Tropical Plant Research
An International Journal
© Society for Tropical Plant Research

ISSN (E): 2349 – 1183
ISSN (P): 2349 – 9265
5(1): 41–45, 2018
DOI: 10.22271/tpr.2018.v5.i1.007

Research article

Response of potato plants to foliar application of cement dust

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Abstract: An experiment was conducted in the net house, Department of Botany, AMU, Aligarh, India, in 2012 to evaluate the effect of foliar application of cement dust (0.00, 0.25, 0.50, 1.00, 2.00 and 4.00 $g.m^{-2}.day^{-1}$) on plant growth, yield, biomass, photosynthetic pigments, NPK concentrations of plants, and protein and carbohydrate contents of *Solanum tuberosum*. Dusting of cement dust caused a significant adverse effect on all the above parameters. As the doses were increased, the values of above parameters were decreased. The epidermal characters of leaves were also observed. The number and size (length and width) of stomata, and size (length and width) of the stomatal aperture on both the surfaces of leaves were gradually decreased with the increase in cement dust levels. While, number and length of trichomes were increased at all the doses of cement dust.

Keywords: Cement dust - Growth - Potato - Stomata - Trichome - Yield.

[Cite as: Tomar D, Khan AA & Ahmad G (2018) Response of potato plants to foliar application of cement dust. *Tropical Plant Research* 5(1): 41–45]

INTRODUCTION

India is a major producer of the cement in the world. Cement dust is a very big problem in India. In 2002, the total production in the country was 100,000 thousand metric tons out of 1,720,000 thousand metric tons of the world (Hendrick 2003). Cement dust arises during processing of raw materials, manufacturing, milling, loading and unloading of cement (Raghav 2006).

The particles going into the atmosphere may remain in the air for varying length of time depending on their size and weight. Dust particles after moving far away from their source of origin fall and get deposited on the plants especially on leaf surfaces forming a layer. After settling, particles create problems to crops, this depends on their setting rate, size, density of particles, turbulence of air and type of particulates as well as the type of plant species. High particulates emission due to uncontrolled management causes a reduction in quality of vegetables and fruits growing close to the sources (Raghav & Khan 2002, Raghav 2006). The present study was a step to observe the effect of cement dust pollution on potato crop.

MATERIALS AND METHODS

Cement dust treatments

For the experiment, cement dust was obtained from (pure cement) from Birla Cement Agency, Aligarh. It was crushed in mortar and pestle and passed through 2 mm sieve and kept for treatment. The five doses of cement dust (0.25, 0.50, 1.00, 2.00 and 4.00 $g.m^{-2}.day^{-1}$) were taken.

Plant culture and setting of experiment

Potato (*Solanum tuberosum* L.) var. Kufri Alankar, collected from Central Potato Reseach Institute, Shimla, India, was selected for the study. Tuber pieces with eyes (2.5–3.0 cm^2) were directly planted (one piece per pot) in clay pots of 30 cm height (25 cm diameter) containing autoclaved field soil on 10th Nov., 2012. The pieces were surface sterilized (dipped in 0.01% $HgCl_2$ for 15 min.) before planting. Total 30 pots including control were prepared for the experiments (6 treatments × 5 replicates). The pots were then arranged on glass house benches at 27/23°C day and night temperature. Photosynthetic active radiation was PAR>750 $\mu mol.m^{-2}.s^{-1}$ between 1100 and 1200 h and humidity in the green house was 67±5%.

Received: 13 December 2017 Published online: 31 March 2018
https://doi.org/10.22271/tpr.2018.v5.i1.007

Foliar application of cement dust

The fine particles of cement dust were dusted by a plastic duster, which delivered the particles uniformly over the leaf surface. The five different doses of cement dust (0.25, 0.50, 1.00, 2.00 and 4.00 $g.m^{-2}.day^{-1}$) were applied on two weeks old plants (four-leaf stage) and continued for 60 days. A plastic hood around the base of each plant was used to cover the soil to prevent cement dust being deposited on the soil surface. Plants were always irrigated under these hoods. The experiments were terminated on 30th Jan., 2013, after 90 days from the date of planting. Plants were uprooted carefully keeping the root system intact and washed thoroughly with a gentle stream of water to remove the soil particles. Plant growth, yield, photosynthetic pigments, NPK concentrations of plants, and protein and carbohydrate contents of potato were estimated through standard methods. Different leaf epidermal characters were also observed. Data were analyzed statistically for significance.

