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STATISTICAL PREDICTION OF ENVIRONMENTAL AND MORPHOLOGICAL PARAMETERS OF BLACKGRAM CULTIVATED AROUND THALAIYUTH SANKAR CEMENT FACTORY OF TIRUNELVELI DISTRICT, INDIA

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ABSTRACT

The sampling sites revealed that the environmental and morphological analysis of black gram cultivated in and around the Sankar Cement factory reported morphological reduction in shoot length, root length, number of branches, number of root nodules, number of leaves, total leaf area, number of pods, weight of pods, length of pods, number of seeds, weight of seeds, moisture content of pods and seeds. The statistical prediction of correlation co-efficient analysis showed both positive and negative significant at 0.01 and 0.05 level of significant.

KEYWORDS: Cement dust, black gram, environmental, morphological, correlation, multiple regression.

INTRODUCTION

Cement dust is a common particulate air pollutant around cement factories and construction sites. Even though cement is very useful to mankind for building purposes faultily affects the vegetation, sporadically settles on the plant surface. Regarding perception amid popular mind of industry as a pollution source the position of cement industry is unique. Its emission of kiln dust from tall chimneys at visible instigation is considered as major threats to environment adversely affect the soil and crops. The increased level of Calcium, Potassium, Magnesium, Manganese, Aluminum, Iron, Silica, Zinc, Copper and Sulphur in the soil, leaves, stem and fruits affect the vegetative growth, metabolism and yield of vegetables (Asubiojo *et al*., 1991; Ade- Ademilua and Umebese, 2007). Cement dust emanating from the factory settles on the surfaces soil and vegetation badly affects large area directly through leaf stomata (Butler and Sharma, 1973) and indirectly by changing the pH of the soil affects plant growth by the formation of crusts on leaves, branches, flowers and fruits (Singh and Rao, 1981). The fall out of cement dust led to changes in the soil characteristics, plant structure and function reflect irremediable habitat degradation. The deposited dust later crystallizes and solidifies to a hard crust indicating intimate contact of dust with the leaf. Prolonged dry periods afford no chance for hydration and crusts formation. Dust deposit cause stomatal plugging and prevent gaseous exchange (Mandre *et al*, 1998).

MATERIALS AND METHODS

Experimental field work was carried out around the Sankar cement factory at Thalaiyuth of Tirunelveli district. The cultivated blackgram around the vicinity of the factory i.e. 3-10 kms highly filth with cement was treated as polluted and beyond 10kms as control plants.

RESULTS AND DISCUSSIONS

Environmental parameters of the sampling sites, morphological, bio-nutritional, micro and macro-nutrients of the cultivated blackgram around Sankar Cement Factory at Thalaiyuth and the obtained data revealed significant reduction of nutrients in cement polluted crop plants while compared with the control plants.

Environmental Parameters

The environmental parameters of the sampling sites, atmospheric temperature, rainfall, pH and relative humidity analysed during summer and monsoon season revealed maximum value at the cement polluted site and minimum values at the control site (Table: 1).

Table 1: Environmental Parameters around the Sankar Cement Factory.

S.No	E.P	A_1	A_2	A_3	A_4
1	AT	33.00 ± 0.000	38.00 ± 0.707	25.00 ± 0.707	28.00 ± 0.000
2	R	28.00 ± 0.000	24.00 ± 0.414	58.00 ± 0.414	45.00 ± 0.414
3	pH	8.10 ± 0.000	10.40 ± 0.141	8.00 ± 0.141	10.30 ± 0.141
4	RH	48.00 ± 0.000	32.00 ± 0.707	58.00 ± 0.414	46.00 ± 0.414

AT- Atmospheric temperature in ^oC; R- Rainfall per annum in cms; RH- Relative humidity in %; A_1- Non-cement polluted area in summer; A_2 Cement polluted area in summer; A_3 - Non-cement polluted area in monsoon; A_4 - Cement Polluted Area in Monsoon.

