*Original Research Article*

# Effect of seed biopriming on germination & seedling attributes in chickpea (*Cicer arietinum* L.)


ABSTRACT

The Study was conducted during *Zaid* season of 2022-2023 with IPC-05-59 genotype of chickpea (*Cicer arietinum L.*) Find out the Effect of seed biopriming on germination & seedling attributes in chickpea (*Cicer arietinum L*). The design of experiment was Completely Randomized Design comprising treatments [viz. T0- uninoculated T1- Bacillus sp, T2- Mesorhizobium *sp*., T3- Pseudomonas *sp*, T4- Bacillus *sp*(0.5)+ Mesorhizobium *sp*.(0.5),T5- Pseudomonas *sp*.(0.5)+ Mesorhizobium *sp*.(0.5), T6- Bacillus *sp*.(0.5)+Pseudomonas *sp*(0.5).+ Mesorhizobium *sp*.(0.5), T7- Bacillus *sp*,T8- Mesorhizobium *sp*, T9- Pseudomonas *sp*, T10- Bacillus *sp*.(0.5) + Mesorhizobium *sp* (0.5),T11-Pseudomonas *sp* (0.5)+Mesorhizobium *sp* ()0.5 T12- Bacillus *sp*.(0.5) + Pseudomonas *sp*. (0.5) + Mesorhizobium *sp*. (0.5) . The treated seeds along with control were evaluated for their morpho-physiological, growth, yield, root parameters and biochemical parameters under laboratory conditions, The study revealed that seeds biopriming techniques with Bacillus *sp*.(0.5)+Pseudomonas *sp*(0.5).+ Mesorhizobium *sp*.(0.5) concentration @ 1.0ml for 1 hours T6 recorded significantly higher germination percent (93%), rate of germination (5.38), mean germination time (11.16), root length (11.73cm), shoot length (13.27cm), seedling length (25.00cm), fresh weight (7.91 gm), dry weight (1.62gm), vigor index-I (2324.91), vigor index – II (135.82), seed density (1.27), electrical conductivity (0.817), seed metabolic efficiency (1.018). which was followed by seed priming with T12- Bacillus *sp*.(0.5)+ Pseudomonas *sp*.(0.5)+ Mesorhizobium *sp*.(0.5) @ 1.5ml for 2 hours and minimum was recorded in T0 (control).



***Key words***: *Chickpea, Bio priming treatment, CRBD (Completely Randomized BlockDesign), germination percent, speed of germination, seedling length, vigour index.*


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## INTRODUCTION

Chickpea (*Cicer arietinum.* L) belongs to the family Fabaceae, subfamily Faboideae.It is commonly known by other names like gram or Bengal gram, Egyptian pea, garbanzo bean or garbanzo. Chickpea have protein (23.3- 28.9%), carbohydrates (61.5%), fats (4.5%) and minerals (phosphorus, calcium, magnesium, iron, zinc). Seed priming is a physiological strategy that involves soaking of seeds in a solution of a specific priming agent followed by drying of seeds that initiates germination related process. This crop was cultivated in about 99Lha. The country harvested a record production of 107 Lt at a highest productivity level of 1086 kg/ha. As usual, Madhya Pradesh has contributed a significant 28% of the total gram area and 34% of total gram production in the country, there by ranking first both in area and production followed by Maharashtra (20% and 18%), Rajasthan (19% & 18%) and Karnataka (10% & 6%).About 97 percent of gram production of the country during the period under report has been realized by 10states of Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Uttar Pradesh, Andhra Pradesh, Gujarat, Chhattisgarh and Jharkhand **(DAC&FW, GOI, 2022).**

Among all the different priming methods, the recent modern techniques biopriming which is a combination of beneficial microorganisms' application on surface of seed and seed hydration **Upadhyay *et al*., (2016**) that integrates both biological and physiological methods to improve growth of plant, along with controlling diseases. Beneficial microorganisms like Pseudomonas and Rhizobium improve plant growth by colonizing on root surface, aiding in enhanced growth of plant. Chickpea is mostly consumed in the form of processed whole seed (boiled, roasted, parched, fried, steamed, sprouted etc.) or dal or as dal flour (besan). It is used in preparing a variety of snacks, sweets and condiments. It is mixed with wheat flour for "chapati" making. Fresh green seeds are consumed as green vegetable. Green leaves are used as vegetable. Grains are also used as vegetable (chole). Husk and bits of dal are used as nutritious feed for animals. Chickpea can also be used as green fodder for animals. It is mainly grown in more than 50 countries including India, Pakistan, Turkey, Iran, Myanmar, Australia, Ethiopia, Canada, Mexico and Iraq **Gaur *et al*., (2010).**

