

**UNIVERSITY GRANTS COMMISSION  
BAHADUR SHAH ZAFAR MARG  
NEW DELHI – 110 002**

**PROFORMA FOR SUBMISSION OF INFORMATION AT THE TIME OF SENDING  
THE FINAL REPORT OF THE WORK DONE ON THE PROJECT**

**1. TITLE OF THE PROJECT:** Evaluation of stress protective properties of 24-epibrassinolide in plants during nematode infection

**2. NAME AND ADDRESS OF THE PRINCIPAL INVESTIGATOR:** Dr Puja Ohri, Department of Zoology, Guru Nanak Dev University, Amritsar-143005, Punjab, India

**3. NAME AND ADDRESS OF THE INSTITUTION:** Department of Zoology, Guru Nanak Dev University, Amritsar-143005, Punjab, India

**4. UGC APPROVAL LETTER NO. AND DATE:** F. No. 41-184/2012 (SR) dated 12.07.12

**5. DATE OF IMPLEMENTATION :** 01.07.2012

**6. TENURE OF THE PROJECT:** 3 years (extended to 6 months 01.07.2012 to 31.12.2015)

**7. TOTAL GRANT ALLOCATED:** 13,48,756/-

**8. TOTAL GRANT RECEIVED:** Rs.12,66,860/-

**9. FINAL EXPENDITURE:** 12,70,405/-

**10. TITLE OF THE PROJECT:** Evaluation of stress protective properties of 24-epibrassinolide in plants during nematode infection

**11. OBJECTIVES OF THE PROJECT :**

The present investigation was undertaken with the following aims and objectives:

- To observe the development of *Meloidogyne incognita* on resistant and susceptible varieties of tomato plant under the effect of 24-Epibrassinolide.
- To observe the effect of 24-Epibrassinolide on growth and development of resistant and susceptible varieties of tomato during various stages of pathogenesis.
- To observe the effect of 24-Epibrassinolide on antioxidative defense system of both the varieties of host plant during various stages of pathogenesis.
- To study the underlying mechanism on the regulation of some key enzymes by exogenous application of 24-Epibrassinolide and their role in providing defense in plant system during oxidative stress.

- To compare the compatible and incompatible interactions of tomato species with *M. incognita*.

## 12. WHETHER OBJECTIVES WERE ACHIEVED:

Yes, the above mentioned objectives were achieved as follows:

- The developmental parameters of *Meloidogyne incognita* on resistant and susceptible varieties of tomato plant were investigated under the effect of 24-Epibrassinolide.
- Effect of 24-Epibrassinolide was observed on growth and development of resistant and susceptible varieties of tomato during various stages of nematode pathogenesis.
- Effect of 24-Epibrassinolide was observed on antioxidative defense system of both the varieties of host plant during various stages of pathogenesis.
- The role of some key enzymes in providing defense in plant system during oxidative stress was studied under the effect of 24-Epibrassinolide.
- Compatible and incompatible interactions of tomato species were compared with *M. incognita*.
- Results were presented in International and National Conferences/Symposias
- Results have been accepted in International Journals

## 13. ACHIEVEMENTS FROM THE PROJECT:

The results of the present studies were compiled and published in International journals. These were also presented in various national and international conferences/symposiums/seminars. Following are outcome of the present study:

Jasrotia, S. and Ohri, P. (2017). Epibrassinolide regulated mitigation of stress in *Meloidogyne incognita* (Kofoid and White, 1919) infected *Lycopersicon esculentum* Mill. (syn. *Solanum lycopersicon*) grown under in-vitro conditions. *In Vitro Cellular & Developmental Biology – Plant* (accepted).

Jasrotia, S. and Ohri, P. (2017). Epibrassinolide regulated mitigation of stress in *Meloidogyne incognita* (Kofoid and White, 1919) infected *Lycopersicon esculentum* Mill. (syn. *Solanum lycopersicon*) grown under in-vitro conditions. *Indian Journal of Nematology* (accepted).

