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Leaf Dust Accumulation and Its Impact on Chlorophyll Production of Azadirachta Indica

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Abstract:
The paper describes the effect of dust on plants around stone crusher Industrial areas, of Bapatla District, at Jangamaheswarapuram.It is main hub for the production of stone crushers Plant species growing in and around crusher areas were selected within 2km far from the industries periphery. Various morphological characteristics and effect of dust on chlorophyll pigment were studied and observed the impact of dust particle on growth of the Azadirachta indica in the study it effects of stone crusher dust on selected tree species was observed and which will help tin managing development of green belt to reduce the air pollution in the study area.

Keywords: Air pollution, Stone crusher industries, Dust, Chlorophyll

1. INTRODUCTION

The stone crusher industry in India is basically a labor intensive small scale industry, where most of the operations are performed manually. Above 12000 stone crushers are working know in India. The number may further depending on the keep in view of rapid development of infrastructure of roads, canals and buildings that are required for overall development of the country. In India, the Stone Crushing Industry sector is estimated to have an annual turnover of more than Rs.5000 core and is, therefore, an economically important sector. The sector is estimated to be providing direct employment to over 500,000 people engaged in various activities such as mining, crushing plant, transportation of mined stones and crushed products, etc. Most of these personnel are from rural and economically backward areas where employment opportunities are limited and therefore it carries greater significance in terms of social importance in rural areas. It is a source of earning for uneducated poor and unskilled rural people. It also helps the poor particularly in dry land areas to prevent migration of labour.

Rare use of PPE during work increases the susceptibility of workers to different pollutants in the industry including particulate matter, dust, heavy metals and noise. It is important to note that PPE were provided to only 6% of workers by the industry and only 2% workers were using these equipment's regularly. This is due to lack of awareness among workers about possible adverse effects of pollutants on their health. Workers with low awareness have high exposure to hazards and low perception (Behrens and Brackbill, 1993).

The leaves of Butea monosperma exhibit ocular anti-inflammatory activity in rabbits (Mengi and Deshpande, 1995).The anti-inflammatory activity of methanolic extract of Butea monosperma evaluated by carrageenan induced paw edema at 600 and 800 mg/kg inhibition of paw edema by 26 and 35% in

cotton pellet granuloma inhibition of granuloma tissue formation by 22 and 28% (Shahavi and Desai, 2008). It shows anticonvulsive activity due to the presence of a triterpene. (Kasture et al., 2002).

The higher percentage of therophytes in the grassland was due to periodic climate change along with interference of crusher unit activities (Mishra 1978; Barik and Mishra, 1998).

Epidermal cells may be attacked earlier by the pollutants than guard cells by virtue of their greater exposure to pollutants (Black and Black 1979a, b). Since guard cells are usually protected by a well-developed cuticle, the pollutant has to reach them by entering the stomatal pore and by transfer through adjacent epidermal cells (Squire and Mansfield 1972).

Dust can cause the leaf injury stomata damage, premature senescence and can decrease photosynthetic activity, disturb membrane permeability and reduce growth and yield in sensitive plant species. (Agrawal et al. 2006, Tiwari et al. 2006) Of the fifteen plants studied Cassia fistula were found more resistant to dust pollution followed by Nyctanthes artabortritis. A decrease in chlorophyll content was observed in Ficus religiosa.

2. MATERIAL AND METHODS

The present study on "The Effects of Stone Crusher Dust on Vegetation" carried out at Jangamaheswarapuram (Latitude 15.896622 N and Longitude 80.460434 E) Martur mandal, Bapatla district, Andhra Pradesh, India, has been conducted during May 2021 to April 2023. Four species, viz. Annona squamosaL, Azadirachta indicaA, Calotropis gigantea L, and Cassia siameaL, were selected for the present study. The study included seasonal variations of dust accumulation on leaves, seasonal variations in production of chlorophyll a, chlorophyll b and total Chlorophyll content. The results of the study are presented in standard units.

2.0 STUDY AREA:

Bapatla is a coastal district in Andhra Pradesh. It is a newly established district raised on 4thApril 2022. The district is formed from parts of the combined Prakasam and combined Guntur districts. Bapatla harbours Indian Air Force Station and several Research institutions. Air force station at Suryalanka of Southern Air Command is a major Defence establishment in the District.

