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Effect of Granite Quarry Mining on Chlorophyll Content of Tropical Plants

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Abstract The research was conducted in the granite mining sites of Kerala to determine the effect of mining on the health of two tropical plants namely *Macarangapeltata* and *Chromolaenaodorata* which were common to the area. The area having high amount of particulate matter in the working hours of the quarry. The plants were severely affected by the mining activities. In this study, it was observed that the quarry dust was affecting the *Chromolaenaodorata*, as it is having chlorophyll lower than the control sites.*Chromolaenaodorata* present in the quarry sites having retarded growth compared to control site plants. In the case of *Macarangapeltata*, samples showed higher concentration of chlorophyll than control to cope up with the stress.

Keywords: *granite quarry, chlorophyll, particulate matter, air pollution*

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1. Introduction

The quarrying activities like every mining operation, is a destructive development activity. The socioeconomic benefits of quarrying are unable to compensate for the overall detrimental effects on natural ecosystems [1]. The opencast mining is more preferable for the most of the quarrying activities to its applicability in all operable areas of exposed rock. This method is suitable for attaining minimum production loss and high production rate, especially in the case of limestone, granite, and iron like ores that are exposed at the surface.

The main air quality issue with quarrying is dust particles [2]. The severity of air pollution will depends on the various kind of factors like dust particles in the ambient air, the chemistry between dust particles, size of the particles etc. The pollutants released from quarrying activities are largely particulates in nature [3]. Solid materials in the form of smoke, dust, and also vapor generated during the quarrying activities are usually suspended over a long period of time in the air. There are different toxic compounds like fluoride, magnesium, lead, zinc, copper, released from these processes and they are injurious to health.

Dust from quarry sites are effect the vegetation, crop yield and this become a threat to survival of plants within that particular area. Dust can also have several physical effects on the surrounding plants such as blocking and damaging the internal structures, abrasion of leaves and cuticles etc [4]. There are many dust particles are released to the environment through drilling like activities. They are considered as one of the major hazardous substance to our respiratory system. Hence those who are working in quarry industry and closely living community people will be affected by the dust particles. , consequently suffers from acute and chronic bronchitis, asthma and even tuberculosis [5]. Overexposure to dust that contains microscopic particles of crystalline silica can cause scar tissue to form in the lungs.

If the dust released from quarrying activities is uncontrollable, there is chances of spreading the dust particles to the surroundings, especially during dry weather, leach into the soil during storms, and create harmful conditions for the flora and fauna. It can also have physical effects on the plants such as blocking and damaging their internal structures and abrasion on leaves and cuticles [4]. Plants are very sensitive, due to the deposition of these particles plants shows symptoms like chlorosis, necrosis and growth retardation [6]. The dust related problems can be mitigated in the quarry sites by preparing a dust control plant [7].

2. Materials and Methods

2.1. Study Area

The study areas are different quarry sites in Kozhikode and in Malappuram. Four quarries were selected from Malappuram of which two are working and two are abandoned. The Quarry selected from `Kozhikode is working.

