

EFFECT OF PETROLEUM PRODUCTS ON MANGROVE SEEDLINGS

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ABSTRACT

The effect of petrol, diesel and motor oil was studied on the fruits of *Rhizophora mucronata* and *Avicennia officinalis*. The former species was found to be more resistant to these petroleum products than the latter, in which more toxic effects were seen. General damage in both the species were burning, yellowing and wilting of the leaves associated with root damage causing retardation of growth. Extensive leaf fall in *Avicennia* seedlings resulted in its mortality.

INTRODUCTION

In India the area covered by mangroves is 6,81,976 hectares (Sidhu, 1963). The dominant species of mangroves along Goa estuaries are *Rhizophora mucronata* Lamk., *Avicennia officinalis* Linn., *Sonneratia acida* Linn. and *Excoecaria agallocha* Linn. and have been the subject of considerable studies in recent years. The mangroves are economically important and are used for firewood, tannin, medicinal products (Loder and Russel, 1969), paper and pulp, timber for house and boat building as well as for aquaculture.

Estuaries get polluted from oil originating from a number of sources (Dwivedi, Bhargava and Untawale, 1975). In recent years, pollution of estuaries has increased due to man's activities and more particularly oil pollution is threatening the well-being of the living resources within areas. The effect of oil pollution on mangrove has been recorded by Mathias (1976), Rutzler and Sterner (1970), Odum and Johannes (1975) and Gundlack and Hayes (1978).

Fringing mangroves of Goa are getting increasingly polluted with oil by the activities of ships, barges, trawlers and other boats. Hence the present study was undertaken, with a view ultimately to protect this ecosystem from these hazards and recommend remedial measures for their conservation. The three refined oils, mainly petrol (not leaded), diesel and motor oil (No. 40) were studied on the seedlings of two common mangrove species, viz. *R. mucronata* and *A. officinalis* along Zuari estuary, at Borim (Goa). The ecology of Borim (Goa) mangroves have been studied by Untawale and Parulekar (1976).

MATERIALS AND METHODS

Healthy fruits and seedlings of *Avicennia officinalis* and *Rhizophora mucronata* were collected from mangrove swamp of Borim (Goa) and used for the following experiments. As the refined oils (petrol, diesel, and motor oil) are used in the fishing vessels and barges, the same were used in the experiments for treating seedlings and fruits.

- Experiment I : Seedlings treated with oils in the field.
- Experiment II : Laboratory treated and transplanted seedlings in the swamp.
- Experiment III : Seedlings treated with 100% petroleum products for different periods (1 hour, 4 hours and 6 hours).
- Experiment IV : Effect of petroleum products on the germination of the fruits of *Avicennia officinalis*.

Acrylic tubes (20 cm long x 6.5 cm wide) were used to give the treatment in field by fixing them in the mud around the seedlings. In the laboratory wide mouth glass bottles were used for the purpose of growing seedlings. The oil treated seedlings were grown in fresh water in the laboratory. Every alternate day water in wide mouth bottles was changed.

The concentrations of (5% and 10%) petroleum products were made in sea-water collected from the same locality for treating the seedlings. For quick germination, after removing their walls, the fruits after treatment (for one hour, 4 hours and 6 hours in 100% petroleum products) were grown in sterilised sand for further study, supplying equal amount of diluted saline water (1:1 concentration). Less saline water was prepared by mixing 1:1 tap water and seawater from Borim mangrove swamp.

In the experiment I and II, for each treatment four plants of each species were used. In experiment III, three fruits of *Avicennia*, were used for each oil treatment while *Rhizophora* seedlings were treated as in experiment I and II. In the experiment IV, 10 fruits of *A. officinalis* were treated with each petroleum product.

In each experiment the seedlings after petroleum treatment were washed with tap water to remove excess of oil adhered to them. In all experiments controls were maintained side by side which received no oil. During the experiments maximum care was taken to avoid mechanical injury to the seedlings.

