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Magnetically treated water irrigation effect on turnip seed germination, seedling growth and enzymatic activities

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ABSTRACT

Pre-sowing magnetic field seed treatment effects on biological characteristics of vegetables and crops have been studied well. However, studies reporting irrigation with magnetically treated water are scanty. Therefore, the effect of irrigation with magnetically treated water on turnip seed germination, seedling growth and enzymatic activities was evaluated. The tap water was treated at 211 mT for 30, 45 and 60 min and used for irrigation of turnip seed and seedlings. Uniform and healthy turnip seed was sown under randomized complete block design (RCBD). The germination, emergence rate index, vigor index I and vigor index II increased up to 28.33%, 11.54%, 57.59% and 32.26%, respectively. The growth parameters such as seedling lengths, fresh & dry weights, chlorophyll content were also enhanced in response of irrigation with magnetically treated water. The seedlings irrigated with magnetically treated water showed 28.92%, 11.36% and 14.76% higher protein content, alpha amylase and protease activities, respectively vs control. Results revealed that irrigation with magnetically treated water has potential to improve turnip germination, seedling growth and enzymatic activities and this study is also extendable to other vegetables and crops for the improvement of germination and growth.

1. Introduction

In view of negative impact of chemical treatment, the modern agriculturists are in research of technologies, based on eco-friendly physical treatment for enhancing the crops productively and magnetic field pre-sowing seed treatment proved to be attractive in this regard [1–5]. Researchers revealed that magnetic field seed pre-sowing treatment leads to better plant growth and yield than chemical sorts. Besides, this technology is also eco-friendly, non-polluting to the soil and is attractive as being affordable to farmers [6]. Researchers already have studied the effect of magnetic field treatment on vegetables and grain crops germination, seedling lengths,

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fresh & dry weights, chlorophyll contents, enzymatic activities and yields and positive results have been documented [1,7–14] and use of magnetic field pre-sowing seed treatment is suggested since it is affordable, non-polluting to the soil and environment because at present the safety of environmental is also important along with food production [1,6,9,11,12,15–37].

Turnip is a tropical legume root that consists of a light or dark brown periderm and a white, crisp, succulent and sweet-starchy pulp. The dry weight of turnip is composed of 32% soluble sugars, 15% starch and 1.4% protein. In Asian countries, cooked turnip can be served as side dish or in raw, shredded form as a popular ingredient of salad [38]. Turnip is eaten as raw or cooked and is cultivated throughout the world including USA, China, Pakistan, India, Bangladesh, Europe, North Africa and Russia [39]. Previously, the effect of magnetically treated water is reported for celery and snow pea [40], tomato, wheat and pea [41,42]. However, the effect of magnetically treated water irrigation on turnip has not been reported. Therefore, present study was conducted to appraise the effect of magnetically treated water on turnip seed germination, seedling growth and biochemical parameters.

2. Material and methods

2.1. *Magnetic field stimulator*

The magnetic field stimulator used to treat water was consisted of twenty-six permanent magnets (thirteen on each side) having magnetic field strength of 211 mT. A Polyvinyl chloride pipe (87 cm length and 12.7 mm internal diameter) was passed through the magnets. The intensity was measured along longitudinal and cross-sectional directions of pipe using magnetic flux meter ELWF (model No. 85396). The tap water was exposed by passing it through magnetic field device. Water was treated magnetically at three doses and denoted as T_1 (211 mT, 30 min), T_2 (211 mT, 45 min) and T_3 (211 mT, 60 min), whereas T_0 (un-treated water) was used as control. The magnetic field stimulator set up is shown in Fig. 1.

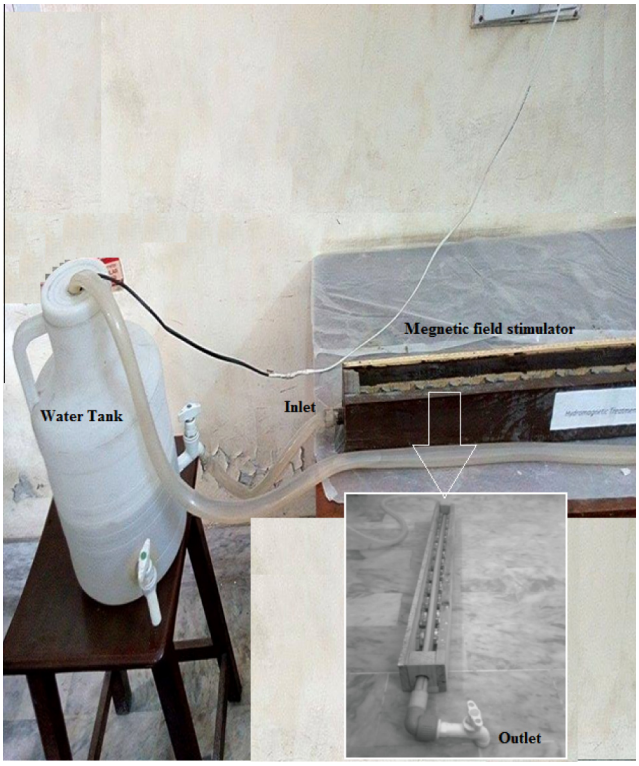

Fig. 1 – Magnetic field stimulator setup for water treatment.

2.2. *Agronomic practice and sowing*

Turnip (*Brassica rapa* L.) seeds were kindly supplied by Institute of Horticulture Sciences, University of Agriculture Faisalabad. For sowing, uniform and healthy seeds were selected by hand picking and seeds with visible defects, insect damage or malformation were discarded. The seeds were soaked in water prior to sowing. For sowing plastic pots (30 × 25 cm) filled in by sand was used and turnip seeds were grown under natural environmental conditions. Before sowing, seeds were sterilized with 0.05% $HgCl_2$ solution (soaked 10 min) and washed with distilled water. Sand was washed with distilled water and dried in open air and then, pots were filled with dry sand. After filling the parts, sand was saturated with Hoagland's nutrient solution (half-strength). The experiment was laid out under CRBD in triplicate including control. Seeds were placed on the sand surface and the pots were filled up with additional sand layer in such a way that seed depth remained in the range of 2–3 cm and pots were placed under natural condition and irrigated with magnetically treated water. The top surface of the sand in the pots was moistened twice a day using a water sprayer. The experiment was performed from January to March, 2015.

2.3. *Determination of water quality parameters*

The pH and dissolve oxygen (DO) of water before and after magnetic field treatment was measured by pH and DO meters (Lovibond Senso Direct 150, Germany). Total dissolve solid (TDS) and total soluble solid (TSS) were measured following already reported methods [30,32]. The microbial population was counted by colony counter (analog and digital spectrophotometers). Sodium Adsorption Ratio (SAR) and Residual Sodium Carbonate (RSC) were determined following reported methods elsewhere [43].

2.4. *Response measurement*

Association of official seed analysis rule [44] was followed for germination measurement. The germinated seeds were counted daily till germination ceased and seedlings (cotyledons visible at the sand surface) were considered germinated. Germination percentage was estimated using Eq. (1) [45]. The vigor indices I and II were calculated using relations shown in Eqs. (2), (3) [13]. Where, TSL and TSDW are presenting total seedling length and total seedling dry weight (root + shoot), respectively.