RESULTS

Plant growth and yield

Data presented in table 1 show that the foliar application of cement dust adversely affected the plant growth, yield and biomass of *Solanum tuberosum*. Plant growth in terms of length, fresh weight, dry weight of root and shoot was reduced gradually and significantly ($P<0.05$ and $P<0.01$) in all the doses of cement dust. Yield in terms of tuber fresh weight and tuber dry weight and plant biomass were also decreased significantly in all the doses as compared to control.

Photosynthetic pigments and NPK

A gradual and significant ($P<0.05$ and $P<0.01$) decrease in photosynthetic pigments has been reported as the doses were increased in *S. tuberosum* (Table 2). However, chlchlorophyll b and carotenoids were at par with control in 0.25 $g.m^{-2}.day^{-1}$ dose at $P<0.01$ level. Similarly, NPK concentrations were also significantly reduced in all the doses except in 0.25 $g.m^{-2}.day^{-1}$ dose at $P<0.01$ level as compared to control.

Protein and carbohydrate

Table 3 shows that soluble, insoluble and total protein contents were decreased significantly ($P<0.05$ and $P<0.01$) with the increase in cement dust doses. Similarly, soluble, insoluble and total carbohydrate contents were also decreased with respect to doses and maximum reduction was occurred in 4.0 $g.m^{-2}.day^{-1}$ dose.

Epidermal characters

Data given in table 4 show the effect of cement dust as foliar application on stomata and trichomes of leaves of *S. tuberosum*. There was a gradual and significant reduction in number of stomata, size of stomata (length and width) and size of the stomatal aperture (length and width) on both the surfaces in all the doses. However, number and length of trichomes were gradually increased ($P<0.05$ and $P<0.01$) in all the doses, except in 0.25 $g.m^{-2}.day^{-1}$ dose, where the length of trichomes on upper surface was non-significant at $P<0.01$ when compared to control.

DISCUSSION

In foliar application, all the doses of cement dust were found harmful to potato crop in the present study. All the growth and yield parameters, biomass, photosynthetic pigments, NPK concentrations of plants, and protein and carbohydrate contents were reduced. Similar responses have also been observed earlier by Darley & Middleton (1966), when cement dust was applied in concentrations of 0.6 to 3.8 $g.m^{-3}$ to bean leaves for eight to ten hours period for two to three days. He found that the average CO_2 exchange was reduced over 30 percent due to dusting of cement. Prasad & Inamdar (1990) have reported that accumulation of cement kiln dust on plant surface of *Vigna mungo* reduced the number and size of flowers, which finally affected the yield to a great extent in the dusted plants. A reduction in transpiration rate, chlorophyll content and productivity of the wheat plants due to cement dust pollution was also observed by Singh & Rao (1981). Prasad *et al.* (1991) observed the stomatal clogging, reduction in growth, phytomass and net primary production, a decrease in the level of protein, amino acids, starch, sugars and phenols in *Cajanus cajan* plants by the application of cement dust. The number of pods per plant and seeds per pod were reduced in the mustard plant when sprayed with cement dust (Shukla *et al*. 1990). In *Oryza sativa*, number and size of panicles and seed weights were highly reduced (Raza *et al.* 1989). Recently, Tomar & Khan (2009) and Tomar *et al*. (2015). Observed the harmful effect of foliar application of brick kiln dust and fly ash on potato crops.

Table 1. Effect of different doses of cement dust as foliar application on plant growth and yield of *Solanum tuberosum* var. Kufri Alankar.

