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Studies on the Evaluation of the Effect of Dust Pollution on Growth and Yield of Blackgram (*Phaseolus mungo* L.)

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ABSTRACT

Effect of dust (cement, stone crusher, and lime) pollution on black gram (*Phaseolus mungo* L.) was studied by comparing plants of polluted as well as from non-polluted (control). Cement dust accumulation on crop canopy of the plant, mainly affected the growth parameters *i.e.* decrease in plant height, number of branches per plant and number of leaves (@ 150 g m^{-2} leads to 18.45, 33.72 and 31.10 per cent decreased when compared to control respectively), number of pods per plant, number of seeds per pod, 100 seed weight, seed yield ha^{-1}, harvest index (57.12, 33.33, 16.48, 76.09 and 68.42 per cent respectively), dry matter (leaves and stem) and total dry matter. Lesser values of CGR and RGR was recorded with cement dust @ 150 g m^{-2} during 60-75 DAS (harvesting) *i.e.,* 2.76 and 1.18 folds lower than the control. The yield components and yield of blackgram were siginificanty decreased with cement dust followed by stone crusher and lime dusts.

Key words : Black gram (*Phaseolus mungo* L.), Cement, Lime dust, Stone crusher.

India is the largest producer and consumer of pulses in the world. Pulses are major sources of proteins among the vegetarian diet and complement the staple cereals in the diet with proteins, essential amino acids, vitamins and minerals. Pulses contain protein per cent up to 22-50%, which is almost twice the protein in wheat and thrice that of rice. Among the pulse crops, Urdbean (*Phaseolus mungo* L.) is one of the important pulse crops grown throughout India. The urdbean share in total production was 8.60 %. This crop is having wider adaptability, suitability under mixed cropping and also has high intensity in crop rotations. Rapid industrialization and addition of the toxic substances to the environment is responsible for altering the ecosystems Iqbal and Shafig (2001). Honjyo *et al*., (1980) in a study found that the vegetation in the polluted area show vital decay. The Chemical and physical properties of various particulate (cement, stone crushing and lime kilns) and non-particulate substances act as nutrients but at the higher concentration, showed toxic effects on seed germination. Dust could produce a number of toxicants which are responsible for the direct or indirect effects on plant seedling growth and adversely affecting plant growth and yield. The cement industry generates lot of dust and plays a vital role in disturbing the environmental equilibrium and produces air pollution hazards (Stern, 1976). The cement, lime dust and stone crushing are the sources of particulate matter, deposit on the plants and resulting in a significant effect, causes damage to plants by inhibiting many enzyme systems, physiological processes such as photosynthetic ability and respiration rate (Shrinivash and Pandey, 2011), causing visible injury such as reduction in growth and productivity (Subramanian *et al.,* 2011). Cement dust is potentially harmful to the environment. The direct effects of the cement dust pollution cause alkalization of the ecosystem and changing the chemical composition of the soil, can undermine the physico-chemical properties. Hence, contaminated soil can adversely affect plant survival and growth (Addo *et al*., 2013). Stone dust is a primary aerosol and is released directly from the source. Primary aerosol has a detrimental effect on people and environment including changes in flora and fauna, change in soil pH, alters the chemical texture of soil which influences surrounding areas, destruction of habitat, damage of natural resources like valuable vegetation and wild lives, promotion of spreading of many diseases *etc*. (Das and Nandi, 2002 and Shiva *et al*., 2006). Dusts consist of many toxic elements which may be hazardous not only to the humans but also to the vegetation in the surrounding area. Keeping this in view, present study was undertaken to find out the effect of particulate dust on morphological parameters of black gram (*Phaseolus mungo* L.)