2.1. Collection of leaf Samples:

Leaf samples were obtained from plants growing in the study area. Fifty leaves of each species were randomly collected in the morning between 8 - 10 AM polythene zip bags. The weight of fresh leaves was taken immediately and samples were preserved in a refrigerator for further analysis.

2.1.1 Dust Deposition:

The leaves were carefully plucked from each species under study and were placed in zip lock polythene cover. The leaves so collected with dust particles were weighed (W_1). The leaves were then carefully washed and wiped with cotton cloth and dried. After ten minutes the leaves were weighed to record 'weight without dust (W_2) finally the weight of dust was estimated by deducting W_1-W_2. Thus the monthly dust accumulation on the leaves was recorded.

$$W = W_1 - W_2$$

Where, W= weight of dust (mg /g).

W_1 = weight of leaves with dust (mg /g).

W_2 = weight of leaves without dust (mg /g).

2.1.2 Extraction of chlorophyll:

This was done adopting the method described by Arnon (1949). Ten fresh leaves were blended and then extracted with 40 ml of 80% acetone and left for 15 minutes. The liquid portion was taken into another tube and was then centrifuged at 5000 rpm for 5 minutes. The supernatant of the sample was transferred in to the cuvettes and the absorbance was measured at 645 nm and 663 nm using a spectrophotometer (Model No SL177). The absorbance at 645nm and 663nm against the solvent (acetone) blank was also taken.

2.1.3 Estimation of chlorophyll content:

One leaf from each twig was kept separately in an ice box for the estimation of Chl. The concentrations of chlorophyll 'a', chlorophyll 'b' and total chlorophyll were calculated using the following equation:

Chlorophyll 'a': $12.7(A_{663}) – 2.69(A_{645})$

Chlorophyll 'b': $22.9(A_{645}) – 4.68(A_{663})$

Total Chlorophyll: $20.2(A_{645}) + 8.02(A_{663})$.

Total chlorophyll content analysis was done by following the method described by Arnon (1949) 0.5g of fresh leaves were blended and then extracted with 10 ml of 80% chilled acetone and left for 15 min. The liquid portion was decanted and centrifuged at 2,500 rpm for 15 min. The supernatant was then collected and the absorbance (Optical Density) was then determined at 645nm and 663nm using a spectrophotometer.

Calculations were made using the formula given below:

Total Chlorophyll Content = (20.2XO.D. at 645nm) + (8.02XO.D at 663nm).

Where, OD=Optical Density

A brief description of the plant species is given below along with systematic position:

3. Azadirachta indica A:

Systematic Position:

Kingdom : Plantae
Order : Sapindales
Family : Meliaceae
Genus : Azadirachta
Species : indica A.

Synonyms : Neem and Mara. Margosa, Neeb, Nimtree, Nimba, Indian-lilac Bemba

Azadirachta is commonly known as neem margosa or Indian lililaceae. It is native of Indian subcontinent. Its seeds and fruits are source of neem oil. It is a tree growing up to 15-20m. It is known for shedding many of the leaves during dry winter months. Leaves opposite, pinnate growing up to 20-40 cm. The petioles are short the fragrant flowers are arranged in drooping axillary panicles and individual flowers 5-6mm long the fruits are glabrous the fruit skin is thin (exocarp) and bitter sweet pulp (mesocarp) is yellowish white and very fribrown. Azadirachta species is known for its drought resistance. It is typical tropical to subtropical tree and tolerates $21\text{-}32^0$C temperature also able to tolerate high to very high temperature and does not tolerate temperature below 5^0C.

Fig3: Azadirachta indica

3.0 RESULTS:

3.1 AZADIRACHTA INDICA:

Azadirachta indica is a very common tree known for excellent medicinal values the tree has maximum medicinal value in all the plant parts very popular as bio pesticides for organic agriculture. The monthly mean of dust accumulation on the leaves for the study period varied widely. The minimum concentration was recorded in April 2023 (0.11 mg/cm^2) and maximum was recorded in February 2023 (2.21 mg/cm^2). The concentration was moderate during rainy and lowest during summer season. The highest concentration of dust was recorded during winter season. The season wise breakup is explained in detail in the ensuing pages (Table: 3.1; Fig: 3.1).

