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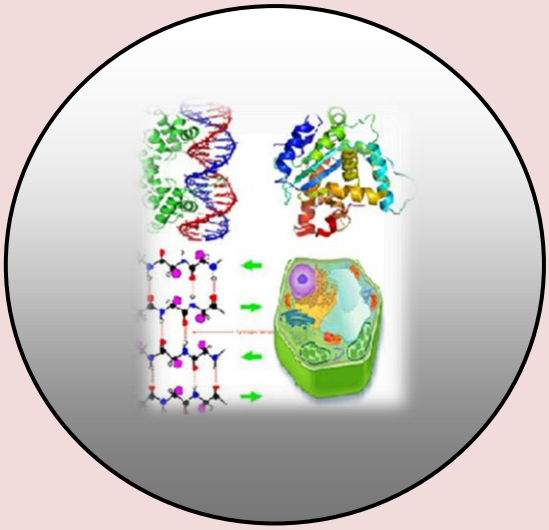

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Effect of Kankar Lime Fly-Ash on Chlorophyll Content and Yield of Four Varieties of Mustard

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ABSTRACT
The influence of air contamination on biological systems is a complex topic, because of the considerable diversity of the pollutants; the viable meterology and topography between source and receptor and the great complexity of biological systems. One of the important particulates dispersed in the air by many factories is fly-ash. It has been observed in kankar lime factory hit area that the oil crop generally fails and sometimes the losses amount to 100%. The present paper deals with the effects of kankar lime fly-ash on chlorophyll content and yield of the 4 varieties of mustard.
Keywords: Kankar Lime Fly-Ash, Chlorophyll Content and Yield.

INTRODUCTION
In a natural ecosystem there is a balance between input and output, with hardly any accumulation of surplus or waste material, but rapid urbanization, industrialization and increasing human population are responsible for the discharge of excessive wastes into the environment which adversely affects the life of organism and mankind. The industrial wastes are principally gases and particulate discharged from chimneys and various factories which dispersed in atmosphere. Fly-ash is one of such important particulates dispersed in the air by many factories. In U.P. there are large number of kanker lime factories situated in cities and small towns. These factories produced kanker lime by burning the pebbles in furnaces and thereafter grinding and filtering which is used as substitute of cement. Inspite of initial positive effects of their Ca and Mg content, long term dust sedimentation can also lead to considerable disturbances in the nutrient balance of soil used for agriculture and forestry. Fly-ash may affect vegetation directly through deposition on leaf surface and indirectly trough accumulation in the soil medium. Direct effects of fly-ash, on plants include changes in the cuticular pattern of leaves, decrease in number and size of stomata and increase in length and density of trichome (Sharma, 1977).

MATERIALS AND METHODS
The kanker lime factory situated at Faizabad-Akbarpur road, near Darshan Nagar (U.P.) town has been selected for the present study. The experimental site is located at the vicinity of river Ghaghra (Saryu) at $20^{0}47'$ N latitude and $82^{0}13'$ E longitude. The experimental field was situated 50 meter (R1), 100 meter (R2), 150 meter (R3) and 200 meter (R4), away from the factory. Control site was selected 5 km. away from factory.

During the course of present study three varieties of *Brassica campestris* and one variety of *Brassica nigra* which are chiefly grown in Eastern U.P., have been taken into consideration for the study. These selected varieties are:

Brassica campestris var. sarson, Prain (Yellow musterd)
Brassica campestris var. dichotoma, Walt (Black musterd)
Brassica campestris var. toria, Puthi and Fuller (Toria)
Brassica nigra L. (Black rai)

To study the chlorophyll content 100 mg. fresh leaf sample (60 days old plants of equally matured) were crushed in pre-chilled pestle and mortar with 80% acetone. The extract was centrifuged at 5000 rpm for 15 minutes. The collected supernatant was diluted upto required constant volume. The samples were kept in dark to avoid chlorophyll degradation. The optical density (OD) of the extract was measured at 645, 663 and 510 nm wavelength on electronic 20 spectrophotometer and chlorophyll content was calculated (Arnon 1949).