MATERIAL AND METHODS

An experiment to study the effect of dust pollution on growth and yield of Black gram (*Phaseolus mungo* L.), variety PU-31 was carried out at the Agricultural College Farm, Agricultural College, Bapatla in sandy clay loam soil during *kharif,* 2014-15. The experiment was laid out in randomized block design with ten treatments *viz.,* control -no dust application (T_1), stone crusher dust @ 50 g m^{-2} (T_2), stone crusher dust @100 g m^{-2} (T_3), stone crusher dust @ 150 g m^{-2} (T_4), lime dust @ 50 g m^{-2} (T_5), lime dust @ 100 g m^{-2} (T_6), lime dust @ 150 g m^{-2} (T_7), cement dust @ 50 g m^{-2} (T_8), cement dust @ 100 g m^{-2} (T_9) and cement dust @ 150 g m^{-2} (T_{10}) in three replications. Dusting of cement @ 50 g/m^2, 100 g/m^2, 150 g/m^2, stone crusher dust @ 50 g/m^2, 100 g/m^2, 150 g/m^2, lime dust @ 50 g/m^2, 100 g/m^2, 150 g/m^2 were given at vegetative stage (30 DAS) as first application and the same concentration was given as a second application at fifteen days thereafter, *i.e.,* at peak flowering stage (45 DAS), besides these, control (without dust) was also maintained.

Seeds were treated with the sprint (carbendizem and thirum) and were dibbled at a depth of 5 cm with a spacing of 30 x 10 cm. Observations were recorded at 15 days interval, starting from 30 days after sowing (DAS) on plant height, no. of leaves, leaf area, number of branches per plant, dry matter production, growth analysis, yield and yield components viz., number of pods per plant, number of seeds per pod, seed yield (kg ha^{-1}), 100 seed weight and harvest index, Where observations were taken from five randomly selected plants from each plot leaving border rows (Non - destructive growth analysis on plant height, number of branches per plant and number of leaves per plant were recorded at specific intervals *i.e.,* at 30 DAS, 45 DAS, 60 DAS and at harvest, destructive growth analysis was done. Plant samples earmarked for destructive growth analysis were collected at regular intervals *i.e.,* 30 DAS, 45 DAS, 60 DAS), and at harvest stage plants were separated into stem, leaves and pods and oven dried at 80°C for 48 h for constant dry weight and their dry weights were recorded separately. The dry weights obtained per plant was used for calculating physiological growth parameters.

RESULTS AND DISCUSSION

Observations were recorded on morphological and physiological parameters at different days after sowing *i.e.,* at 15 days interval starting from 30 DAS. Data on the yield and its components were recorded at harvest. At all the stages, in all dust treatments, plant height was significantly reduced compared to control. At 30 days after sowing plant height was found non significant in all the treatments due to no dust application. Application of cement dust @ 150 gm^{-2} (T_{10}) at 45, 60, 75 DAS, showed significant decrease in plant height (17.57, 24.47 and 24.93 cm, respectively) over control (20.37, 29.77 and 30.57 cm, respectively), whereas there was no significant difference among the remaining treatments and were found on par with control. Cement dust @ 150 g m^{-2} decreased the number of leaves by 9.6, 8.2, 25.9 and 31.1 per cent at 30, 45, 60 and 75 DAS, respectively over control. This is mainly due to the inhibited growth in plants dusted at two growth stages due to the reduced chlorophyll content under the dust pollution .This reduction in leaf number might be attributed to retarded photosynthesis in affected plants caused by several factors including absorption of light by cement crust Pierce (1910), Singh and Rao (1980). Decreased the number of branches by 11.7, 6.7 and 33.7 and 33.7 per cent at 30, 45, 60 and 75 DAS respectively, over control (Table 1).

Leaf dry matter production was also influenced by dust particles at 45 days after sowing. Cement dust @ 150 g m^{-2} and 100 g m^{-2} showed significant decrease in leaf dry matter content over control. Remaining treatments were found on a par with control (5.47 g). At 60 days after sowing, all treatments except stone crusher dust @ 50 g m^{-2} showed considerable decrease in leaf dry weight compared to control (7.83 g). More decrease in leaf dry weight was observed with cement dust @ 150 g m^{-2} and 100 g m^{-2}. At 75 days after sowing (harvesting), leaf dry matter was significantly decreased in all the dust applied treatments. Among all treatments, cement dust @ 150 g m^{-2} and 100 g m^{-2} showed more reduction in leaf dry matter

Table 1. Effect of stone crusher, lime and cement dust on plant height, number of leaves plant^{-1} and number of branches plant^{-1} of blackgram.