Biofertilizers may colonizes the rhizosphere and promotes growth by increasing the availability and supply of nutrients and/or growth stimulus to crop. Nitrogen fixer and phosphate solubilizing microorganisms play an important role in supplementing nitrogen and phosphorus to the plant, allowing a sustainable use of nitrogen and phosphate fertilizers.

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**Commented [U6]:** Please rewrite as 'Among all the different priming methods, the recent modern technique is bio priming, which involves the application of beneficial microorganisms on the surface of seeds and seed hydration (Upadhyay et al., 2016). This method integrates both biological and physiological approaches to improve plant growth while also controlling diseases"

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Some important strains are mentioned as plant growth promoting rhizobacteria (PGPR) and that can be used as biofertilizers **Kennedy *et al*., (2004)** i.e. Rhizobium, Azospirillum, Azotobacter, Bacillus, Burkholdaria, Erwinia, Mycobacterium, Flavobacterium etc The bio-priming techniques changes physiological behavior of the host under stress moreover significantly plays vital role to improve seeds tolerance level under environmental stress conditions (**Entesari *et al*., 2013).** Priming of seeds with helpful microorganisms and bio control means has been testified more proficiently for the management of diseases and pests as equated to other available methodologies (**Prabha *et al*., 2019**). The seed biopriming is a recently adapted method of seed priming. Seed priming is a pre-sowing treatment which leads to a physiological state that allows seed to germinate more proficiently. The preponderance of seed treatments are based on seed imbibition allowing the seeds to go through the first reversible stage of germination but does not allow radical protrusion through the seed coat. Seeds keeping their desiccation tolerance are then dehydrated and can be stored until final sowing **(Stanley *et al*., 2016).**

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**Physiological and biochemical changes in seeds on priming:**

During seed germination an initial rapid uptake of water is followed by a visible lag phase. Only after the germination is completed a further increase in water uptake occurs, as the embryonic axis elongates. Movement of water across cell membranes is essential for the initiation of metabolism and the water movement is mediated by aquaporins. Transmembrane proteins are aquaporins (AQPs) which plays a vital role in plant water relations. High expression of AQPs during priming increases the water transport across the plasma membrane which facilitate water supply to the expanding tissues and enhance the germination potential of primed seeds. This may be the reason for the faster imbibition of water by primed seeds in comparison with non-primed ones. Priming leads to differentbiochemical and physiological changes in seeds. It synchronizes germination after breaking dormancy **Nascimento *et al*.,(2004)**, diminishes the lag time required for imbibition, hydrolyses or metabolises inhibitors, activates enzymes, mobilises reserved food and enhances embryonic tissue outgrowth **Rafi *et al*.,(2015)**. Starch metabolism is of great importance during seed metabolism which influences. seedling vigour under stress. This metabolism is brought about by α-amylases which hydrolyse the starch reserves into metabolisable sugars providing energy to the developing embryo. Seed priming enhances α- amylase and dehydrogenase activity that could hydrolyse the starch macromolecules into

smaller and simple sugars with increased ATP production and respiration. Phytase, amylase, and protease also increase during this process. Likewise **Kamithi *et al*., (2016)** have shown increased activity of α-amylase in primed barley seeds by 2.8 times, whereas in primed wheat seeds activity was increased by 2.7 times compared to unprimed seeds. This might have led to enhanced germination events in primed seeds.

**Bio-Priming of Seeds in Seed Production:**

Seed bio-priming offers significant advantages to the seed manufacturing business. In the same way that genetic traits are passed down through generations, seed bacteria and other promising bio-gents are now being employed to increase seed vigour. In many crops, the addition of these helpful microorganisms to the seed and soil interface is a crucial strategy for producing high-quality seeds. Therefore, the seed producing sectors will be the first to gain from seed bio-priming techniques. By undergoing a number of structural, physiological, and biochemical changes within the plants, seed priming with advantageous microorganisms or biocontrol agents increases the availability of nutrients to the plants and induces systemic resistance against biotic and abiotic stresses in various ecological conditions. These microorganisms encompass a variety of bacterial and fungal agents that encourage plant development.

