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LEAF DUST DEPOSITION AND ITS IMPACT ON CHLOROPHYLL CONTENT OF ANNONA SQUAMOSA

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ABSTRACT
Seasonal variation in dust accumulation on leaves and Chlorophyll a, b and total chlorophyll content of leaves of species around crusher at study area. The impact of crusher dust was observed via biochemical attributes (chlorophyll contents) from leaves of Annona squamosa the result showed maximum dust deposition in winter moderate by summer and minimum rainy for plant species. It was seen that total chlorophyll decreased with the increasing dust load of selected crusher dusted plant species the result shows significant correlation (negative) between dust load and pigment content in all three seasons. Thus plants can be used in the subsiding of crusher dust pollution by acting as natural filters.

KEYWORDS: Crusher dust, Chlorophyll, Seasonal variation and Dust accumulation.

1. INTRODUCTION

It is advantageous if the crushed stone unit is set up near the quarries where the boulders of various sizes are available for the crushing unit. Hard lime boulders are transported by road or rail and unloaded. Big crusher units use boulders of various sizes which are fed into crushers for size reduction. Depending on the desired output size of the crushed stone, the raw materials may be fed to one or two crushers in a sequence. Then these crushed stones are passed on to the rotary screen for size gradation. Material is handled through a belt conveyor to the different places of operation. The main machinery involved in the stone crushing industry is Crusher, Screen, Conveyors, etc. The process involved is to feed the stone in to the Crushers to make it further smaller in size as required by the customer. The crushed stone is screened to separate the produce in different sizes (40 mm, 30 mm, and 20 mm) by the separator and these are conveyed by the conveyors to trucks for transport to the market place or storage area.

Air pollution is a major problem in modern society. Even through air pollution is usually a greater problem in cities, pollutants contaminate air everywhere. The interaction between plants and pollutants were investigated by many authors: most studies on the influence of environmental pollution focus on physiological aspects (Heumann, 2002; Psaras and Christodoulakis, 1987; Velikova et al., 2000). Studies concerning the anatomy of the vegetative organs under conditions of pollution have been also carried out (Alves et al., 2008; Ahmad et al., 2005; Silva et al., 2005, 2006, Verma et al., 2006). The reaction of different species to the altered environmental conditions is strongly correlated with their structural and functional features.

The study revealed that the total chlorophyll in control plants was always higher than that of the plants grown in dust polluted atmosphere. The reduction in yield may be attributed to the reduction in the photosynthetic pigments and the deposition of dust which leads to the clogging of stomata that interferes with gaseous exchange. The decrease in total chlorophyll content in unit fresh weight of polluted leaves might be due to chloroplast damage by incorporation of dust particulates into leaf tissue. Similar observations have also been made by Singh and Rao (1978).

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. Plant species, viz. *Annona squamosa*L, 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.

The following account brief up about the collection and preservation of leaves, preparation of samples for estimation Chl a, Chl b, and total chlorophyll.

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.

2.2 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).

2.3 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.

2.4 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. *Annona squamosa* L

Systematic position

Kingdom: plantae

Order: Magnoliales

Family: Annonaceae

Genus: *Annona*

Species: *squamosa* L.

Synonyms: Alphonsea forskahlii, Annona asiatica, Alphonsea cinerea.

A. squamosa L is known as Sugar apple, Custard apple Sweetsop, Buah Nona, Seri Kaya, Bullock's Heart. It is native of Singapore. It is tree or shrub perennial, autotrophic irregular, its growing up to 3m-6m, terrestrial and tropical regions. Leaves are elliptic to oblong rounded acute apex, alternate with entire leaf margins the fragrant flowers are arranged in hang down wards either singly or group of 2-4. Each oblong flower has 3 elongated outer petals and three in conspicuous inner petals (2.5-4 cm long). The bark of leaves contain annonaine an alkaloid, in tropical America; Adecoction of leaves is used as a cold remedy and to clarify urine. A bark decoction is used to stop Diarrhea. Root used to treatment dyentary.

