IMPACTS OF *AZOTOBACTER* AND PHOSPHATE SOLUBILIZING FUNGI ON *CAPSICUM ANNUUM* GROWTH AND YIELD

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Abstract

Biofertilizers are microorganisms that come from the soil's rhizosphere or root nodules. They enrich the soil by increasing the crop's access to nutrients and they decrease the use of chemical fertilizers, which protects the environment. The two main plant nutrients known as the master essential elements in crop production are nitrogen and phosphorus. Beneficial microbes that can fix atmospheric nitrogen or solubilize phosphorus in the soil are some of the beneficial microbes utilized in biofertilizers. Other beneficial microbes include N_2 fixing bacteria. In the current investigation, the rhizosphere of chilies in Anand District yielded fifteen *Azotobacter* isolates and five phosphate solubilizing fungal (PSF) isolates. All isolates were recognized using morphological, cultural, microscopic, and several biochemical assays. The results of yield parameters revealed that the treatment, 100% RDF + commercial *Azotobacter* + commercial PSF, showed the highest number of fruits (41.67/ plant), number of flowers (55.67 / plant), length of fruit (9.60 cm) and green Chili yield (25.23 t/ ha) was on par with treatment, 100% RDF + Efficient *Azotobacter* + Efficient PSF i.e., number of flowers (52.87 / plant), number of fruits (39.00 / plant), length of fruit (8.80 cm) and green chili yield (21.69 t/ ha). Whereas, highest dry matter weight (102.21 g), available N (178.75 Kg/ha), P (22.03 Kg/ha) and K (187.22 Kg/ha) was showed by treatment, 100% RDF + commercial *Azotobacter* + commercial PSF which was on par with treatment, 100% RDF + Efficient *Azotobacter* + Efficient PSF i.e., dry matter weight (98.00 g), available N (176.66 Kg/ha), P (21.59 Kg/ha) and K (186.40 Kg/ha) in soil after harvest.

Key words: *Azotobacter*, biofertilizer, microorganisms, nitrogen, phosphorus, rhizosphere soil, PSF, PDA, N-agar, Ashby's Nitrogen free selective media.

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INTRODUCTION

Biofertilizers are Microbs that come from the rhizosphere or the root nodules of plants. They enrich the soil by making nutrients more available to crops and by lowering the use of chemical fertilizers, which protects the environment (Patel & Shaikh, 2021). By providing more fundamental nutrients (nitrogen and phosphorus) available to the host plant, biofertilizer—which contains living microorganisms promotes growth. Additionally, biofertilizer supplies the nutrients that plants need and works with soil's natural microorganisms to improve soil quality (Vessey, 2003). N_2 fixing bacteria, phosphate-solubilizing microbes, and *Mycorrhizae*, which may fix atmospheric nitrogen or solubilize phosphorus in the soil, are some of the advantageous microbes employed in biofertilizers (Subba, 1999). In agricultural practices, the use of microorganisms as biofertilizers is widespread (Hindersah, 2017). The biofertilizers are beneficial microorganisms that are alive or contain latent cells that increase the availability of nutrients to plants. *Rhizobium, Azotobacters, Azospirillum, Cyanobacteria, Phosphobacteria, Aspergillus, Penicillium*, and *Mycorrhiza* are the helpful microorganisms. *Azotobacters* and phosphate fungi are among those that play a significant role in the provision of nutrients and in activities that promote plant growth. As biofertilizers, they were intentionally multiplied and added to agricultural soils (Elekhtyar, 2022).

A lot of studies there on the use of biofertilizers in agricultural practices. The two main plant nutrients that are considered to be the "master key" to crop output are nitrogen and phosphorus (Osorio & Habte, 2001). A common vegetable and global spice crop, the chili (*Capsicum annuum L.*) is grown extensively in temperate, tropical, and subtropical regions of the world. As a result of its pungency, spicy flavor, alluring aroma, and indispensable status in every kitchen. Rutin, which is widely utilized in pharmaceuticals, is present in large amounts in green chillis (Purseglove, 1997).

One of the most crucial elements in increasing the production of chili is nutrient management. The continuous, indiscriminate, and unbalanced use of chemical fertilizers damages soil and water resources, reduces plant nutrient uptake efficiency, and ultimately decreases production while also polluting the environment (Chung, et al., 2005). Many microorganisms have been used as biofertilizers throughout the past few decades. *Azotobacter* is a soil-found, free-living, aerobic, heterotrophic, nitrogen-fixing, non-symbiotic bacterium that can fix, on average, 20 kg of nitrogen per hectare per year. *Azotobacter* species have been linked to specific plant species (Kass, 1971).

Phytohormones such auxins and other biologically active compounds are also produced by Azotobacter (Ahmad, 2005) (Patel D. &., 2021) which promotes plant growth (Oblisami, 2005) (Rajaee, 2007). Although phosphorus is present in large quantities in soils in both organic and inorganic forms, plants cannot use it. The majority of soil phosphorus about 95–99% is contained in insoluble form; this form is predominant in alkaline soil and cannot be used by plants (Lee, 2005).