Jasrotia, S. and Ohri, P. (2016). Effect of 24-Epibrassinolide on Antioxidative enzymes of tomato plants during *Meloidogyne incognita* infection. In: International Conference on Environmental Mutagenesis, Carcinogenesis and Health” Department of Botanical & Environmental Sciences, Guru Nanak Dev University, Amritsar, 17-19<sup>th</sup> February, pp.110.

Jasrotia, S. and Ohri, P. (2015). 24-epibrassinolide regulated morphological and biochemical changes in tomato during biotic stress conditions. In: “National Symposium on Nematode Management: A Challenge to Indian Agriculture in the Changing Climate”, YASHADA, Pune, 8-10 January, pp61.

- Jasrotia, S. and Ohri, P. (2014). 24-Epibrassinolide regulated morphological changes in tomato during *Meloidogyne incognita* infection. In: International Conference on Technological Interventions in Agricultural Sciences for Enhanced Productivity, Nutritional Quality and Value Addition (TIAS-2014), Central Institute of Horticulture Department of Agriculture and Co-operation, 17-19<sup>th</sup> February, pp 15.
- Jasrotia, S. and Ohri, P. (2014). Morphological and biochemical changes regulated by 24-epibrassinolide in nematode infected tomato cultivar. In: 4<sup>th</sup> International Science Congress, Pacific University, Udaipur, Rajasthan, 8-9<sup>th</sup> December, pp 6.
- Jasrotia, S. and Ohri, P. (2013). *In vitro* effect of 24-epibrassinolide on antioxidative enzymes of tomato plants during *Meloidogyne incognita* infection. In: 6<sup>th</sup> International Congress on Environmental Research, Aurangabad, Maharashtra, 19-21 December, pp 220.
- Jasrotia, S., Bali, S., Khajuria, A. and Ohri, P. (2013). 24-Epibrassinolide regulated morphological changes in tomato infested with *Meloidogyne incognita*. In: National Symposium on Nematode: A friend and foe of agri-horticultural crops, Dr Y.S. Parmar University of Horticulture & Forestry, Nauni, Solan, 21-23 November, pp68.

#### **14. SUMMARY OF THE FINDINGS:**

Plants produce a wide array of growth regulatory compounds which have broad spectrum effects. Of the varied natural compounds, brassinosteroids (BRs) are one of the key growth hormones found throughout the plant kingdom that regulates many aspects of growth and development, including stem elongation, pollen tube growth, leaf bending and epinasty, fruit development, ethylene biosynthesis, proton pump activity, xylem differentiation, photosynthesis, gene expression etc. In addition to its critical role in plant growth regulation and photomorphogenesis, BRs induces plant resistance to a variety of abiotic stresses such as high and low temperature, drought, salinity and heavy metal. Since plant parasitic nematodes are closely associated to plants for their nutritional requirement, they cause biotic stress to plants. Among the many genera of plant parasitic nematodes (e.g Heterodera, Globodera, Pratylenchus, Tylenchus, etc.) having some economic impact, *Meloidogyne* species are responsible for large amount of damage to agricultural crops. In the present work, 24-epibrassinolide (EBI), which is one of the most potent brassinosteroid, was evaluated for its stress protective properties in tomato varieties during nematode infection. *In vitro* effects of EBI were evaluated on morphological and biochemical parameters of susceptible (Pusa Ruby) and resistant (PNR-7) cultivars of tomato, 1, 3, 5 and 7 days after nematode inoculation. Sterilized seeds of susceptible (Pusa Ruby) and resistant (PNR-7) cultivars of tomato were treated with different concentrations of EBI ( $10^{-11}$ ,  $10^{-9}$  and  $10^{-7}$  M) and then allowed to germinate in controlled conditions. Three replicates were made for each concentration along with two controls -CI (untreated, uninoculated) and CII (untreated, inoculated). Six-seven days old seedlings were then inoculated with second stage juveniles of *M. incognita*. Morphological parameters (i.e. percentage germination of seeds, total plant height, plant biomass and number of galls) as well as alterations in biochemical parameters i.e. changes in the activities of antioxidative enzymes (catalase, ascorbate peroxidase, guaiacol peroxidase, glutathione reductase, glutathione peroxidase and superoxide dismutase) and

