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Evaluation of Antimony Induced Yield Shift Attributes in Mustard

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ABSTRACT: Due to various anthropogenic emission activities, antimony (Sb) concentration is gradually rising day by day in the agricultural system. The intake of Sb is more on those soils which are having high contamination in the form of soil soluble Sb. Antimony is a lustrous grey metalloid that is to be present in nature in the form of Sulfide mineral stibnite (Sb2S3). Sb is a toxic trace element and it has wider scopes in terms of research as there is very less work is done on the soil contaminated with metalloids like antimony, arsenic, etc. Antimony is found to be less toxic when compared to other elements like arsenic. During our research crop trial, we apply the salt of Antimony potassium tartrate hemihydrate (100 ppm) in solution form individually and also in combination with *Trichoderma hamatum*. 6 gram of *Trichoderma hamatum* is applied to the pot. Various parameters viz; Pod per plant, Siliqua length, Weight per pod, Seed per pod, Chlorophyll index of pods are taken into account to check the effect of Sb induced pot culture on Indian mustard (*Brassica juncea*).We have examined that pots having an antimony concentration of 100 ppm shows lower upper mentioned yield attributes whereas pots having a microbial culture of *Trichoderma hamatum* helps in either increasing the yield or counteract the bad effects of antimony toxicated soils.

Keywords: Antimony, Biotic, Crop, Density, Pot, Mustard, Trichoderma

INTRODUCTION

Antimony is a common toxic heavy metal found in the soil flora in an inorganic form, and it can cause toxicity to both plant and animal species either directly or indirectly (Kumar *et al.,* 2108vi; Chand *et al.,* 2020; Kumar and Pathak 2019; Kumar 2018). Even though it is not a necessary nutrient provider for plant species, its amalgam may have toxic effects on plants. Antimony has varying levels of toxicity depending on its valence state, with trivalent antimony being more toxic than pentavalent antimony. Cancer-causing properties exist in antimony and its amalgam, as well as threshold toxicity. Antimony is considered a major pollutant in agricultural systems due to its extreme toxicity (Kumar *et al.,* 2014; Mani and Kumar, 2020; Kumar and Dwivedi, 2013; Kumar *et al.,* 2018; Kumar *et al.,* 2020). Environmental pollution has increased globally in the twenty-first century as a result of increased mine digging practices increased industrialization and the introduction of more technological approaches in agricultural systems. Antimony and other metalloids are major polluters of the environment (Kumar *et al.,* 2018; Kumar *et al.,* 2013; Mani and Prasann, 2019).

In the past, a lot of researchers observed the concentration and bioavailability of antimony in soils. Only fewer studies are performed on the alteration of yields of crops due to the toxicity of heavy metals like antimony. The knowledge regarding the use of microorganisms like *Trichoderma hamatum* at different concentrations promotes higher and safer production of mustard and other crops (Li *et al.,* 2021).

To test the effect of Sb toxicity (100ppm), we used mustard (Genotype PBR-357) as well as *Trichoderma hamatum* (6 g per 10 kg of soil). Different treatment combinations are applied in a 30cm diameter and 25cm height pot at Lovely Professional University, Punjab. PBR-357 (Raya) variety is used for our research trial with a maturity period of 140-145 days. The primary goal of our experiment is to investigate the effect of Sb stress on the various yield attributes of mustard-like Siliqua per plant, Siliqua length, Weight of siliqua, Seeds per Siliqua, and Chlorophyll index of mustard pods. In this pot trial, Indian mustard was grown in soil treated with either a mixture of Sb and *Trichoderma hamatum* or Sb and *Trichoderma hamatum* as a single treatment.

This study helps us to know that how the utilization of *Trichoderma hamatum* in combination helps to mitigate the effects of Sb stress on mustard crops while also producing a high yield (Mishra *et al.,* 2012; Pathak *et al.,* 2016; Prakash *et al.,* 2017). Also, the knowledge regarding the use of microorganisms like *Trichoderma hamatum* at different concentrations promotes higher and safer production of mustard and other crops.

MATERIALS AND METHODS

The crop research trial was conducted at the School of Agriculture, Lovely Professional University (LPU), Phagwara, Punjab, in pots with natural conditions. The experimental area is located 232 meters above mean sea level, with latitude and longitude of 31.244604 N and 75.701022 respectively (Fig. 1).