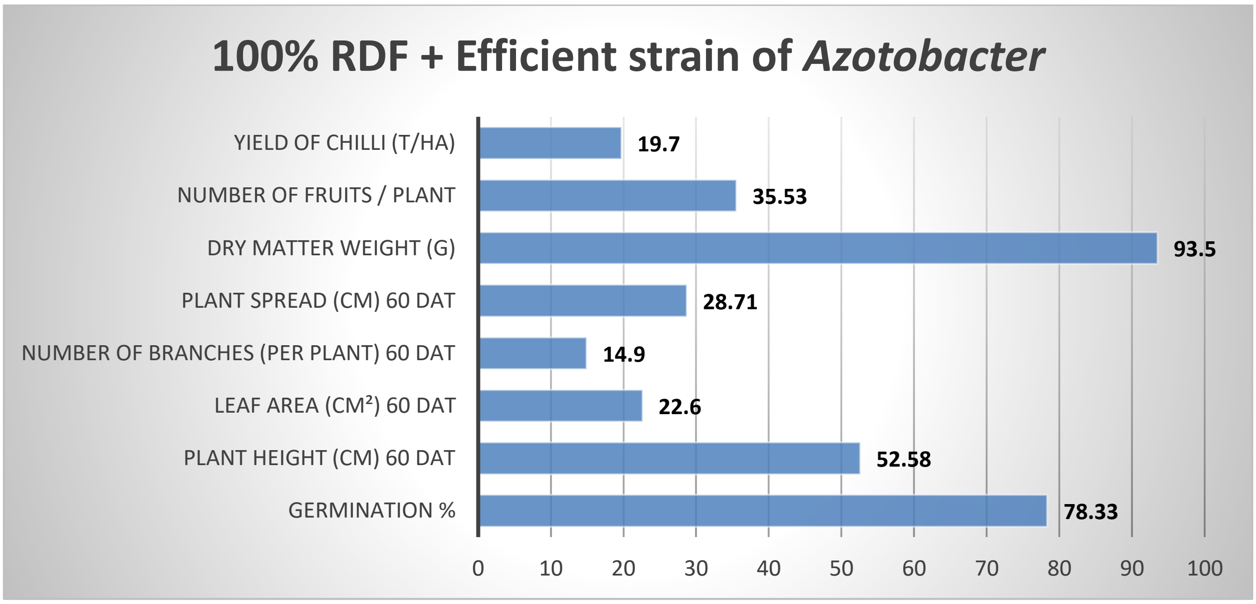
By microbial communities including fungi, bacteria, and others, inorganic phosphorus is frequently dissolved under in vitro conditions (Vahora, 2021). While biofertilizers alone cannot satisfy the crop's nutrient needs, the widespread use of inorganic fertilizers in chili pollutes the environment. As a result, in order to produce chilies of the desired quantity and quality while simultaneously enhancing soil quality, an optimal ratio of chemical and biofertilizer inputs is needed. In considering this, the current study was conducted to determine the effects of *Azotobacter* and phosphate-solubilizing fungi on the growth and yield of chili.

MATERIALS AND METHODS

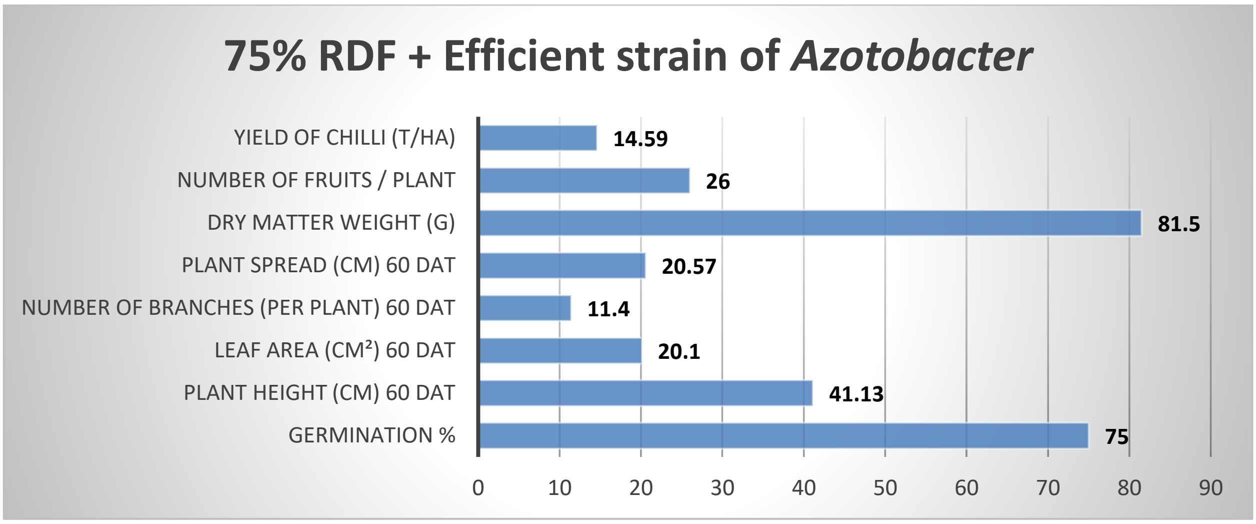
The experiment was undertaken at Department of Microbiology, M B Patel Science College, Anand during the year of 2021-2023. Five PSF isolates and fifteen *Azotobacter* were isolated in the Anand District's chili rhizosphere. The media used in this test were PDA, N-agar, Ashby's Nitrogen free selective media. On the basis of cultural (colony colour, shape, structure, margin, elevation, size), microscopic observations, morphological (Gramme staining, cell shape, cell arrangement, stain colour, motility test, KOH test), and various biochemical tests, including the methyl red test, starch hydrolysis, catalase test, starch hydrolysis, gelatine hydrolase, gas production, H_2S production, N fixing, and P solubilizing ability, oxidase test, respectively. We had carried out the research on the species of *Azotobacter* 2 and Phosphate Solubilizing Fungal 2. With three replications and eleven treatments, the experiment was set up using a randomized block design (the graphs). On raised beds, Pule Jyoti seeds were sowed, and seedlings were raised. Using the seedling root dip method, the roots of healthy chili seedlings were treated in talcum-based fungal inoculums for 30 minutes. Following that, seedlings were given a treatment of isolate-based lignite-based *Azotobacter* inoculums for 30 minutes. The seedlings were raised in raised beds in the field before being moved to a field that had been treated with culture using the root dip method. Plants were transplanted into their appropriate plots in accordance with the layout plan. Statistics are used to record and assess data.

