

# Effect of NPK fertilizers on seedling growth of mangrove species

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## Abstract

An experiment was conducted to assess the effect of NPK fertilizers on seedling growth and survival of five important mangrove species of Bangladesh for nine months. Seedlings were raised in the nursery using plastic pots. NPK fertilizers with three treatments (control, 4 gm and 8 gm doses) were used two times when seedlings age was 3 and 6 months. The result showed that seedlings height growth of *Excoecaria agallocha* was enhanced significantly with the application of NPK fertilizers but it was shown negatively significant effect on height growth of *Xylocarpus mekongensis* after second time fertilizer application. Moreover, NPK application enhanced mortality of *Avicennia officinalis* and *Ceriops decandra* seedlings in both times of fertilizer application. But no effect of NPK fertilizers on seedlings growth and survival of *Heritiera fomes* were observed.

## Introduction

Mangroves are salt tolerant forest ecosystems of tropical and sub-tropical inter-tidal regions of the world. The largest single tract natural mangrove forest in the world- the sundarbans is situated at the south-western part of Bangladesh spanning an area of 6017 km<sup>2</sup> (Siddiqi 2001). The floristic composition of this forest is rich compared to many other mangroves of the world. It is a highly productive mangrove ecosystem. Chaffey and Sandom (1985) enlisted 66 plant species in the Sundarbans. *Heritiera fomes* (sundri) and *Excoecaria agallocha* (gewa) are the major mangrove species of this forest comprising 73 % and 16% of the growing stock respectively. The mangroves play an important role in the national economy of Bangladesh. Timber, fuelwood, thatching materials, house post and other non-timber produces are harvested from this mangrove forest. Mangroves are important not only in protecting the coast from erosion by storm tides and cyclones but also in maintaining the diversity of coastal ecosystems by contributing quantities and providing favorable habitats for other plants and animals (Tomlinson 1986).

The coastline of Bangladesh is 710 kilometer long extending along the Bay of Bengal comprises numerous off-shore islands. It lies between latitude 21<sup>0</sup> to 23<sup>0</sup> N and longitude 89<sup>0</sup> to 93<sup>0</sup> E. Erosion and sedimentation are the common characteristics of the coastal environment. Afforestation with mangrove species was initiated in 1966 along the coastal belt with the primary objective to protect lives and properties of coastal communities from cyclone and tidal surges (Das and Siddiqi 1985). About an area of 0.192 million hectares of accreted lands were afforested with mangrove species in the coastal belt (Hasan 2013). In the beginning, almost all the commercially important mangrove species were tried but mostly failed due to lack of knowledge on appropriate nursery and plantation techniques. Among the planted species, only *Sonneratia apetala* (keora) is the most successful species in all along the coastal belt and *Avicennia officinalis* (baen) is the successful only in the eastern coastal belt (Siddiqi and Khan 2004). Some trial plantations with other mangrove species such as *E. agallocha* (gewa), *H. fomes* (sundri), *Xylocarpus mekongensis* (passur), *Aegiceras corniculatum* (khalshi) and *Phoenix paludosa* (hantal) were found suitable inside *S. apetala* forest as underplanting (Siddiqi et al. 1992, Siddiqi 2001 and Islam et al. 2013). Therefore, but growth and yield of planted mangrove species in Bangladesh are lower as compared to other South Asian countries (Hawlder 1999).

Over the last two decades, forest plantation areas have been rapidly increased world wide. In such plantations, fertilization is commonly practiced as a silvicultural tool. Fertilizer enhances the growth of plants. Tree yield can be increased even more by planting on soils with a better texture, breeding or genetic improvement programs and intensive silvicultural treatments such as fertilization and irrigation. It is now well established that the application of commercial fertilizers accelerate the seedlings growth of many tree species (Walker et al. 1993 and Sanginanga et al. 1989). Phosphorus is perhaps the most common limiting nutrient in many tropical areas where it plays as essential role in plant nutrition and energy transparence (Ackerson 1985).

Fertilization has not been practiced in Bangladesh mangrove forestry service. Many studies throughout the world have demonstrated that fertilization of young trees increase the growth performance. Many previous studies showed that nutrient availability; especially N (Nitrogen) and P (Phosphorous) are important factor responsible for mangrove growth (Feller 1995, Mckee et al. 2002; Lin and Stenberg 2007). Although N: P ratios have been widely used to determine plant nitrogen and phosphorus limitation in wetland (Güseweel and Koerselman 2002; Güsewell et al. 2003). Boto and Wellington (1983) reported that significant growth response following ammonium fertilization of a mangrove forest in northern Australia and phosphorus limitation among other factors may be a major control on mangrove growth. NPK fertilizers are three components of fertilizers providing nitrogen, phosphorus and potassium. Nitrogen functions on

leaf growth, phosphorus on development of roots, flowers, seeds fruits and potassium on strong stem growth, movement of water in plants, promotion of flowering and fruiting. The healthy seedlings are essential for raising a successful plantation in the stressed condition. Therefore, the present study was undertaken to determine the effect of fertilization on survival and growth performance of some mangrove species at seedling stage.