Keeping in the view, the importance of crop and benefits of seed bio priming with microbes, the aim of the study is to identify the most effective agents for bio priming of chickpea seeds and their and their effect on emergence, growth and seed quality parameters.

**OBJECTIVES:**

- To produce the inoculums of the indigenous bacterial isolates.
- To evaluate the effect of selected indigenous potential isolates on germination and seedling parameters of chickpea.

**JUSTIFICATION:**

There is to be proper study regarding impact of seed biopriming treatment for improvement of plant growth attributes in chickpea, So this study helps us to investigate effect of bio priming seed treatment, Biofertilizers may colonizes the rhizosphere and promotes growth by increasing the availability and supply of nutrients and/or growth stimulus to crop on chickpea. Selecting appropriate seeds and treatments is key in crop production. Biofertilizers has shown better improvement of physiological and morphological growth attributes of crop growth.

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## MATERIAL AND METHODS

The materials, methodology and techniques adopted in the present experiment entitled, "**Effect of seed biopriming on germination & seedling attributes in chickpea (*Cicer arietinum* L.)"** with a brief description regarding the site of the experiment, temperature conditions, sampling techniques and statistical analysis are presented in this chapter with following headings

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**Experimental design:**

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The experiment consists of 13 treatments including control which are replicated four times and allocated in Completely Randomized Block Design in each replication.

**List 1 : Details of layout**

| | |
|---|---|
| Crop | Chickpea (*Cicer arietinum* L.) |
| Genotype | IPC-05-59 |
| Season | Zaid 2022-23 |
| Number of Replications | 4 |
| Number of Treatments | 13(12+1) |
| Number of seeds per replication | 100 |
| Method of germination | Between the paper method |
| First count | 4th DAS |
| Final Count | 8th DAS |

**List 2 : Treatment Combinations**

| Treatment | Organism | Concentration | Duration (hours) |
|---|---|---|---|
| T0 | Uninoculated | NIL | - |
| T1 | Bacillus sp. | 1ml | 1 |
| T2 | Mesorhizobium sp. | 1ml | 1 |
| T3 | Pseudomonas sp. | 1ml | 1 |
| T4 | Bacillus sp(0.5)+ Mesorhizobium sp.(0.5) | 1ml | 1 |
| T5 | Pseudomonas sp.(0.5)+ Mesorhizobium sp.(0.5) | 1ml | 1 |
| T6 | Bacillus sp.(0.5)+ Pseudomonassp(0.5).+ Mesorhizobium sp.(0.5) | 1ml | 1 |
| T7 | Bacillus sp. | 1.5 ml | 2 |
| T8 | Mesorhizobium sp. | 1.5 ml | 2 |
| T9 | Pseudomonas sp. | 1.5 ml | 2 |
| T10 | Bacillus sp.(0.5)+ Mesorhizobium sp(0.5) | 1.5 ml | 2 |
| T11 | Pseudomonas sp(0.5).+ Mesorhizobium sp.(0.5) | 1.5 ml | 2 |
| T12 | Bacillus sp.(0.5)+ Pseudomonas sp.(0.5)+ Mesorhizobium sp.(0.5) | 1.5 ml | 2 |

**Preparation of solutions:**

Bacterial cultures :

**Preparation of media:**

For *Bacillus sp* Nutrient broth media will be used which is a composition of

Manitol agar - 10 gm/litre

$K_2HPO_4$ - 0.5 gm/litre

$MgSO_4$ - 0.2gm/litre

NaCl -0.1 gm/litre

$CaCO_3$ -4gm/litre

Yeast extract -0.1 gm/litre

For *Rhizobium sp* Yama brothmedia will be used which is a composition of

Peptone - 5 gm/litre

Beef extract - 3gm/litre

Nacl - 5gm/litre

For *Pseudomonas sp*: pseudomonas agar is used which is a composition of

Casine hydrolysate - 10gm/litre

Protease,peptone - 10gm/litre

$K_2HPO_4$ - 1.5gm/litre

$MgSo_4 .7H_2O$ - 1.5gm/litre

pH - 7

a. Autoclave media at 120° for 15 min.
b. After media gets cooled down fresh culture of Bacillus spp ,Pseudomonas spp, Rhizobium spp. Areseparately inoculated in specific broth.
c. Incubate at 28°c for 2-3 days.
d. Seeds were surface disinfected with ethanol
e. The sterilized seeds were soaked in bacterial suspention ($1\times\mathbf{10^7}$cells /ml) for 1 ,2 hours respectively, incase of control , the seeds are soaked in distilled water.
f. Seeds were air dried for 48 hours
g. Seeds were placed on each germination paper for germination tests
h. Observations were recorded on first count and last count ie on $4^{th}$ and 8th day after kept for germination.

