Biocatalysis and Agricultural Biotechnology 6 (2016) 102–106

Contents lists available at ScienceDirect

Biocatalysis and Agricultural Biotechnology

journal homepage: www.elsevier.com/locate/bab

Effect of chitosan on growth, yield and curcumin content in turmeric under field condition

Sathiyanarayanan Anusuya, Muthukrishnan Sathiyabama *

Department of Plant Science, Bharathidasan University, Tiruchirappalli 620 024, Tamil Nadu, India

ARTICLE INFO

Article history:
Received 18 December 2015
Received in revised form
22 February 2016
Accepted 4 March 2016
Available online 7 March 2016

Keywords:
Chitosan
Curcumin
Turmeric
Defense response
Plant growth
Rhizome rot

ABSTRACT

Field experiments were conducted at the experimental field in Erode, TamilNadu to investigate the effect of foliar application of chitosan (a growth promoter) on growth, yield attributes and curcumin content of turmeric (Erode local). The chitosan (0.1%, w/v) was sprayed at a regular interval of 30 days up to 210 days. Results revealed that the growth parameters (shoot height, leaf number/plant, plant fresh weight) were increased with application of chitosan. Foliar application of chitosan induced the activity levels of defense enzymes such as protease inhibitors (PI), β-1,3 glucanases, peroxidases (PO) and polyphenol oxidases (PPO) in the leaves and rhizomes of turmeric plants. Chitosan treatment to turmeric plants results in high yield and curcumin content. The results suggest that chitosan can be used as an eco-friendly compound to induce defense responses as well as the growth and curcumin content of turmeric plants.

1. Introduction

Turmeric (*Curcuma longa* L.) is an important common flavoring spice of daily use. A recent report indicates that, the export and demand of Indian turmeric have increased due to increased food as well as non-food uses (Ray et al., 2016). Turmeric contains the main active constituent curcumin has a wide range of biological activities including antioxidant, anti-inflammatory, antimutagenic, anti-carcinogenic and anti-angiogenic properties (Kunnumakkara et al., 2007; Li et al., 2009). The use of turmeric and its value added products is recognized globally and hence the production has to be increased to meet the requirements. However, its cultivation is affected by several fungal diseases. Among the fungal diseases, rhizome rot causes a severe yield reduction and reduce the quality (Rathaiah, 1980). Therefore, finding the effective method to solve this problem should be considerably focused.

Chitosan, a biopolymer, has been reported to stimulate the immune system involved in plant resistance to pathogen infection (Pichyangkura and Chadchawan, 2015). In addition, chitosan has been widely used to stimulate growth, germination and enhance yield in many crop species such as in orchid (Nge et al., 2006), faba bean (El-sawy et al., 2010), cucumber (Sheheta et al., 2012) and corn (Boonlertnirun et al., 2011; Lizárraga-Paulín et al., 2011). Faoro et al. (2008) showed that the chitosan applied as a foliar spray on barley reduced locally and systemically the infection by powdery mildew pathogen *Blumeria graminis* f. sp. *hordei*. Considering the above facts, the present research work was undertaken to evaluate the foliar application of chitosan on growth, curcumin content and in control of rot disease in turmeric plants under field condition.

2. Materials and methods

2.1. Biological material and experimental design

The field experiment was conducted in the Oonjalur village of Erode District, Tamil Nadu, where the cultivation of turmeric is highly practiced. The widely cultivated turmeric cultivar Erode local (*Curcuma longa*) was used as test crop. The experimental field was prepared properly with ploughing and laddering. The trials were laid out in a randomized block design (RBD) with net plot size of 4 × 2 m. Rhizomes (each rhizome with 3 nodes) of cultivar Erode local were planted on row ridges (4 m long; 25 plants/row) spaced 40–60 cm apart and 15 cm between plants for all the treatments at the same time. Each treatment consisted of 3 replications in the field experiment. Turmeric plants (30 day old) were sprayed with chitosan (0.1%, w/v) at regular interval of 30 days up to 210 days (6 ml/plant) and water sprayed plants served as control. Rhizomes treated with mancozeb (0.3%) for 30 min at the time of sowing and spraying of tilt 25 EC (propiconazole, 0.1%)

* Corresponding author.
E-mail address: sathiyabamam@yahoo.com (M. Sathiyabama).