Fig. 3: *Annona squamosa.*

3.1 *Annonasquamosa*l

It was a widely popular tree in the region and almost every house in the village has at least one *Annona* tree. The air downwind from the crusher carries the dust varying sizes deposits on the trees. The comparatively larger size of the leaves and good canopy enables the plant to filter the dust in the air. As the dust accumulation is considerable, there is a chance of dust influencing the production of chlorophyll a, b and total chlorophyll and also influencing the functioning of stomata. Thus the formation of pheophytin is favoured which is a loss to the productivity of the plant. The detailed effects are delineated below.

The monthly mean of dust concentration in study period May 2021 to April 2023 showed a wide range of concentrations. (Table: 4.1, Fig: 4.1) The minimum concentration of dust was recorded in March 2023 (0.18 mg/cm^2) and maximum was recorded in February 2023 (4.13 mg/cm^2) while the mean concentration of dust for the whole study period was (2.031 mg/cm^2). The seasonal distribution of dust was almost similar during the two years. The summer season showed moderate concentration of dust and rainy season showed the lowest concentrations while highest concentration of the dust was during winter season.

Table 3.1: Distribution of dust concentration over the leaves *Annona squamosa* during the study period.

Month	Dust mg/cm^2 2021-2022	Dust mg/cm^2 2022-23
May	2.31	2.18
June	1.16	0.31
July	1.81	0.36
August	1.65	0.97
September	1.91	1.16
October	2.32	2.04
November	2.54	2.34
December	3.21	3.11
January	3.45	3.32
February	3.81	4.13
March	1.21	0.18
April	1.81	1.46
Mean		2.03125 ± 1.091849

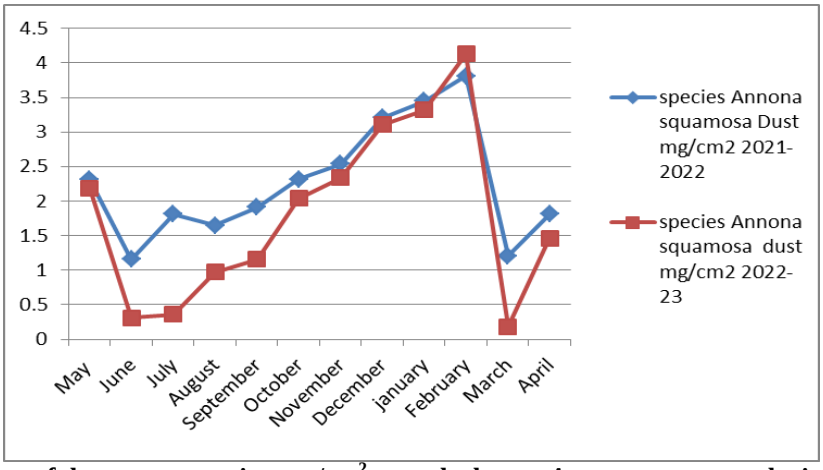

Fig. 3.1: Distribution of dust concentration mg/cm^2 over the leaves *Annona squamosa* during the study period.

Distribution of dust over the leaves during winter season during the study period on *Annona squamosa*

The spread of dust during the study is not uniform throughout all the month. The dust accumulation varied every day and moreover the variation was moreover the variation was high estimated season wise. In general, winter showed high accumulation levels with a mean of 3.25 mg/cm^2 in 2021-22 while a slightly lower mean was recorded3.22 mg/cm^2 November, December, January and February months are shown as winter season. Among these four months highest monthly means were recorded viz. February (3.9 mg/cm^2), January (3.38 mg/cm^2), December (3.16 mg/cm^2) and November (2.44 mg/cm^2) in that order. This indicates that the dust accumulation increased with increase of RH in the winter season (Table: 3.1.1; Fig: 3.1.1).