RESULTS AND CONCLUSION

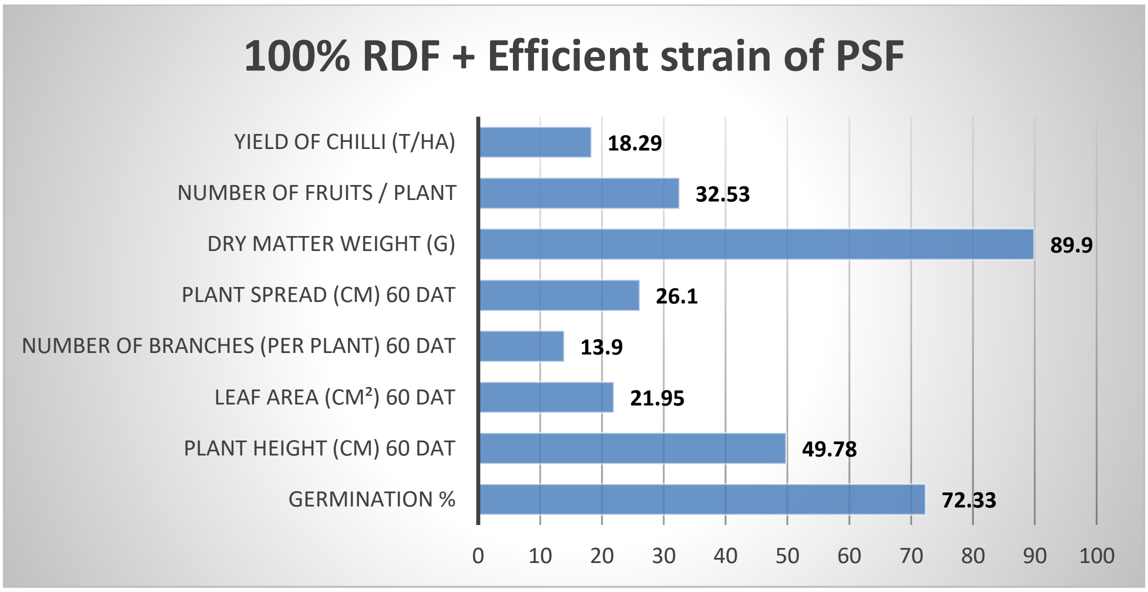
The findings of the experiment indicated a number of characteristics about growth, yield-attributing factors, and chili yield. The data in the graphs showed that when seedlings were treated with *Azotobacter* and phosphate solubilizing fungi in comparison to single inoculation and uninoculated control, seed germination, plant height, leaf area, number of branches, and plant spread were all significantly increased. The treatment 75% RDF + Commercial strain of *Azotobacter* + Commercial strain of PSF (87.33%) and treatment 100% RDF + Commercial *Azotobacter* + Commercial PSF (91%) both demonstrated significant rates of germination. While treatment control with RDF saw the lowest seed germination rate (68.33%). The outcomes are consistent with Sandeep et al.'s (2011) observation that *Azotobacter chroococcum* inoculation increased seed germination in *Amaranthus gangaticus* with maximal length of plumule and radicle when compared to uninoculated control. In pearl millet, brinjal, and tomato seeds at 60 DAT, the treatment consisting of 100% RDF + Commercial *Azotobacter* + Commercial PSF produced the highest plant height (61.38 cm), leaf area (24.82 cm2), number of branches (17.70 / plant), and plant spread (33.97 cm), which was comparable to the treatment consisting of 100% RDF + Efficient *Azotobacter* + Efficient PSF, which produced plant height (56.64 cm), leaf area (23.50 cm2), number of branches (16. Whereas, 100% RDF + commercial *Azotobacter* + commercial PSF treatment yielded the highest dry matter weight (102.21 g). In comparison to the treatment using *Azotobacter* with 80% RDF, the plant height greatly increased in the treatment using *Azotobacter* with 100% RDF. In comparison to the treatment using *Azotobacter* with 80% RDF, the plant height greatly increased in the treatment using *Azotobacter* with 100% RDF. According to (Yadav, Pal, Singh, & Yadav, 2018), *Azotobacter* + PSB with 75%N and RDFYM produced the maximum plant spread (39.14 cm) in Marigold. Rathi et al. (2005) found that 75% N + Full dose of PK with *Azotobacter* and Phosphobacteria produced the largest plant spread (31.47 E-W and 37.47 N-S). (Islam, 2018) found that an increase in nitrogen and phosphorus content resulted in an increase in plant canopy. The results for the yield parameters showed that the 100% RDF + Commercial *Azotobacter* + Commercial PSF treatment had the highest number of fruits (41.67 / plant), and the treatment of 100% RDF + Efficient *Azotobacter* + Efficient PSF had the same number of fruits (39.00 / plant) and green chili yield (21.69 t/ ha). The findings agree with those of the researchers who came after. In contrast to other *Azotobacter* treatments and the control with RDF (71.85), the treatment with 75% N + Full P K with *Azotobacter* showed considerably increased (79) in number of fruits per plant in chili, according to (Khan, 2012).