RESULTS

Experiment I : *Seedlings treated with oils in the field*

Avicennia seedlings showed an adverse effect on growth with all the three refined oils given in both the concentrations. Petrol showed more harmful effect like burning and seedlings survived only for three weeks with 5% concentration and for two weeks with 10% concentration. However, with diesel too, burning effect was observed (i. e. after certain period of treatment leaves of the treated seedlings started drying and finally detached from it). This burning effect of diesel oil treatment was observed for 6 weeks in 5% concentration and two weeks with 10% concentration. As a result of the treatment with motor oil, seedlings survived upto 12 weeks in higher concentration (10%).

Initially the growth in *Rhizophora* seedlings treated with petrol and diesel was rapid, subsequently enough harm was done as observed by the burning and deterioration of the foliage and death of the seedlings. With motor oil, yellowing of the leaves was seen followed by wilting of the seedlings (Figs. 1 & 2. Table I)

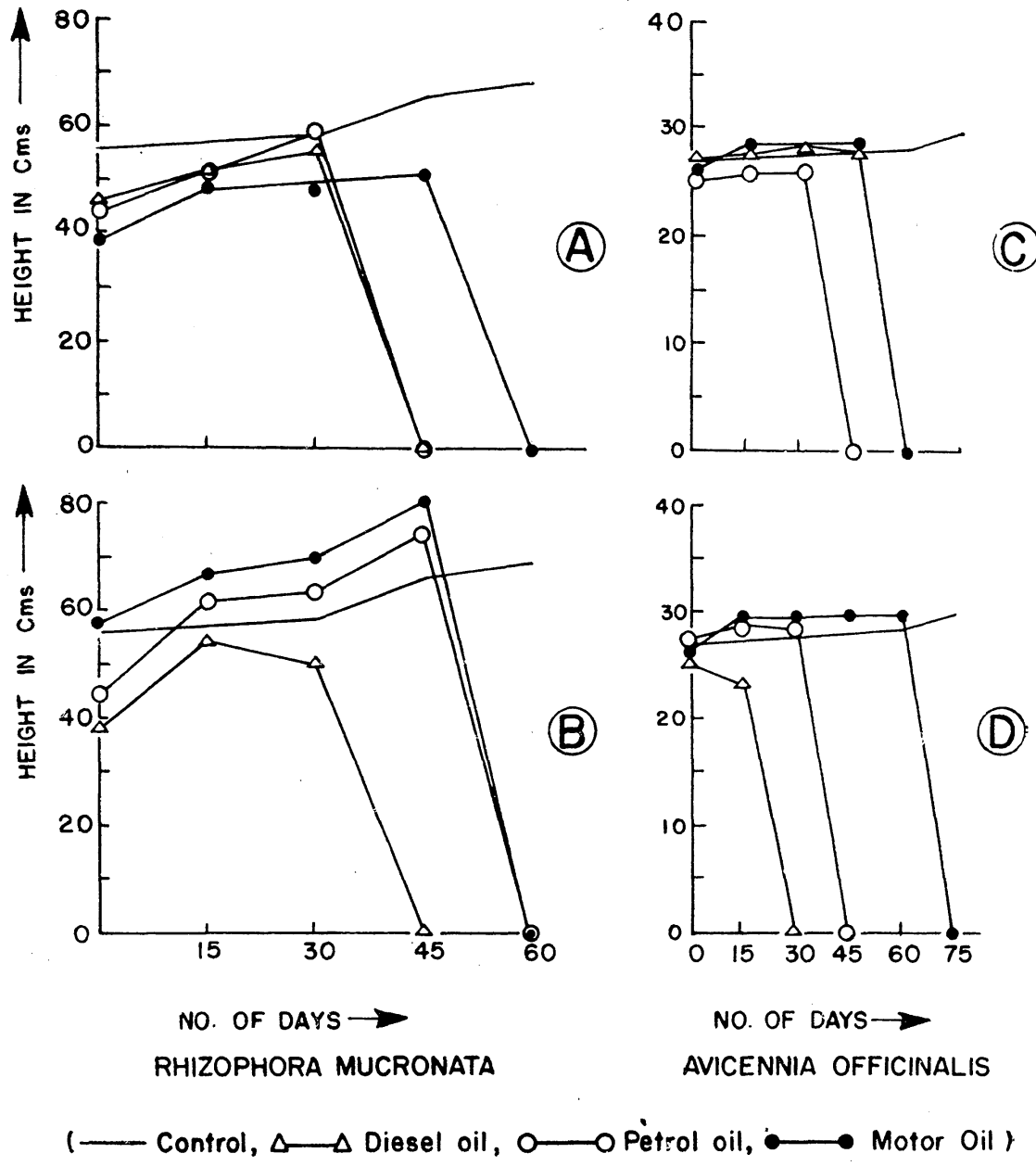


Fig. 1. Growth and survival rate in the seedlings of *A. Officinalis* Linn. and *R. mucronata* Lamk. treated with petroleum products in the field with 5% and 10% concentrations (A, C=5% concentration of oil, B, D=10% concentration of oil).

Experiment II: Laboratory treated and transplanted seedlings in the swamp.

During exposure to the above mentioned oils, burning of the leaves was seen after two days in *Avicennia* but no significant damage was observed in *Rhizophora*.

Avicennia seedlings treated with both the concentrations of petrol survived for one week, before transplanting while in diesel they survived upto two weeks with 5% concentration and 10 days with 10% concentration, after transplanting in the swamp. The *Avicennia* seedlings treated with 5% motor oil were killed before transplanting in the swamp.

