Tables 1-5), soil salinity varied from edge of the creek to barren zone or halophytic populations. Soil salinity increases with increased distance from the creek. In Vamsadhara estuary, Bhavanapadu, 28ppt salinity was recorded at edge of the creek or "0" M distance while at 30M distance from the creek 32 ppt salinity was recorded. In Kothapalem region of Gautami Godavari, soil salinity was varied from 26 (creek edge) to 32 ppt (at 60 M distance from creek edge). Soil salinity gradually increased from edge of the creek to 60 M away from the forest (table 2). In Odalarevu region of Vainateyam Godavari estuary, soil salinity was varied from 29 (creek edge) to 33 ppt (45 M distance from creek edge, table 3). Soil salinity at Biyyaputippa region of Vashista Godavari estuary varied from 28ppt (creek edge) to 33 ppt (45 M distance from the creek edge, table.4). In Sorlagondi Reserve Forest region of Krishna estuary soil salinity varied from 25 ppt to 32 ppt, soil salinity increased with increased distance from the edge of the creek (Table 5). In all study sites pH of the sediment samples varied from 7.6 to 7.9 (Tables 1 to 5), and minimum pH values were recorded in Sorlagondi Reserve Forest of Krishna estuary (Table 5). Analysis of the sediment samples shows that there was a gradual increase in the sand particles percentage from water front to barren zone or end of the forest (Tables 1 to 5), likewise silt and clay percentages were varied from "0" M to 60 M distance from the creek in all study sites in this study (Tables 1-5). Results of this study agrees with the investigations of Bhaskara Rao *et al* (1992) on sediment analysis of mangroves of Godavari estuary. Bhaskara Rao *et al* (1992) reported that high density of mangroves was observed where sand particles were minimum and high percentages of silt and clay particles were reported.

Narasimha Rao and Dora (2009) studied the distribution in relation to salinity and pH of the soil samples along the transect lines and observed that true mangroves occur very near to the water front region where salinity was in between 25 to 26.5 ppt while halophytes grow near to the barren zone where salinity

was 40ppt. In the present study salinity varied from 25 to 33 ppt (water front to halophytic zone) which agrees the earlier observations of Bhaskara Rao et al (1992), Narasimha Rao and Dora (2009) and Narasimha Rao and Murty (2015). Narasimha Rao and Murty (2015) studied the distribution of *Salicornia brachiata* in relation physico chemical features of Chollongi, Matlapalem, Gaderu, Masanitippa, Pandi and Anthervadi of Godavari estuary and reported that mangrove and associated mangroves prefers to grow where salinity ranges from 24 to 29 ppt while halophytes including *Salicornia* grows where salinity levels are high such as 30 to 34 ppt. In this present study, obtained results on salinity, pH agrees with Bhaskara Rao et al (1992), Narasimha Rao and Dora (2009) and Narasimha Rao and Murty (2015). Percentages of soil particles such as sand, silt and clay contents varied in the sediment samples. Sand particles in the sediment ranged from 12 to 16 %, silt varied from 47 to 60% and clay ranged from 27 to 40 % (Tables 1-5) in all five study sites. Findings of the present study

supports the earlier works of Bhaskara Rao et al (1992) and Narasimha Rao and Murty (2015). In general mangrove species and species of associated mangroves prefer to grow in the salinity fluctuations of 5 to 25 ppt, besides sediment characters such as proportions of low sand content and higher percentages of clay and silt contents in the sediments promotes the formation and development of mangroves in estuarine habitats. Sediment analysis and physico chemical features of the present study reveals that *Salicornia brachiata* or halophytes prefer to grow away from the creek or canal where soil salinity is more than 28 ppt and low percentage of sand particles and high amount of silt and clay particles may be responsible for proper growth and development. Based on the obtained results in the present study indicates that these study sites may be suitable for commercial cultivation of *Salicornia brachiata* in estuarine habitats of Andhra Pradesh, East Coast of India.

Table 1: Soil salinity, soil pH and Percentages of various soil particles in mangrove habitats of Vamsadhara estuary near Bhavanapadu

S. No	Distance from creek edge (in meters)	Soil salinity (‰)	Soil pH	Sand (grams)	Silt (grams)	Clay (grams)
1	0	28	7.8	12	53	35
2	15	31	7.9	13	47	40
3	30	32	7.9	14	56	30

Table 2: Soil salinity, soil pH and Percentages of various soil particles in mangrove habitats of Gautami Godavari estuary near Kothapalem

S. No	Distance from creek edge (in meters)	Soil salinity (‰)	Soil pH	Sand (grams)	Silt (grams)	Clay (grams)
1	0	26	7.7	12	60	28
2	15	28	7.8	12	58	30
3	30	30	7.9	13	58	29
4	45	29	7.8	14	56	30
5	60	32	7.9	15	55	30

Table 3: Soil salinity, soil pH and Percentages of various soil particles in mangrove habitats of Vainateyam Godavari estuary near Odalarevu

S. No	Distance from creek edge (in meters)	Soil salinity (‰)	Soil pH	Sand (grams)	Silt (grams)	Clay (grams)
1	0	29	7.7	12	54	34
2	15	30	7.8	14	53	33
3	30	33	7.9	12	58	30

Table 4: Soil salinity, soil pH and Percentages of various soil particles in mangrove habitats of Vashista Godavari estuary near Biyyaputippa

S. No	Distance from creek edge (in meters)	Soil salinity (‰)	Soil pH	Sand (grams)	Silt (grams)	Clay (grams)
1	0	28	7.7	13	55	32
2	15	32	7.8	15	52	33
3	30	33	7.9	15	56	29