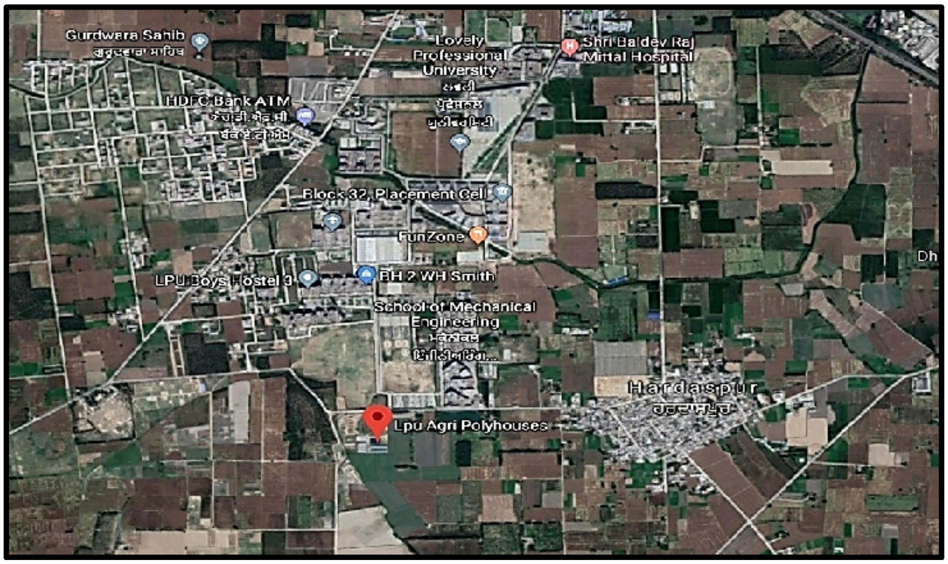

Fig. 1. Google photo of the experimental site. (Source: - Google Earth, 2020).

A. Climatic Conditions

Punjab (Phagwara region) is located in the Northeastern part of India, in the central plain zones. The annual rainfall in Punjab ranges from (250-1000 mm/year). In the winter, the temperature drops to 5 degrees at night and rises to 12-15 degrees in the morning. The maximum temperature in the summer exceeds 40 degrees Celsius. Summer temperatures in Punjab's Ludhiana district reached 46.1 degrees Celsius, while Amritsar and Patiala districts reached 45-50 degrees Celsius. The average annual temperature is 24.1 degrees Celsius, with 686 mm of rainfall. (From en.climate-data.org)

B. Treatments Details

The pot experimental research trial was carried out on the Mustard PBR-357 genotype, which was obtained from the Punjab Agriculture University at Ludhiana. Fig. 2 depicts the seeds and their characteristics. There were four treatments (T0, T1, T2, and T3) with three replications (R1, R2, and R3). The total number of pots was 12, with diameter and height measurements of 30cm and 25cm, respectively. The experiment was carried out on an agriculture farm at Lovely Professional University's School of Agriculture.

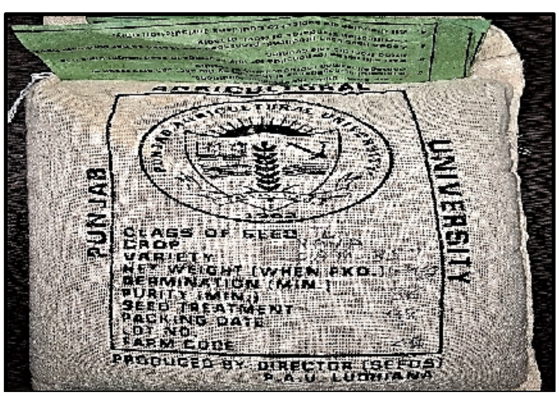

Fig. 2. PBR-357 taken for research.

Heavy metal toxicity was caused by the application of Antimony potassium tartrate hemihydrate 100 ppm per 10 kg of soil, and the treatment was *Trichoderma hamatum* 6 gram per pot. Before two days after sowing, all treatments are applied to the soil rather than directly to the plants. 15 days after sowing, samples were collected for the estimation of various biochemical parameters (Table 1 and 2).