Treatments	30 DAS			45 DAS			60 DAS			75 DAS		
	Plant Height (cm)	Number of leaves plant^{-1}	Number of branches plant^{-1}	Plant Height (cm)	Number of leaves plant^{-1}	Number of branches plant^{-1}	Plant Height (cm)	Number of leaves plant^{-1}	Number of branches plant^{-1}	Plant Height (cm)	Number of leaves plant^{-1}	Number of branches plant^{-1}
T1: Control (No dust application)	9.9	4.87	2.8	20.37	9	4	29.77	10.53	5.13	30.57	9	5.13
T2: Stone crusher dust @ 50 g m^{-2}	9.67	4.6	2.47	19.3	8.2	3.4	28.23	9.87	4.27	29.07	8.4	4.27
T3: Stone crusher dust @ 100 g m^{-2}	9.7	4.8	2.67	18.67	7.8	3	27.4	9.33	3.73	28.53	7.47	3.73
T4: Stone crusher dust @ 150 g m^{-2}	9.73	4.67	2.53	18.07	7.53	2.87	26.07	9.07	3.47	27.4	7.6	3.47
T5: Lime dust @ 50 g m^{-2}	10.1	4.4	2.73	18.9	8.47	3.73	29.1	10.4	4.27	29.7	8.8	4.27
T6: Lime dust @ 100 g m^{-2}	9.7	4.4	2.8	18.73	8.2	3.53	28.77	10	4.07	28.97	8.13	4.07
T7: Lime dust @ 150 g m^{-2}	9.33	4.6	2.73	18.3	8.07	3.4	27.63	9.87	3.73	27.7	8.2	3.73
T8: Cement dust @ 50 g m^{-2}	9.8	4.6	2.47	18.97	8	3.47	27.53	9.67	3.8	27.63	7.53	3.8
T9: Cement dust @ 100 g m^{-2}	9.93	4.47	2.53	18.27	7.33	3	26.8	9.2	3.6	26.93	7.33	3.6
T10: Cement dust @ 150 g m^{-2}	9.7	4.4	2.67	17.57	7.27	2.8	24.47	7.8	3.4	24.93	6.2	3.4
SEm±	0.47	0.15	0.11	0.79	0.28	0.12	1.04	0.34	0.13	0.99	0.24	0.13
CD (P=0.05)	NS	0.43	0.32	2.36	0.83	0.36	3.1	1.02	0.38	2.93	0.72	0.38
CV (%)	8.34	5.5	7.13	7.35	6.04	6.36	6.54	6.21	5.68	6.07	5.31	5.68

compared to control (7.52 g). Leaf dry matter decreased with cement dust @ 150 g m^{-2} by 1.04, 1.17, 1.28 and 1.25 folds at 30, 45, 60 and 75 DAS respectively, over control.

Stem dry matter production was recorded at 45 days after sowing at regular intervals. The stem dry weight was significantly differed from control significant reduction was observed with cement dust and stone crusher dust @ 150 g m^{-2} followed by cement dust and stone crusher dust @ 100 g m^{-1}, lime dust @ 150 g m^{-2} and cement dust @ 50 g m^{-2} over control (5.23 g). At 60 days after sowing, stem dry matter significantly decreased in all the dust applied treatments except stone crusher dust and lime dust @ 50 g m^{-2}, stone crusher dust and lime dust @ 100 g m^{-2}. Lesser dry matter was observed with cement, stone crusher and lime dust @150 g m^{-2}, followed by cement dust @100 gm^{-2} over control (6.87 g). At harvesting (75DAS), all dust treatments showed significant decrease in stem dry weight except lime dust @ 50 g m^{-2}. Significant decrease in stem dry weight was observed with cement dust @ 150 g m^{-2} and 100 g m^{-2}, followed by stone crusher dust and lime dust @ 150 g m^{-2} over control (8.10 g). Stem dry weight decreased with cement dust @ 150 gm^{-2} by 1.21, 1.21, and 1.29 folds at 45, 60 and 75 DAS respectively, over control.

All the treatments differed significantly in influencing total dry matter at all stages of crop growth. At 30 days after sowing, total dry weight was

Table 2. Effect of stone crusher, lime and cement dust on leaf, stem and total dry matter plant^{-1} (g) of blackgram.