http://dx.doi.org/10.1016/j.bcab.2016.03.002
1878-8181/

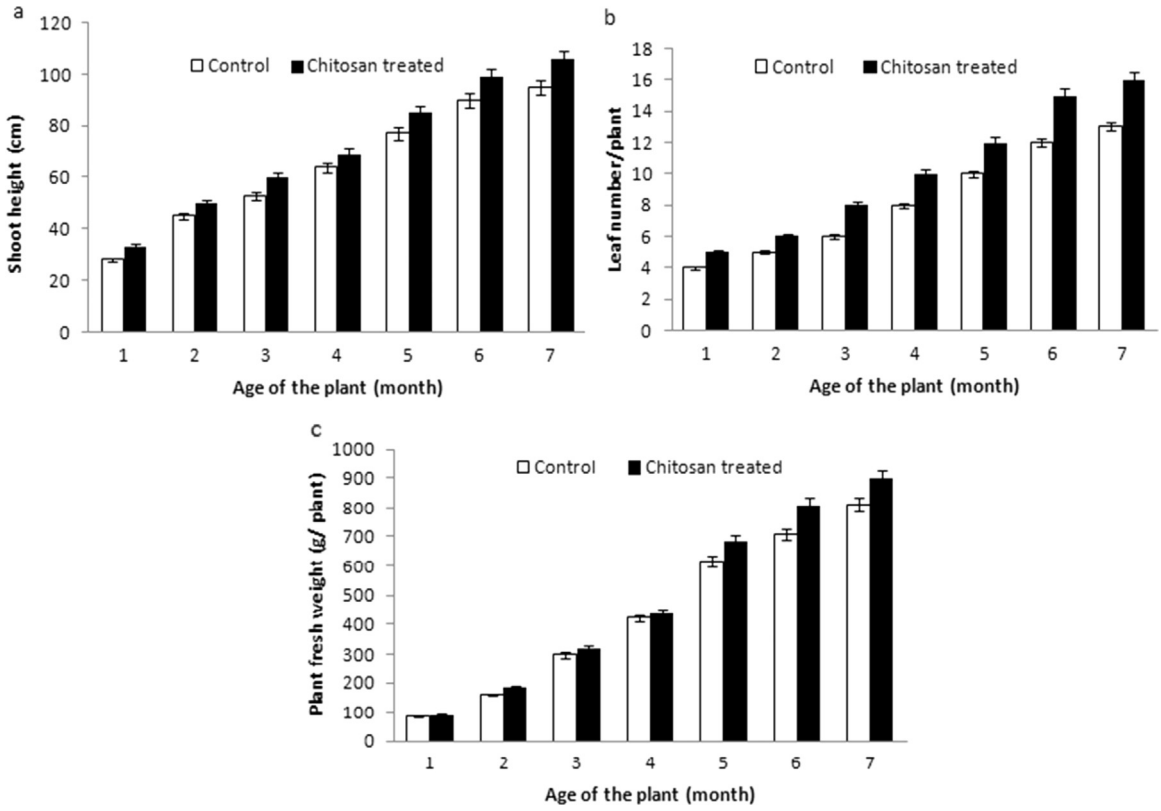

Fig. 1. Shoot height (a), leaf number/plant (b) and plant fresh weight (c) of turmeric plants treated with chitosan under field condition. Data represent Mean ± Standard Error.

along with Dithane M-45 75 WP (0.25%) thrice at 20 days interval served as fungicide treated. Plants were irrigated at regular intervals. The leaves were removed after 210 days and the rhizomes were left for another 30 days to harvest.

2.2. Effect of chitosan on plant growth

Growth parameters such as leaf number, shoot height, plant fresh weight in control and treated plants were monitored at different age levels up to 215 days.

2.3. Protein extraction, estimation and enzyme activities

Leaves and rhizomes were collected from control and GNP treated turmeric plants at regular intervals. They (1 g /2 ml) were homogenized with potassium phosphate buffer (0.02 M, pH 7.6) and centrifuged at 10,000*G* for 10 min at 4° C. The clear supernatant was used as a source of protein, enzymes. The protein concentration of the supernatant was estimated by Bradford's method (1976) using BSA fraction V (Sigma Chem. Co., USA) as a standard.

β-1,3 glucanase, Peroxidase (PO), Polyphenol Oxidase (PPO) and Protease inhibitor (PI) activity were assayed as described previously (Anusuya and Sathiyabama, 2015).

2.4. Effect of chitosan on rhizome yield and curcumin content

Rhizome yield was determined at the time of harvest. The average fresh and dry weight of rhizome per plant was expressed in terms of gram. The yield increase percentage was calculated using the following formula; Yield increase (%)=[treatment yield − control yield]/ control yield × 100 (Tariq et al., 2010).

For curcumin analysis, rhizomes (1 g/10 ml) were extracted with methanol at 60° C for seven hours in a Soxhlet apparatus and dried using a rotary evaporator (Yamato RE 601). 1 mg of extracted sample was mixed with methanol and OD was taken at 425 nm using curcumin (Sigma Chem Co., USA) as a standard (Chauhan et al., 1999). Curcumin content of control and treated plants were expressed as milligram per plant.

2.5. Disease incidence

Turmeric plants (control, chitosan treated, fungicide treated) showing typical symptoms of rotting under field conditions were assessed at the time of harvest. Disease incidence was determined on the basis of disease score, an estimate of the area decayed using a five-class scale (Campbell and Madden, 1990) as follows: 0=No disease (none affected); 1=Slight rot or discoloration (less than 30% affected tissue); 2=Moderate rot or discoloration (30–70% affected tissue); 3=Severe rot or discoloration (more than 70% affected tissue); 4=Complete rot. The percentage of disease incidence was calculated as described by Guo et al. (2004). Rot incidence=([Scale × Number of plants infected]/[Highest scale × Total number of plants]) × 100.

2.6. Statistical analysis

All the data were subjected to one-way analysis of variance to determine the significance of individual differences in $p < 0.01$ and 0.05 levels. All statistical analysis was conducted using SPSS 16 software support.

3. Results and discussion

Foliar application of chitosan to turmeric plants increased the number of leaves/plant, shoot height and plant fresh weight when