Table 3.1.1: Distribution of dust over the leaves during winter season during the study period on *Annona squamosa*.

Month	Dust mg/cm^2 2021-22	Dust mg/cm^2 2022-23	Mean
November	2.54	2.34	2.44 ± 0.141421356
December	3.21	3.11	3.16 ± 0.070710678
January	3.45	3.32	3.38 ± 0.091923882
February	3.81	4.13	3.97 ± 0.22627417
Mean	3.2525 ± 0.5351868	3.225 ± 0.73586683	

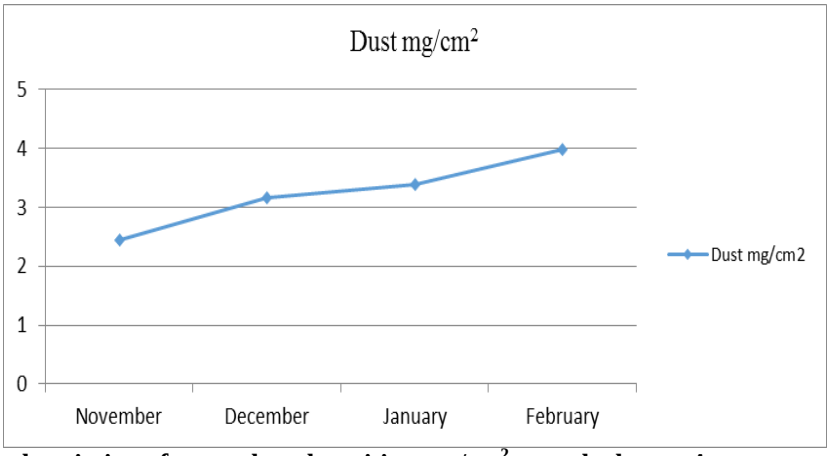

Fig. 3.1.1: Seasonal variation of mean dust deposition mg/cm^2 over the leaves *Annona squamosal* in winter.

Distribution of dust over the leaves during summer season during the study period on *Annona squamosal*

The dust levels accumulated in summer viz .March, April, May and June months varied widely from minimum of 0.18 mg/cm^2 in 2022-23 June to a maximum of 2.31 mg/cm^2 in May 2021-22. The accumulation of dust on leaves was always less than 2 mg/cm^2 during the entire summer except during may in both the years of study.(Table: 3.1.2; Fig: 3.1.2).

Table 3.1.2: Dust deposition during summer season in *Annona squamosal.*

Month	Dust mg/cm^2 2021-22	Dust mg/cm^2 2022-23	Mean
March	1.21	0.18	0.695 ± 0.728319985
April	1.81	1.46	1.635 ± 0.247487373
May	2.31	2.18	2.245 ± 0.091923882
June	1.16	0.31	0.735 ± 0.091923882
Mean	1.6225 ± 0.54524459	1.0325 ± 0.957126	

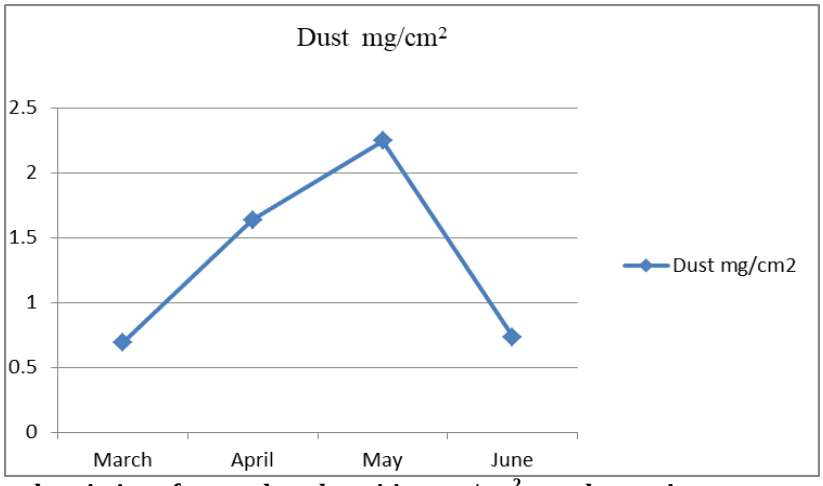

Fig. 3.1.2: Seasonal variation of mean dust deposition mg/cm^2 over leaves *Annona squamosa* in summer.

