



Effect of copper on Growth of Blackgram (*Phaseolus radiatus* L. Var. GT.1)

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Abstract: Copper is one of the micronutrients to plants. Excess copper is phytotoxic in nature. Copper concentration is increased in mining areas as well as near copper smelters. Industrialization also adds copper to the soil and water. Blackgram, important pulses, is used for the study of excess copper on plants. Seeds of blackgram were soaked in CuSO₄ (1mM) and distilled water (DW) for 5 h. Plants were raised from unsoaked, DW soaked and CuSO₄ soaked seeds. Vegetative and reproductive growth was studied from these plants. Soaking the seeds in DW before promotes the vegetative growth but inhibits the reproductive growth. CuSO₄ soaking decreases vegetative and reproductive growth. It is observed that exposure of seeds to excess copper before sowing adversely affects the growth of the plants. Five hours exposure with copper is initial stage of germination behaved as phytotoxic element for blackgram GT-1 plants.

Keywords: Copper, blackgram, vegetative growth, reproductive growth.

I. INTRODUCTION

Copper is an essential micronutrient for plants but excess copper is phytotoxic i.e. it inhibits growth, metabolic and physiological processes. The total amount of copper present in the soil is not usually available for plants because soil colloids bind the copper. The widespread use of copper increases this metal in the environment. In mining areas and in the vicinity of copper smelters 2000 ppm of copper was found in the soil. The copper present in the sewage sludge and fungicides also potentially toxic. The municipal and industrial effluents also increase the level of soluble copper in fresh water. Thus it is interested to study the effect of excess copper in plants. Fernandes and Henriques (1991) reviewed the biochemical, physiological and structural effects of excess copper in plants. Effect of copper toxicity on growth uptake and translocation of metal in rice plants were reported (Lindon and Henriques, 1993) Long term studies (30 days) were conducted with rice subjected to increasing copper concentration (ranging from 0.002 to 6.25 mg/l) showed an increase in copper concentration in root and shoot tissue. Lentil was found to be quite sensitive to copper. Seed germination, plant growth and productivity were adversely affected in the plants treated with higher concentration of copper (Khan and Khan, 1994) Toxic effect varies with species for e.g. *Vicia faba* is very sensitive. Toxicity is visible after 24 h after application of 1 ppm copper (Kostal, 1974). Blackgram is one of the important pulses in India. It is used to dal, papad, idli, dosa etc. The green pods are used as vegetable and whole plant is used as fodder as well as green manure. Blackgram GT-1 variety is widely cultivated in Gujarat. It was selected for the study.

II. MATERIALS AND METHODS

Seeds of blackgram (*Phaseolus radiatus* L. var GT-1) were exposed to copper by soaking the seeds in CuSO₄ (1mM) for 5h. For comparative study, seeds were also soaked in DW for 5h. Unsoaked, DW soaked and CuSO₄ soaked seeds were sown in earthen pots (30 cm D – each pot containing 10 plants and 20 pots per treatment). Plants were cultivated using normal practice. Control and treated plants were studied for their growth at the intervals of 10 days and that up to 50 days.

(A) Study on Vegetative Growth:

Following parameters were studied:

- 1) Root length (cm/plant)
- 2) Shoot length (cm/plant)
- 3) Leaf number (no/plant)
- 4) Fresh weight of root, stem and leaf (g/plant)
- 5) Dry weight of root, stem and leaf (g/plant)

The details of method are as follows:

Twenty plants at random for each treatment were selected, uprooted carefully and brought to the laboratory. The plants were thoroughly washed with water to remove soil and then gently press to the blotting sheets to remove moisture on their surface. Length of root, shoot of each plant was measured and expressed as cm/plant. Leaf number was also noted. Plant part viz. root, stem and leaf were separated and fresh weight of each part was recorded. These were then placed in a paper bag and transferred to



an oven at 800 C for a period of a week for complete drying. The dry weights were recorded. Using the data of fresh and dry weight, percent moisture was calculated.

(B) Study on Reproductive Growth:

On completion of 50 days, number of flower and fruit, as well as fresh weight, dry weight and percent moisture of flower and fruit were noted from each treatment.