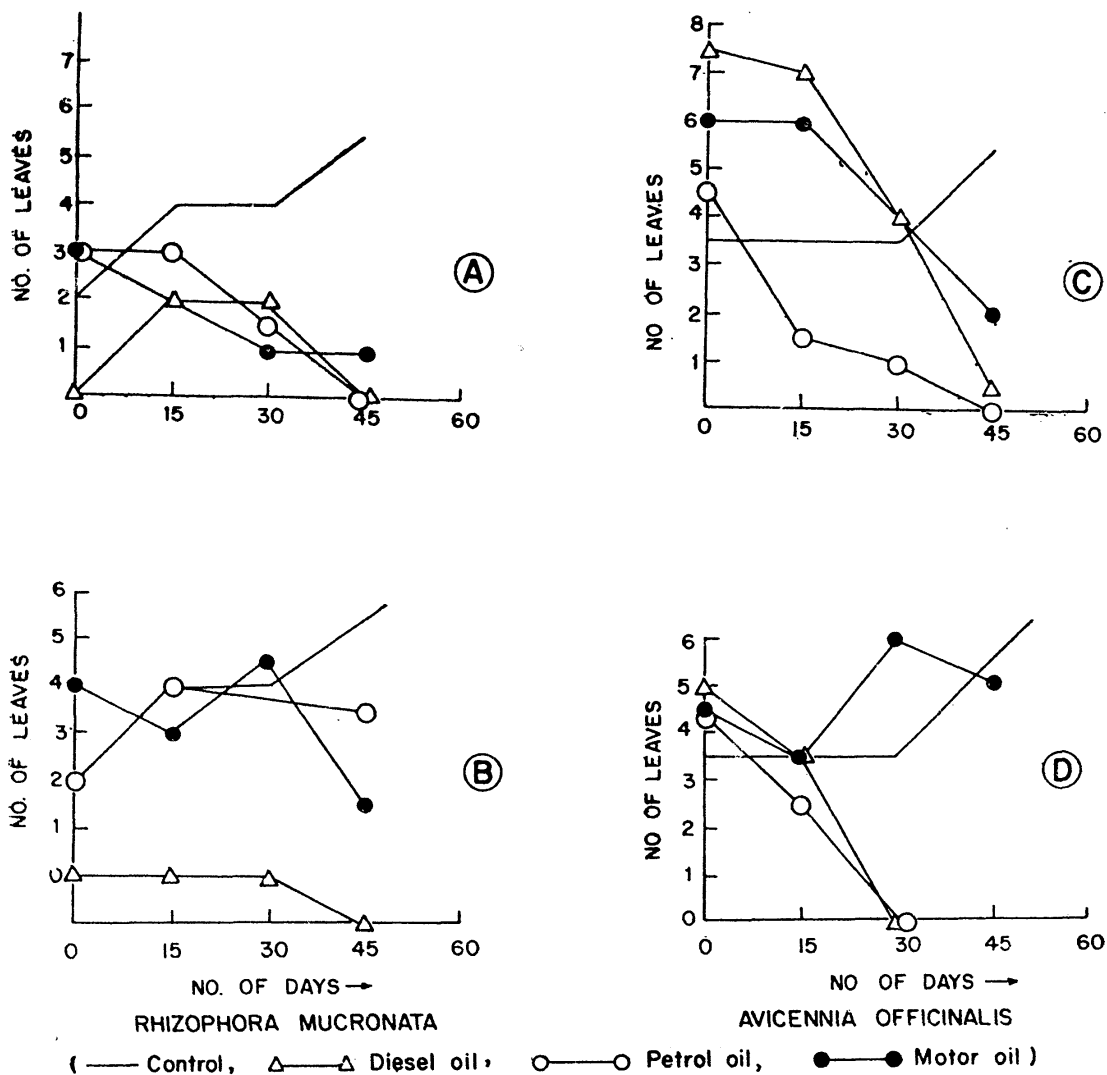


Fig. 2. Leaf fall rate in seedlings of *A. officinalis* Linn. and *R. mucronata* Lamk. treated with petroleum products in the field with 5% and 10% concentrations. (A, C=5% concentration of oil. B, D=10% concentration of oil.)

Slow effect of these three oils was seen on *Rhizophora* seedlings, as compared to *Avicennia* seedlings. In petrol, *Rhizophora* seedlings survived for 4 weeks, in diesel and motor oil 6 weeks, in both the concentrations (Table I). Initially *Rhizophora* showed sudden increase in height as compared to control.

Table I. Effect of petroleum products on survival of the mangrove seedlings.

Plant	Concentration of petroleum products (%)	Damage caused	Survival period (days)		Remarks
			Experiment I	Experiment II	
<i>Avicennia officinalis</i>	5 D	Burning	45	15	Toxic
	10 D	Burning	15	10	Toxic
	5 M	Yellowing and wilting	45 (one survived)	30	Harmful
	10 M	Yellowing and wilting	90 (one survived)	before transplanting all the seedlings wilted	Harmful
<i>Avicennia</i>	5 P	Burning	30	6	Highly toxic
	10 P	Burning	15	6	Highly toxic
	Control	—	Continued its survival		Showed steady growth
<i>Rhizophora mucronata</i>	5 D	Burning	30	45	Toxic
	10 D	Burning	30	45	Toxic
	5 M	Yellowing and wilting	75	45	Harmful
	10 M	Yellowing and wilting	45 (one survived upto 90 days)	45	Slow adverse effect
<i>Rhizophora</i>	5 P	Burning	30 (one survived upto 60 days)	30	Highly toxic
	10 P	Burning	45	30	Highly toxic
	Control	—	—	Continued its survival	showed steady growth

Experiment III: Seedlings treated with 100% Petroleum products for different periods (1 hour, 4 hours and 6 hours).

In case of *Avicennia* seedlings treated with 100% petrol were immediately killed on second day after being treated for all the periods (1, 4 and 6 hours). On the other hand, seedlings were found growing well in control. Somehow, the seedlings treated with diesel and motor oil did not show significant changes. *Rhizophora* seedlings showed similar damage as in experiments I and II.

Experiment IV: Effect of petroleum products on the germination of the fruits of *Avicennia officinalis*.

Germination was not observed in the fruits of *Avicennia* soaked for different periods (1 hour, 4 hours and 6 hours) in 100% petroleum products. However, in control 100% germination was achieved within eleven days only (Table II).