Distribution of dust over the leaves during Rainy season during the study period on *Annona squamosa*

The rainy season is spread from July, August September and October. These four months corresponds to the south west monsoon. The dust accumulation will be generate less during rainy season. the values in the table in 2021-22 and 2022-23 reveal that the rains are less in 2021-22 compared to 2022-23. The rains generally wash away all the dust particles and the particulate matter in the ambient air is also very less. A similar trend is observed in 2022-23 whereas the dust accumulation was good as in other season in 2021-22 because of less or no rains in the first year of study. However, the October month during both the years was high perhaps due to withdrawal of the southwest monsoon and lack of rains (Table: 3.1.3; Fig: 3.1.3).

Table 3.1.3: Dust accumulation during Rainy season in *Annona squamosal.*

Month	Dust mg/cm^2 2021-22	Dust mg/cm^2 2022-23	Mean
July	1.81	0.36	1.085 ±1.02530483
August	1.65	0.97	1.31 ± 0.480832611
September	1.91	1.16	1.535 ± 0.53033008
October	2.32	2.04	2.18 ± 0.19798989
Mean	1.9225 ± 0.28581754	1.33 ± 0.694616201	

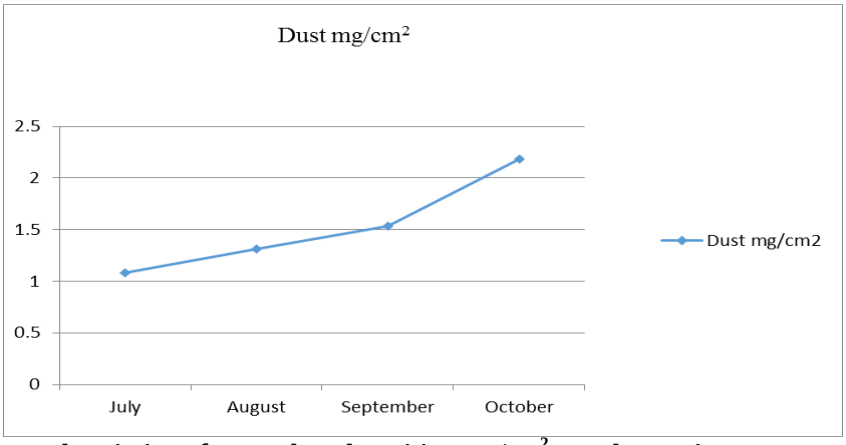

Fig. 3.1.3: Seasonal variation of mean dust deposition mg/cm^2 over leaves *Annona squamosa in* rainy.

3.2 *Annona Squamosa* L

The chlorophyll content in *Annona squamosa* showed a minimum chlorophyll a content of 6.01 mg/g. during October and maximum 7.099 mg/g during September concentration were similar during both the years of study. The *Annona squamosa* is a subtropical moderate tree and hence throughout the year never loses green colour attributed by chlorophyll. during the both the years the difference between the minimum and maximum was hardly 1.1 mg/g. The mean concentration of chlorophyll of all the months during the study period was 6.3 mg/g. the quantity of chlorophyll is almost double to compared to chlorophyll b. the seasonal variations was also very marginal in all the seasons. There was only 1 mg/g difference. The higher chlorophyll was recorded in south west monsoon season (Table: 3.2; Fig: 3.2).