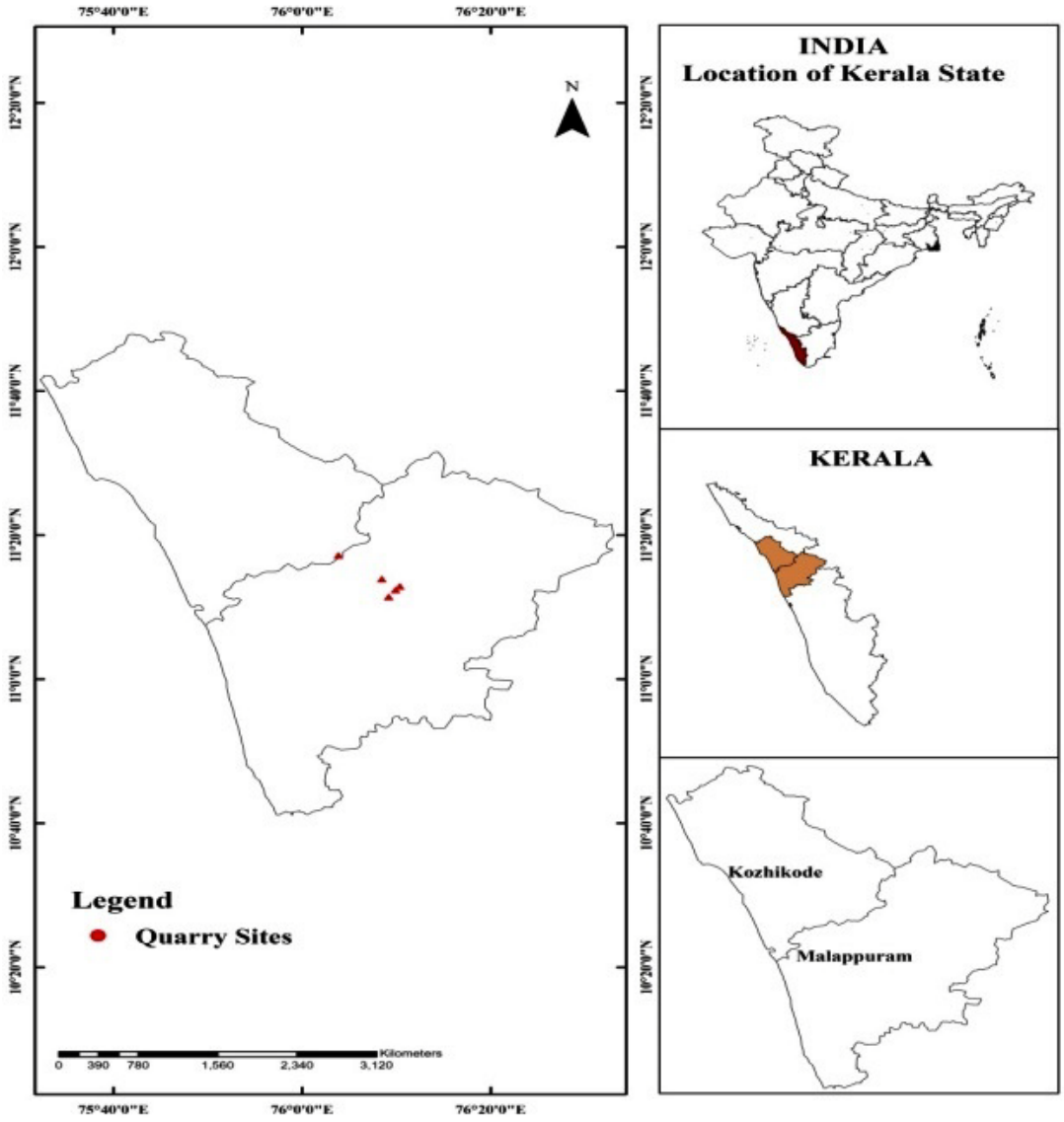

Figure 1. Location of Quarry sites in Malappuram and Kozhikode

The first study area (QS/01) was located on Thiruvali Panchayath, Malapuuram district. It is lies geographically between coordinates 11°12'55.7"N and 76°10'23.3" E. The working of this quarry was stopped recently 3 years. Second quarry area was located in Edachola, Malappuram district. The area was lies geographically between coordinates 11°12'25.5" N and 76°09'56.5" E. Third quarry was situated on Ainthur, Malappuram district. Its geographical coordinates are 11°11' 28.4" N, 76°09'11.0" E. Fourth quarry located on geographically between coordinates N11°13'56.2" N, 76°08'29.0" E. The fifth quarry was located on Thottumukkam, Kozhikkode District. The area was lies within latitude N11°17'15.3" N and 76°03'52.4 E longitude. The study period was December 2018 to April 2019.