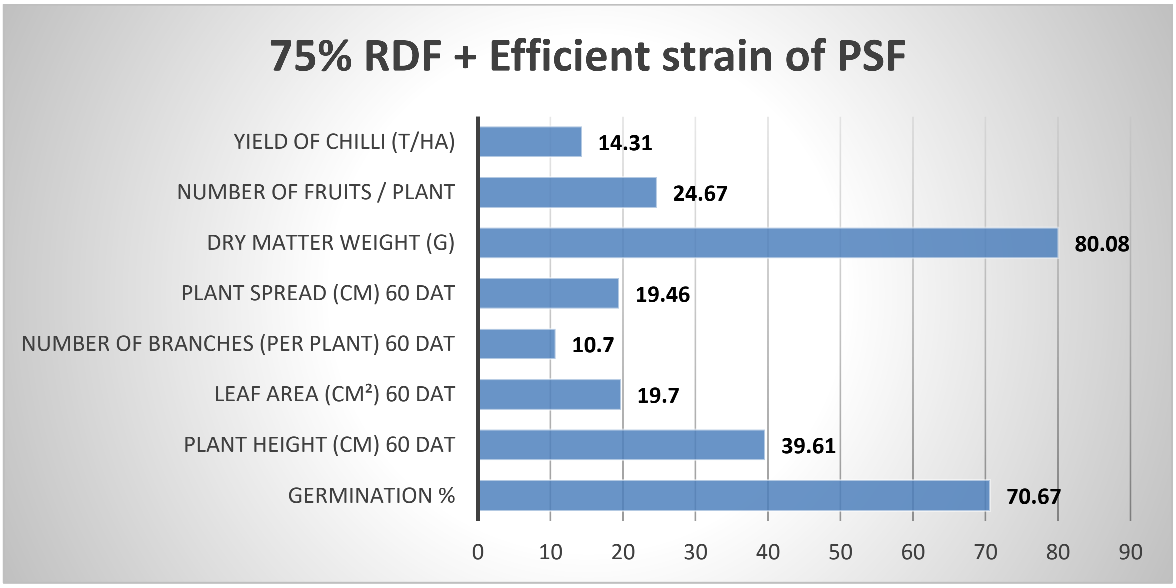
Graph 1 : Effect of 100% RDF & efficient strain of *Azotobacter* on growth parameter of chili



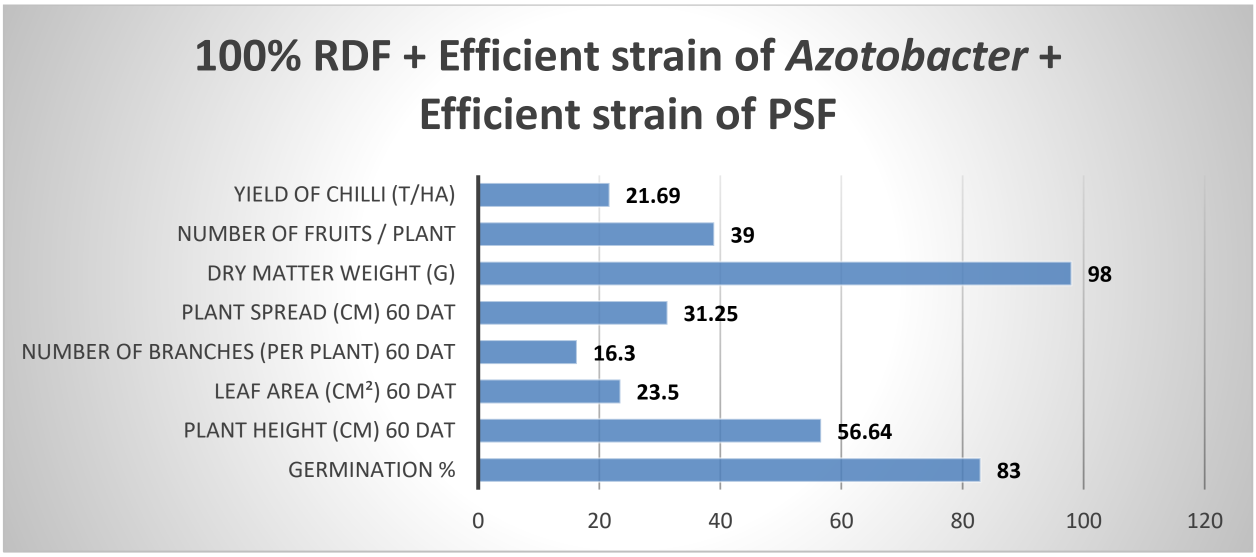
Graph 2 : Effect of 75% RDF & Efficient strain of *Azotobacter* on growth parameter of chili



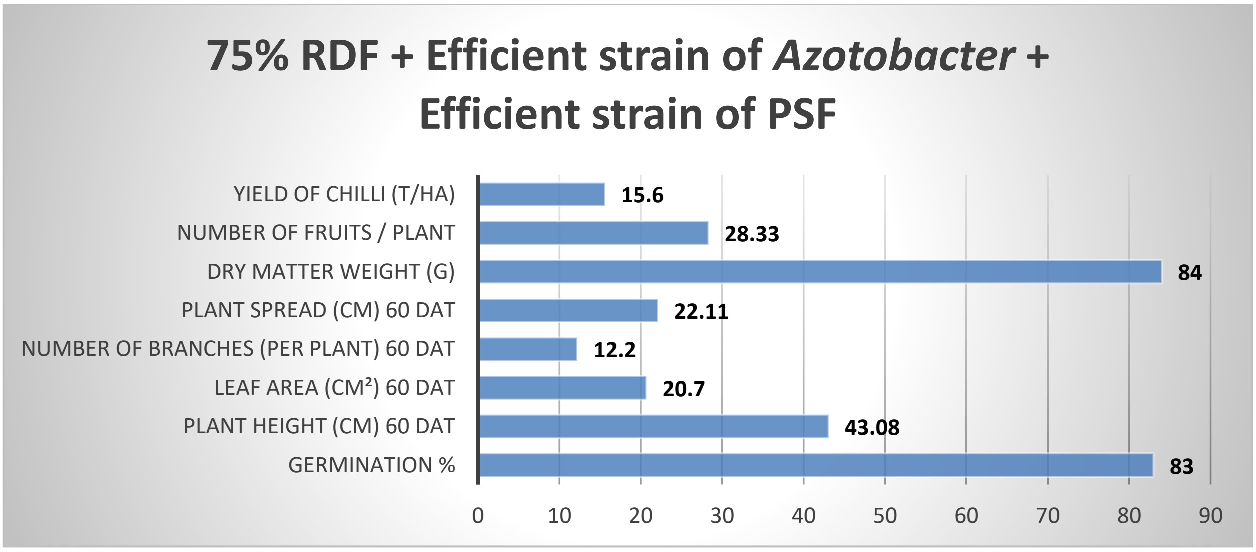
Graph 3 : Effect of 100% RDF & Efficient strain of PSF on growth parameter of chili