## RESULTS AND DISCUSSION

An experiment ~~entitled ""Effect of seed biopriming on germination & seedling attributes in chickpea (*Cicer arietinum* L)"~~ was conducted at Seed Testing Laboratory, Department of Genetics and Plant Breeding, Naini Agricultural Institute, SHUATS, Prayagraj, (U.P). during *Zaid* season of 2022-2023. ~~The results of this experiment are presented in the following pages under appropriate sub headings. Experimental findings are discussed in the light of scientific reasoning and their conformity with the previous researchers.~~

**Analysis of Variance:** The analysis of variance for Germination and Seedling Attributes in chickpea was given below table. Analysis of variance revealed that the differences among thirteen treatments were significant for germination and seedling attributes *viz.*, Germination percentage (%), Rate of germination, Mean germination time, Root length(cm), Shoot length(cm), Seedling length(cm), Fresh weight(g), Dry weight(g), Vigour Index-I, Vigour Index-II, Seed density, Electrical conductivity(dSm-1), Seed metabolic efficiency.

**Table 1: Analysis of variance for seed germination and seedling parameters of bio-priming by *Rhizobium, Bacillus, Pseudomonas* in chickpea *(Cicer arietinum L.).***

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|---|---|---|---|
| | | **Treatments (df=12)** | **Error (df=39)** |
| 1 | Germination percentage (%) | 125.4231* | 4.0000 |
| 2 | Rate of germination | 0.5409* | 0.4288 |
| 3 | Mean germination time | 1.8061* | 0.0576 |
| 4 | Root length(cm) | 7.8748* | 0.0112 |
| 5 | Shoot length(cm) | 7.4281* | 0.0617 |
| 6 | Seedling length(cm) | 29.8297* | 0.0921 |
| 7 | fresh weight(g) | 4.8217* | 0.0999 |
| 8 | dry weight(g) | 0.0296* | 0.0051 |
| 9 | vigour index-I | 418188.5837* | 283.6725 |
| 10 | vigour index-II | 527.8566* | 42.1658 |
| 11 | Seed density | 0.0032* | 0.0013 |
| 12 | Electrical conductivity(dSm-1) | 0.5077* | 0.0338 |
| 13 | Seed metabolic efficiency | 0.0545* | 0.0192 |