The fruits soaked in different oils started decaying their cotyledons after a few days. First decaying of the cotyledons was observed with petrol. Some of the

Table II. Germination study in oil treated fruits of *Avicennia officinalis*

	Control	Petrol			Diesel			Motor oil		
		1H	4H	6H	1H	4H	6H	1H	4H	6H
1	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—
3	—	Started decaying			—	—	—	—	—	—
4	—	All decayed			—	—	—	—	—	—
5	Started Germination									
6	4	Seedlings			Started decaying			—	—	—
7	5	—,,—			-do-			—	—	—
8	7	—,,—			All decayed			—	—	—
9	8	—,,—			—	—	—	—	—	—
10	9	—,,—			—	—	—	—	—	—
11	10	—,,—			—	—	—	—	—	—
12										
13										
14										
15										
16								Some fruit just showed root growth		
17								Started decaying		
18								Decayed		
Germination 100 percentage		0			0			0		

fruits treated with motor oil showed root growth, but failed to produce root system further, while control seedlings showed steady growth.

DISCUSSION

Three of the refined oils i.e. petrol, diesel and motor oil, showed significantly adverse effects on the growth and survival of the mangrove seedlings studied. From the results in experiments I and II, it can be concluded that *Avicennia* seedlings are more sensitive to these oils as compared to *Rhizophora*. Petrol and diesel were found to be comparatively more toxic to these seedlings.

Extensive damage to mangroves has been reported from a spill of crude oil (Gilmore, Smith, Rice, Shantu and Messen, 1970; Diaz-Piferrer, 1962; Rutzler and Sterrer, 1970). They observed that the *Rhizophora* seedlings were killed along with a variety of intertidal invertebrates, turtles, birds and algal mats in the mangrove community. We too, have observed defoliated *Sonneratia* plants near *Elephanta Islands*, Bombay, where crude oil spill is frequent.

In the present investigation, *Avicennia* showed weak growth and more damage to foliage as compared to control plants. In *Rhizophora* normal growth was enhanced initially to be followed by the death of the plants. Similar observations were made during the field studies, with laboratory grown plants. These observations positively indicate that these oils have an adverse effect on the growth of mangrove seedlings. In general, damage caused to both the mangrove species was leaf and root damage growth retardation and ultimately the death of the seedlings after certain period. Presumably, damage from heavy oil spills to mangrove results from mechanical

clogging of lenticels and air holes of prop roots and pneumatophores. Similar observations were made by Mathias (1976) who found mortality of the *Avicennia* seedlings in higher concentration of diesel in the laboratory. Young mangroves are damaged by crude oil concentration of 208 ml/m² (Mackin, 1950). These oils are more dangerous to *A. officinalis* than to *R. mucronata*. However, some abnormal effects were observed with the treatment of diesel and motor oil as in experiment III. But the absence of germination in the case of oil treated *Avicennia* seeds would indicate toxicity of these oils. Further it has proved that at higher concentrations, petrol and diesel can kill seedlings immediately within 2 weeks in case of *Avicennia* and within 6 weeks in *Rhizophora*. There are also references on an angiosperm which got damaged due to oil and industrial pollutants (Cowell, 1969; Baker, 1969, 1970, 1971; Stucky and Wantz, 1969; Roberts, 1954). During present investigation ultimate death of the mangrove seedlings by oil treatment was noticed within a few months.

The mangrove swamp where the seedlings were treated with oil was frequently visited and found devoid of new seedling growth. This means oil spillage has got chronic effects on vegetation. Therefore, it is suggested that the important mangrove ecosystem (Darnell, 1967) should be protected from any type of hazards. To protect coastal vegetation from oil spill as well as industrial pollution, preventive measures could be taken like warning the trawler or ship owners not to wash their tankers within the estuary and maximum care should be taken not to spill the oil into it. Industrialists also should be warned not to release the effluents into the estuary. In case, an accidental spill occurs, alternatives to mitigate the evil should be studied.

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