Treatment ($g.m^{-2}.day^{-1}$)	Plant growth						*Yield*		Plant biomass (g)
	Length (cm)		Fresh weight (g)		Dry weight (g)		Tuber fresh weight (g)	Tuber dry weight (g)	
	Root	Shoot	Root	Shoot	Root	Shoot			
0	21.35	30.92	6.30	35.70	0.79	4.46	108.32	16.66	21.91
0.25	20.82	29.86	5.90	34.15	0.73	4.29	98.31	15.10	20.12
0.50	19.25	27.31	5.30	32.90	0.64	4.07	87.75	13.78	18.49
1.00	17.71	25.84	4.20	28.85	0.52	3.72	79.60	11.32	15.56
2.00	15.61	23.63	3.10	21.62	0.40	3.00	68.84	9.05	12.45
4.00	12.85	19.54	2.15	18.73	0.28	2.40	57.30	7.75	10.43
LSD (P<0.05)	0.180	0.514	0.240	0.723	0.031	0.073	5.781	0.875	0.924
LSD (P<0.01)	0.245	0.699	0.326	0.983	0.042	0.099	7.858	1.189	1.256

Note: Each value is a mean of five replicates.

Table 2. Effect of different doses of cement dust as foliar application on photosynthetic pigments and NPK uptake of *Solanum tuberosum* var. Kufri Alankar.

Treatment ($g.m^{-2}.day^{-1}$)	Photosynthetic pigments (per g fresh weight)				NPK amount by plant (dry weight)		
	Chlorophyll a ($mg.g^{-1}$)	Chlorophyll b ($mg.g^{-1}$)	Total chlorophyll ($mg.g^{-1}$)	Carotenoids ($mg.g^{-1}$)	Nitrogen ($mg.plant^{-1}$)	Phosphorus ($mg.plant^{-1}$)	Potassium ($mg.plant^{-1}$)
0.00	0.81	0.38	1.19	0.0042	277	15.3	125
0.25	0.74	0.35	1.09	0.0039	250	14.0	115
0.50	0.70	0.30	1.00	0.0034	235	12.8	105
1.00	0.64	0.26	0.90	0.0030	197	10.7	89
2.00	0.51	0.21	0.72	0.0026	157	8.6	71
4.00	0.43	0.18	0.61	0.0019	130	7.2	59
LSD (P<0.05)	0.042	0.022	0.045	0.0002	25.6	0.96	9.1
LSD (P<0.01)	0.057	0.030	0.061	0.0003	34.9	1.31	12.4

Note: Each value is a mean of five replicates.

Table 3. Effect of different doses of cement dust as foliar application on protein and carbohydrate contents of *Solanum tuberosum* var. Kufri Alankar.

Treatment ($g.m^{-2}.day^{-1}$)	Protein content			Carbohydrate content		
	Soluble protein (%)	Insoluble protein (%)	Total protein (%)	Soluble carbohydrate (%)	Insoluble carbohydrate (%)	Total carbohydrate (%)
0.00	2.61	5.14	7.75	7.47	10.80	18.27
0.25	2.51	4.98	7.49	7.39	10.61	18.00
0.50	2.45	4.86	7.31	7.27	10.39	17.66
1.00	2.40	4.77	7.17	7.10	10.07	17.17
2.00	2.35	4.69	7.04	6.82	9.63	16.45
4.00	2.27	4.54	6.81	6.63	9.17	15.80
L.S.D. (P<0.05)	0.063	0.094	0.157	0.049	0.120	0.161
L.S.D. (P<0.01)	0.084	0.126	0.211	0.067	0.163	0.219

Note: Each value is a mean of five replicates.

Table 4. Effect of different doses of cement dust as foliar application on epidermal characters of leaves of *Solanum tuberosum* var. Kufri Alankar.