Treatments	30 DAS			45 DAS			60 DAS			75 DAS		
	Leaf dry matter (g)	Stem dry matter (g)	Total dry matter (g)	Leaf dry matter (g)	Stem dry matter (g)	Total dry matter (g)	Leaf dry matter (g)	Stem dry matter (g)	Total dry matter (g)	Leaf dry matter (g)	Stem dry matter (g)	Total dry matter (g)
T1: Control (No dust application)	3.20	3.01	6.21	5.47	5.23	10.70	7.83	6.87	14.70	7.52	8.10	15.61
T2: Stone crusher dust @ 50 g m^{-2}	3.16	2.95	6.11	5.14	4.75	9.89	7.05	6.36	13.40	6.70	7.27	13.97
T3: Stone crusher dust @ 100 g m^{-2}	3.05	2.89	5.95	5.07	4.57	9.64	6.74	6.24	12.98	6.52	6.86	13.38
T4: Stone crusher dust @ 150 g m^{-2}	3.18	3.04	6.19	4.97	4.48	9.45	6.53	6.17	12.70	6.34	6.69	13.03
T5: Lime dust @ 50 g m^{-2}	3.11	2.91	6.02	5.17	4.89	10.06	6.97	6.39	13.36	6.69	7.36	14.05
T6: Lime dust @ 100 g m^{-2}	3.17	2.96	6.13	5.03	4.77	9.80	6.80	6.24	13.04	6.55	7.08	13.63
T7: Lime dust @ 150 g m^{-2}	3.09	2.91	6.00	4.90	4.58	9.48	6.55	6.11	12.66	6.33	6.79	13.11
T8: Cement dust @ 50 g m^{-2}	3.18	3.00	6.19	4.93	4.63	9.56	6.59	6.12	12.71	6.42	6.83	13.26
T9: Cement dust @ 100 g m^{-2}	3.16	2.95	6.11	4.73	4.54	9.27	6.31	5.86	12.17	6.28	6.60	12.88
T10: Cement dust @ 150 g m^{-2}	3.07	2.88	5.94	4.66	4.33	8.99	6.12	5.69	11.81	6.03	6.29	12.32
SEm±	0.14	0.13	0.25	0.20	0.20	0.34	0.29	0.22	0.58	0.28	0.27	0.57
CD (P= 0.05)	NS	NS	NS	0.61	0.58	1.00	0.86	0.64	1.73	0.82	0.80	1.70
CV (%)	7.88	7.35	7.20	7.08	7.25	6.01	7.39	6.02	7.78	7.30	6.70	7.31

found non significant in all the treatments due to no dust application on plants. At 45DAS, lesser total dry weight was observed with cement dust, stone crusher dust and lime dust @150 g m^{-2}, cement dust and stone crusher dust @ 100g m^{-2}, and cement dust @ 50 g m^{-2} over control (10.70g) except stone crusher dust @ 50 g m^{-2}, lime dust @ 100 and 50 g m^{-2}. At 60 DAS, compared to control (14.7), lower total dry matter was noticed in the treatments *i.e.,* cement dust, stone crusher dust and lime dust each applied @ 150g m^{-2}, cement dust @ 50 g m^{-2} and 100g m^{-2}. At harvesting (75 DAS), total dry weight was significantly reducein all the dust applied treatments except lime dust and stone crusher dust @ 50 g m^{-2}. Significant decrease in stem dry weight was also observed with cement dust and stone crusher dust @ 150 g m^{-2}, cement dust @ 100 g m^{-2}) over control(15.62 g). Total dry weight decreased with cement dust @ 150 g m^{-2} by 1.19, 1.24, and 1.27 folds at 45, 60 and 75 DAS, respectively, over control (Table 2.).

The CGR was recorded at 30-45 DAS, 45-60 DAS and 60-75 DAS. The CGR increased during 30 DAS to 45 DAS, it decreased at 45-60 DAS and 60-75 DAS. At 30-45 DAS, CGR decreased significantly with cement dust, stone crusher dust, lime dust @ 150 gm^{-2} followed by cement dust @ 100gm^{-2} and 50 gm^{-2} over control (9.97 g m^{-2} d^{-1}).