Table 5: Soil salinity, soil pH and Percentages of various soil particles in mangrove habitats of Krishna estuary near Sorlagondi Reserve Forest

S. No	Distance from creek edge (in meters)	Soil salinity (‰)	Soil pH	Sand (grams)	Silt (grams)	Clay (grams)
1	0	25	7.6	12	56	32
2	15	28	7.7	13	56	31
3	30	31	7.8	14	54	32
4	45	31	7.8	16	57	27
5	60	32	7.9	16	55	29

**Fig. 1: Experimental cultivation of *Salicornia brachiata* at Godavari estuary****Acknowledgements**

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REFERENCES

- Bhaskara Rao, V., GM. Narasimha Rao, GVS Sarma and B. Krishna Rao, Mangrove environment and its sediment characters in Godavari estuary, East coast of India. Indian Journal of Marine Sciences 21: 1992. 64-66.
- Carver, R.E Sedimentary petrology, (John Wiley & Sons Inc, London) 1971, pp.653. Glenn, E.P., O'Leary, J.W., Watso, M.C., Thompson, T.L., Kuehl, R.O., 1991. *Salicornia bigelovii* Torr: an Oil Seed Halophytes for Sea Water Irrigation. Sci., Vol. 251: pp. 1065-1067.
- Narasimha Rao, G.M., 2008. Mangrove Populations of Visakhapatnam and Sarada and Varaha estuarine Complex, India. International Journal of Plant Sciences. 3 (2): 686-687.
- Narasimha Rao, G.M., 2012. Distribution Pattern and Present Scenario of Mangroves an Associated Flora of Andhra Pradesh In: Biodiversity of Aquatic Resources, Chapter 3, 29-49.
- Narasimha Rao, G.M 2014. Distribution, Density and Conservation of mangroves in the Godavari Estuary, Andhra Pradesh, India. J.Biol.Chem. Research Vol. 31(2) 614-622.
- Narasimha Rao, G.M. , and S.V.V.S.N.Dora. 2009. An experimental approach to mangroves of Godavari estuary. Indian journal of Forestry. Vol.32.no.3. 2009.pp.431-432.
- Narasimha Rao, G.M. and Murty, P.P., 2010a. Mangroves and Associated Flora of Vashista and Vainateyam Estuaries, Andhra Pradesh. India. Not Sci Biol 2(4) 40-43.
- Narasimha Rao, G.M. and Murthy, P.P, 2010b. Mangrove Populations of Vamsadhara Estuary. International Journal of Plant Sciences. 3 (2) 686-687.
- Narasimha Rao, G.M and B.N. Reddi, 2013. Distribution and Density of *Salicornia brachiata* (a potential halophyte) in Godavari Estuary.

International Journal of Biology, Pharmacy and Allied Sciences 2(4), 2013, 974-979.

- Narasimha Rao, G.M. and Subba Rangaiah, G., 2010. Distribution of Mangroves and Associated Flora of the Pandi Back Waters of Gautami Godavari Estuary, Anu. J. Nat. Sci.2 (1) 2010 22-26.
- Narasimha Rao, G.M. and P. Prayaga Murty. 2015. Distribution of *Salicornia brachiata* in Relation to Physico-chemical and Soil Characteristics in Godavari Estuary, AP, India. IOSR Journal of Pharmacy and Biological Sciences (IOSR- JPBS) Volume 10, Issue 4 Ver. V (July-Aug. 2015), pp. 13-16.
- Narasimha Rao, G.M., P. Prayaga Murty and M. Murali Krishna Kumar. 2015. Seeds of *Salicornia brachiata* as a source of edible oil. Indian Journal of Applied Research, Vol. 5 | No. 8 | : 532-533.
- Narasimha Rao, G.M., Lakshminarayana, V. and Reddi, B.N., 2012. Distribution and Composition of Halophytes at Vainateyam Estuary, Andhra Pradesh. Plant Science Research. 34 (1&2) 97-98.
- Narasimha Rao, G.M., 2018. Distribution, Conservation and Future Prospects For Halophytes in Godavari Estuary of Andhra Pradesh Chapter 14 published in "Human Development and Natural Resource Management Edited by: Dr. Ram Krishna Mandal and Dr. Ahongshangbam Ibotombi Singh ISBN:978-93-5056-896-5 Published by: Discovery Publishing House Pvt. Ltd., New Delhi (India) PP.140-151.
- Narasimha Rao, G.M., 2020. Flora of Mangrove Species Utilized for Ethno medicinal Practices in Gautami Godavari Estuary, Andhra Pradesh, India. In book: Medicinal Plants: Biodiversity, Sustainable Utilization and Conservation. DOI: 10.1007/978-981-15-1636-8_5
- Narasimha Rao, G.M and K.Lohitasyudu, 2023. Current status of Mangrove populations in Godavari estuary- A Socio-Ecological study. In: Exploring emerging Techniques in Plant Sciences, Publisher: Vaagdevi Degree & PG College, Hanumakonda, Telangana. PP.84-101
- Prasanna Lakshmi. V.Lakshminarayana and G.M. Narasimha Rao. 2015. In-vitro antimicrobial activity of *Salicornia brachiata* (Roxb.) against selected pathogens. WJPR. Vol.4 (12) : 1286-1294.
- Venkanna,P. G.M.Narasimha Rao. 1993. Distribution pattern of the Mangroves in the Krishna Estuary Indian J. Forestry, Vol.16, 1993, pp.48-53
- Weber, D.J., Ansari, R., Gul, B. and M.A. Khan. 2007. Potential of Halophytes as Source of Edible Oil. J. Arid Environments, Vol. 68: pp. 315-321.