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Original Article

Response of some varieties of canola plant (*Brassica napus* L.) cultivated in a newly reclaimed desert to plant growth promoting rhizobacteria and mineral nitrogen fertilizer

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Abstract A field experiment was conducted on a sandy loam soil (newly reclaimed desert), during two successive seasons, to evaluate the effect of plant growth promoting rhizobacteria (PGPR), *i.e. Azotobacter chroococcum, Azospirillum brasilense* and *Paenibacillus polymyxa* were added with 30 kg N per fadden (as NH_4NO_3) in comparison with 30 or 60 kg N only, on yield and its components of canola plants, as well as on the microbial activities in soil, namely CO_2 evolution and dehydrogenase activity. A number of canola varieties were tested, i.e. Sedo, Duplo, Serw-4, Pactol and Drakkar.

The obtained results showed that the variety Serw-4 was the best as it recorded the highest values, for most of the studied parameters, i.e. the obtained values of seed yield/plant and seed yield/hectare were (53.11 g and 3034.57 kg) and (56.20 g and 3211.28 kg), in both cultivation seasons, respectively. Results also, indicated that application of PGPR significantly increased both measures of seed yield. However, plant inoculation with *Azospirillum brasilense* + 30 kg N/fed. (T2) showed the highest increases of both seed yield/plant and seed yield/hectare (37.85 g and 2147.05 kg) and (37.92 g and 2235.33 kg), in both seasons, respectively, as compared with the other bacterial agents or the un-inoculated plants that amended with 30 kg N/fed. However, the highest values obtained with 60 kg N/fed., for seed yield/pant and seed yield/hectare, were (50.96 g and 2934.73 kg) and (50.52 fcsw and 2886.77 kg), in both seasons respectively. Addition of any of the PGPR significantly improved microbial activities in the rhizosphere soil of canola plants, represented by dehydrogenase activity and CO_2 evolution. The results gained showed that the Serw-4 variety with 60 kg N/fed. scored the highest values among the other tested varieties, i.e. (73.70 g and 4211.24 kg) and

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(76.33 g and 4361.70 kg), in both seasons, respectively. Response of the other examined varieties to the experimental treatments revealed the order: Serw4 > Duplo > Sedo > Drakkar > Pactol.

1. Introduction

Beneficial plant–microbe interactions in the rhizosphere are determinants of plant health and soil fertility (Jeffreys et al., 2003). In the era of sustainable agricultural production, the interactions in the rhizosphere play a pivotal role in transformation, mobilization, solubilization, etc. from a limited nutrient pool in the soil and subsequent uptake of essential plant nutrients by the crop plants to realize full genetic potential of the crop. Soil microorganisms are very important in the biogeochemical cycles of both inorganic and organic nutrients in the soil and in the maintenance of soil health and quality (Jeffreys et al., 2003). Thus, the need of the hour is to enhance the efficiency of the meager amount of external inputs by employing the best combinations of beneficial microbes for sustainable agricultural production. Soil–plant–microbe interactions are complex and there are many ways in which the outcome can influence the plant health and productivity (Kennedy et al., 2004). Plant growth promoting rhizobacteria (PGPR) comprise a diverse group of rhizosphere-colonizing bacteria and diazotrophic microorganisms, when grown in association with a plant, stimulate growth of the host. PGPR can affect plant growth and development indirectly or directly (Glick, 1995; Vessey, 2003). In indirect promotion, the bacteria decrease or eliminate certain deleterious effects of a pathogenic organism through various mechanisms, including induction of host resistance to the pathogen (Van Loon and Glick, 2004; Van Loon, 2007). In direct promotion, the bacteria may provide the host plant with synthesized compounds, facilitate uptake of nutrients; fix atmospheric nitrogen; solubilize minerals such as phosphorus; produce siderophores, which solubilize and sequester iron, synthesize phytohormones, including auxin, cytokinins, and gibberellins, which enhance various stages of plant growth, or synthesize enzymes that modulate plant growth and development (Lucy et al., 2004; Gray and Smith, 2005).

Canola plants (*Brassica napus* L.) is an important oil crop that ranks only behind soybean and palm oil in global production (Francois, 1994). Once considered a specialty for Canada, it is now a global crop. Many other countries including the United States, Australia and those in Europe also grow canola. However, Canada and the United States account for most of the global production. In Egypt canola has a bright future to contribute in reducing oil deficiency gap between production and consumption of edible oil. Growing canola oil crop in less fertile and/or salt affected soils may become successful if it could produce a relatively high economic yield with low level of inputs mainly nitrogen fertilizer.

The present study aims at declaring the influence of using PGPR, i.e. *Azotobacter chroococcum*, *Azospirillum brasilense*, and *Paenibacillus polymyxa* on growth, yield and some yield components of some varieties of canola, as well as the overall microbial activities in soil, represented by CO_2 evolution rate (soil respiration) and dehydrogenase activity under the conditions of newly reclaimed desert in Egypt.

2. Materials and methods

2.1. Microorganisms (PGPR) used

Cultures of each of *Azotobacter chroococcum*, *Azospirillum brasilense*, and *Paenibacillus polymyxa* were kindly obtained from the Biofertilizers Production Unit, Agric. Microbiology Dept., Soils, Water and Environ. Res. Inst.(SWERI) Agric. Res. Center (ARC), Giza, Egypt.

2.2. Preparation of bacterial inocula

Each of the bacterial agents, mentioned above, was pre-cultured on the recommended media (Hegazi and Niemeia, 1979; Dobereiner, 1978; Dowson, 1957, respectively). The bacterial strains were grown in nutrient broth liquid media for 2 days at 30 °C. Cultures were then centrfugated at 1000 rpm for 30 min. at 10 °C. The sediment was re-suspended in 5 ml sterilized 0.8% KCl (w/v). Each bacterial suspension was again shacked for 5 min. These materials were considered as inocula.

2.3. Agricultural practices

A field experiment was carried out during two successive seasons of 2008/2009 and 2009/2010 on a newly reclaimed desert, at the farm of the Environmental Studies and Research Institute, Minufiya University, Sadat City, Minufiya Governorate, Egypt, to evaluate the effect of inoculation with the above mentioned PGPR plus a half dose of nitrogen fertilizer on growth of some canola varieties (*Brassica napus* L.). Ammonium nitrate (33.5%N) was added as recommended at a rate of 60 kg N/fed. (full dose) and considered as a control. Experimental treatments were divided into three portions, i.e. 20% and 40% after 30 days from sowing, and the third was 40% added at the flowering stage, for the full N doses, whereas the others received half N dose in combination with PGPR. The experimental area was fertilized with super phosphate (15.5% P_2O_5) at a rate of 100 kg/fed. and potassium sulfate (48% K_2O) at a rate of 50 kg/fed., directly before sowing. Randomized complete blocks design, spilt–spilt plots with three replicates, was undertaken where the varieties lay out in the mean plots and the treatments in the sub plots (9 m^2). Ordinary agricultural practices and drip irrigation were applied.

Initial analyses, for some physical and chemical properties of the experimental soil, were performed and data are presented in Table 1. Analytical procedures were those recommended by (Cottenie et al., 1982). The experimental soil was sandy loam with above neutral reaction.

The treatments applied were concisely as follows:

1. Inoculation with *Azotobacter chrococcum* + 30 kg N/fed. (T1).
2. Inoculation with *Azospirillum brasilense* + 30 kg N/fed. (T2).