## Materials and Methods

Five commercially important mangrove species such as *H. fomes* (sundri), *X. mekongensis* (passur), *E. agallocha* (gewa), *Ceriops decandra* (goran) and *A. officinalis* (baen) were chosen for this study due to their multipurpose values.

*H. fomes* (sundri): It has limited distribution and is restricted to the mangroves of Myanmar, Bangladesh and Indian Sundarbans (Kostermans 1959). It is common in less and moderately saline zones of the Sundarbans. It is a small to moderate size evergreen tree with buttressed stem and pneumatophores. It is generally 15-20m tall in the north-eastern part and reducing 5-10m in the south-eastern part of the Sundarbans. Wood is used for bridge and house construction, boat building, electric poles, paneling and furniture.

*X. mekongensis* (passur): Occurs in Asia, Oceania and East Africa. In Bangladesh it is found in the northern part of the Sundarbans. It is moderate size tree attaining height of about 15 m. It is a highly valuable timber species. Wood is used as posts, poles, beams and for making musical instruments and high grade furniture.

*E. agallocha* (gewa): This species occurs in Asia and Oceania. In Bangladesh, the species is found in the Sundarbans and in the coastal plantations. It is a small to medium size evergreen tree. The tree is normally 10 m in height but occasionally grows up to 15m in the north-eastern part of the Sundarbans. Wood is used for making papers, packing boxes, matches and fuelwood.

*C. decandra* (goran): It is found in Asia and the Pacific. It is the dominant species in the strongly saline zone of the Sundarbans. It is a large shrub to small evergreen tree attaining about 4-15m in height. Wood is used as fuelwood with high calorific value. It is also used as house posts and fencing materials.

*A. officinalis* (baen): The species is found in Asia and the Pacific. In Bangladesh, it is found in the Sundarbans and in the coastal plantations. It is a big tree, attaining heights of 10-15m. Wood of this species is used for construction, rough walling of houses, furniture accessories, rice pounders and tool handles. Logs and branches are used as fuelwood and as anchors.

A nursery trial was conducted in 2012 at the Plantation Trial Unit Division Head Quarter of Bangladesh Forest Research Institute, Barisal to observe the effect of different dosages of NPK fertilizers on growth performance of seedlings of these five mangrove species. The seedlings were raised in plastic containers of size 22.86 cm in length and 12.42 cm in diameter having 8 numbers of pores on sides and bottom. The pots were filled with powdered loamy soil and decomposed cowdung mixture at a ratio of 5:1. Seeds/ propagules of these species were collected from the Rangabali island of Patuakhali district in early June to mid August. Twenty pots were used for each replication for each species with three treatments. So, totals of 180 pots (20x 3 replication x 3 treatments) for each species were used and thus a total of (180 x 5 species) 900 pots for raising seedlings for 5 mangrove species. Seeds/ propagules were sown in the pot to ensure raising of one seedling in each pot. NPK Fertilizers namely Urea, TSP and MP were used at a ratio of 1:2:1. Three treatments were control (no fertilizer), 4gm and 8 gm mixed NPK fertilizers. NPK fertilizers were applied first time when seedlings were 3 months old and it was applied second time when seedlings were 6 months old. Nursery beds were maintained by regular watering, weeding etc. Data on seedlings survival and height growth were recorded two times when seedlings age was 6 and 9 months respectively. Data were computed and analyzed using MINITAB statistical package.

## Result and discussion

### *Plant height*

The result showed that after first application of NPK on the seedlings of five mangrove species had a significant effect only on *E. agallocha*. After 3 months of first application of fertilizer the height of *E. agallocha* was 25.18 cm, 30.05 cm and 31.06 cm for control, 4 gm and 8 gm treatments respectively. No significant differences were found on seedlings height growth of other four species such as *H. fomes*, *X. mekongensis*, *C. decandra* and *A. officinalis*. The height of *H. fomes* was 32.21 cm, 31.83 cm and 29.42 cm for control, 4 gm and 8 gm treatments respectively. The height of another important species *X. mekongensis* was found 56.67 cm, 56.20 cm and 56.37 cm for control, 4 gm and 8 gm respectively (Table 1).

After second application of NPK fertilizers, the height growth showed significantly negative effect on *X. mekongensis*. The heights were 99.30 cm, 83.63 cm and 81.34 cm for control, 4 gm and 8 gm treatments of NPK fertilizers respectively. But, no significant difference was found between 4 gm and 8 gm NPK treatments. The *E. agallocha* species had shown significant effect on plant height after second application of fertilizer like first application. The height of *E. agallocha* was 115.92 cm, 141.48 cm and 150.10 cm for control, 4 gm and 8 gm respectively. The result showed significant difference between control and NPK treatments. But no difference was found between 4 gm and 8 gm treatments of NPK fertilizers. The height data showed

insignificant in both control and NPK treatments for *H. fomes*, *C. decandra* and *A. officinalis* (Table 2).