Atmospheric Temperature

Atmospheric temperature at the control site varied from the minimum of 25.00 ± 0.707^0 C in monsoon to the maximum of 33.00 ± 0.000^0 C in summer. On the other hand, atmospheric temperature at the cement polluted site varied from the minimum of 28.00 ± 0.000^0 C in monsoon to the maximum of 38.00 ± 0.707^0 C in summer.

Rainfall

The control site revealed minimum rainfall 28.00 ± 0.000 cm in summer and maximum 58.00 ± 0.414 cm during monsoon. On the other hand, the cement polluted site reported minimum rainfall 24.00 ± 0.414 cm during summer to the maximum of 45.00 ± 0.414 cm during monsoon.

Soil pH

Soil pH at the control site varied from the minimum of 08.00 ± 0.141 in monsoon to the maximum of 08.10 ± 0.000 in summer. On the other hand, soil pH at the cement polluted sites varied from the minimum of 10.30 ± 0.141 in monsoon to the maximum of 10.40 ± 0.141 in summer.

Relative Humidity

Relative humidity observed at the control site varied from the minimum of 48.00 ± 0.000 % in summer to the maximum of 58.00 ± 0.414 % in monsoon. On the other hand, at the cement polluted site relative humidity varied from the minimum of 32.00 ± 0.707 % in monsoon to the maximum of 46.00 ± 0.414 % in monsoon.

Correlation co-efficient for the Environmental Parameter of Rice

Correlation co-efficient analysis revealed that the environmental parameters via atmospheric temperature, rainfall, pH and relative humidity at the sampling sites are positively correlated at 0.01 and 0.05 level of significant (Table: 2).

Table 2: Correlation Co-efficient Analysis for Environmental parameters compared with different variables.

S.No	E.P	A_1- A_3	A_2 - A_1	A_3 - A_4	A_4 - A_2
1	RH	-0.07	0.86*	0.87*	0.96**
2	R	0.35	0.88*	0.86*	0.95**
3	pH	-0.08	0.90*	0.98**	0.90*
4	AT	0.01	0.90*	0.99**	0.91**

*0.05 level significant; **0.01 level significant.

Atmospheric Temperature

Atmospheric temperature is positively correlated 0.90* (A_2-A_1) at 0.05 level of significant whereas, 0.91** (A_4-A_2) and 0.99** (A_3-A_4) showed 0.01 level of significant.

Rainfall

Rainfall noticed during summer and monsoon season at the cement polluted and control sites are positively correlated 0.86* (A_3-A_4), 0.88* (A_2-A_1) at 0.05 level of significant whereas, 0.95** (A_4-A_2) showed 0.01 level of significant.

Soil pH

Soil pH is positively correlated 0.90*(A_2-A_1) and (A_4-A_2) at 0.05 level of significant whereas, 0.98** (A_3-A_4) showed 0.01 level of significant.

Relative Humidity

Relative humidity is positively correlated 0.86** (A_2- A_1) and 0.87* (A_3-A_4) at 0.05 level of significant whereas, 0.96** (A_4- A_2) showed 0.01 level of significant.

Morphological Parameters

Shoot Length

The shoot length in inches/ plant of cement polluted blackgram varied from the minimum of 8.90 ± 0.141 cm in monsoon to the maximum of 9.60 ± 0.283 cm in summer. On the other hand, the shoot length in inches/ plant of non-cement polluted blackgram varied from the minimum of 15.20 ± 0.212 cm in summer to the maximum of 15.90 ± 0.000 cm in monsoon (Table: 3).

Table 3: Morphological parameters of Black gram growing around Sankar Cement Factory.