III. RESULTS AND DISCUSSION

(A) Study on Vegetative Growth:

Table-1 represents data on root length, shoot length and leaf number. DW soaking does not give any adverse effect on root length, while soaking in copper decreases the root elongation. Shoot length was more in plants raised from DW dipped seeds, while it is reduced in the plants raised from copper treated seeds. Adverse effect is more shoot than on root. The number of leaf is more in DW treated plants while CuSO₄ dipping decreased the number of leaves in 50 days old plants. From the data it seems that seed dipping in CuSO₄ (1 mM) for 5h is injurious for the growth of plants. When seeds were dipped in CuSO₄, copper must be taken up by the seeds and accumulation of copper imbalances the mineral uptake by the plants. Copper is known to induce chlorosis in the leaf it also decreases the photosynthesis (Stoyanova and Tchakalova, 1993). Thus dipping in CuSO₄ may accumulate copper in seeds. Excess copper may photosynthesis, chlorophyll content and ultimately reduces the growth of the plant.

Table-1 Effects of CuSO₄ (1mM) on growth of blackgram

Parameter	Treatment	Growth period (days)				
		10	20	30	40	50
Root length (cm/plant)	Control (undipped)	4.19 ± 0.24	6.61 ± 0.64	7.77 ± 0.41	8.75 ± 0.39	11.60 ± 0.46
	DW dipped	4.86 ± 0.25	6.70 ± 0.36	7.80 ± 0.54	10.50 ± 0.42	11.80 ± 0.82
	CuSO ₄ dipped	3.94 ± 0.29	5.46 ± 0.41	6.80 ± 0.58	7.92 ± 0.46	9.90 ± 0.78
Shoot length (cm/plant)	Control (undipped)	11.13 ± 0.32	15.2 ± 0.56	23.4 ± 0.58	41.3 ± 0.42	59.8 ± 0.75
	DW dipped	12.08 ± 0.59	18.20 ± 0.29	27.6 ± 0.62	46.1 ± 0.61	61.4 ± 0.78
	CuSO ₄ dipped	11.11 ± 0.39	13.2 ± 0.64	22.5 ± 0.32	39.2 ± 0.54	49.0 ± 0.72
Leaf (no/plant)	Control (undipped)	2.0	3.0	5.0	6.0	8.0
	DW dipped	2.0	3.0	6.0	8.0	9.0
	CuSO ₄ dipped	2.0	3.0	5.0	6.0	6.0

Table- 2 represents the data on fresh weight, dry weight and percent moisture in blackgram plants. Fresh weight of root, stem and leaf is higher in plants raised in DW dipped seeds. The maximum effect is found on the leaf. CuSO₄ dipping lower the fresh weight of all the organs. The stem and leaf of 50 days old plants are highly affected. The intensity of the effect is increased with advancing growth.

The dry weight of root, stem and leaf is more in plants grown from DW dipped seeds in comparison with that in control and CuSO₄ treatment. Effect is more on root and leaf. CuSO₄ dipping decreases the dry weight of all the organs. Root is affected more. Data suggests that copper treatment to the seeds before sowing lower the biomass of plant. DW dipping is beneficial for the plants. Seed dipping in CuSO₄ enhances the percent moisture in root, stem and leaf up to 20 days of growth. DW dipping decreases the percent moisture in leaf.



Table-2 Effects of CuSO₄ (1mM) on Fresh weight, Dry weight and Percent Moisture of blackgram.