Table: 3.1Distribution of dust concentration over the leaves Azadirachta indica during the study period

Month	Dust mg/cm^2 2021-2022	Dust mg/cm^2 2022-23
May	0.41	0.48
June	0.47	0.73
July	0.51	0.88
August	0.72	0.94
September	0.98	1.16
October	1.05	1.31
November	1.42	1.47
December	1.17	1.58

January	1.29	1.87
February	1.48	2.21
March	0.52	0.28
April	0.11	0.91
Mean		0.997917 ± 0.522552

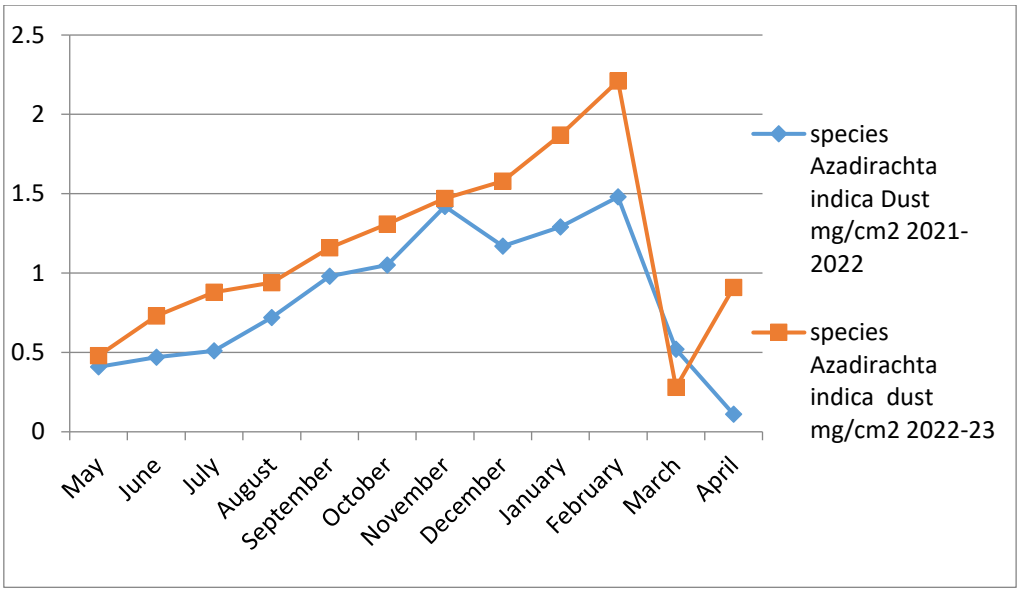

Fig: 3.1 Distribution of dust concentration mg/cm^2 over the leaves ofduring the Study period.

Distribution of dust over the leaves during winter season during the study period on Azadirachta indica

The accumulation of dust on the leaves of this tree varied widely during different seasons in a year .the dust retention capacity of the tree is less because of the comparatively narrow and short and the canopy is located at a height of 6-8 ft., from ground. This high density of leaves with serrated margins and all these characterstics support low dust holding capacity primarily sickle shape with serrated margins and smooth surface .but when the climate is too cold and the wind velocity is low particularly during the winter the dust accumulation was formed to be less, Yet the comparatively thick, high canopy up to 18-20 m height from the ground. The mean dust accumulation when measured was only1.34 mg/cm^2 in 2021-22 and 1.78 mg/cm^2 in 2022-23. The lowest accumulation during the two years of study was 1.17 mg/cm^2 (2021- 22) and highest accumulation was 2.21 mg/cm^2 (2022-23).the lowest values of dust were due to the height of canopy which is exposed to wind turbulence (Table: 3.1.1; Fig: 3.1.1).

Table: 3.1.1 Dust deposition during winter season in Azadirachta indica

Month	Dust mg/cm^2 2021-22	Dust mg/cm^2 2022-23	Mean
November	1.42	1.47	1.445 ± 0.035355339
December	1.17	1.58	1.375 ± 0.28991378
January	1.29	1.87	1.58 ± 0.410121933
February	1.48	2.21	1.845 ± 0.51618795
Mean	1.34 ± 0.138323293	1.7825 ± 0.33119732	