Chlorophyll b concentration in *Annona squamosa* during the study period was also estimated. The chlorophyll b content was fairly lower compared to chlorophyll a. A minimum of 3.01 mg/g was recorded in October 2021-22 and a maximum of 4.097 mg/g was recorded in September 2022-23. Rainy season showed higher concentration compared to winter.

The total chlorophyll (mg/g) was estimated and the minimum total chlorophyll recorded was 9.020 mg/g during October 2022-23, respectively winter and summer concentration s of total chlorophyll was similar and higher concentration were recorded in rainy season during both years of the study period.

Table 3.2: Distribution of chlorophyll a, b, and total chlorophyll content in the leaves of *Annona squamosa* 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	6.07	3.045	9.115	6.082	3.059	9.141
June	7.044	4.06	11.104	7.049	4.069	11.118
July	7.06	4.07	11.130	7.072	4.073	11.145
August	7.085	4.081	11.166	7.091	4.085	11.176
September	7.09	4.092	11.182	7.099	4.097	11.196
October	6.01	3.01	9.020	6.015	3.016	9.031
November	6.022	3.015	9.037	6.027	3.022	9.049
December	6.031	3.027	9.058	6.036	3.029	9.065
January	6.045	3.035	9.08	6.048	3.038	9.086
February	6.047	3.037	9.084	6.052	3.041	9.093
March	6.050	3.041	9.091	6.059	3.049	9.108
April	6.055	3.043	9.098	6.062	3.055	9.117
Mean				6.38408	3.37967	9.76375

				± 0.50676	± 0.51425	± 1.02098

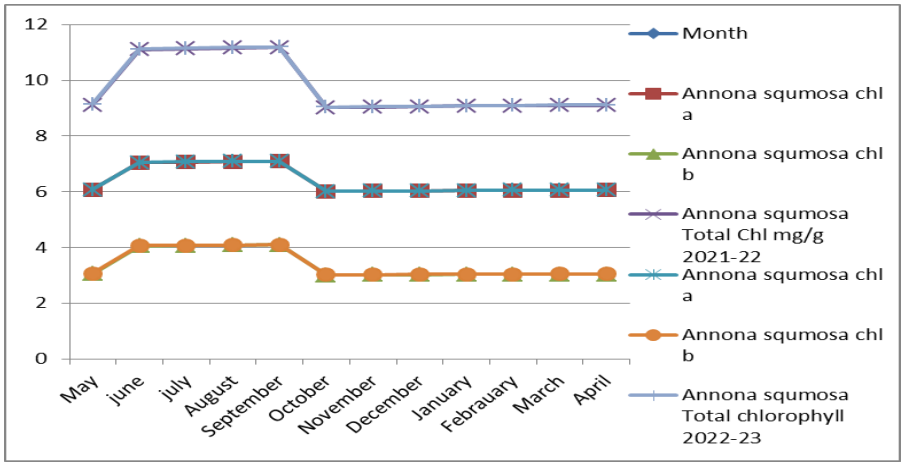

Fig. 3.2: Distribution of total chlorophyll content mg/g in the leaves during study period.

Distribution of chlorophyll a, chlorophyll b and total chlorophyll content in the *Annona squamosa* during winter season

The total chlorophyll in *Annona squamosa* during the study period 2031-22 and 2022-23 years was more or less similar and the means of both the years confirm this while during the four months and winter season the difference were marginal 9.037-9.084 mg/g and then standard deviation at 0.05 mg/g level was also insignificant.(Table: 3.2.1; Fig: 3.2.1).