Parameter	Treatment	Growth period (days)				
		10	20	30	40	50
Fresh weight (g/plant)						
Root	Control	1.31	1.98	4.10	5.00	9.60
	DW dipped	1.52	2.05	4.25	6.20	9.78
	CuSO ₄ dipped	1.20	1.65	3.68	4.20	8.15
Stem	Control	6.43	8.78	13.50	23.60	34.54
	DW dipped	6.90	10.80	16.00	26.62	36.10
	CuSO ₄ dipped	6.38	7.62	12.99	22.64	27.78
Leaf	Control	5.14	8.00	12.35	15.42	20.60
	DW dipped	6.10	9.15	18.30	24.20	27.40
	CuSO ₄ dipped	4.65	4.80	11.62	11.78	16.17
Dry weight (g/plant)						
Root	Control	0.09	0.13	0.38	0.58	1.05
	DW dipped	0.11	0.15	0.42	0.75	1.38
	CuSO ₄ dipped	0.07	0.09	0.31	0.51	0.96
Stem	Control	0.70	1.40	2.04	4.05	6.54
	DW dipped	0.88	1.61	2.10	4.35	6.95
	CuSO ₄ dipped	0.64	1.20	1.70	3.90	6.27
Leaf	Control	0.61	1.23	2.05	2.26	2.79
	DW dipped	0.87	1.81	3.51	3.87	3.96
	CuSO ₄ dipped	0.48	0.63	1.98	2.10	2.23
Percent Moisture (Percent)						
Root	Control	93.12	93.43	90.73	88.40	89.06
	DW dipped	92.76	92.68	90.11	87.90	85.88
	CuSO ₄ dipped	94.16	94.54	91.57	87.85	88.22
Stem	Control	89.11	84.05	84.88	82.33	81.06
	DW dipped	87.24	85.09	86.87	83.73	80.74
	CuSO ₄ dipped	89.96	84.25	86.91	82.77	77.42
Leaf	Control	88.13	84.62	84.04	85.34	86.45
	DW dipped	85.73	80.21	90.81	84.00	85.47
	CuSO ₄ dipped	89.67	86.87	82.96	85.74	86.20

Excess copper is an inhibitor of plant growth. When plants grown in soil, copper availability is decreased due to the strong binding of copper by soil colloids (Fernandes and Henriques, 1991), thus copper toxicity is reduced, but copper toxicity was more in plants germinated in solution culture or without soil. Copper is the most toxic among 10 metals in root growth of rye grass

grown with culture medium containing 0.002 ppm copper (Wong and Bradshaw, 1982). Similar results were also reported by Stiborova et.al.(1986), Gupta and Mukherji, (1977) and Hogan and Rauser, (1981) for Zea mays, Oryza sativa and Agrostis gigantea respectively. Blackgram is legume. The effect of copper on lentil was studied by Khan and Khan, 1994. Higher concentration of copper decreased the plants growth and productivity, number of rhizobial nodules on root was decreased, root growth was stunted. Leaf pigment was also decreased. Vicia faba is very sensitive to copper and toxicity is visible after 24h of copper (1 ppm) application (Kostal, 1974). Vesper and Weidensaul, (1978) reported the reduction in nodule number, N₂ fixation and dry weight of soyabean plants treated with copper. It seems that if seeds are immersed in copper contaminated water for few hours before sowing, copper significantly reduced the growth of Blackgram GT-1.

(B) Study on Reproductive Growth:

On completion of 50 days, reproductive growth in terms of number of flower and fruit per plant as well as their fresh weight, dry weight and percent moisture were recorded from 20 plants. Table-3 represents the data on effect of CuSO₄ dipping on reproductive growth of blackgram plants. Number of flowers and fruits as well as their fresh weight and dry weight were decreased by dipping treatment. CuSO₄ was more effective. Khan and Khan, (1994) reported that number of pods of lentil plants was decreased by copper. Copper decreased reproductive processes in red pine (Chaney and Strickland, 1984). From the present study it is suggested that copper inhibits the reproductive growth of plant. Data also indicates that seed dipping in DW retards the reproductive growth of the plant thus there may be leakage of some important metabolites from seed during dipping which may ultimately reduce the reproductive growth of plants.

Table-3 Effects of CuSO₄ (1mM) on reproductive growth of blackgram

Parameter	Treatment	Number (no/plant)	Fresh wt. (g/plant)	Dry wt. (g/plant)	Moisture Percent (%)
Flower	Control	4	0.60	0.09	85.00
	DW dipped	3	0.54	0.07	87.03
	CuSO ₄ dipped	2	0.29	0.05	82.75
Fruit	Control	8	26.0	3.70	85.70
	DW dipped	6	16.0	1.45	90.9
	CuSO ₄ dipped	5	9.80	1.13	88.4

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