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Research Article

INTERACTIVE EFFECT OF COBALT AND SOME PHENOLIC COMPOUNDS ON THE SEED GERMINATION AND SEEDLING GROWTH IN CUCUMBER (*CUCUMIS SATIVUS* L.)

***Barket Ali**
Department of Botany, Government College for Women, M. A. Road, Srinagar, Jammu and Kashmir
**Author for Correspondence*

ABSTRACT
Phenolic compounds are group of secondary metabolites which are implicated in diverse physiological processes in plants whereas, cobalt is considered as a beneficial element for plants, at a very low concentration. With an objective to explore the interactive effect cobalt and phenolic compounds, cucumber (*Cucumis sativus* L.) cv. Long Green seeds treated with cobaltous chloride ($CoCl_2$; 10 µM) and/or 10^{-4} M each of catechol and gallic acid. Exposure of the seeds to the phenolic compounds significantly decreased the germination percentage, growth of radicle and hypocotyls and the fresh and dry weight of the seedlings. However, the follow up treatment with 10 µM $CoCl_2$ reversed the inhibitory impact of the phenolic compounds and there was a significant improvement in these parameters after $CoCl_2$ treatment.

Keywords: *Catechol, Cobalt, Cucumber, Gallic Acid, Germination, Phenolic Compounds*

INTRODUCTION

Cobalt (Co) is a metal and is considered as a beneficial element for plants, at a very low concentration. It is an integral component of the coenzyme cobalamine (vitamin B_{12} and its derivatives). Its deficiency has been found to affect nitrogen metabolism in legumes (Marschner, 2003). Besides this, it also increases the vase life of the cut-flowers (Muzaffar and Ali, 2015). However, the elevated concentration has been found to cause toxicity in plants. It caused a marked inhibition of growth of a plant together with chlorosis and necrosis in *Citrus* plants (Marschner, 2003) declines the Hill activity and catalase activity and deteriorates the quality of produce (Chatterjee *et al.,* 2006). Excess cobalt also causes enzyme inhibition (Shalygo *et al.,* 1999). However, at higher concentration it becomes deleterious and affects several physiological processes. For example, it alters the photosynthetic activity of the plants in numerous ways, such as pigments, stomatal functioning, electron transport chain, enzymes, and thylakoid membrane (Mysliwa-Kurdziel *et al.,* 2004) and also affects membrane functioning and enzyme activities (Ali *et al.,* 2010; Ali 2014). Phenolic compounds are of wide occurrence in plants and are present in thousands of number in plant kingdom. These compounds are of great significance in the development of a plant. They are involved in diverse processes such as vitrification (Kevers *et al.,* 1984), rhizogenesis (Curir *et al.,* 1990), resistance to biotic and abiotic stress (Delalonde *et al.,* 1996), seed germination (Muzaffar *et al.,* 2012; Ali *et al.,* 2013) and improves total antioxidant capacity under moisture stress (Ozfidan-Konakci *et al.,* 2015). Some of the phenolic compounds play an important role in several physiological responses in plants, e.g. salicylic acid has a direct involvement in plant growth, thermogenesis, flower induction and uptake of ions. It affects ethylene biosynthesis, stomatal movement and also reverses the effects of abscisic acid (ABA) on leaf abscission. Enhancement of the level of chlorophyll and carotenoid pigments, photosynthetic rate and increasing the activity of numerous enzymes are other roles assigned to this and its structurally related phenolic compounds (Hayat *et al.,* 2007). Present experiment was undertaken to study the interactive effect of these two entities on the processes related to seed germination in cucumber.

MATERIALS AND METHODS

Cucumber (*Cucumis sativus* L.) cv. Long Green seeds were germinated in petriplates containing blotting paper moistened with distilled water (control), Cobalt in the form of cobaltous chloride ($CoCl_2$) and/or 10^{-4} M each of catechol and gallic acid were used for treatment purpose. Each petriplates contained 25 seeds and the petriplates were maintained in dark at 25°C. The seeds were treated with the solutions of phenolic compounds (10^{-4} M each) for 12 hours separately and was followed by treatment with $CoCl_2$ (10 µM) for another 12 h. Simultaneously, control sets were also maintained by treating the seeds with water, $CoCl_2$ (10 µM) alone or phenolic compounds (10^{-4} M each) alone. Germination (emergence of radicle) was recorded after every 24 hours of soaking. After 72 h of soaking, the lengths of radicle and hypocotyl were measured in 10 seedlings picked up randomly. The seedlings were weighed to determine their fresh weight and then washed with running tap water followed by a washing with distilled water. The seedlings were gently blotted dry with blotting paper and then dried at 80°C for 24 h in an oven. After drying, dry weight of the seedlings was recorded. Each treatment was replicated thrice and the least significant difference was calculated manually at 5% level to determine the degree of response to various treatments.