S.No	M.P	A_1	A_2	A_3	A_4
1	SL	15.20 ± 0.212	9.60 ± 0.283	15.90 ± 0.000	8.90 ± 0.141
2	RL	15.20 ± 0.283	9.60 ± 0.354	15.90 ± 0.071	8.90 ± 0.071
3	NB	7.00 ± 0.000	3.00 ± 0.000	8.00 ± 0.000	3.00 ± 0.000
4	NRN	68.00 ± 0.121	29.00 ± 0.243	72.00 ± 0.243	36.00 ± 0.121
5	NL	16.00 ± 0.000	9.00 ± 0.000	16.00 ± 0.707	9.00 ± 0.707
6	TLA	326.15 ± 0.243	130.00 ± 0.828	328.00 ± 0.243	150.00 ± 0.414
7	NP	22.00 ± 0.707	15.00 ± 0.414	25.00 ± 0.707	18.00 ± 0.414
8	WP	550.00 ± 0.414	290.00 ± 0.707	555.00 ± 2.121	299.00 ± 0.134
9	LP	6.60 ± 0.212	4.10 ± 0.707	7.100 ± 0.556	6.90 ± 0.838
10	NS	16.00 ± 0.000	9.00 ± 0.000	18.00 ± 0.707	9.00 ± 0.000
11	WS	632.00 ± 0.283	412.00 ± 0.828	693.00 ± 0.243	426.00 ± 0.414
12	MCP	92.10 ± 0.636	70.20 ± 0.485	93.10 ± 0.414	73.20 ± 0.546
13	MCS	93.20 ± 0.778	76.10 ± 0.263	94.10 ± 0.071	73.20 ± 0.495

SL – Shoot Length in cms; RL- Root Length in cms; NB- Number of Branches per Plant; NRN – Number of Root Nodules; TLA – Total Leaf Area in sq. cms; NP – Number of Paddy / inflorescence; WP - Weight of Paddy in mgs; LP – Length of Pods in cms; NS – Number of seeds; WS – Weight of seeds in mgs; MCP- Moisture content of Paddy in %; MCS – Moisture content of seeds in %. A_1 – Non Cement Polluted Blackgram in summer; A_2- Cement Polluted Blackgram in summer; A_3 – Non Cement Polluted Blackgram in Monsoon; A_4 – Cement Polluted Blackgram in Monsoon.

Root Length

The root length in inches/ plant of cement polluted blackgram varied from the minimum of 8.90 ± 0.071 cm in monsoon to the maximum of 9.60 ± 0.354 cm in summer. On the other hand, the root length in inches/ plant of non-cement polluted blackgram varied from the minimum of 15.20 ± 0.283 cm in summer to the maximum of 15.90 ± 0.071 cm in monsoon.

Number of Branches

Number of branches in the cement polluted blackgram varied from the minimum of 7.00 ± 0.000 in summer to the maximum of 8.00 ± 0.000 in monsoon. On the other hand, number of branches in the blackgram plant reported similar data 3.00 ± 0.000 during monsoon and summer.

Number of Root nodules

Number of root nodules in the cement polluted blackgram plants varied from the minimum of 29.00 ± 0.243 in summer to the maximum of 36.00 ± 0.121 in monsoon. On the other hand, the number of root nodules in non-cement polluted blackgram varied from the minimum of 68.00 ± 0.121 in summer to the maximum of 72.00 ± 0.243 in monsoon.

Number of Leaves

Number of leaves in the cement polluted blackgram plants revealed similar data 9.00 ± 0.000 in monsoon and summer whereas, the control leaves showed similar data 16.00 ± 0.000 in monsoon and summer.

Total Leaf Area

Total leaf area of cement polluted blackgram varied from the minimum of 130.00 ± 0.828 sq.cm in summer to the maximum of 150.00 ± 0.414 sq.cm in monsoon. On the other hand, the total leaf area varied from the minimum of 326.15 ± 0.243 sq.cm in summer to the maximum of 328.00 ± 0.243 sq.cm in monsoon.