RESULTS AND DISCUSSION

Total chlorophyll in all the experimental plants ranges between 1.89 mg g-1 fresh weight to 3.26 mg g-1 fresh weight. Significant decrease ($P<0.05$) in chlorophyll content was observed at R1 site *B. campestris* var. Sarson. No significant effect of fly-ash was observed in R2 and R3 site. However, chlorophyll content was found to be slightly enhanced at R4 site of same species. Chlorophyll content was also significantly ($P<0.05$) decreased in *B. campestris* dichotoma at R1 site but it was not significantly changed at R2, R3 and R4 sites. However, slightly increased chlorophyll content was observed at R4 sites. No significant changing in chlorophyll content was observed in *B. campestris* var. toria. Significant ($P<0.05$) decrease in chlorophyll content was estimated at R1 and R2 sites in *B. nigra*. However, no significant effect of fly-ash on R3 and R4 sites was observed in *B. nigra* (Table-1).

Table 1. Effect of kanker lime fly-ash on chlorophyll content (mg per gm fresh weight) of 3 varieties of *B. campestris* and *B. nigra*.

Varieties	Sites				
	R1	R2	R3	R4	Control
B. campestris var. sarson	1.89* ±0.12	1.91 ±0.17	2.16 ±0.23	2.48 ±0.41	2.36 ±0.15
B. campestris var. dichotoma	2.03* ±0.09	2.22 ±0.24	2.31 ±0.25	2.41 ±0.21	2.36 ±0.12
B. campestris var. toria	2.56 ±0.18	2.76 ±0.08	2.89 ±0.12	2.94 ±0.14	2.73 ±0.24
B. nigra	2.80* ±0.12	2.74* ±0.14	2.96 ±0.21	3.13 ±0.25	3.26 ±0.16

*** = P<0.05**

Table 2. Effect of kanker lime fly-ash on average yield per plant (gm) of 3 varieties of *B. campestris* and *B. nigra*.

Varieties	Sites				
	R1	R2	R3	R4	Control
B. campestris var. sarson	98.18 (37.23)	100.19 (35.53)	112.75 (27.67)	153.67 (1.42)	155.89 (0.00)
B. campestris var. dichotoma	100.14 (30.99)	104.78 (27.79)	115.91 (18.84)	140.17 (3.41)	145.12 (0.00)
B. campestris var. toria	105.78 (33.95)	108.18 (32.45)	120.78 (24.58)	156.18 (2.48)	16.16 (0.00)
B. nigra	150.19 (30.18)	151.12 (29.95)	163.46 (24.01)	209.98 (2.38)	215.12 (0.00)

Note: Figure in parentheses represent the percentage reduction in yield per plant.

Kanker lime fly-ash highly affected the yield of all the four varieties. Maximum reduction in yield (37.23%) was found to be in *B. campestris* var. sarson at R1 site. However, only 1.42% reduction was observed in R4 site of the same variety. Fly-ash also resulted in the reduction in yield of *B. campestris* var. dichotoma, *B. campestris* var. toria and *B. nigra* where 30.99%, 33.95% and 30.18% reduction in yield was observed (Table-2). Reduction in yield was also prominent at R2 and R3 sites. However, no significant reduction in yield was observed at R4 site in all the varieties. The reduction in average yield at R4 site was 1.42% in *B. campestris* var. dichotoma, 2.48% in *B. campestris* var. toria and 2.38% in *B. nigra* (Table-2).

In the present experiment it has been observed that chlorophyll content decreased at higher fly-ash polluted sites. Reduction in chlorophyll content at higher fly-ash concentration was due to the alkalinity caused by excessive soluble salts on the leaf surfaces. Chlorophyll degradation is also possible because of thick fly-ash covering over the surface of the leaf; which inhibits the transpiration and eventually evaporative cooling. The reduction in chlorophyll pigment, in leaves thickly covered with fly-ash has earlier been reported because of increase foliar temperature which retards chlorophyll synthesis (Garg and Varshney 1985).
The reduction in chlorophyll content may have been caused by the alkaline nature of fly-ash which might have degraded the chlorophyll molecules (Borka 1980, 1981).
Reduction in yield may be due to the failure of pollen germination and fertilization on the dust coated stigmatic surfaces (Czaja 1966). As a result, oil content also reduced. Because maximum concentration of fly-ash was on R1 site hence the yield was most adversely affected.

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