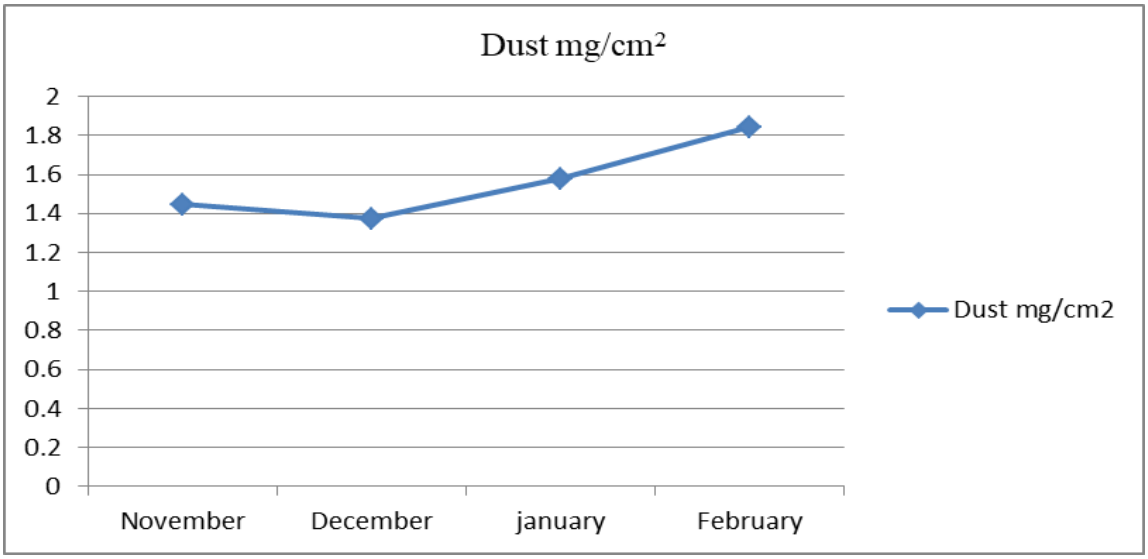

Fig: 3.1.1 seasonal variation of mean dust deposition mg/cm² over the leaves of Azadirachta indica in winter

Distribution of dust over the leaves during summer season during the study period on Azadirachta indica

The dust accumulation during summer season i.e. March, April, May and June was very minimum i.e. less than 1.0 mg/cm^2,the variation from a minimum of 0.11 mg/cm^2 to a maximum at 0.91mg/cm^2(2022-23). Incidentally the lowest and highest concentration appeared in April. However the mean values of was almost double that of 2021-22 viz 0.6 and 0.37 mg/cm^2 respectively. The smooth leaf surface, high wind velocity and height of the canopy contributed to low retention of dust (Table: 3.1.2; Fig: 3.1.2).

Table: 3.1.2 Dust deposition during summer season in Azadirachta indica

Month	Dust mg/cm^2 2021-22	Dust mg/cm^{2}2022-23	Mean
March	0.52	0.28	0.4 ± 0.169705627
April	0.11	0.91	0.51 ± 0.565685425
May	0.41	0.48	0.44 ± 0.049497475
June	0.47	0.73	0.6 ± 0.183847763
Mean	0.3775 ± 0.183915742	0.6 ± 0.27676705	

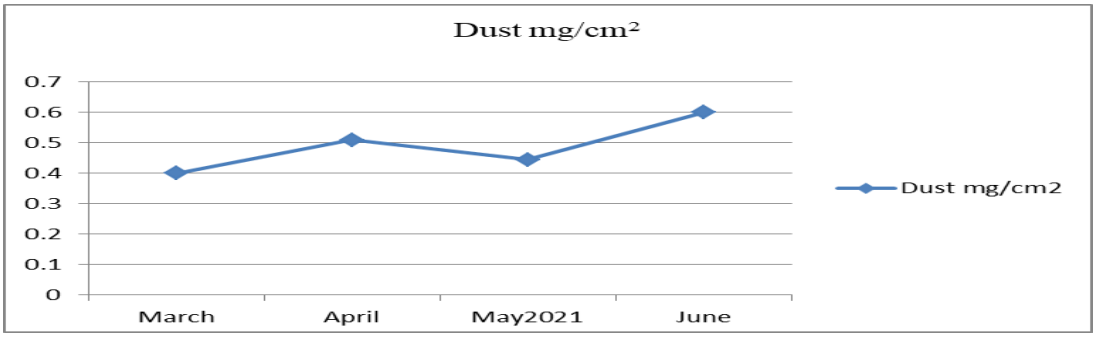

Fig: 3.1.2 Seasonal variation of mean dust deposition mg/cm² over the leaves of Azadirachta indica in summer

Distribution of dust over the leaves during Rainy season during the study period on Azadirachta indica

July, August September and October months are grouped and named as rainy season. The south west monsoon which is the major rain contributor this place. Due to the seasons explained earlier. The mean dust accumulation during 2022-23 was 1.07 mg/cm^2 which were slightly higher 0.81 mg/cm^{2}in 2021-22 than previous year. During the entire period of study, the deviation was very slight and standard deviation also was significant (Table: 2.3; Fig: 2.3).