2.2. Sample Collection and Preservation

The present study was conducted on different quarry sites. Two abandoned stone quarry, two working stone quarry, and one granite quarry are selected for this study. Plant leaf samples larger were cut from the plant and immediately placed in aluminum foil. The sample is then labelled, placed in a re-sealable plastic bag, and frozen in a cooler. Samples were kept in a darkened environment to prevent Chlorophyll degradation. Appropriate sample documentation was made in. Darkness must be maintained during the storage period and analyses must be carried out in subdued light to avoid Chlorophyll degradation. Also, to avoid degradation, analytical procedures were performed with opaque containers or containers covered with aluminum foil. Analysis was done with standard procedures [8].

The quarrying activities like crushing of stones, transportation release huge quantities of dust to environment. Foliar surface of plants is continuously exposed to the surrounding atmosphere and is therefore the main receptor of dust. The dust particulates in the cell sap are responsible for Chlorophyll degradation and reduced photosynthetic activity. To determine the effect of dust pollution on plants, two common plant species; *Macarangapeltata* and *Chromolaenaodorata* were selected from the working quarries. These quarries are located at Thottumukkam, Kolappad, and Ainthur and the sample codes are QS/02, QS/03, QS/04 respectively. Then the variation in Chlorophyll concentration was analyzed.

3. Results and Discussion

The dust deposition in leaves of the plant changed Chlorophyll content. The plants were collected from polluted and non-polluted sites in the quarry stations. These plants show a greater variation in Chlorophyll content. In station QS/02 the Chlorophyll concentration of Chl a in the leaves of *Chromolaenaodorata* at polluted sites was recorded as 0.71mg/g FW, which was 1.41mg/g FW in control site. The concentration of Chlorophyll b was 0.33mg/g FW in the samples collected from polluted sites, while it was 1.10mg/g FW in control sites. Similarly the plant samples in the QS/03 and QS/04 stations shows a greater variation in Chlorophyll content when compare to control.

Table 1. Chlorophyll concentration analysis in *Chromolaenaodorata*

	Polluted sites			Control sites		
Parameter	QS/O2 (mg/g) FW	QS/03 (mg/g) FW	QS/04 (mg/g) FW	QS/O2 (mg/g) FW	QS/O3 (mg/g) FW	QS/O4 (mg/g) FW
Chlorophyll a	0.71	0.79	1.63	1.41	1.20	1.86
Chlorophyll b	0.33	0.42	0.88	1.10	0.93	1.45
Total Chlorophyll	1.04	1.21	2.52	2.51	2.13	3.31