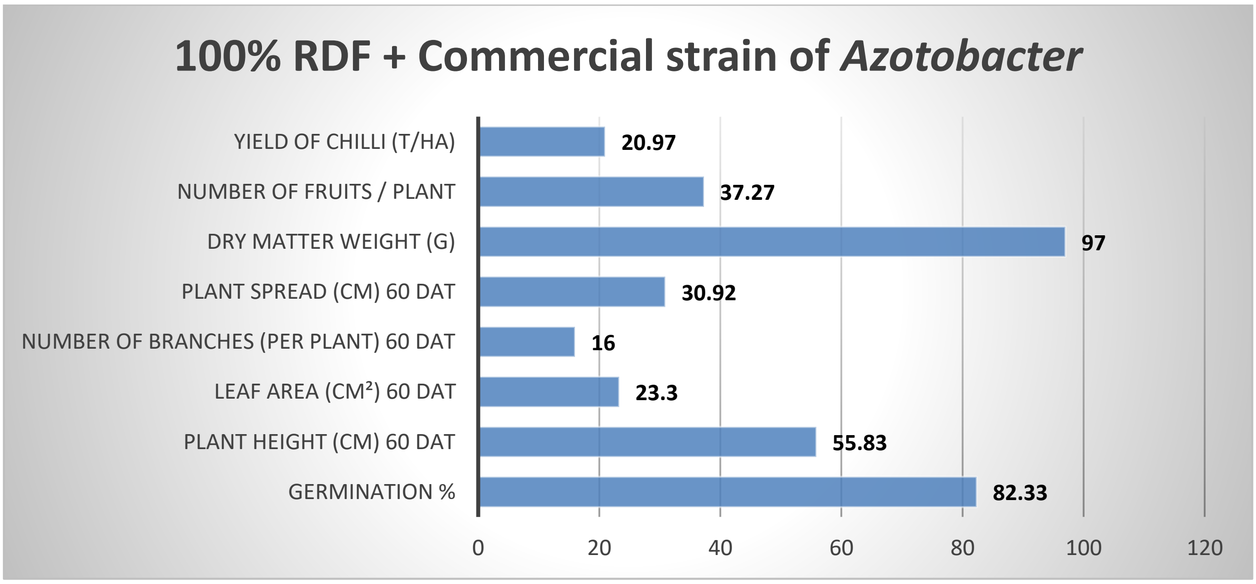
Graph 4 : Effect of 75% RDF & Efficient strain of PSF on growth parameter of chili



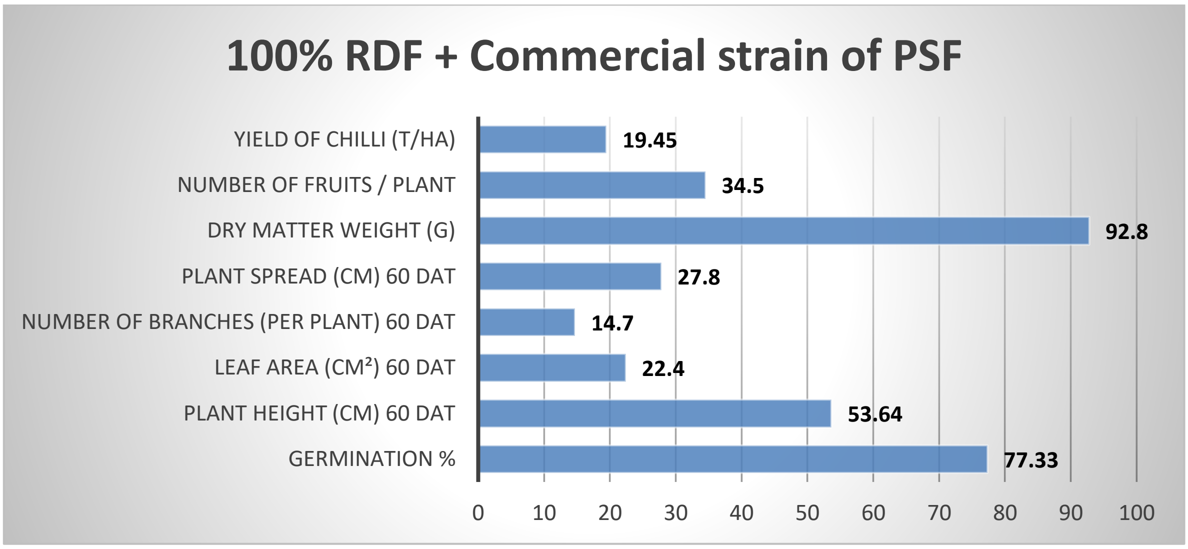
Graph 5 : Effect of 100% RDF + Efficient strain of *Azotobacter* + Efficient strain of PSF on growth parameter of chili