Table 1. Effect of NPK fertilizers on survival and height growth of five mangrove species after first application.

Treatment	Name of Species									
	<i>A. officinalis</i>		<i>X. mekongensis</i>		<i>E. agallocha</i>		<i>H. fomes</i>		<i>C. decandra</i>	
	Height (cm)	Survival %	Height (cm)	Survival %	Height (cm)	Survival %	Height (cm)	Survival %	Height (cm)	Survival %
Control	36.39a	72c	56.67a	100a	25.18b	98a	32.21a	100a	12.85a	80c
4 gm	36.44a	65b	56.20a	100a	30.05a	100a	31.83a	100a	12.86a	72b
8 gm	31.17a	50a	56.37a	100a	31.06a	100a	29.42a	100a	13.28a	32a

(Figures followed by different letters like a, b and c differ significantly at 5% level)

### ***Plant survival***

The result showed that application of NPK fertilizers had negative significant affect on seedlings survival of *C. decandra* and *A. officinalis* after first application. The survival of *C. decandra* was 80%, 72%, 32% and for *A. officinalis* was 72%, 65%, 50% for control, 4 gm and 8 gm treatments respectively. When the uses of NPK fertilizers were increased then survival was decreased for these two species. The highest survival (100%) was recorded for *E. agallocha*, *X. mekongensis* and *H. fomes* in all treatments (Table 1). This means no significant effect of NPK on seedlings survival was found for these three species.

Table 2. Effect of NPK fertilizers on survival and height growth of five mangrove species after second application.

Treatment	Name of Species									
	<i>A. officinalis</i>		<i>X. mekongensis</i>		<i>E. agallocha</i>		<i>H. fomes</i>		<i>C. decandra</i>	
	Height (cm)	Survival %	Height (cm)	Survival %	Height (cm)	Survival %	Height (cm)	Survival %	Height (cm)	Survival %
Control	42.73a	64b	99.30b	100a	115.92b	98a	52.87a	88a	16.83a	72c
4 gram	40.83a	16a	83.63a	100a	141.48a	100a	51.63a	87a	15.94a	57b
8 gram	34.00a	15a	81.34a	100a	150.10a	100a	46.98a	87a	17.44a	17a

(Figures followed by different letters like a, b and c differ significantly at 5% level)

Similarly, application of NPK had a significant negative effect after second application of fertilizer on survival of *A. officinalis* and *C. decandra* plants. The lowest survival was only 15% and 16% for 4 gm and 8 gm treatments on *A. officinalis* and 17% and 57% for 4 gm and 8 gm treatments on *C. decandra* respectively (Table 2). But, no significant effect was found on seedlings survival of *H. fomes*, *X. mekongensis* and *E. agallocha*.

## Discussion

It was observed that only height of *E. agallocha* was significantly increased after applying NPK fertilizers in both two treatments but no difference between 4 gm and 8 gm treatments were observed. Significantly negative performance on height growth of *X. mekongensis* was observed after second time fertilizer application. Hussain and Abohossan (2010) reported that application of N fertilizer had a significant negative effect on plant height of *Avicennia marina*. Positive growth response for applying N fertilizer was found in *Avicennia marina* (Boto et al. 1985 and Naidoo 1987). Stewart et al. (1979) stated that nitrogen (N) had been indicated as a major factor limiting the growth of halophytes (Mangrove) in inter-tidal areas. The present study showed that survival of *C. decandra* and *A. officinalis* were decreased in both applications. So this result indicated mortality of this two species were increased for applying NPK fertilizers. Catherine et al. (2009) found that fertilization with nitrogen (N) enhanced mangrove mortality in many sites of Australia. In the present study, the NPK fertilizers enhance mortality of *A. officinalis* and *C. decandra*. Further intensive research on the effect of N, P and K fertilizers separately and NPK mixture in newly established mangrove plantations should be carried out.