Table 1: Treatments Details.

Treatments	Details of the treatments	Time of application
T-0	Control	Before sowing
T-1	Sb + *Trichoderma hamatum* (100 ppm + 6 g per 10 kg of soil)	Before sowing
T-2	Sb (100 ppm per 10 kg of soil)	Before sowing
T-3	*Trichoderma hamatum*(6 g per 10 kg of soil)	Before sowing

Table 2: Layout Details.

S. No.	Particulars	Details
1.	Layout	CRD
2.	Treatment	4
3.	Replication	3
4.	Total number of pots	4*3= 12
5.	Soil per pot	10 Kg
6.	Genotype	PBR-357

C. Observation to be recorded

The observation was recorded at the time of maturity. Scissors, Ziplock cover pouch bags (Reusable/ Resealable), permanent marker, Weighing machine, SPAD mater are the instruments and materials were used during the time of data recording. Different yield attributes of mustard observed were:

1. Siliqua per plant

2. Siliqua length(cm)
3. Weight of siliqua (g),
4. Seeds per siliqua,
5. Chlorophyll index of the pods (SPAD meter)

RESULTS

A. Siliqua per plants

The number of siliqua per plant is lesser in T2[Sb (100 ppm per 10 kg of soil)].When compared to T0 (Control), there isa 30.38 % increasein numbers of siliqua per plant, 21.64 % inT1[Sb + *Trichoderma hamatum* (100 ppm + 6 g per 10 kg of soil)], 39.11% inT3[*Trichoderma hamatum* (6 g per 10 kg of soil)]. Thus, we have observed that *Trichoderma hamatum* application plays a very crucial and positive role in counteracting the effect of Sb toxicity. The following patterns of increase in the number of siliqua are sown in Fig. 3.

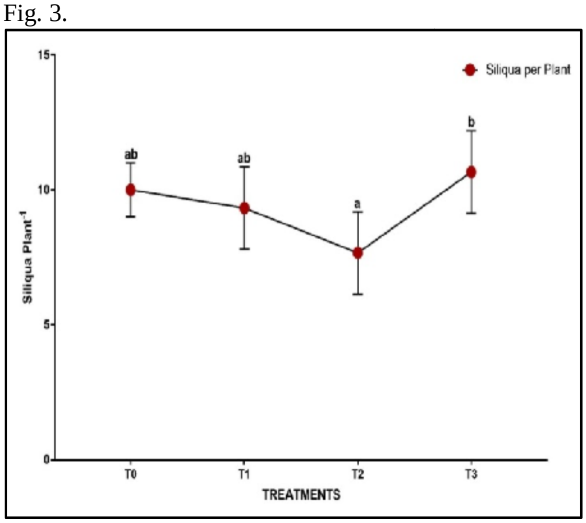

Fig. 3. Siliqua per plant.

where, T0: Control, T1: Sb + *Trichoderma hamatum* (100 ppm + 6 g per 10 kg of soil), T2: Sb (100 ppm per 10 kg of soil), T3: *Trichoderma hamatum* (6 g per 10 kg of soil).

B. Siliqua length (cm)

The siliqua length (cm) is lesser in T2 [Sb (100 ppm per 10 kg of soil)]. When compared to T0 (Control), there is10.97 % increase in siliqua length (cm), 12.85 % in T1 [Sb + *Trichoderma hamatum* (100 ppm + 6 g per 10 kg of soil)], 22.26 % in T3 [*Trichoderma hamatum* (6 g per 10 kg of soil)]. Thus, we have observed that *Trichoderma hamatum* application plays a very crucial and positive role in counteracting the effect of Sb toxicity. The following patterns of increase in the siliqua length (cm) are sown in Fig. 4.

C. Weight of Siliqua (g)

The weight of Siliqua (g) is lesser in T2 [Sb (100 ppm per 10 kg of soil)]. When compared to T0 (Control), there is 8.33 % increase in weight of siliqua (g), 25% in T1 [Sb + *Trichoderma hamatum* (100 ppm + 6 g per 10 kg of soil)], 58% in T3 [*Trichoderma hamatum* (6 g per 10 kg of soil)]. Thus, we have observed that *Trichoderma hamatum* application plays a very crucial and positive role in counteracting the effect of Sb toxicity. The following patterns of increase in the weight of siliqua (g) are sown in Fig. 5.