Table: 3.1.3 Dust deposition during rainy season in Azadirachta indica

Month	Dust mg/cm^2 2021-22	Dust mg/cm^2 2022-23	Mean
July	0.51	0.88	0.695 ± 0.26162950
August	0.72	0.94	0.83 ± 0.155563492
September	0.98	1.16	1.07 ± 0.127279221
October	1.05	1.31	1.18 ± 0.183847763
Mean	0.815 ± 0.247991935	1.0725 ± 0.198892768	

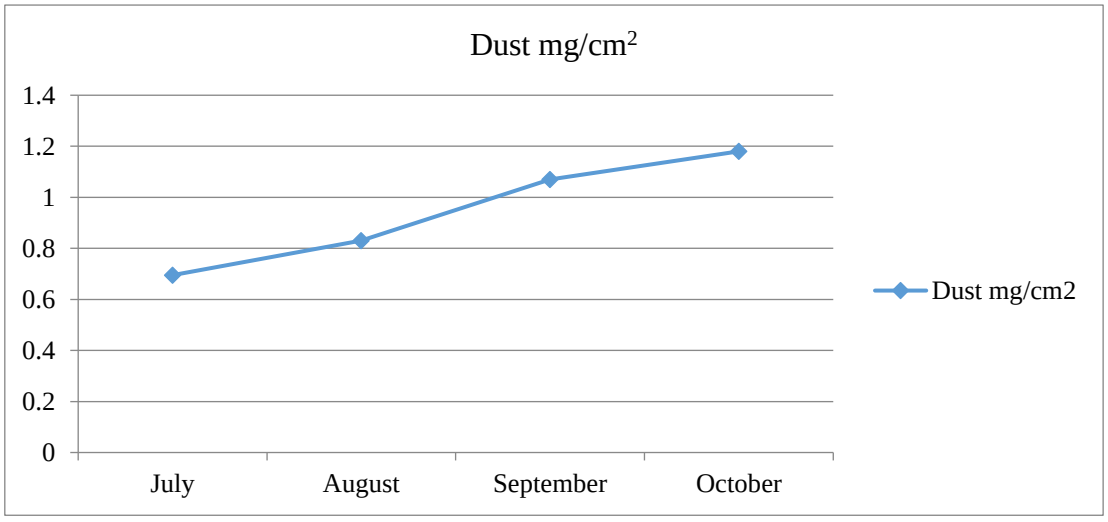

Fig: 3.1.3 Seasonal variation of mean dust deposition mg/cm^2 over the leaves of Azadirachta indica in rainy

The impact of crushers on vegetation, human beings and on properties like houses is adverse to moderate basing on the operation time, wind velocity and direction, distance from source, and size of the particulates. As the dust retention time on leaves quantum of deposition finally decide the nature and magnitude of impacts on different plant parts such as leaf surfaces, bottom of leaves closure of stomata, deposition among serration, floral parts inflorescence etc.

3.2 AZADIRACHTAINDICA L:

The chlorophyll a content in Azadirachta indica was double the chlorophyll b as was in three plants. The seasonal March of chlorophyll a, b and total was distinct and similar to other trees the chlorophyll a in Azadirachta varied from lowest 2,110 mg/g to a height 5.040 mg/g during the study period. The production of chlorophyll a content was similar in both the years of study (Table: 3.2; Fig: 3.2).

The chlorophyll b was a little less than half of the chlorophyll a content during the entire study period with a minimum of 1.002 mg/g in October 2021-22. Maximum of 1.920 mg/g in September 2022-23. The variations in chlorophyll b production were not much as was chlorophyll and difference between maximum and minimum was only 0.918 mg/g which was very marginal.

The total chlorophyll content production in Azadirachta indica was moderate with a minimum of 3.112 mg/g in October 2021-22 and a maximum of 6.950 mg/g in September during both the years of study. The variations in the total chlorophyll production were 3.838 mg/g during the study period.

