Innovations in Agriculture
www.innovationsagriculture.com

ISSN: 2617-1295
DOI: https://doi.org/10.25081/ia.2022.v5.1078

Short Communication

Soil applied cobalt alters the growth parameters and dry matters production of Bhendi (*Abelmoschus esculentus* L.)

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ARTICLE INFO

Received: April 17, 2022
Revised: May 30, 2022
Accepted: June 02, 2022
Published: June 11, 2022

Keywords:

Bhendi, cobalt, heavy metal, vegetable production

ABSTRACT

In this study, an economically important crop plant Bhendi (*Abelmoschus esculentus* L.) were treated with various concentrations of cobalt to test its effect on the growth of the plants. For the growth of many plants, cobalt is necessary. Conversely, higher amounts of cobalt are poisonous to plants. Seeds were cultivated in pots with soil that had not been treated (the control) and soil that had cobalt added to it in doses of 50, 100, 150, 200, and 250 mg kg^{-1}. For each sample, the several morphological characteristics including root length, shoot length, number of nodules, total leaf area, dry weight of root and shoot per plant, and leaf area were measured. Soil cobalt level of 50 mg kg^{-1} was found beneficial to the plants.

INTRODUCTION

Heavy metal contamination in soil is a major problem in many parts of the world. Agricultural soils are under the threat of heavy metals [1]. Heavy metals have been found in numerous studies to have negative impacts on the health of living things. The harmony and delicate balance of necessary and harmful metals in the environment have been upset by the ever-increasing human interference with environmental factors [2]. One of the main ways that heavy metals enter the ecosystem is through inappropriate waste management. Metals like Cu, Zn, and Fe are necessary for a healthy body, but too much of these micronutrients can be dangerous [3].

Heavy metal toxins like Cd, Cu, Zn, Ni, Co, Cr, Pb, and As are mildly to significantly contaminating agricultural soils throughout much of the world [4]. This may be caused by the long-term use of phosphoric fertilizers, the application of sewage sludge, dust from smelters, industrial waste, and improper irrigation techniques in agriculture. Their interactions with the antioxidant system, disruption of the electron transport chain, or interference with the metabolism of vital components are some examples of the indirect methods [5]. Lipid peroxidation, which can directly result in bio membrane damage, is one of the most harmful impacts of heavy metal exposure on plants. Metals are important for plant growth and productivity in an optimal concentration and can be applied to the plants like other nutrients even through foliar spray applications [6].

Bhendi (*Abelmoschus esculentus* L.) is a vegetable crop and native of tropical Africa. Bhendi is an important member of the family Malvaceae. This is commonly known as lady's finger. It was cultivated by Europeans as early as 1216 A.D., and has now been introduced into most warm tropics and subtropics [7]. In India, it is widely cultivated as a summer season crop in Gujarat, Andhra Pradesh, Karnataka and Tamil Nadu. The total area under bhendi cultivation in India is 3,83,000ha. Whereas in Tamil Nadu the area under this crop is 3,500ha with a production of about 24,500mt [8].

It is a tropical direct sown vegetable with a short duration of 90-100 days [9]. Bhendi seeds contain 18 to 20 per cent of oil and 20 to 30 per cent of crude protein. Further, bhendi has a vast potential as one of the foreign exchange earners and accounts for about 60 per cent of export of fresh vegetables excluding potato, onion and garlic etc. [10].

Vegetable production in India is quite inadequate to meet the daily requirement (300g for adults and 85g for children) in the Indian diet. Bhendi being self-pollinated crop has an out crossing to an extent by insects [11]. It can yield up to 15t/ha in short duration of 85 to 90 days. The young fruits are very mucilaginous and are much used in soups under the name "gumbo" the spanish word for 'bhendi' [12]. This study was conducted to investigate the effect of cobalt (0, 50, 100, 150, 200 and 250 mg kg^{-1} soil) on the morphological parameters, dry matter yield and the cobalt uptake and accumulation of Bhendi.

MATERIALS AND METHODS

The variety of Bhendi (*Abelmoschus esculentus* L.) was used in the present study. Seeds used in the experiments were obtained from the vegetables division, Tamil Nadu Vegetable Research Station, Palur, Cuddalore district.

Seeds were cultivated in pots with soil that had not been treated (the control) and soil that had cobalt added to it in doses of 50, 100, 150, 200, and 250 mg kg^{-1}. Polythene sheets were used to line the interior surface of the pots. The dirt in each pot was air dried and weighed 3 kg. The surface soil was treated with cobalt as a finely powdered substance ($CoCl_2$), and the soil was extensively combined with the cobalt. Each pot held ten seeds that were sowed. Every day, all pots received a full field's worth of water. After a week of germination, the number of plants in each pot was reduced to a maximum of six. Five copies of each treatment, including the control, were made.

Sample collection

The plants sample 15 and 30 days were collected at the measurement of various morphometrical growth parameters.

Morphological parameters

For each sample, the several morphological characteristics including root length, shoot length, number of nodules, total leaf area, dry weight of root and shoot per plant, and leaf area were measured.

Statistical analysis

The experimental results were statistically analyzed in accordance with the methodology of Gomez and Gomez [13].

RESULTS AND DISCUSSION

Root length (cm plant)

Tables 1 and 2 show the root length of Bhendi plants under cobalt stress at various growth stages. The root length of Bhendi declined (except at a soil cobalt level of 50 mg kg^{-1}) as plant age grew and increased with soil cobalt concentrations. The lowest root length was seen at 250 mg kg^{-1} (2.2) on the fifteenth day, while the highest root length was noted at 50 mg/kg (15.2) on the thirty-first day. F-test results for cobalt levels and sample days were significant at 1%.