***Indicates 5% Level of Significance**

| Treatments | Germination percentage (%) | Rate of germination | Mean germination time | Root length(cm) | Shoot Length(cm) | Seedling length(cm) | Fresh weight (g) | Dry weight (g) | Vigour index I | Vigour index II | Seed density | Electrical conductivity | Seed metabolic efficiency |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **T0** | **68** | **3.77** | **8.16** | **6.64** | **7.67** | **14.32** | **3.07** | **1.25** | **973.18** | **84.71** | **1.15** | **1.905** | **0.556** |
| **T1** | 78 | 4.66 | 9.36 | 9.31 | 10.95 | 20.27 | 4.54 | 1.35 | 1580.45 | 105.72 | 1.21 | 1.766 | 0.823 |
| **T2** | 79 | 4.76 | 9.48 | 10.4 | 10.65 | 21.05 | 3.81 | 1.36 | 1662.81 | 128.26 | 1.21 | 1.686 | 0.690 |
| **T3** | 81 | 4.95 | 9.72 | 7.49 | 9.15 | 16.65 | 4.21 | 1.39 | 1348.03 | 112.68 | 1.19 | 1.625 | 0.789 |
| **T4** | 82 | 4.95 | 9.84 | 10.14 | 10.77 | 20.91 | 4.88 | 1.46 | 1714.33 | 126.28 | 1.20 | 1.078 | 0.722 |
| **T5** | 86 | 5.10 | 10.32 | 10.62 | 12.41 | 23.04 | 5.46 | 1.51 | 1980.81 | 130.21 | 1.23 | 0.902 | 0.591 |
| **T6** | **93** | **5.38** | **11.16** | **11.73** | **13.27** | **25.00** | **7.91** | **1.62** | **2324.91** | **135.82** | **1.27** | **0.817** | **1.018** |
| **T7** | 73 | 4.23 | 8.76 | 6.85 | 8.59 | 15.45 | 3.26 | 1.34 | 1127.26 | 106.24 | 1.17 | 1.848 | 0.861 |
| **T8** | 79 | 5.09 | 9.48 | 9.77 | 10.51 | 20.29 | 3.8 | 1.36 | 1602.14 | 109.57 | 1.24 | 1.734 | 0.862 |
| **T9** | 80 | 4.95 | 9.60 | 9.21 | 10.77 | 19.99 | 5.53 | 1.39 | 1598.59 | 114.2 | 1.20 | 1.686 | 0.841 |
| **T10** | 82 | 4.81 | 9.84 | 8.85 | 10.43 | 19.29 | 4.04 | 1.43 | 1581.16 | 111.48 | 1.22 | 1.331 | 0.650 |
| **T11** | 85 | 4.81 | 10.20 | 9.41 | 11.19 | 20.61 | 4.59 | 1.46 | 1751.22 | 114.94 | 1.19 | 1.002 | 0.772 |
| **T12** | **89** | **5.23** | **10.68** | **11.60** | **12.63** | **24.23** | **5.51** | **1.54** | **2156.37** | **119.02** | **1.25** | **0.891** | **0.948** |
| **Grand mean** | **81** | **4.82** | **9.74** | **9.39** | **10.69** | **20.08** | **4.66** | **1.42** | **1646.25** | **115.66** | **1.21** | **1.406** | **0.779** |
| **S. Em** | 1.155 | 0.378 | 0.139 | 0.061 | 0.143 | 0.175 | 0.182 | 0.041 | 9.724 | 3.749 | 0.021 | 0.106 | 0.080 |
| **SE(d)** | 1.633 | 0.535 | 0.196 | 0.086 | 0.203 | 0.248 | 0.258 | 0.058 | 13.752 | 5.302 | 0.029 | 0.150 | 0.113 |
| **C.D (0.05)** | 3.357 | 1.099 | 0.403 | 0.178 | 0.417 | 0.509 | 0.530 | 0.120 | 28.267 | 10.898 | 0.060 | 0.309 | 0.233 |

**Table no: 2Mean Performance of germination and seedling parameters of bio-primed seeds by *Rhizobium, Bacillus, Pesudomonas* in Chickpea *(Cicer arietinum L.)* Genotype*: IPC-05-59***

**Germination percent:**

A perusal of data on germination percent was recorded during the experimental period revealing a significant difference in germination percent, which was recorded As per the data tabulated germination percent was recorded significantly higher in treatment (T6 - Bacillus sp.(0.5)+ Pseudomonas sp(0.5).+ Mesorhizobium sp.(0.5) @ 1ml) with 93% and treatment (T12- Bacillus sp.(0.5)+ Pseudomonas sp.(0.5)+ Mesorhizobium sp.(0.5) @ 1.5ml) with 89% was statistically at par with treatment T6 and the lowest germination percent was recorded in treatment T0 (control) with 68%.

Pseudomonas strains are known to produce plant growth-promoting hormones such as auxins and cytokinins. These hormones can stimulate seed germination and early seedling growth by promoting cell elongation, root development, and nutrient uptake. Pseudomonas treatments can induce systemic resistance in plants. This means that chickpea seeds treated with Pseudomonas may become more resilient to stressors and pathogens, thereby improving their chances of germination and early growth.

**Rate of germination:**

From the data recorded it is obvious that treatment (T6 - Bacillus sp.(0.5)+ Pseudomonas sp(0.5).+ Mesorhizobium sp.(0.5) @ 1ml) gave significantly higher rate of germination with 5.38% over all other treatments. However, treatment (T12- Bacillus sp.(0.5)+ Pseudomonas sp.(0.5)+ Mesorhizobium sp.(0.5) @ 1.5ml) recorded a rate of germination of 5.23% and was statistically at par with T3 and the lowest rate of germination was obtained in T0 (control) with 3.77%.