Table: 3.2 Distribution of chlorophyll a, b, and total chlorophyll content in the leaves of Azadirachta indica during the study period

Month	Chl a	Chl b	Total Chl mg/g 2021-22	Chl a	Chl b	Total Chl mg/g 2022-23
May	3.150	1.345	4.495	3.165	1.336	4.501
June	4.887	1.835	6.722	4.993	1.845	6.838
July	4.996	1.845	6.841	5.010	1.865	6.875
August	5.020	1.860	6.880	5.025	1.870	6.895
September	5.030	1.920	6.950	5.040	1.910	6.950
October	2.110	1.002	3.112	2.120	1.110	3.230
November	2.225	1.110	3.335	2.235	1.125	3.360
December	2.250	1.135	3.385	2.265	1.140	3.405
January	2.260	1.150	3.410	2.275	1.155	3.430
February	3.063	1.281	4.344	3.090	1.290	4.380
March	3.110	1.315	4.425	3.120	1.325	4.445
April	3.125	1.330	4.455	3.140	1.345	4.485
Mean				3.446 ± 1.185021	1.435167 ± 0.32648	4.881167 ± 1.510314

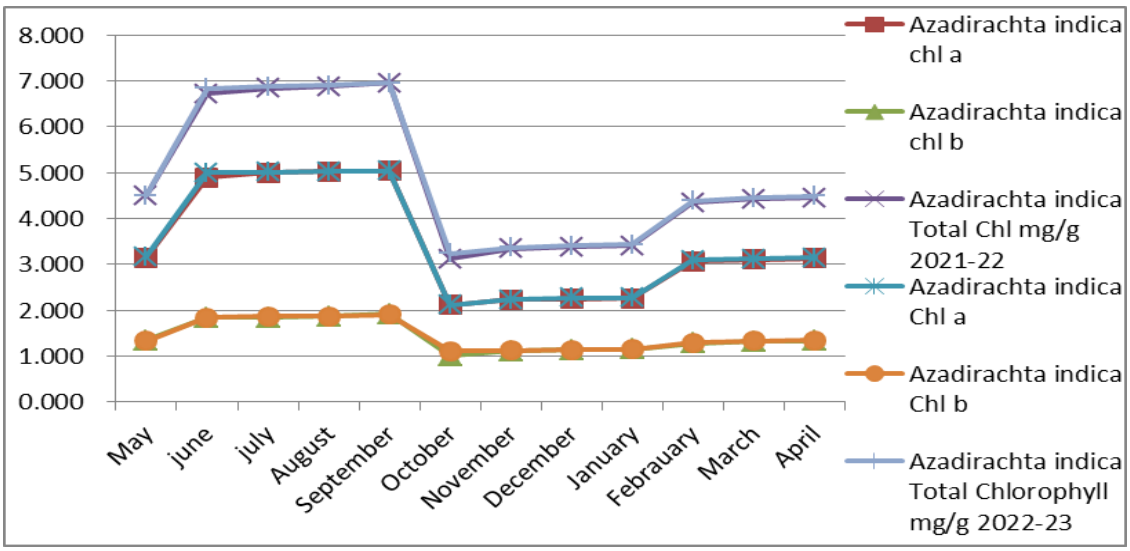

Fig: 3.2 Distribution of total chlorophyll content mg/g in the leaves during study period

Distribution of chlorophyll a, chlorophyll b and total chlorophyll content in the Azadirachta indicaduring winter season.

The total chlorophyll mg/g during winter month has minimum because of high accumulation of dust and the winter condition low turbulence of atmosphere the retention of the dust increases reflects in the lower production of total chlorophyll. Both the years of study showed the similar effect. November, December and January have low total chlorophyll and as the temperature start increasing i.e. in February the relative humidity gradually decrease indicating on set of summer. Both the years of study have shown production a similar quality of chlorophyll the first three months of winter have shown the similar quality of production (Table: 3.2.1; Fig: 3.2.1).