Number of Pods

Number of cement polluted blackgram pods varied from the minimum of 15.00 ± 0.414 in summer to the maximum of 18.00± 0.414 in monsoon. On the other hand, number of non-cement polluted blackgram pods varied from the minimum of 22.00 ± 0.707 in summer to the maximum of 25.00 ± 0.707 in monsoon.

Weight of Pods

Weight of the cement polluted blackgram pods varied from the minimum of 290.00 ± 0.707 mg in summer to the maximum of 299.00 ± 0.134 mg in monsoon. On the other hand, weight of the control pod varied from the minimum of 550.00 ± 0.414 mg in summer to the maximum of 555.00 ± 2.121 mg in monsoon.

Length of Pods

Length of the cement polluted blackgram pods varied from the minimum of 4.10 ± 0.707 cm in summer to the maximum of 6.90 ± 0.838 cm in monsoon. On the other hand, length of the control blackgram pods varied from the minimum of 6.60 ± 0.212 cm in summer to the maximum of 7.100 ± 0.556 cm in monsoon.

Number of Seeds

Number of cement polluted blackgram seeds revealed similar data 9.00 ± 0.000 in summer and monsoon. On the other hand, number of blackgram seeds varied from the minimum of 16.00 ± 0.000 in summer to the maximum of 18.00 ± 0.707 in monsoon.

Weight of Seeds
Weight of the cement polluted blackgram seeds varied from the minimum of 412.00 ± 0.828 mg in summer to the maximum of 426.00 ± 0.414 mg in monsoon. On the other hand, weight of the non-cement polluted blackgram seeds varied from the minimum of 632.00 ± 0.283 mg in summer to the maximum of 693.00 ± 0.243 mg in monsoon.

Moisture Content of Pods
Moisture content of the cement polluted blackgram pods varied from the minimum of 70.20 ± 0.485 % in summer to the maximum of 73.20 ± 0.546 % in monsoon. On the other hand, moisture content of the non-cement polluted blackgram pods varied from the minimum of 92.10 ± 0.636 % in summer to the maximum of 93.10 ± 0.414 % in monsoon.

Moisture Content of Seeds
Moisture content of the cement polluted blackgram seeds varied from the minimum of 73.20 ± 0.495 % in monsoon to the maximum of 76.10 ± 0.263 % in summer. On the other hand, moisture content of the non-cement polluted blackgram seeds varied from the minimum of 93.20 ± 0.778 % in summer to the maximum of 94.10 ± 0.071 % in monsoon.

Correlation co-efficient for Morphological Parameters of Blackgram
Shoot Length
Shoot length of blackgram are positively correlated 0.99^{**} (A_2 -A_1) & (A_3-A_4) at 0.01 level of significant.

Root Length
Root length of blackgram are positively correlated 0.99^{**} (A_2 -A_1) & 0.97^{**} (A_3-A_4) at 0.01 level of significant.

Number of Branches
Number of branches in blackgram are positively correlated 0.97^{**} (A_2 -A_1) & 0.96^{**} (A_3-A_4) at 0.01 level of significant.

Number of Root nodules
Number of root nodules are positively correlated 0.86^{*} (A_2 -A_1) & (A_3-A_4) at 0.05 level of significant whereas, 0.99^{**} (A_4-A_2) showed 0.01 level of significant.

Table 4: Correlation Co-efficient for Morphological parameters of Black gram compared with different variables.