## References

- Ackerson, R.C. 1985. Osmoregulation in cotton in response to water stress. III. Effects of phosphorous fertility. *Plant Physiology*, **77**: 309–312.
- Boto, K.G., Saffigna, P. and Clough, B. (1985) Role of nitrate in nitrogen nutrition of the mangrove *Avicennia marina*, *Mar. Ecol. Prog. Ser.*, 21: 259-265.
- Boto, K.G. and Wellington, J.T. (1983) Phosphorus and nitrogen nutritional status of a northern Australian mangrove forest, *Mar. Ecol. Prog. Ser.*, 11: 63-69.
- Catherine E. Lovelock., Marilyn C.B., Katherine C. Martin and Ilka C. Feller (2009) Nutrients enrichment increases mortality of mangroves, *PLoS ONE* 4 (5):e5600 published online 2009 May 19 doi: [10.1371/journal.pone.0005600](https://doi.org/10.1371/journal.pone.0005600)
- Chaffey, D.R. and Sandom, J.H. 1985. *Sundarbans Forest Inventory Project, Bangladesh. A Glossary of Vernacular Plant Names and a Field Key to the Trees*. Overseas Development Administration England. 23 pp.
- Das, S. and Siddiqi, N. A. (1985). The Mangroves and Mangrove Forests of Bangladesh. Bulletin No. 2, Mangrove Silviculture Division, Bangladesh Forest Research Institute, Chittagong, Bangladesh. pp. 142.
- Feller, I.C.(1995) Effects of nutrient enrichment on growth and herbivory of dwarf red mangrove (*Rhizophora mangle*), *Ecol. Monogr.*,65: 477-505
- Güsewell, S. and Koerselman, W. (2002) variation in nitrogen and phosphorus concentrations of wetland plants, *Perspect. Ecol. Evol. Syst.*, **5**: 37-61.

- Güsewell, S. Koerselman, W. and Verhoeven, J.T.A. (2003) Biomass N:P ratios as indicators of nutrient limitation for plant populations in wetland,. *Ecol Appl.*, **13**: 372-384.
- Hasan, D.Z. (2013) Plants in mangroves and coastal afforestation in Bangladesh. Dewan House, Ukilpara, Naogaon-6500, Bangladesh.pp.164.
- Hawlder, N.I. (1999). Forest Resources Management Project. Mid-Term Review, Ministry of Environment and Forest, Dhaka. pp. 103.
- Hussein E.O. and Atalla A. A. (2010) Effect of NPK Fertilization on Growth and Dry Matter Accumulation in Mangrove [ *Avicennia marina* ( Forssk) vierh] Grown in Western Saudi Arabia. *JKAU : Met., Env & Arid Land Agric. Sci.*, 21: (2) 57-70 DOI: 10.4197/Met. 21-2.5
- Islam, S.A.; Miah, M.A.Q.; Habib, M.A; Moula, M.G and Rasul, M.G. 2013. Growth performance of underplanted mangrove species in *Sonneretia apetala* (Keora) plantations along the western coastal belt of Bangladesh. *Bangladesh Journal of Forest Sciences*, 32(2):26-35.
- Kostermans, A.J.G.J. 1959. A monograph of the genus *Heritiera*, Aiton (Sterenl.) *Reinwardtia* 4(4): 465-583.
- Lin, Y.M. and Sternberg, L.S.L. (2007) Nitrogen and phosphorus dynamics and nutrient resorption of *Rhizophora* mangle leaves in south Florida, U.S.A. *Bull. Mar. Sci.*, 80: 159-169
- Mckee, K.L., Feller, I.C. Popp, M. and Wanek, W. (2002) Mangrove isotopic (15N and 13C) fraction across a nitrogen vs phosphorus limitation gradient. *Ecology*,83:1065-1075.
- Naidoo, G. (1987) Effect of salinity and nitrogen on growth and water relations in the mangrove, *Avicennia marina* (Forsk.)Vierh, *New Phytol.*, 107: 317-325.
- Sanginga, N., Danso, S.K.A. and Bowen, G.D. 1989. Nodulation and growth response of *Allocasuarina* and *Casuarina* species to P fertilization. *Plant and Soil*, **119**: 125–132
- Siddiqi, N.A.; Khan, M.A.S.; Islam, M.R. and Hoque, A.K.F. 1992. Underplanting - a means to ensure sustainable mangrove plantations in Bangladesh. *Bangladesh Journal of Forest Science* 21:1-6.
- Siddiqi, N.A. 2001 Mangrove Forestry in Bangladesh. Institute of Forestry and Environmental Sciences, University of Chittagong. 201 pp.
- Siddiqi, N.A. and Khan, M.A.S. 2004. Human-induced succession of vegetation on new accretions in the coastal areas of Bangladesh. *Journal of Tropical Forest Science* 16(2): 187-198.
- Stewart, G.R., Larher, F., Ahmad, I. and Lee, J.A., (1979) Nitrogen metabolism and salt tolerance in higher plant halophytes. In R.L., Jefferies and A.J. Davey (ed.), *Ecological Process in Coastal Environments*. Blackwell Scientific.
- Tomlinson, P.B. (1986) *The Botany of Mangroves*, Cambridge University Press, Cambridge.
- Walker, R.B., Chowdappa, P. and Gessel, S.P. 1993. *Major element deficiencies in Casuarina equisetifolia*. *Fertilizer Research*, 34: 127–133.