RESULTS AND DISCUSSION

The treatment of the seeds with the phenolic compounds, viz., catechol and gallic acid significantly decreased the germination percentage (Table 1). However, follow-up treatment with cobalt brought about some improvement in these parameters, compared to those which received the treatment of phenolic compounds only. Similarly, the growth of radicle and hypocotyl was suppressed by the phenolic compounds (catechol and gallic acid) used. The phenolic compound catechole had lesser inhibitory impact than gallic acid. Treatment with Co enhanced the seedling growth, even in the seedlings pre-exposed to the phenolic compound used. Likewise, the fresh and dry weight of the seedlings was also declined by catechol and gallic acid. However, Co treatment reversed the inhibitory impact of the phenolic compounds on these parameters, irrespective of the phenolic compound used in the treatment. Comparing the phenolic compounds used, gallic acid was more inhibitory on the growth of seedlings, which reversed by Co follow-up treatment.

Table 1: Interactive Effect of Cobalt (10 µM) and Phenolic Compounds; Catechol and Gallic Acid (10^{-4} M each) on Length of Hypocotyls and Epicotyls (cm); Fresh and Dry Weight of Seedling (g); and Relative Water Content (RWC) and Final Germination Percentage (FGP) (%) in Cucumber (*Cucumis sativus* L.) at 72 hr (± = Standard Error)

Treatment	Length of Hypocotyls (cm)	Length of Epicotyls (cm)	Fresh Weight of Seedling (g)	Dry Weight of Seedling (g)	RWC (%)	FGP (%)
Control	4.40±0.82	4.50±0.78	1.57±0.48	0.42±0.35	75.0± 4.8	64.5±3.2
Cobalt (Co)	4.48±0.56	2.12±0.67	2.76±0.44	0.77±48	88. 6±5.0	78.2±4.4
Catechol	2.48±0.76	1.12±0.58	1.16±0.25	0.31±20	71.9±4.4	58.2±2.6
Gallic acid	2.36±0.34	1.28±0.23	1.08±0.31	0.25±18	70.8±3.2	56.2±3.0
Catechol + Co	4.05±0.45	1.83±0.27	2.34±0.40	0.50±26	87.9±3.9	60.4±2.5
Gallic acid + Co	4.10±0.42	2.60±0.30	2.12±0.37	0.55±34	85.5±4.3	61.7±3.3

Seed germination is in fact a cumulative consequences of many physical, physiological, biochemical, cellular and molecular events rendering the radicle able to emerge from the seed. They are well versed with intracellular bodies of lipids, proteins, carbohydrates, organic phosphate and various other inorganic compounds, which facilitate the process of germination and the growth of the resulting seedlings. These compounds are consumed during the course of germination by involving various enzymes such as hydrolases, lipases, proteinases and phosphatases, which are released and/or synthesized *de novo* to facilitate the availability of simpler substances to the embryo, for its growth. However, in the present research, treating the seeds with graded concentrations of phenolic compounds, viz., catechol and gallic acid resulted in a sharp decline in germination and seedling growth. The inhibitory effect of these compounds on early growth is not surprising since phenolic acids are potent germination and growth inhibitors (Mizutani, 1999). Similarly, Baleroni *et al.,* (2000) demonstrated that p-coumaric acid at 1mM severely affects the root growth and fresh weight of canola (*Brassica napus*). Moreover, Co at a low concentration, independently as well as in combination with phenolic compounds had a favourable effect on the processes associated with the germination and seedling growth. This favourable effect of relatively low concentration of Co on seed germination is in conformity with the observations of Ali (2014) in *Cice arientinum*.

In conclusion, the phenolic compounds had an inhibitory impact on the seed germination and seedling growth in cucumber (*Cucumis sativus* L.). However, subsequent treatment of seeds at germination stage with Co (10 µM) improved the seed germination and seedling growth.

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