Table: 3.2.1Total chlorophyll content during winter season in Azadirachta indica

Month	Total Chl mg/g 2021-22	Total Chl mg/g 2022-23	Mean
November	3.335	3.36	3.348 ± 0.01767
December	3.385	3.405	3.395 ± 0.1414
January	3.410	3.430	3.420 ± 0.01414
February	4.344	4.38	4.362 ± 0.2546
Mean	3.619 ± 0.485	3.64375 ± 0.491687	

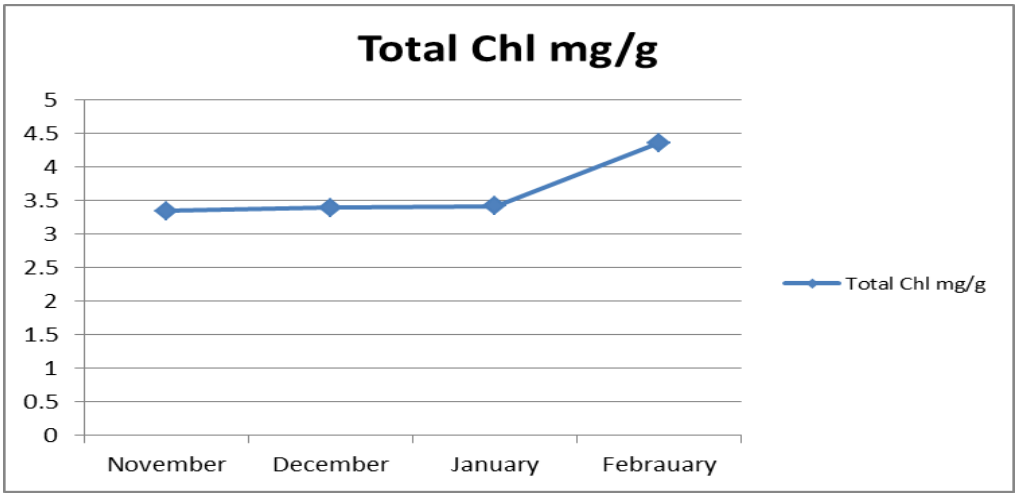

Fig: 3.2.1 Seasonal variation of Total Chlorophyll content (mg/g) in leaves of Azadirachta indica in winter

Distribution of chlorophyll a, chlorophyll b and total chlorophyll content in the Azadirachta indica during summer season

The summer season showed a moderate quality of chlorophyll because of the increased temperatures, atmospheric turbulence the first three months and the chlorophyll content production increased from June month. The summer months do not produce the chlorophyll is replaced by pheophytin and the plant also sheds its leaves during summer. The onset of rains marks the increase new leaf formation and slow increase of chlorophyll production a subsequent month in rainy season showed increased chlorophyll production indication of increased productivity and decreased of dust accumulation.(Table: 3.2.2; Fig:3.2.2).

Table: 3.2.2Total chlorophyll content during summer season in Azadirachta indica

Month	Total Chl mg/g 2021-22	Total Chl mg/g 2022-23	Mean
March	4.425	4.445	4.435 ± 0.14142
April	4.455	4.485	4.47 ± 0.0212
May	4.495	4.501	4.498 ± 0.0042
June	6.722	6.838	6.78 ± 0.0820
Mean	5.024 ± 1.132196501	5.06725 ±1.180735	