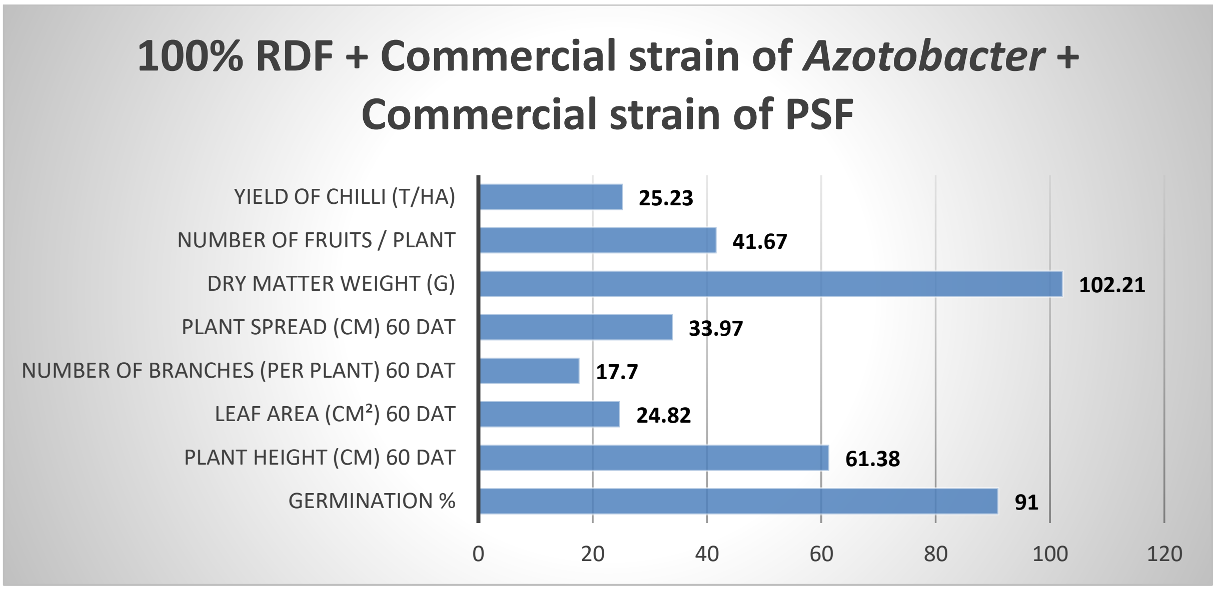
Graph 6 : Effect of 75% RDF, Efficient strain of *Azotobacter* & Efficient strain of PSF on growth parameter of chili



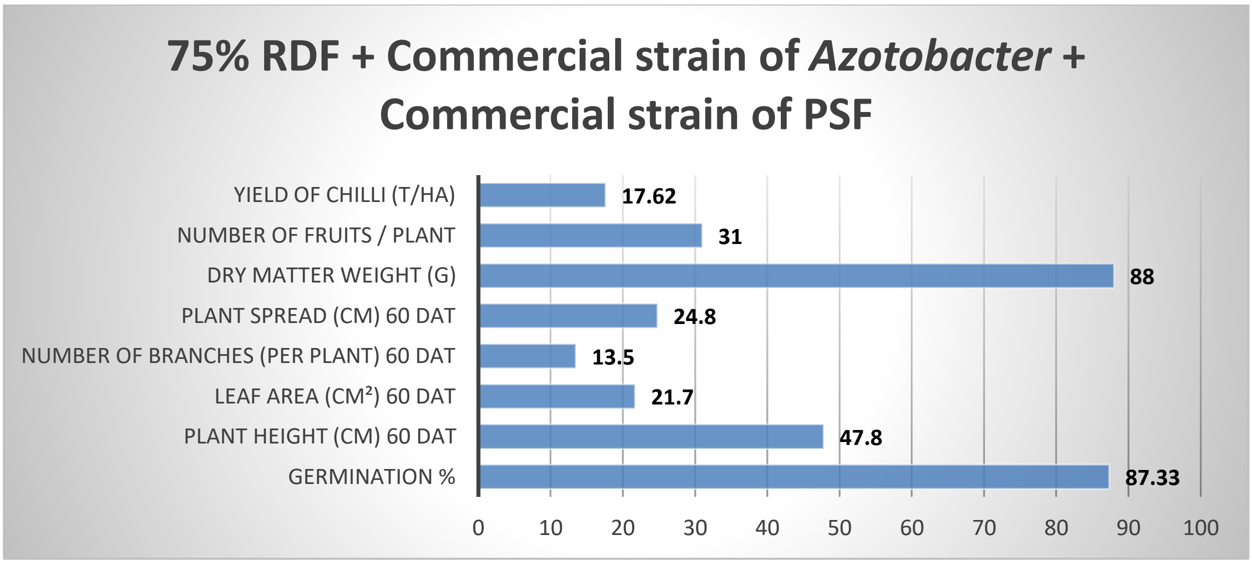
Graph 7 : Effect of 100% RDF & Commercial strain of *Azotobacter* on growth parameter of chili



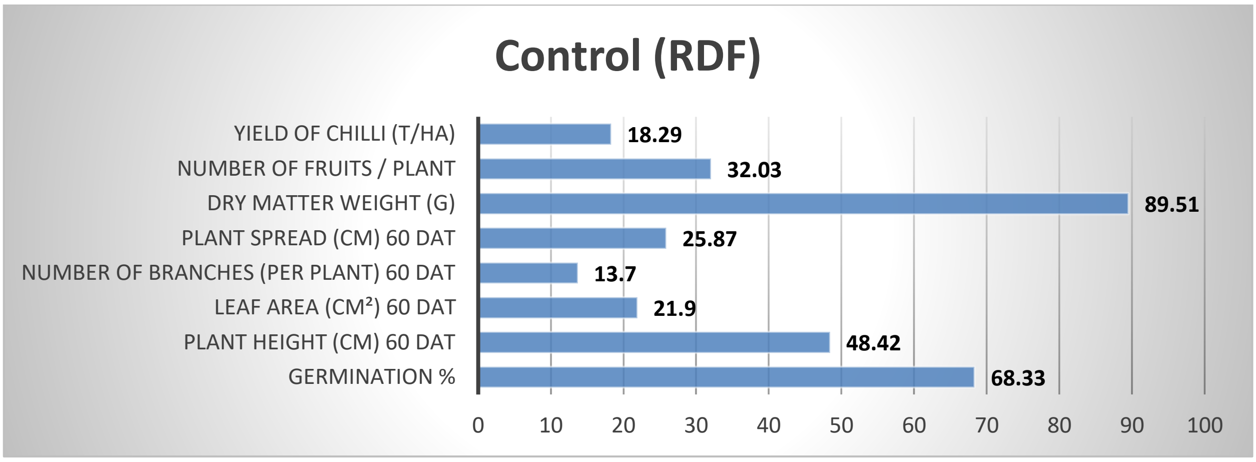
Graph 8 : Effect of 100% RDF & Commercial strain of PSF on growth parameter of chili