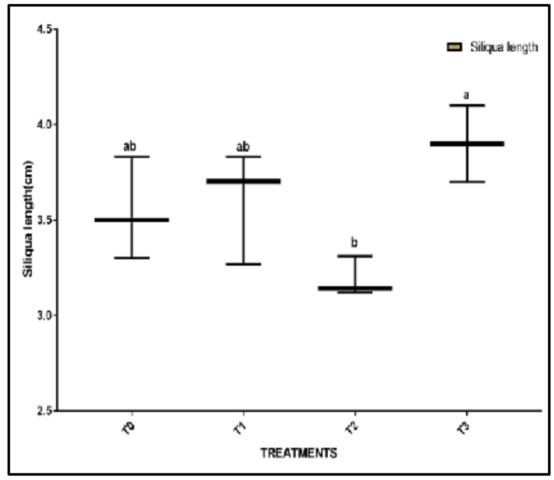

Fig. 4. Average siliqua length (cm).

where, T0: Control, T1: Sb + *Trichoderma hamatum* (100 ppm + 6 g per 10 kg of soil), T2: Sb (100 ppm per 10 kg of soil), T3: *Trichoderma hamatum* (6 g per 10 kg of soil).

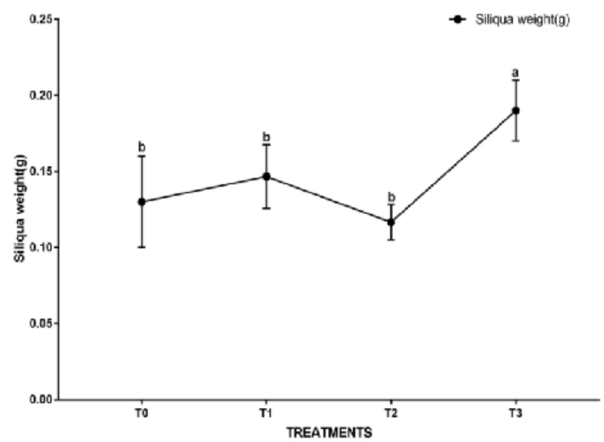

Fig. 5. Average weight of siliqua.

where, T0: Control, T1: Sb + *Trichoderma hamatum* (100 ppm + 6 g per 10 kg of soil), T2: Sb (100 ppm per 10 kg of soil), T3: *Trichoderma hamatum* (6 g per 10 kg of soil).

D. Chlorophyll Index of Siliqua

Just after the harvest of the siliqua of the plant, the Chlorophyll index is measured by using the SPAD meter. The chlorophyll index of siliqua is lesser in T2 [Sb (100 ppm per 10 kg of soil)]. When compared to T0 (Control), there is 48.15% increase in chlorophyll index of siliqua, 24.71 % in T1 [Sb + *Trichoderma hamatum* (100 ppm + 6 g per 10 kg of soil)],33.82 % in T3 [*Trichoderma hamatum* (6 g per 10 kg of soil)]. Thus, we have observed that *Trichoderma hamatum* application plays a very crucial and positive role in counteracting the effect of Sb toxicity. The following patterns of increase in the chlorophyll index of siliqua are sown in Fig. 6.

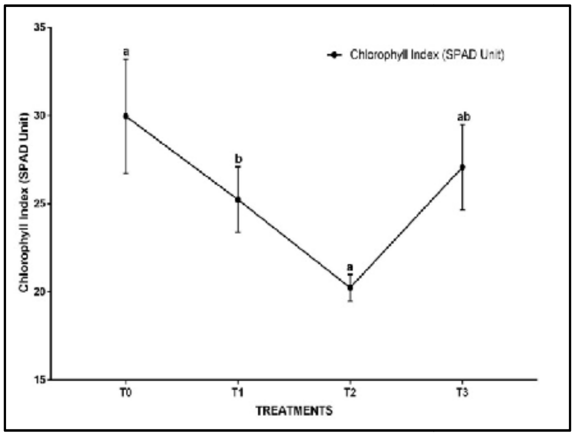

Fig. 6. Chlorophyll Index of Sliqua.

where, T0: Control, T1: Sb + *Trichoderma hamatum* (100 ppm + 6 g per 10 kg of soil), T2: Sb (100 ppm per 10 kg of soil), T3: *Trichoderma hamatum* (6 g per 10 kg of soil).

