COMPARATIVE MACRONUTRIENT, MICRONUTRIENT AND BIOCHEMICAL CONSTITUENTS ANALYSIS OF *ARACHIS HYPOGAEA*

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ABSTRACT

Ariyalur, known as cement city is surrounded by cement factories and limestone mines. These act as the sources of dust and particulates in and around the living place. To know about the extent of dust pollution, a common plant ***Arachis Hypogaea L*** was found to be one of the plant which is higher in number. The leaf area of control plant was 39.8 cm and that of affected plant were 21.71 cm. Similarly the shoot length was 114.8 cm for control and for affected plants it was 37.3 cm. the number of leaves happens to be 14 and 11 in the control and affected plant. When the plant samples were analysed for various parameters the amount of organic carbon, total nitrogen, total sodium, total nitrogen, total sodium, Total calcium, Zinc, Iron magnesium, alkaloids Glycosides, Chlorophyll a, Chlorophyll b and total chlorophyll was higher in the normal plants when compared with the affected plants. The values seen that the affected plants were 2.11%, 1.67% 0.29%, 5.1%, 4.52%, 45%,13% , 0.32%, 0.06%, 4.365×10^{-4} mg/g and 3.4×10^{-4} mg/g respectively.

INTRODUCTION

The peanut, or groundnut (***Arachis hypogaea***), is a species in the legume or "bean" family (Fabaceae). The peanut was probably first cultivated in the valleys of Peru. It is an annual herbaceous plant growing 30 to 50 cm (1.0 to 1.6 ft) tall. The leaves are opposite, pinnate with four leaflets (two opposite pairs; no terminal leaflet), each leaflet 1 to 7 cm (⅜ to 2¾ in) long and 1 to 3 cm (⅜ to 1 inch) broad. The flowers are a typical pea flower in shape, 2 to 4 cm (0.8 to 1.6 in) (¾ to 1½ in) across, yellow with reddish veining. *Hypogaea* means "under the earth", after pollination, the flower stalk elongates causing it to bend until the ovary touches the ground. Continued stalk growth then pushes the ovary underground where the mature fruit develops into a legume pod, the peanut – a classical example of geocarpy. Pods are 3 to 7 cm (1.2 to 2.8 in) long, containing 1 to 4 seeds. Peanuts are known by many other local names such as **earthnuts**, **ground nuts**, **goober peas**, **monkey nuts**, **pygmy nuts** and **pig nuts.** Despite its name and appearance, the peanut is not a nut, but rather a legume.

With reference to Ariyaur cement factory (Saralabai and vive kandan, 1996) which do not relate to the effects of crop plants with field conditions under natural exposure to CKD pollution. Hence, the present

investigation was undertaken to study the effects of structural and functional aspects of crop plants viz., ***Arachis hypogaea*** field conditions under natural exposure to CKD pollution.

The alleviation measures to control CKD pollution at the sources are limited by economic, political and technical implications beyond the control of most agriculturists. So they are entrusted to grow their crop in an atmosphere containing certain levels of ambient particulate pollutants. Since the crop selected in the present study are the top most economically important oil crop, it is desirable to investigate them in the polluted environment. Thus, this study has been planned and performed to provide a thorough knowledge to resolve the difficult problem of cultivation in the polluted environment with the following objectives.

1. To study the casual effects relationship among plant, to assess the severity of foiler damage to crop plant and translate this to economic loss.
2. To conduct field – plot experiments with field conditions in the vicinity of a cement factory under natural exposure to CKD emission study, results a wider context.
3. To estimate the rate of dust fall and CKD on surfaces of plants and soil in the vicinity of a cement factory.
4. To study the structural modification developed internally and externally, due to exposure of plants to CKD pollution.
5. Ultimately to suggest the implications of the study to the farmers and scientific community.

MATERIALS AND METHODS

Study area

The study area located 3 kms away from Ariyalur and about 90 km from the chidambaram and it lies at 11° latitude and 79° longitude. The cement factory was started in 1978 where the cement manufacturing type is dry process. The basic raw material for cement is lime stone, river sand, coal, and gypsum. There is a hub of (nine) cement industries operating in the Ariyalur region and each industry is having three pairs smokestacks with different heights, it emits potentially harmful hazardous material like coal dust along with gaseous pollutants and particulate pollutants spread around the 12 km radius from the factory.