Treatment ($g.m^{-2}.day^{-1}$)		Stomata					Trichomes	
		Number	Size		Stomatal aperture Size		Number	Length
		(cm^{-2} leaf surface) ($\times 10^3$)	Length (µm)	Width (µm)	Length (µm)	Width (µm)	(cm^{-2} leaf surface) ($\times 10^3$)	(µm)
0.00	U	5.40	17.40	10.50	9.47	3.20	1.10	291
	L	16.71	18.60	10.41	9.85	3.35	1.90	310
0.25	U	5.30	17.12	10.35	9.13	3.17	1.15	294
	L	16.32	17.98	10.24	9.62	3.14	1.95	308
0.50	U	5.25	16.73	10.25	8.90	3.14	1.20	298
	L	15.97	17.22	10.10	9.16	3.07	2.00	313
1.00	U	5.05	16.28	10.10	8.47	2.98	1.30	301
	L	15.41	16.87	9.97	8.85	2.91	2.10	319
2.00	U	4.75	15.90	9.89	8.00	2.87	1.35	305
	L	15.10	16.22	9.68	8.39	2.74	2.15	324
4.00	U	4.58	14.71	9.62	7.61	2.64	1.40	307
	L	14.41	15.65	8.91	7.93	2.56	2.25	326
LSD	U	0.056	0.065	0.091	0.193	0.012	0.032	2.5
(P<0.05)	L	0.172	0.315	0.117	0.141	0.102	0.035	1.1
LSD	U	0.076	0.088	0.124	0.262	0.016	0.048	3.4
(P<0.01)	L	0.234	0.428	0.159	0.192	0.139	0.049	1.5

Note: Each value is a mean of five replicates. U=Upper surface. L=Lower surface.

The length, size and number of stomata, as well as length and width of aperture of stomata on lower and upper surfaces, were badly affected due to the foliar application. This might be due to the presence of toxic compounds in the dust. Effects of cement dust on leaf cuticle and stomatal behaviour have already well worked out on many crops. The chemicals altered the stomatal structure and ontogeny (Gupta 1992, Tomar & Khan 2009, Tomar *et al*. 2017). Transpiration rate of cement dusted plants declined at all stages of growth (Raghav 2006, Singh & Rao 1981), possibly due to decreased stomatal and cuticular transpiration of encrusted leaf surfaces. Interestingly, the trichomes number and size of trichomes were increased. These might be developed in response to defense with the external factor, which was nothing but the cement dust.

ACKNOWLEDGEMENT

The authors are thankful to the Head, Department of Botany, Aligarh Muslim University, for providing all the assets required in the experiment.

REFERENCES

Darley EF & Middleton JT (1966) Problems of air pollution in plant pathology. *Annual Review of Phytopathology* 4: 103–108.

Gupta M (1992) Effect of growth regulators on foliar stomata of *Vicia faba* L. *Advances in Plant Sciences* 5: 483–495.

Hendrick G van Oss (2003) *Mineral Commodity Summaries*. U.S. Geological Survey, USA, pp. 44–45.

Prasad MSV & Inamdar JA (1990) Effect of cement kiln dust pollution on black gram (*Vigna mungo*). *Proceedings of the Indian Academy of Sciences (Plant Science Section)* 100: 435–443.

Prasad MSV, Subramaniam RB & Inamdar JS (1991) Effect of cement kiln dust on *Cajanus cajan* (L.) Millsp. *Indian Journal of Environmental Health* 33: 11–21.

Raghav D & AA Khan (2002). Impact of industrial particulate pollutants applied to soil on growth and yield of tomato. *Thai Journal of Agricultural Science* 35(2): 187–194 **.**

Raghav D (2006) Studies on the effects of particulate air pollutants application on potato (*Solanum tuberosum* L.), Ph. D. Thesis. Aligarh Muslim University, Aligarh, India.

Raza SH, Fatima N & Murthy MSR (1989) Urea and ascorbic acid as ameliorators of cement dust toxicity in *Oryza sativa*. *Environmental Pollution* 62: 213–217.

Shukla J, Pandey V, Singh SN, Yunus M, Singh N & Ahmad KJ (1990) Effect of cement dust on the growth and yield of *Brassica campestris*. *Environmental Pollution* 66: 81–88.

Singh SN & Rao DN (1981) Certain responses of wheat plants to cement dust pollution. *Environmental Pollution* 24: 75–81.

Tomar D & Khan AA (2009) Influence of foliar application of brick kiln dust on potato plants. In: *International Conference on Emerging Technologies in Environmental Science and Engineering*. Department of Civil Engineering, A.M.U. Aligarh, India, pp. 1581–1590.

Tomar D, Khan AA & Safiuddin (2017) Impact of foliar application of fly ash on potato crop. *Journal of Functional And Environmental Botany* 7(1): 45–49.