E. Seeds per Siliqua

Seeds are the main yield attributes of many crops. The seeds per silique are lesser in T2 [Sb (100 ppm per 10 kg of soil)]. When compared to T0 (Control), there is 22.17 % increase seeds per siliqua, 16.67 % in T1 [Sb + *Trichoderma hamatum* (100 ppm + 6 g per 10 kg of soil)], 38.83 % in T3 [*Trichoderma hamatum* (6 g per 10 kg of soil)]. Thus, we have observed that *Trichoderma hamatum* application plays a very crucial and positive role in counteracting the effect of Sb toxicity. The following patterns of increase in the seeds per siliqua are sown in Fig. 7.

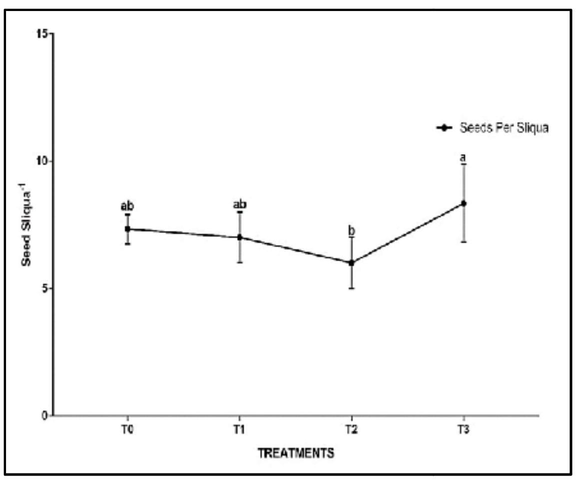

Fig. 7.

where, T0: Control, T1: Sb + *Trichoderma hamatum* (100 ppm + 6 g per 10 kg of soil), T2: Sb (100 ppm per 10 kg of soil), T3: *Trichoderma hamatum* (6 g per 10 kg of soil).

From this pot experiment, a small pot experiment having three treatments and three replications and mustard genotype PBR-357 is grown in 100 ppm Sb stress per 10 kg of soil and application of *Trichoderma hamatum* (6 g per 10 kg of soil) to mitigate the effect of Sb toxicity.

DISCUSSION

Trichoderma hamatum is considered one of the most beneficial microbes in the agriculture sector. *Trichoderma* is economical, most culturable and effectively utilized in any of the agricultural systems (Thapa *et al.*, 2020). The use of *Trichoderma hamatum* increases enzyme concentrations in soil along with the nutrient status of the soil (Halifu *et al.*, 2019).

There is degradation in the performance of the crops and health of the soil through the application of agrochemicals in intensive agriculture systems. The presence of Sb in soil surely affects the plant growth and its development that is reflected in terms of their yield attributes. Plants grown in Sb stressed soil shows a decrease in all the yield attributes by significant difference and the application of *Trichoderma hamatum* helps to mitigate the effect of Sb toxicity. *Trichoderma hamatum* helps to make the nutrients available to the crop by the degradation of heavy metals like antimony. Therefore, from these above results, we can conclude that *Trichoderma hamatum* application proved very crucial on plant growth on that soil where there is a dominant presence of Sb toxicity. Thus by the utilization of *Trichoderma hamatum*, it promises its future perspectives in sustainable agriculture by the reduction in the harmful contaminants in the agricultural fields.

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Author Contributions

The study was designed by Chiter Mani and Prasann Kumar the biochemical protocolizations were established, the experiment was carried out and the data analyzed and interpreted were collected. The paper has been written by Chiter Mani and Prasann Kumar.

Conflict of Interest Statement. The authors state that they have no interest in conflicts.

REFERENCES

Chand, J., & Kumar, P. (2020). Biochemical shift of mustard grown under cadmium contaminated soil. *Journal of Pharmacognosy and Phytochemistry*, **9**(3), 178-183.

Chitra Mani, Kumar, P. (2020). Evaluation of antimony induced biochemical shift in mustard. *Plant Archives*, **20**(2), 3493-3498.