Survey of vegetation

The area around the cement factory is cultivatable with dry and wetland farming. The crop like chilies, green grams, groundnut, rice, black gram and sorghum cultivars are cultivated in the area. The soil is black clay loamy with calcareous deposit. The average rainfall is about 2.89 cm. The maximum rainfall is during October to November due to low pressure of northeast monsoon.

Pot culture experiment

Healthy seeds of Groundnut were selected and treated for surface sterilization 0.2% of Hgcl2 for 20 minutes then thoroughly washed with tap water. The earthen pots were used for pot culture experiment, though the cement dust thoroughly mixed with the garden soil at the concentration of 200g/Kg soil. Exactly 15 seeds were sown in earthen pots containing garden soil with and without cement dust. The seedlings were raised in the cement dust free soil was treated as control. The seedlings were raised under the natural photoperiod with day and night temperature in the range of 30°-32°c and 23°-25°c. After germination the seedlings were thinned down to 10/pot for healthy growth of the seedlings. Foliar application of cement dust was done from the 7th day at the concentration (Control, 1, 5, 10, 15, 20g dust/pot) of cement dust regularly by using a hand sprayer. Physic-chemical analysis if soil were carried out before sowing and after harvesting the crop by the standard method (Piper, 1966).

Morphometry studies

The morphological parameters like such as shoot length (cm), root length (cm), total leaf area (cm2), fresh weight (g) and dry weight (g) and yield (g) were observed and recorded at 30, 60 and 90 days.

Total leaf area (cm2)

The leaf area was calculated by measuring the length and breadth of the leaf was described by Yoshida *et al.* (1972).

Leaf area (cm2) = K × length × breadth

Where, K = Kemp's constant (for dicot leaves) = 0.66

Biochemical analysis

The seedlings and the plant materials were collected from both germination studies (7th day) and pot culture experiments (30th and 60th days). The leaf, root of plants were separated and used for the biochemical's analyses such as chlorophyll (Arnon, 1949), carotenoid (Krik and Allen, 1965), protein (Lowry *et al.*, 1951), amino acid (Moore and Stein, 1948), reducing sugar (Nelson, 1944), non-reducing sugar (Nelson, 1944) and total sugar.

Estimation of Photosynthetic pigment

Accurately 0.5 g of fresh leaf material was taken and ground with help of pestle and mortar with 10 ml of 80% acetone. The homogenate was centrifuged at 800 rpm for 15 minutes. The supernatant was saved and the residue was re-extracted with 80 per cent acetone. The supernatant was saved and used for estimation of chlorophyll. The absorbance was read at 645nm for Chlorophyll 'a' and 663nm for chlorophyll 'b' in Spectrophotometer. Simultaneously, the carotenoid content of the extract was read at 480 nm. The results were obtained by the formula proposed by Arnon (1949) for total chlorophyll and Krick and Allen (1965) for carotenoid content.

Estimation of Protein

The protein content was quantified by the method of Lowry et al., (1951). 0.5 g of plant materials (Root and Shoot) were weighted and ground in a pestle and mortar with 10 ml of 20 per cent TCA (Trichloro Acetic Acid). The homogenate was centrifuged for 15 minutes at 800 rpm. The supernatant was discarded. To the pellet, 5 ml of 0.1 N NaOH was added and centrifuged for 5 minutes. The supernatant was saved and made up to 10 ml of 0.1 N NaOH. This extract was used for the estimation of protein. 1 ml of the extract was taken in a 10 ml test tube and 5 ml of reagent C was added. This solution was mixed thoroughly and kept in darkness for 10 minutes. After that, 0.5 ml Folin-phenol reagent was added. It was kept in dark for 30 minutes. The sample was read at 660 nm in UV-Spectrophotometer.

RESULT AND DISCUSSION

The present study particularly discriminate the effect of cement dust deposition on soil and over the vegetation and its consequences effect on groundnut crop, which is popularly grown in and around the vicinity of cement industry. Deposition of cement dust over the surfaces of the groundnut crops leaf reflects changes in morphological and biochemical content of the plant when compared with non- cement dusted plant. The morphological parameter such as shoot length, root length, total leaf area of groundnut under cement dust pollution all morphological parameters were reduced when compared with control crop due to increase concentration of cement dust. The highest growth parameters were recorded in control crop and lowest biomass growth showed in 20g/pot treated crop.