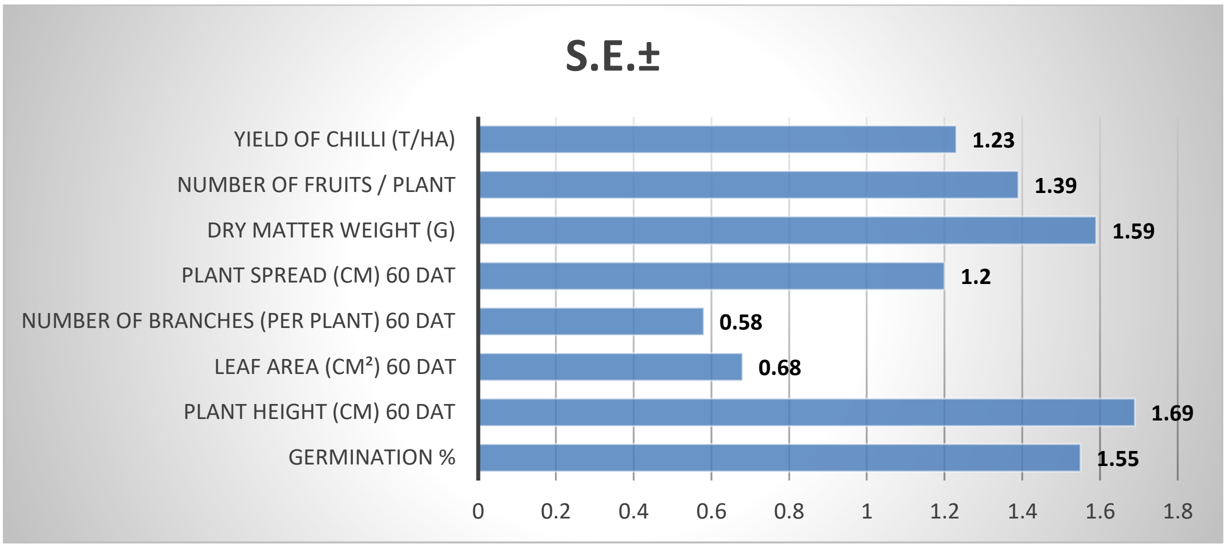
Graph 9 : Effect of 100% RDF, Commercial strain of *Azotobacter* & Commercial strain of PSF on growth parameter of chili



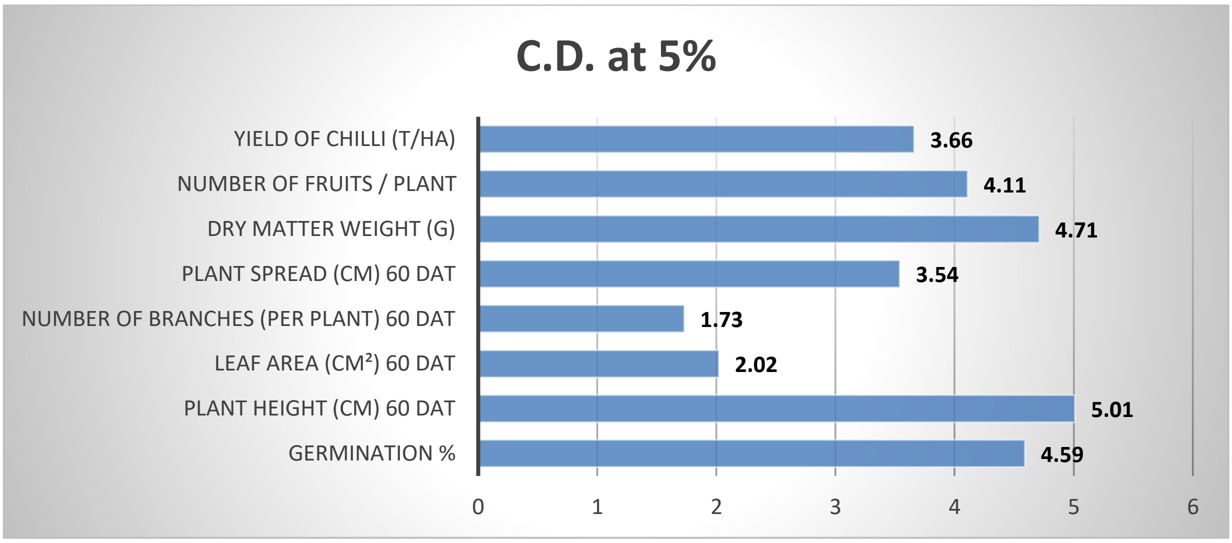
Graph 10 : Effect of 75% RDF, Commercial strain of *Azotobacter* & Commercial strain of PSF on growth parameter of chili