changes in the content of non-enzymatic antioxidants (total phenolic content, total flavonoid content, ascorbic acid content and total glutathione content) were evaluated at different time intervals (1, 3, 5, 7 days) of nematode infection in both the cultivars.

Results obtained ascertained that in case of Pusa Ruby overall decrease was observed in the plant growth parameters with nematode inoculation. However, EBI application helped the tomato plants in regaining the growth parameters. Similar trend was seen in PNR-7 but seedlings showed better growth as compared to Pusa Ruby seedlings. In addition, when nematode gall formation was observed in both the cultivars at different time intervals, the gall number in got reduced significantly with increase in EBI concentration. When the biochemical estimations were done for antioxidative enzymes, it was found that in Pusa Ruby, the specific activities of most of the antioxidative enzymes got suppressed in nematode infected plants. However, the specific activities of these enzymes were enhanced after EBI treatment. On the other hand, in PNR-7, specific activities of enzymes got enhanced with nematode inoculation and then further with steroid treatment. In case of non-enzymatic antioxidants, here also in Pusa Ruby, alterations in the total content of antioxidants were observed in nematode infected plants whereas enhanced levels were found in EBI treated plants. In PNR-7, overall content of antioxidants got enhanced with nematode infection which further increased with EBI treatment. When the comparison of all the parameters at all time intervals were made, in Pusa Ruby, most effective time interval was found to be 5 DAI with  $10^{-11}$ M as the effective EBI concentration. In addition, 7DAI was the most effective time interval in PNR-7 with  $10^{-7}$ M as the most effective concentration. Also, when the two cultivars were compared with each other, more prominent results were obtained in the resistant variety.

It was observed that the deleterious effects of nematode infection on growth and development of tomato plants were reduced with brassinosteroid treatment. Moreover, the defence system of plants (both enzymatic and non-enzymatic) was also boosted. It thereby, suggested a pivotal role played by EBI in ameliorating the oxidative stress generated by nematodes in plants. Thus, suggesting a possible role of EBI in lessening the oxidative stress generated during nematode invasion and boosting the resistance capacity of plants.

## **15. CONTRIBUTION TO THE SOCIETY:**

Since plant parasitic nematodes are a menace to Agriculture and cause a great amount of crop loss, there is a need to manage them with eco-friendly strategies. The present studies shows a pivotal role played by 24-Epibrassinolide in lessening the oxidative stress caused by nematodes in tomato plants and boosting their resistance capacity.

## **16. WHETHER ANY PH.D. ENROLLED/PRODUCED OUT OF THE PROJECT:**

Yes, Mr Shivam Jasrotia (Thesis submitted)

## **17. NO. OF PUBLICATIONS OUT OF THE PROJECT :**

**Research Papers: 2 (accepted)**

Jasrotia, S. and Ohri, P. (2017). Epibrassinolide regulated mitigation of stress in *Meloidogyne incognita* (Kofoid and White, 1919) infected *Lycopersicon esculentum* Mill. (syn. *Solanum*

*lycopersicon*) grown under in-vitro conditions. *In Vitro Cellular & Developmental Biology – Plant* (accepted).

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**Abstracts: 6**

Jasrotia, S. and Ohri, P. (2016). Effect of 24-Epibrassinolide on Antioxidative enzymes of tomato plants during *Meloidogyne incognita* infection. In: International Conference on Environmental Mutagenesis, Carcinogenesis and Health” Department of Botanical & Environmental Sciences, Guru Nanak Dev University, Amritsar, 17-19<sup>th</sup> February, pp.110.

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