Table 3.2.1. Total chlorophyll content during winter season in *Annona squamosal.*

Month	Total Chl mg/g 2021-2022	Total Chl mg/g 2022-23	Mean
November	9.037	9.049	9.043 ± 0.008485
December	9.058	9.065	9.0615 ± 0.00495
January	9.08	9.086	9.083 ± 0.004243
February	9.084	9.093	9.0885 ± 0.00636
Mean	9.06475 ± 0.021746647	9.07325 ± 0.020073	

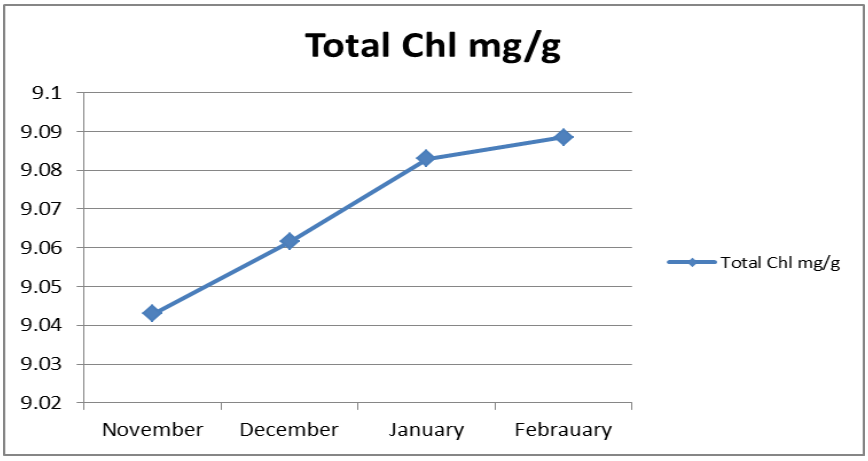

Fig. 3.2.1: Seasonal variation of Total Chlorophyll content (mg/g) in leaves of *Annona squamosa* in winter.

Distribution of chlorophyll a, chlorophyll b and total chlorophyll content in the *Annona squamosa* during summer season

The total chlorophyll was estimated mg/g and the content of total chlorophyll was more or less similar except in June (both the years) when it increased from 9.115-11.104 mg/g. the first three months in summer in both the years the total chlorophyll ranged from 9.091-9.141 mg/g and it was found that the standard deviation of mean was also insignificant the June month is the beginning of south west monsoon India particularly in Andhra Pradesh. The onset rains encourage green pigment in plants and chlorophyll content usually high during rainy season and jute month (both the years) showed higher total chlorophyll compared to earlier three months (Table: 3.2.2; Fig: 3.2.2).

Table 3.2.2: Total chlorophyll content during summer season *Annona squamosal.*

Month	Total Chl mg/g 2021-2022	Total Chl mg/g 2022-23	Mean
March	9.091	9.108	9.100 ± 0.012021
April	9.098	9.117	9.1075 ± 0.013435
May	9.115	9.141	9.128 ± 0.018385
June	11.104	11.118	11.111 ± 0.009899
Mean	9.602 ±1.001384042	9.621 ± 0.998097	

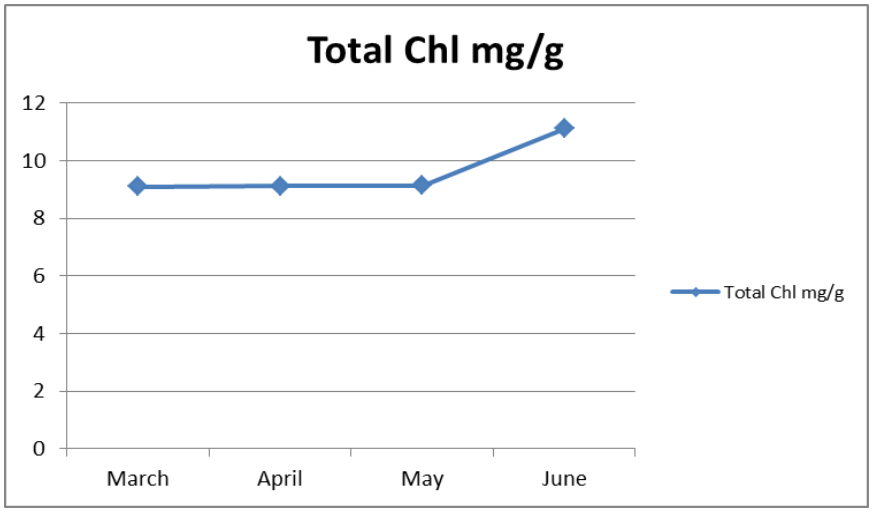

Fig. 3.2.2: Seasonal variation of Total Chlorophyll content (mg/g) in leaves of *Annona squamosa* in summer.