At 45-60 DAS, cement dust, stone crusher dust and lime dust @ 150 gm^{-2}, lime dust and cement dust @ 100 g m^{-2}, cement dust @ 50 g m^{-2} showed significant decrease in crop growth rate than control. Among all the treatments cement dust @ 150 gm^{-2} recorded lesser crop growth rate (6.27 g m^{-2} d^{-1}) over control (8.88 g m^{-2} d^{-1}). At 60-75 DAS, compared to control, CGR decreased significantly in all the dust applied treatments. Cement dust @ 150gm^{-2} showed more decrease in crop growth rate followed by cement dust @ 100gm^{-2} (*i.e.,* 0.74 and 0.89 g m^{-2} d^{-1} respectively,) over control (2.04 g m^{-2} d^{-1}). Crop growth rate was significantly reduced with cement dust @ 150 gm^{-2} by 1.47, 1.42 and 2.76 folds at 30-45, 45- 60 and 60-75 DAS.

Crop gowth rate (CGR) is a measure of rate of biomass production per unit of ground area per unit time. The CGR of control plants and rest of the treatmental plants differed at all the stages. The maximum CGR was found at 30-45 DAS in control plants (9.97 g m^{-2} d^{-1}), than lateral stages of the crop. Crop growth rate decreased significantly with all types of dust application, which was due to less photosynthetic activity and low dry matter accumulation by the plants.

At 30-45 DAS, relative growth rate decreased significantly in all the dust treatments. Among all the treatments cement dust @ 150gm^{-2}showed more decrease in relative growth rate followed by cement dust @ 100gm^{-2} over control (*i.e.,* 2077and 2106 (mg g^{-1} d^{-1}) respectively). At 45-60 DAS and 60-75 DAS all dust treatments showed significant decrease in relative growth rate. RGR decreased significantly more with cement dust @ 150 gm^{-2} (2322 and 2345 mg g^{-1} d^{-1}) than rest of the treatments. Relative growth rate reduced significantly with cement dust @ 150 gm^{-2} by 1.18, 1.18 and 1.18 folds at 30-45, 45-60 and 60-75DAS. Very slight increase was recorded in RGR values during 60-75 DAS in all the treatments which may be due to higher pod filling. The rate of decrease in RGR was high when dust applied was @ 100 g m^{-2} and 150 g m^{-2} this may the due to maximum damage of photosynthetic tissues, stomatal size and number and also reduction in number of leaves per plant (Table 3.).

At harvest (*i.e.,* 75 DAS), cement dust @ 150gm^{-2} recorded lesser number of pods (8.33) and it was on a par with stone crusher dust and lime dust @ 150 g m^{-2}, cement dust, stone crusher dust and lime dust @ 100 g m^{-2}, cement dust, stone crusher dust and lime dust @ 50 g m^{-2} . At harvesting (*i.e.,* 75 DAS), total number of pods reduced Significantly with cement dust @ 150 g m^{-2} by 57.12%.At harvesting (*i.e.,*75 DAS), cement dust @ 150gm^{-2}, 100 gm^{-2}, 50gm^{-2} and stone crusher dust @ 150 gm^{-2} showed significant reduction in total number of seeds per pod (*i.e.,* 4, 4.33, 4.67 and 4.67 respectively) over control (6.0). There was no significant difference in remaining treatments and they were found on a par with control. Reduction in grain yield with deposition of cement dust due to poor pollen germination and fertilization was also reported by Singh and Rao (1980) Moreover cement dust was also reported to increase the percentage of infertile seeds in sunflower when plants were dusted with cement. At harvesting (*i.e.,* 75 DAS), total number of seeds per pod were reduced more with cement dust @ 150 g m^{-2} by 33.33%.

At harvest (*i.e.,* 75 DAS), all treatments showed significant decrease in harvest index compared to control. Lesser harvest index was noticed with cement dust @ 150 gm^{-2} and 100 gm^{-2} (*i.e.,*7.2 and 9.6 respectively) over control (22.8). At harvesting (*i.e.,* 75 DAS), harvest index was reduced more with cement dust @ 150 g m^{-2} by 68.42%.