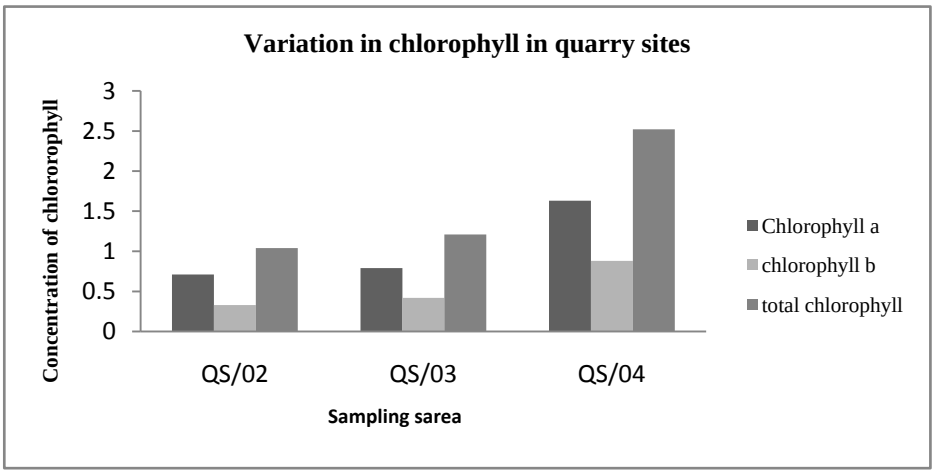

Figure 2. Chlorophyll concentration of *Chromolaenaodorata* in quarry sites

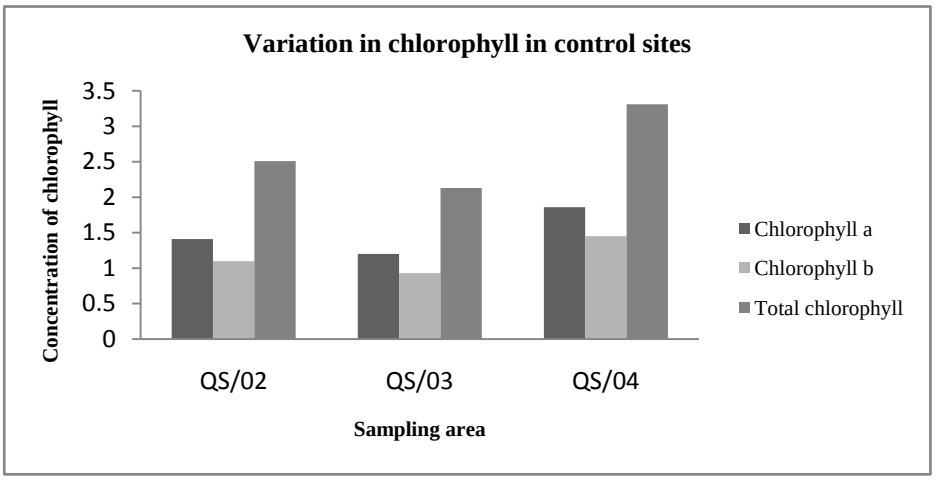

Figure 3. Chlorophyll concentration of *Chromolaenaodorata* in control sites

Macarangapeltata is a small tree; it is one of the most widely occurring early successional woody species. The Chlorophyll contents were analyzed in this species to determine the effect of dust in their photosynthetic pigments. In station QS/02, the concentration of Chl a in the leaves of *Macarangapeltata* was 1.60 mg/g FW and Chlorophyll b was 0.84 mg/g. In control site, the Chlorophyll a and b was recorded as1.16 mg/g FW and 0.71 mg/g FW respectively.

Table 2. Chlorophyll concentration analysis in *Macarangapeltata*

	Polluted sites			Control sites		
Parameter	QS/O2	QS/03	QS/04	QS/O2	QS/O3	QS/O4
Chlorophyll a	1.60	1.64	1.79	1.16	1.10	1.15
Chlorophyll b	0.84	1.07	1.46	0.71	0.59	0.88
Total Chlorophyll	2.44	2.71	3.26	1.87	1.69	2.03