Morphological and Biochemical analysis of leaves

Determination of shoot/root ratio

A comparison of the morphological characters of the control and the affected plant has been tabulated in table.1.

A marked difference has been noticed with all the tested parameters. The leaf area of control plant was 39.8 cm and that of affected plant were 21.71 cm. Similarly the shoot length was 114.8 cm for control and for affected plants it was 37.3 cm. the number of leaves happens to be 14 and 11 in the control and affected plant.

When the plant samples were analysed for various parameters the amount of organic carbon, total nitrogen, total sodium, total nitrogen, total sodium, Total calcium, Zinc, Iron magnesium, alkaloids Glycosides, Chlorophyll a, Chlorophyll b and total chlorophyll was higher in the normal plants when compared with the affected plants. The values seen that the affected plants were 2.11%, 1.67% 0.29%, 5.1%, 4.52%, 45%,13% , 0.32%, 0.06%, 4.365×10^{-4} mg/g and 3.4×10^{-4} mg/g respectively. (table -2)

A mild increase has been noticed with the valves of total phosphorous potassium, magnesium, sulphur, copper, Boron, molybdenum, flavonoide and for tannin.

Table -1: Mean values of *Arachis Hypogaea L.*floral morphology under natural exposure in the vicinity of Ariyalur

Plant	Leaf area (cm)	Mean shoot length cm^{-1}	Mean root length cm^{-1}	Mean number of leaves
Affected plant	**3.71**	**7.3**	**2.3**	**19**
Control plant	**5.80**	**14.8**	**3.2**	**24**

Table -2: Comparative macronutrient, micronutrient and biochemical constituents' analysis of the control and affected plant

Sl.No	Name of the Parameter	SAMPLE DETAILS	
		Normal	Affected
1	Ash (%)	1.26	1.59
2	Moisture (%)	8.95	7.98
3	Organic Carbon (%)	3.49	2.11
4	Total Nitrogen (%)	2.49	1.67
5	Total Phosphorus (%)	0.58	0.98
6	Total Potassium (%)	3.18	3.51
7	Total Sodium (%)	0.08	0.29
8	Total Calcium (%)	5.13	5.10
9	Total Magnesium (%)	3.19	3.48
10	Total Sulphur (%)	0.18	0.22
11	Total Zinc (ppm)	4.93	4.52

12	Total Copper (ppm)	0.51	0.87
13	Total Iron (ppm)	50.29	45.62
14	Total Magnesium (ppm)	14.20	12.79
15	Total Boron (ppm)	0.10	0.16
16	Total Molybdenum (ppm)	0.06	0.08
17	Chlorophyll a (Mg/g)	$1.134x10^{-4}$	$1.091x10^{-4}$
18	Chlorophyll b (Mg/g)	$5.22x10^{-4}$	$4.365x10^{-4}$
19	Total chlorophyll (Mg/g)	$3.869x10^{-4}$	$3.402x10^{-4}$
20	Total Alkaloids (mg kg^{-1})	0.44	0.32
21	Total flavonoids (mg kg^{-1})	1.49	1.51
22	Tannin (mg kg^{-1})	0.30	0.33
23	Lignin (mg kg^{-1})	0.42	0.41
24	Glycosides	0.09	0.06
25	Serpentines (mg kg^{-1})	0.06	0.05
26	Heavy Metals (ppm)	Present	Present

Fly ash comprises divided particles of ash entrained in flue gases arising from combustion of coal. The size of fly ash particles may vary from 0.02 μm to over 300 μm. It contains incompletely burned coal and the carbon content of fly ash may vary from 5 to 20%, though some samples may contain as high as 50%. Also a large number of minerals, originally present in the coal, may also occur in fly-ash. Thangarasu-2002).

Cement manufacturing industries have found to contribute substantially to the air pollution problem as point source of emission. Fallout of cement factory emission is determined by several factors. Such as variations in cement manufacturing process, efficiency of emission control devices, and meteorological and topographical conditions, vegetation and soil are also important sinks for airborne pollutants. In India, high dust fall rates around cement factories have been reported by several workers. (Agarwal, 1997).