Shoot length (cm plant)

Table 6 shows the shoot length of Bhendi under cobalt stress at various growth stages. The longest shoots were measured at 50 mg kg^{-1} (25.9) plants of Bhendi on the 30th day. Bhendi plants with a 250 mg kg^{-1} concentration demonstrated the minimal length of a shoot (7.5) on the fifteenth day. The difference between cobalt levels and sample days was significant at the 1% level according to F-test values.

Total leaf area (cm^2 plant)

Table 2 displays the total leaf area of Bhendi under cobalt stress at various growth stages. On day 15, the Bhendi plants' total leaf area was measured at 0, 50, 100, 150, 200, and 250 mg kg^{-1} soil, respectively. It was determined to be 3.24, 4.27, 3.03, 2.69, 2.55, and 1.79. Following sampling periods showed an increase at 50 mg kg^{-1} and a decline at high soil cobalt levels (100–250 mg kg^{-1}). ANOVA findings for cobalt levels and sampling days were significant at 1%.

Dry matter production ($plant^1$)

Root

The root dry weight of Bhendi plants raised in various Levels of cobalt at different stages of growth is furnished in Table 2. When compared to the control, cobalt at 50 mg kg^{-1} level in the soil increased the dry weight of root and decreased the same at high levels (100-250 mg kg^{-1}) in all the sampling days. Statistical analysis revealed significant (1%) F-test values for cobalt levels in the soil and Sampling days.

Shoot

Table 2 provides the shoot dry weight of Bhendi plants at varying cobalt levels. The maximum dry weight of Bhendi was recorded on day 30, at a cobalt level of 50 mg kg^{-1} (0.70). On the fifteenth day, for Bhendi, the minimum shoot dry weight was noted at 250 mg kg^{-1} cobalt level (0.035). The F-test values were significant at 1% for the variance between the different cobalt levels and sampling days.

Seedling growth of bhendi showed a progressive decline with increase in cobalt concentration. However, 50 mg kg^{-1} cobalt levels were favorable for the seedling growth. The seedling growth parameter like root lengths were reduced at higher cobalt levels. Similar results were reported in different plants [14].

Bhendi plant root and shoot length reduced as soil cobalt concentration rose. At 50 mg kg^{-1}, cobalt was observed to increase the root and shoot length of bhendi. At high concentrations, cobalt may directly restrict root growth by inhibiting cell division, cell elongation, or a combination of the two.

Leaf area of Bhendi decreased with increase in the cobalt content of the soil. However, it increased at 50 mg/kg level in the soil. Similar reduction in the total leaf area due to cobalt on soybean plant [15].

Dry matter production in various part of bhendi varied according to zinc Level dry me matter of root, stem, leaf and shoot was the highest at 50 mg/kg cobalt level. Similar report by [16].

CONCLUSION

In this study, we suggested that cobalt may be a crucial plant micronutrient. For the growth of many lower plants, cobalt is necessary. Cobalt is a mineral that is found in many proteins and enzymes that are involved in the metabolism of plants. If the availability of cobalt is severely constrained, plants may display cobalt shortage. Conversely, higher amounts of cobalt are poisonous to plants. In addition to causing iron shortage in plants, high amounts of cobalt induce pale leaves, discolored veins, and leaf loss. With the development of omics, it is envisaged that Cobalt's unique function in plant metabolism will be solely revealed as an ingredient in enzymes and proteins.

CONFLICTS OF INTEREST

The authors declare no conflict of interest

Table. 1. Effect of cobalt on seedling growth and dry matter production of Bhendi on 15th day.

Sl. No	Cobalt concentration (mg/kg)	Whole plant fresh weight (g/10 pts)	Whole plant dry weight (g/10 pts)	Root lenth (cm)	Shoot lenth (cm)	Leaf area (cm^2 plant')
1	**CONTROL**	0.490	0.046	6.1	12.4	3.24
2	50	0.561 (+14.4)	0.047 (+2.1)	7.2 (+18.3)	12.9 (+4.0)	4.27 (+31.79)
3	100	0.444 (-9.3)	0.045 (-2.1)	5.3 (-13.1)	12.1 (-3.0)	3.03 (-6.48)
4	150	0.433 (-11.6)	0.044 (-4.3)	3.6 (-40.9)	11.2 (-9.6)	2.69 (-16.97)
5	200	0.374 (-23.6)	0.037 (-19.5)	2.7 (-55.7)	9.8 (-20.9)	2.55 (-21.69)
6	250	0.301 (-38.5)	0.035 (-23.9)	2.2 (-63.9)	7.5 (-39.5)	1.79 (-44.75)

(Percent over control given parenthesis)

Table. 2. Effect of cobalt on seedling growth and dry matter production of Bhendi on 30th day.

Sl. No	Cobalt concentration (mg/kg)	Whole plant fresh weight (g/10 pts)	Whole plant dry weight (g/10 pts)	Root lenth (cm)	Shoot lenth (cm)	Leaf area (cm² plant')
1	**CONTROL**	1.51	0.49	13.7	24.8	6.48
2	50	1.72 (+13.9)	0.70 (+42.8)	15.2 (+10.9)	25.9 (+4.4)	7.17 (+10.6)
3	100	1.44 (-4.6)	0.41 (-16.3)	7.5 (-45.2)	24.3 (-6.5)	6.07 (-6.32)
4	150	1.37 (-9.2)	0.35 (-28.5)	6.2 (-54.7)	22.5 (-9.27)	5.38 (-16.97)
5	200	1.29 (-14.5)	0.21 (-57.1)	5.1 (-62.7)	18.9 (-23.7)	5.03 (-22.37)
6	250	1.11 (-26.1)	0.09 (-81.6)	4.4 (-67.8)	16.1 (-35.2)	3.58 (-44.75)

(Percent over control given parenthesis)

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