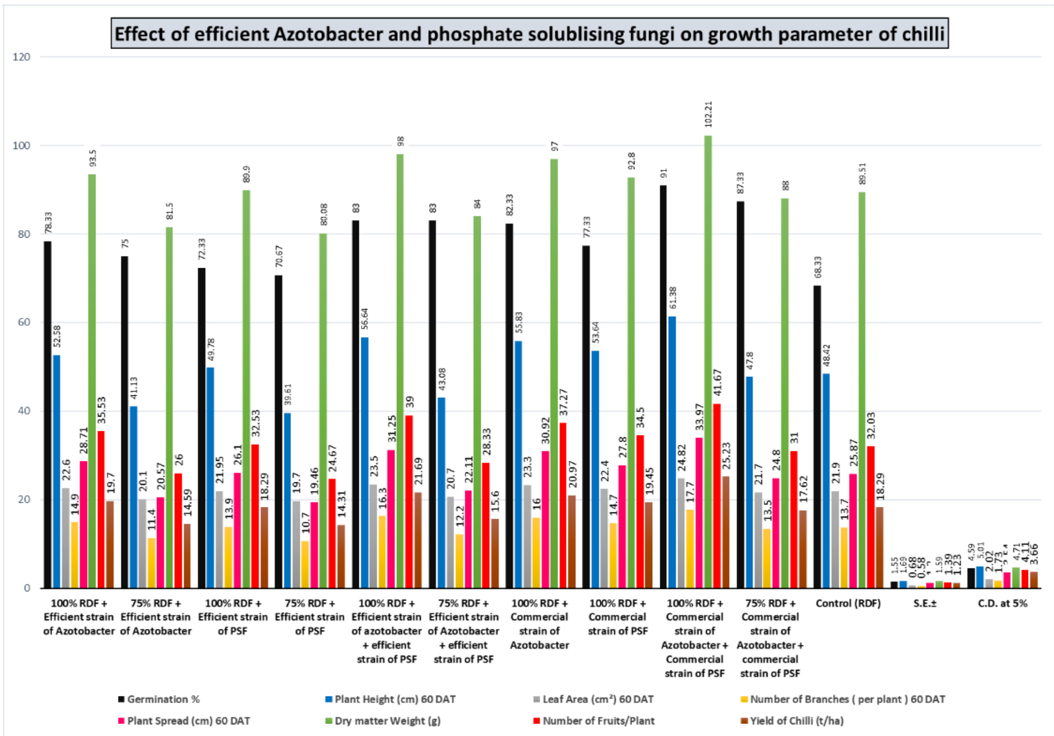
Graph 11 : Control (RDF)



Graph 12 : S.E.±

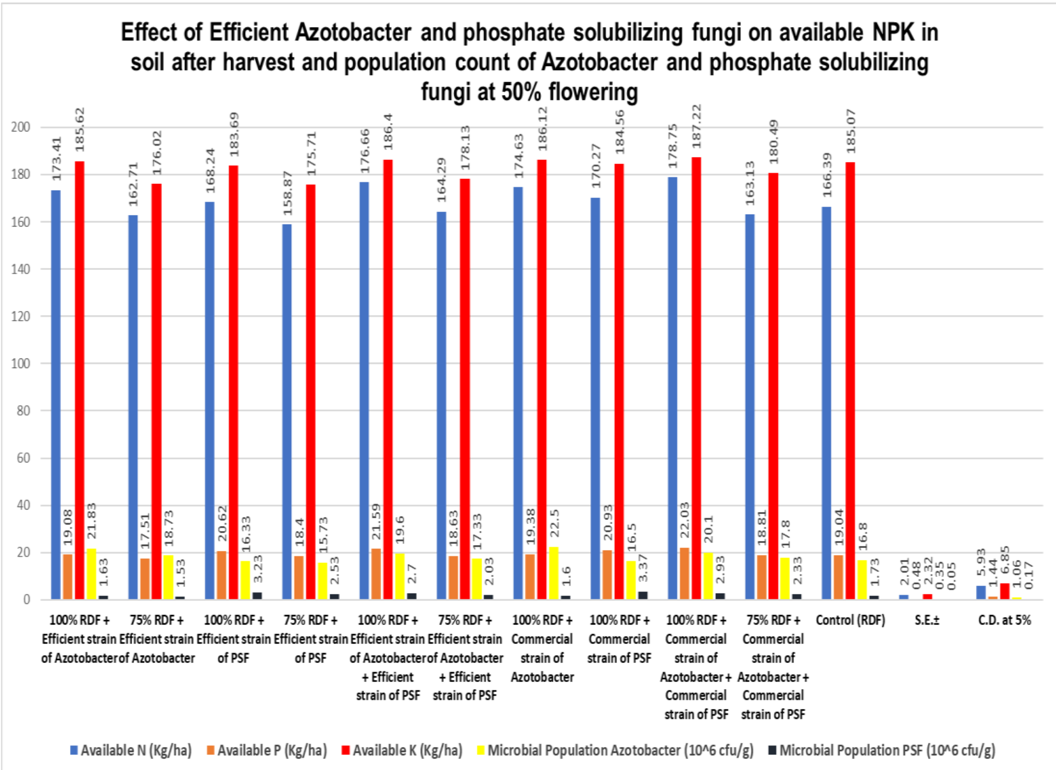


Graph 13 : C.D. at 5%



Graph 14 : Effect of Efficient *Azotobacter* and phosphate solublising fungi on growth parameter of chili

According to a study of the data below in the graph, using *Azotobacter* and PSF greatly increases the amount of accessible N, P, and K when compared to control. The treatment consisting of 100% RDF + commercial *Azotobacter* + commercial PSF demonstrated the highest levels of available N (175.73 kg/ha), P (21.02 kg/ha), and K (186.21 kg/ha), which were comparable to the levels of available N (175.65 kg/ha), P (21.55 kg/ha), and K (186.50 kg/ha) in soil following harvest.



Graph 15: Shows the impact of effective *Azotobacter* and phosphate-solubilizing fungus on the amount of NPK that is available in the soil after harvest and the population of these organisms at 50% flowering.

CONFLICT OF INTEREST

The authors of this research article have no conflict of interest.

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