At harvest (*i.e.,* 75 DAS), 100 seed weight decreased significantly with cement dust, stone crusher dust and lime dust each applied @ 150 g m^{-2},100 g m^{-2} and 50 g m^{-2} over control (4.55g). There was no significant difference in the remaining treatments. At harvesting (*i.e.,* 75 DAS), 100 seed weight reduced significantly with cement dust @ 150 g m^{-2} by 16.48%. At harvest (*i.e.,* 75 DAS), among all the dust applied treatments cement dust and stone crusher dust @ 150 gm^{-2} showed lesser yield (*i.e.,*423 and 670 kg/ha respectively) over control (1769 kg/ha) and they were found on a par with cement dust @ 50g m^{-2}, stone cruher dust @ 100 g m^{-2} and lime dust @ 150 g m^{-2}. At harvesting (*i.e.,* 75 DAS), grain yield was reduced more with cement dust @ 150g m^{-2} by 76.09%. (Table 4).

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Table 3. Effect of stone crusher, lime and cement dust on crop growth rate ($g\ m^{-2}\ d^{-1}$) and relative growth rate ($mg\ g^{-1}\ d^{-1}$) of blackgram.

Treatments	30-45 DAS		45-60 DAS		60-75 DAS	
	crop growth rate ($g\ m^{-2}\ d^{-1}$)	relative growth rate ($mg\ g^{-1}\ d^{-1}$)	crop growth rate ($g\ m^{-2}\ d^{-1}$)	relative growth rate ($mg\ g^{-1}\ d^{-1}$)	crop growth rate ($g\ m^{-2}\ d^{-1}$)	relative growth rate ($mg\ g^{-1}\ d^{-1}$)
T1: Control (No dust application)	9.97	2448	8.88	2730	2.04	2769
T2: Stone crusher dust @ 50 $g\ m^{-2}$	8.41	2171	7.80	2442	1.53	2464
T3: Stone crusher dust @ 100 $g\ m^{-2}$	8.20	2146	7.42	2412	1.13	2417
T4: Stone crusher dust @ 150 $g\ m^{-2}$	7.25	2123	7.22	2392	1.01	2395
T5: Lime dust @ 50 $g\ m^{-2}$	8.97	2188	7.34	2438	1.58	2470
T6: Lime dust @ 100 $g\ m^{-2}$	8.15	2160	7.21	2414	1.31	2438
T7: Lime dust @ 150 $g\ m^{-2}$	7.74	2130	7.05	2387	1.21	2403
T8: Cement dust @ 50 $g\ m^{-2}$	7.50	2136	7.01	2392	1.27	2412
T9: Cement dust @ 100 $g\ m^{-2}$	7.04	2106	6.44	2350	0.89	2389
T10: Cement dust @ 150 $g\ m^{-2}$	6.77	2077	6.27	2322	0.74	2345
SEm±	0.66	84.86	0.56	85.85	0.08	91.24
CD (P= 0.05)	1.95	252.12	1.66	255.07	0.23	271.08
CV (%)	14.21	6.78	13.31	6.12	10.74	6.45

Table 4. Effect of stone crusher, lime and cement dust on yield components and yield of blackgram.

Treatments	Yield components and yield				Seed yield (kg/ha)
	Total number of pods per plant	Total number of seeds per pod	Harvest index (%)	100 seed weight (g)	
T1: Control (No dust application)	19.43	6.00	22.8	4.55	1769
T2: Stone crusher dust @ 50 $g\ m^{-2}$	12.20	5.33	14	4.48	971
T3: Stone crusher dust @ 100 $g\ m^{-2}$	11.63	5.00	12.6	4.26	826
T4: Stone crusher dust @ 150 $g\ m^{-2}$	10.43	4.67	10.7	4.13	670
T5: Lime dust @ 50 $g\ m^{-2}$	16.33	5.67	19.3	4.50	1388
T6: Lime dust @ 100 $g\ m^{-2}$	15.07	5.33	16.7	4.37	1171
T7: Lime dust @ 150 $g\ m^{-2}$	12.97	5.00	13.6	4.24	917
T8: Cement dust @ 50 $g\ m^{-2}$	11.33	4.67	11.7	4.16	733
T9: Cement dust @ 100 $g\ m^{-2}$	10.33	4.33	9.6	3.91	583
T10: Cement dust @ 150 $g\ m^{-2}$	8.33	4.00	7.2	3.80	423
SEm±	0.48	0.37	0.93	0.07	60.0
CD (P= 0.05)	1.44	1.08	2.78	0.22	178.37
CV (%)	6.55	12.65	11.70	3.00	11.00

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