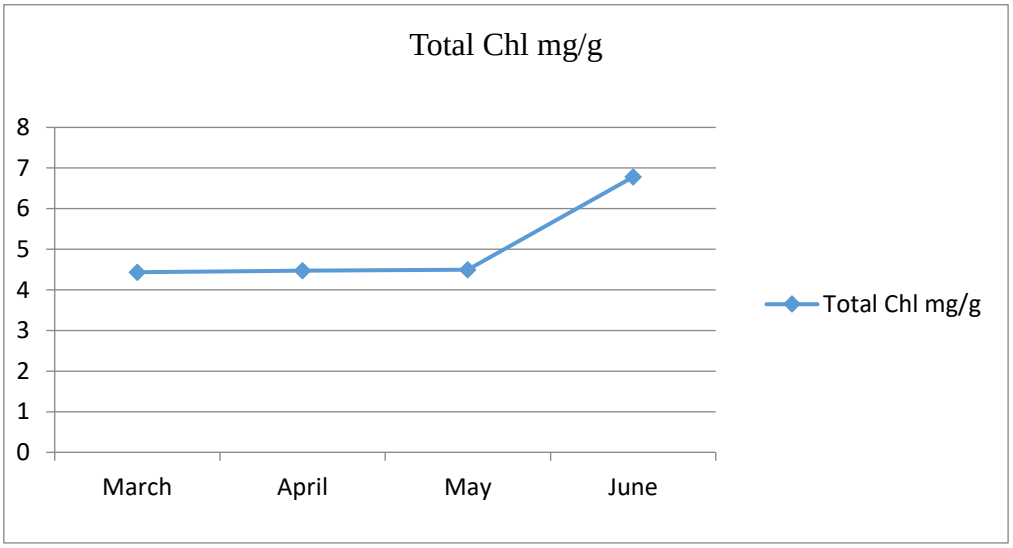

Fig: 3.2 2Seasonal variation of Total Chlorophyll content (mg/g) in leaves of Azadirachta indica in summer

Distribution of chlorophyll a, chlorophyll b and total chlorophyll content in the Azadirachta indica during rainy season

The total chlorophyll content production was high to moderate during rainy season. The first three months in rainy season. Was similar in quantity of total chlorophyll and the decreased to 50% in the next month i.e. October. The mean total chlorophyll production during the both the years of study are similar (Table: 3.2.3; Fig: 3.2.3).

Table: 3.2.3 Total chlorophyll content during rainy season in Azadirachta indica

Month	Total Chl mg/g 2021-22	Total Chl mg/g 2022-23	Mean
July	6.841	6.875	6.858 ± 0.02404
August	6.880	6.895	6.888 ± 0.01607
September	6.950	6.95	6.950 ± 0
October	3.112	3.23	3.171 ± 0.08343
Mean	5.946 ± 1.890	5.9875 ± 1.838607	

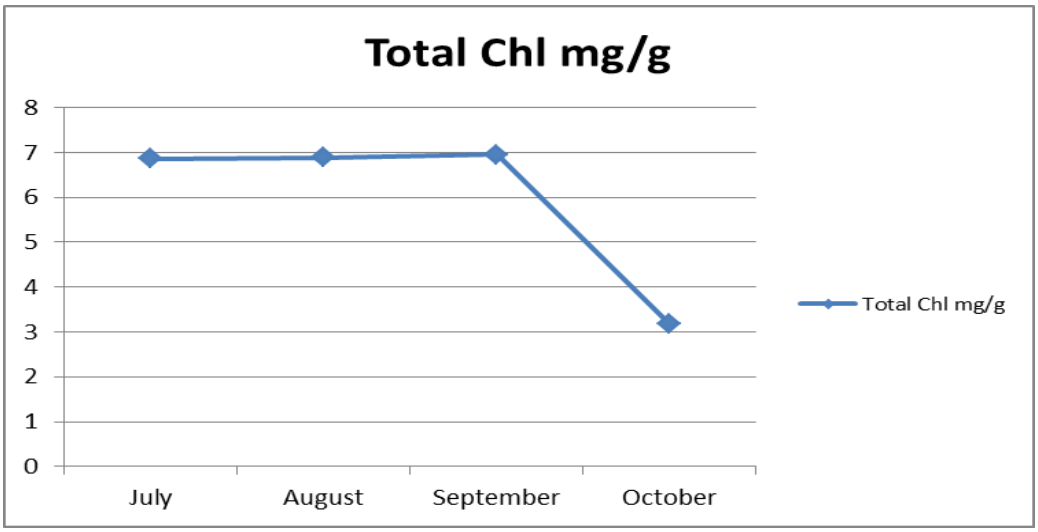

Fig: 3.2.3 Seasonal variation of Total Chlorophyll content (mg/g) in leaves of Azadirachta indica in rainy

SUMMERY & CONCLUSION:

Azadirachta indica is a very common tree known for excellent medicinal values the tree has maximum medicinal values in all the plant parts and very popular as bio pesticides and for organic agriculture. The monthly mean of dust accumulation on the leaves for the study period varied widely. The minimum concentration was recorded in April 2023 (0.11 mg/cm2) and maximum in February 2023 (2.21 mg/cm2). The concentration was moderate during rainy and lowest during summer season. The highest concentration of dust was recorded during winter season.

The summer months do not produce the chlorophyll is replaced by pheophytin and the plant also sheds its leaves during summer. The onset of rains marks the increase new leaf formation and slow increase of chlorophyll production a subsequent month in rainy season showed increased chlorophyll production indication of increased productivity and decreased of dust accumulation. The total chlorophyll content production was high to moderate during rainy season.

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