S.No	M.P	A_1- A_3	A_2 - A_1	A_3 - A_4	A_4 - A_2
1	SL	0.01	0.99^{**}	0.99^{**}	-0.18
2	RL	0.07	0.99^{**}	0.97^{**}	-0.21
3	NB	0.31	0.97^{**}	0.96^{**}	-0.18
4	NRN	0.52	0.86^{*}	0.86^{*}	0.99^{**}
5	NL	-0.19	0.98^{*}	0.98^{**}	0.99^{**}
6	TLA	-0.21	0.87^{*}	0.90^{*}	0.99^{**}
7	NP	-0.18	0.88^{*}	0.90^{*}	0.01
8	WP	0.35	0.90^{*}	0.86^{*}	0.01
9	LP	-0.57	0.86^{*}	0.87^{*}	0.01
10	NS	0.52	0.96^{**}	0.99^{**}	0.98^{**}
11	WS	0.41	0.96^{**}	0.99^{**}	0.98^{**}
12	MCP	0.31	0.86^{*}	0.87^{*}	0.97^{**}
13	MCS	-0.55	0.90^{*}	0.87^{*}	0.99^{**}

Number of Leaves
Number of blackgram leaves are positively correlated 0.98^{**} (A_2 -A_1) & (A_3-A_4), 0.99^{**} (A_4-A_2) at 0.01 level of significant.

Total Leaf Area
Total leaf area of blackgram are positively correlated 0.87^{*} (A_2 -A_1) & 0.90^{*} (A_3-A_4) at 0.05 level of significant whereas, 0.99^{**} (A_4-A_2) showed 0.01 level of significant.

Number of Pods
Number of blackgram pods are positively correlated 0.88^{*} (A_2 -A_1) & 0.90^{*} (A_3-A_4) at 0.05 level of significant.

Weight of Pods
Weight of blackgram pods are positively correlated 0.90^{*} (A_2 -A_1) & 0.86^{*} (A_3-A_4) at 0.05 level of significant.

Length of Pods
Length of blackgram pods are positively correlated 0.86^{*} (A_2 -A_1) & 0.87^{*} (A_3-A_4) at 0.05 level of significant.

Number of Seeds
Number of blackgram seeds are positively correlated 0.96^{**} (A_2 -A_1), 0.99^{**} (A_3-A_4) and 0.98^{**} (A_4-A_2) at 0.01 level of significant.

Weight of Seeds
Weight of blackgram seeds are positively correlated 0.96^{**} (A_2 -A_1), 0.99^{**} (A_3-A_4) and 0.98^{**} (A_4-A_2) at 0.01 level of significant.

Moisture content of Pods
Moisture content of blackgram pods are positively correlated 0.86^{*} (A_2 -A_1) & 0.87^{*} (A_3-A_4) at 0.05 level of significant whereas, 0.97^{**}(A_4-A_2) showed 0.01 level of significant.

Moisture content of Seeds

Moisture content of blackgram seeds are positively correlated 0.90^{*} (A_2 -A_1) & 0.87^{*} (A_3-A_4) at 0.05 level of significant whereas, 0.99^{**} (A_4-A_2) showed 0.01 level of significant.

Multiple Regression for the Morphological Parameters of Blackgram

Multiple regression analysis revealed that the morphological parameters of blackgram are highly dependent against the variables; R^2 value (0.987326291) and multiple R (0.972356732) in the control blackgram during summer whereas, R^2 value (0.955673275) and multiple R (0.963267135) in the cement polluted blackgram during summer. On the other hand, the morphological parameters are highly dependent against the variables R^2 value (0.977783281) and multiple R (0.967321832) in the control whereas, R^2 value (0.966532503) and multiple R (0.955548967) in the cement polluted blackgram during monsoon (Table: 5).

Table 5: Multiple Regression for Morphological parameters of Blackgram growing around Sankar Cement Factory.

Variables	R Square value	Multiple R
A_1	0.998345678	0.978346282
A_2	0.955435877	0.932352753
A_3	0.983456892	0.925432893
A_4	0.923453282	0.901458393

CONCLUSION

The environmental and morphological analysis of the cultivated blackgram around Thalaiyuth Sankar cement factory revealed that the fall out of cement dust on the crop plants reflect that the reduction of vegetative and reproductive parts result in the reduction of the yield was a great loss to the poor farmers who reside near to the factory and nutritional constituents of crops around the cement factory is perilous, as far as the health of consumers is concerned.

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