Halifu, S., Deng, X., Song, X., & Song, R. (2019). Effects of two *Trichoderma* strains on plant growth, rhizosphere soil nutrients, and fungal community of *Pinus sylvestris* var. mongolica annual seedlings. *Forests*, **10**(9), 758.

Kumar P. (2018vi). Metals and Micronutrients-Food Safety Issue. [Ed. Kumar P and Bharti P.K, Discovery Publication, New Delhi][ISBN: 978-93-86841-56-8][p. 126-147].

Kumar, P. (2018). Impact of Polyamines and Mycorrhiza on Chlorophyll Substance of Maize Grown under Cadmium Toxicity. *International Journal of Current Microbiology and Applied Sciences*, **7**(10), 1635-1639.

Kumar, P, Mishra, P.K., & Singh, S. (2014). Heavy metal analysis in the root, shoot and a leaf of *Psidium guajava* L. by using atomic absorption spectrophotometer. *Pollution Research*, **33**(4), 135-138.

Kumar, P., & Pathak, S. (2019). Responsiveness index of sorghum (*Sorghum bicolor* (L.) Moench) grown under cadmium contaminated soil treated with putrescine and mycorrhiza. *Bangladesh Journal of Botany*, **48**(1), 139-143.

Kumar, P., Mandal, B., & Dwivedi, P. (2013). Phytoremediation for defending heavy metal stress in weed flora. *International Journal of Agriculture, Environment and Biotechnology*, **6**(4), 647.

Li, B., Xu, R., Sun, X., Han, F., Xiao, E., Chen, L., ... & Sun, W. (2021). Microbiome–environment interactions in antimony-contaminated rice paddies and the correlation of core microbiome with arsenic and antimony contamination. *Chemosphere*, **263**, 128227.

Mani, C. & Kumar, P. (2019). Impacts of Foliar Feeding of Zinc and Polyamine on the Productivity of Wheat. *International Journal of Emerging Technologies and Innovative Research,* **6(2**), 354-372.

Mishra, P.K., Maurya, B.R., & Kumar, P. (2012). Studies on the biochemical composition of *Parthenium hysterophorus* L. in different season. *Journal of Functional and Environmental Botany*, **2**(2), 1-6.

Pathak, S., Kumar, P., Mishra, P. K., & Kumar, M. (2016). Plant-based remediation of arsenic-contaminated soil with special reference to sorghum-a sustainable approach for a cure. *Journal of the Kalash Sciences, An International Journal*, **4**(2), 61-65.

Pathak, S., Kumar, P., Mishra, P.K., & Kumar, M. (2017). *Mycorrhiza* assisted approach for bioremediation with special reference to biosorption. *Pollution Research*, **36**(2), 330-333.

Prakash, A., & Kumar, P. (2017). Evaluation of heavy metal scavenging competence by in-vivo grown *Ricinus communis* L. using atomic absorption spectrophotometer. *Pollution Research*, **37**(2), 148-151.

Kumar, P., Biswapati, M., & Dwivedi, P. (2013). Combating heavy metal toxicity from hazardous waste sites by harnessing scavenging activity of some vegetable plants. *Vegetos*, **26**(2), 416-425.

Kumar, P., Sunil, K., Mandala, H., Mohit, N., Yumnam, J., Kumar, P. S., ... & Lamneivah, M. (2018). Evaluation of plant height and leaf length of sorghum grown under different sources of nutrition. *Annals of Biology*, **34**(3), 284-286.

Kumar, P., Vijai, K., Pandey, A.K., Shweta, P., & Anaytullah, S. (2018). Assessment of scavenging competence for cadmium, lead, chromium and nickel metals by in vivo grown *Zea mays* L. using atomic absorption spectrophotometer. *Annals of Agri Bio Research*, **23**(2), 166-168.

Kumar, P., Kumar, T., Singh, S., Tuteja, N., Prasad, R., & Singh, J. (2020). Potassium: A key modulator for cell homeostasis. *Journal of Biotechnology*, **324**, 198-210.

Rai, N., Limbu, A.K., & Joshi, A. (2020). Impact of *Trichoderma* sp. in Agriculture: A Mini-Review. *Journal of Biology and Today's World*, **9**(7), 1-5.

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