Plants play an important role in monitoring the ecological balance by actively participating in the cycling of nutrients, gases and fly ash. Sensitivity of plants to air pollutant is variable. Air pollution effects on plants have been known as a number of morphologhical and anatomical studies [Chaudhari, 2000, Chaudhari, 1984, Tiwari, 1993, Roa. 1975, Bechulal. 1980, Partha Sarthy. 1975, Singh 2002, Andrew.1993.

Physiological and Biochemical trait of different plant species have been worked out and the changes induced by different pollutants have been well documented.

On comparing the biochemical compounds of the leaf material of ***Arachis Hypogaea L*** grown in control & affected area, it is very clear that the chlorophyll content a,b total chlorophyll & carotenoid content have got reduced due to the deposition of the particulate matter emitted from the cement plant.

Further it is very clear that the dust has added the calcium & sodium to a considerable extent in the affected leaver, which is also due to the nature & chemical composition of the cement. Thus it is true effective measures if not taken towards the reduction of pollution in terms of dusts, it will not only affect the plant species but also the living organisms. Hence the following suggestions are given with the aim of reducing the dust pollution.

CONCLUSION

Ariyalur, known as cement city is surrounded by cement factories and limestone mines. These act as the sources of dust and particulates in and around the living place. To know about the extent of dust pollution, a common plant ***Arachis Hypogaea L*** was found to be one of the plant which is higher in number. The chlorophyll a, chlorophyll b, total chlorophyll, & carotenoid content of the leaves have found to decrease in the leaves of the plant grown in areas exposed to dust when compared with control plant, grown in unpolluted areas. Similarly the other components such as calcium, sodium, manganese magnesium, zinc got increased in the affected plant. Certain parameters such as alkaloids, flavonoids, tannin, lignin have got decreased in its quantity in case of affected plant.

Thus the effect of the cement dust on one of the commonest plant ***Arachis Hypogaea L*** has been studied. It is clear that the cement dust affects certain biochemical components and physical characteristics of shoot length, root length, leaf area and yield of the plant.

REFERENCES

- Agarwal, M and N.Khanam. 1997. Variation in concentration of particulate matter around a cement factory in Environment. Ind.J.Environ.Prot. **39** (2): 97-102.
- Arnon, D.I. 1940. Copper enzymes isolated chloroplast. Poly phenoloxidase in *Beta vulgaris*. Plant physiol., **24**(2):1-15.
- Behera,D.K., R.M.Senapati, and S.P.Rout. 1980. Study of atmospheric pollution in mini cement plants in Orrisa. Ind.J.Environ.Prot. **9** (12): 918-920.
- Chaudhri, G.S., N.V. Rao and J.A.Inamdar. 1984. Act of air pollution on leaf epidermis and architecture of *Lycopersicum.L*. Karsts. *Var. angurlata*. Ind. J.Environ.Hlth., **26**(3): 238-243.
- Krishna mohan, K. I and N.Muthukrishnan. 1996. Ambient Air quality in madras city.Ind.J.Environ.Prot**. 16** (8):602-608.
- Parthasarathy, S.,N.Aruna chalam., K.Natarajan., G.Oblisami and G.Rangasamy. 1975., Effect of cement dust pollution on certain physical parameters of maize crop and soils. Ind. J.Environ.Hlth. **17** (2): 114-120.
- Rao, M.N and H.V.N. Rao.1975 (Eds). Air Pollution. Tata Mc Graw Hill Publication. Co. Ltd., New Delhi. PP: 226-232.
- Saralabai,V.C and M.Vivekanandan.1995.Does application of cement kiln exhausts affect root nodule, bio chemistry and soil Nitrogen fixing microbes. Appl.Biochem.Biotech.**50** (1):1-10.
- Singh,R.B., U.C.Das., B.B. Prasad and S.K.Jha. 2002. Monitoring of dust pollution by leaves. Poll. Res., **21**(1): 13-16.
- Tiwari, T.N and M.K. Patel. 1993. Effect of cement dust on some common plants, correlations among foliar dust deposition and chlorophyll content and calcium content. Ind.J.Environ.Prot**., 13** (2): 93-95.
- Thangarasu, S. 2002. Comparative field investigations on structural and functional aspects of few crops under unnatural exposure to cement kiln dust. Ph.D., thesis. Bharathidasan University. Trichy.