Distribution of chlorophyll a, chlorophyll b and total chlorophyll content in *Annona squamosa* during rainy season

The month viz. July, August, September and October are designated as rainy season endowed with adequate relative humidity and ideal temperatures in the most favourable season for vegetative growth that reflects in branching, new leaves and physical growth (stem) etc. the first three months the total chlorophyll was 9.020 and 9.031 mg/g in the study period which in the transition from rainy season to winter. The total chlorophyll content was a little decreased in winter compare to rainy season (Table: 3.2.3; Fig: 3.2.3).

Table 3.2.3: Total Chlorophyll content during rainy season in *Annona squamosal.*

Month	Total Chl mg/g 2021-2022	Total Chl mg/g 2022-23	Mean
July	11.130	11.145	11.138 ± 0.010607
August	11.166	11.176	11.171 ± 0.007071
September	11.182	11.196	11.189 ± 0.007071
October	9.020	9.031	9.026 ± 0.007778
Mean	10.625 ± 1.069887689	10.637 ± 1.070872	

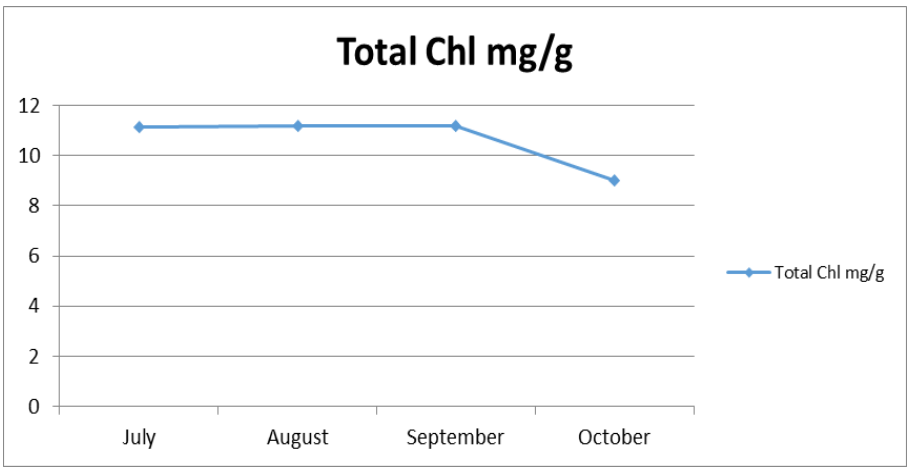

Fig. 3.2.3: Seasonal variation of Total Chlorophyll content (mg/g) in leaves of *Annona squamosa* in rainy.

SUMMERY AND CONCLUSION

Annona squamosa L: It was a common fruit yielding grow in every house. The dust is carried from the crusher in varying sizes deposits on the trees. The larger size of the leaves and good canopy enables the plant to filter the dust in the air. This affects production of chlorophyll a, b and total chlorophyll and also influencing the functioning of stomata. The winter season showed high accumulation of dust with a mean of 3.25 mg/cm2 in 2021-22 while a slightly lower mean was recorded 3.22 mg/cm2. The dust levels accumulated in summer viz .March, April, May and June months varied widely from minimum of 0.18 mg/cm2 in 2022-23 June to a maximum of 2.31 mg/cm2 in May 2021-22. The accumulation of dust on leaves was always less than 2 mg/cm2 during the entire summer.

The rains wash away all the dust particles and the particulate matter in the ambient air is also very less. A similar trend is observed in 2022-23 whereas the dust accumulation was as good as in other season in 2021-22.

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