**Mean germination time:**

As per the data recorded the treatment (T6 - Bacillus sp.(0.5)+ Pseudomonas sp(0.5).+ Mesorhizobium sp.(0.5) @ 1ml) had significantly highest mean germination time of 11.16 over all other treatments and treatment T12- Bacillus sp.(0.5)+ Pseudomonas sp.(0.5)+ Mesorhizobium sp.(0.5) @ 1.5ml with 10.68 of mean germination time was statistically at par with T3. The lowest mean germination time was recorded in T0 (control) with 8.16.

**Root length:**

From the data recorded it is obvious that treatment (T6 - Bacillus sp.(0.5)+ Pseudomonas sp(0.5).+ Mesorhizobium sp.(0.5) @ 1ml) gave significantly higher root length with 11.73cm over all other treatments considered. Treatment (T12- Bacillus sp.(0.5)+ Pseudomonas sp.(0.5)+ Mesorhizobium sp.(0.5) @ 1.5ml) recorded a root length of 11.60cm and was statistically at par with T6 and the lowest root length was obtained in T0 (control) with 6.64cm.

Pseudomonas treatments can stimulate the development of root hairs, which are extensions of root epidermal cells. Root hairs increase the surface area for nutrient and water absorption, enhancing overall root growth. Pseudomonas bacteria can trigger the production of antioxidants in chickpea

seedlings. Antioxidants protect plant tissues from oxidative stress, allowing roots to grow without hindrance.

**Shoot length:**

As per the data recorded the treatment (T6 - Bacillus sp.(0.5)+ Pseudomonas sp(0.5).+ Mesorhizobium sp.(0.5) @ 1ml) had significantly highest shoot length of 13.27cm over all other treatments and treatment T12- Bacillus sp.(0.5)+ Pseudomonas sp.(0.5)+ Mesorhizobium sp.(0.5) @ 1.5ml with 13.27cm of shoot length was statistically at par with T6. The lowest shoot length was recorded in T0 (control) with 7.67cm.

**Seedling length:**

The significantly higher seedling length (25.00cm) was recorded with treatment (T6 - Bacillus sp.(0.5)+ Pseudomonas sp(0.5).+ Mesorhizobium sp.(0.5) @ 1ml) over the rest of the treatments taken. In contrast a significantly lower seedling length of 14.32cm was recorded with treatment (T0-control). However, treatment (T12- Bacillus sp.(0.5)+ Pseudomonas sp.(0.5)+ Mesorhizobium sp.(0.5) @ 1.5ml) with 24.23cm was statistically at par with T6.

Pseudomonas treatments can trigger the production of antioxidants in chickpea seedlings. Antioxidants protect plant tissues from oxidative stress, which can hinder growth. With lower oxidative stress, seedlings can focus on elongating their stems and leaves. Pseudomonas treatments can induce systemic resistance in chickpea seedlings. When the seedlings are primed for defense responses, they allocate more resources to growth, resulting in increased seedling length.

**Fresh weight:**

The significantly higher seedling fresh weight was obtained in treatment (T6 - Bacillus sp.(0.5)+ Pseudomonas sp(0.5).+ Mesorhizobium sp.(0.5) @ 1ml) with 7.91gm among all the other treatments and the lowest seedling fresh weight was recorded in T0 (control) with 3.07gm respectively. The treatment (T12- Bacillus sp.(0.5)+ Pseudomonas sp.(0.5)+ Mesorhizobium sp.(0.5) @ 1.5ml) was statistically at par with T6 with 5.51gm.

Pseudomonas treatments can promote more efficient nutrient uptake by the seedlings. This increased nutrient absorption can support the development of larger and heavier seedlings. Pseudomonas can produce plant growth-promoting hormones like auxins and cytokinins. These hormones stimulate cell division and elongation, leading to increased biomass and fresh weight in seedlings. Pseudomonas treatments can induce systemic resistance in chickpea seedlings. As a result, seedlings are better protected against pathogens and environmental stresses, allowing them to allocate more energy to growth and fresh weight gain.

**Dry weigtht:**

The significantly higher seedling dry weight (1.62gm) was recorded with treatment (T6 - Bacillus sp.(0.5)+ Pseudomonas sp(0.5).+ Mesorhizobium sp.(0.5) @ 1ml). In contrast a significantly lower dry weight of 1.25 was recorded with treatment (T0-control). However, treatment (T12- Bacillus sp.(0.5)+ Pseudomonas sp.(0.5)+ Mesorhizobium sp.(0.5) @ 1.5ml) with 1.54gm was statistically at par with treatment T2.