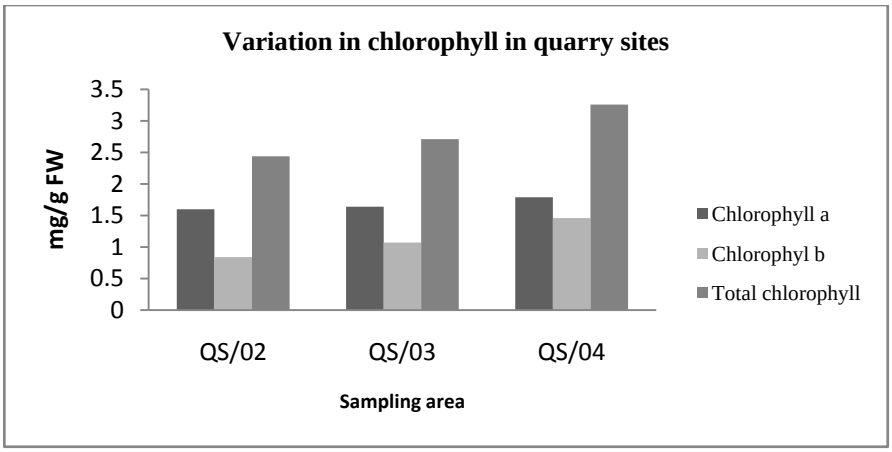

Figure 4. Chlorophyll concentration of *Macarangapeltata*in quarry sites

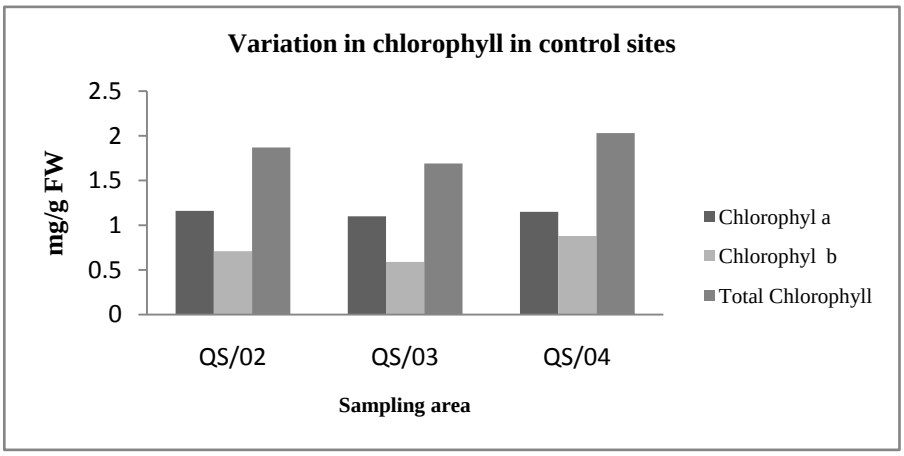

Figure 5. Chlorophyll concentration of *Macarangapeltata*in control sites

The sample from QS/03 station showed 1.64 mg/g FW of Chla and 1.07 mg/g of Chl b FW, in control, 1.10 mg/g FW Chl a and 0.59 mg/g FW Chl b was recorded. In the case of QS/04 site, 1.79 mg/g FWChla and 1.46 mg/g FW Chl b was recorded. In control sites, 1.15 mg/g FW Chla and 0.88 mg/g FW Chl b was recorded. From these results it was observed that Chlorophyll concentration of samples from polluted sites were higher than control sites.

In this study, it was observed that the quarry dust was affecting the *Chromolaenaodorata*. The samples from three quarry sites shows variation of Chlorophyll content than control [9]. In the case of *Macarangapeltata*, Samples shows higher concentration of Chlorophyll than control. The changed ambient environment due to the particulate matter pollutant in urban areas has exerted a profound influence on the morphological, biochemical and physiological status of plants and its responses [10,11]. The dust deposition makes severe impacts in plants [12]. More researchis requiredon the methods to clean agricultural products, and it'll contribute to creating consumption procedures within thesituation where consumers' demand is more for agricultural products which were grown following good agricultural practices [13]. Similar reduction has been recorded in the leaves of *Pinushallepensis* [10]. Damage in Chlorophyll content in *R. ecklonii* planted in heavy traffic road sites has also been recorded by [12]. Dusted or encrusted leaf surface is responsible foclr reduced photosynthesis and thereby causing reduction in Chlorophyll content [14].

A similar kind of Chlorophyll reduction of plants in quarry sites was explained in a study, impact of crushing and quarrying [15]. In which they take agricultural crops like Species of Oryza sativa, Capsicum frutescens as samples. All samples showed marked reduction in Chlorophyll concentration. Chlorophyll content in leaves (polluted) is relatively less than the control indicating that the quarrying activity has put the plants under stress and has affected the physiology of plants. According to researchers, plants can reduce concentration of primary particulate by directly reducing the matter by attaching it to their wax layers on the leaves [16,17] or by reducing the originators of secondary particulate matter [18]. Moreover, plant can reduce the second generation of the particulate matter among atmosphere by reducing the heat island effect of the suburban area [19].

4. Conclusion

Quarrying activity has put the plants under stress and has affected the physiology of plants. Huge amount of particulate matter is released from quarrying activities, which affect physical environment. The particulate matter deposition makes severe impacts in plants. In some of the plants collected from polluted environment, the photosynthetic pigments were reduced and the percentage of reduction was studied. The reduction in chlorophyll will lead to stunted growth of the plants. Results of this

study show that there is negative impact on plants by granite quarry pollution and plant species differ in their response to stress environment. The particulate matter which contains other harmful pollutants like heavy metals may affect the growth of the plants. Further research is needed in this area.

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