Pseudomonas treatments often lead to the development of more extensive and well- branched root systems. A healthy root system allows for better nutrient and water absorption, ultimately contributing to increased seedling dry weight. Pseudomonas treatments may enhance the efficiency of photosynthesis in chickpea seedlings, leading to increased production of carbohydrates and dry biomass.

**Vigour index I:**

Significantly higher vigour index I was recorded in treatment T6 - Bacillus sp.(0.5)+ Pseudomonas sp(0.5).+ Mesorhizobium sp.(0.5) @ 1ml with 2324.91 and the treatment T12- Bacillus sp.(0.5)+ Pseudomonas sp.(0.5)+ Mesorhizobium sp.(0.5) @ 1.5ml with vigour index I of 2156.37 was statistically at par with T6. The lowest vigour index I was recorded in treatment T0-control with vigour index I of 973.18.

Pseudomonas treatments often lead to the development of a more extensive and well- branched root system. A healthy root system enhances nutrient and water uptake, supporting overall seedling vigor. Pseudomonas treatment promotes germination, seedling length, and dry weight through better cell division increasing the seedling vigour.

**Vigour index II:**

As per the data recorded during laboratory study the vigour index II was recorded significantly higher in treatment T6 - Bacillus sp.(0.5)+ Pseudomonas sp(0.5).+ Mesorhizobium sp.(0.5) @ 1ml with vigour index II of 135.82 and statistically at par value was recorded in treatment T12- Bacillus sp.(0.5)+ Pseudomonas sp.(0.5)+ Mesorhizobium sp.(0.5) @ 1.5ml with 130.21. The lowest data on vigour index II was recorded in treatment (T0-control) with 84.71.

**Seed density:**

The treatments varied significantly and the highest seed density was recorded in treatment T6 - Bacillus sp.(0.5)+ Pseudomonas sp(0.5).+ Mesorhizobium sp.(0.5) @ 1ml with 1.27 $dsm^{-1}$. The treatement (T12- Bacillus sp.(0.5)+ Pseudomonas sp.(0.5)+ Mesorhizobium sp.(0.5) @ 1.5ml) with seed density of 1.25 $dsm^{-1}$ was statistically at par with T6 and the lowest seed density was recorded in treatemnt T0 - control with1.15 $dsm^{-1}$.

Pseudomonas treatments can stimulate the development of a more extensive root system in chickpea seedlings. These well-developed root systems enable seedlings to explore a larger soil volume for resources, indirectly contributing to their overall vigor and potential seedling density.

**Electrical conductivity:**

As per the data tabulated electrical conductivity was recorded significantly lower in treatment (T6 - Bacillus sp.(0.5)+ Pseudomonas sp(0.5).+ Mesorhizobium sp.(0.5) @ 1ml) with 0.817 and treatment (T12- Bacillus sp.(0.5)+ Pseudomonas sp.(0.5)+ Mesorhizobium sp.(0.5) @ 1.5ml) with 0.891 was at par with T6 and the highest electrical conductivity was recorded in treatment (T0-control) with 1.905. Pseudomonas seed treatment may influence the ion-selective transport systems in chickpea root cells. These bacteria can modulate ion channels and transporters to favor the uptake of essential nutrients (e.g., potassium and calcium) while limiting the uptake of potentially detrimental ions (e.g., sodium and chloride). This selective ion regulation can lead to an altered ion composition within the plant and, consequently, a lower EC of the plant sap.

**Seed metabolic efficiency:**

A perusal of data on seed mobilization efficiency was recorded during the experimental period on different treatments revealing a significant difference in seed mobilization efficiency, As per the data tabulated seed mobilization efficiency was recorded significantly higher in treatment (T6 - Bacillus sp.(0.5)+ Pseudomonas sp(0.5).+ Mesorhizobium sp.(0.5) @ 1ml) with 1.018 and treatment (T12- Bacillus sp.(0.5)+ Pseudomonas sp.(0.5)+ Mesorhizobium sp.(0.5) @ 1.5ml) with 0.948 was statistically at par with T6 and the lowest seed mobilization efficiency was recorded in treatment (T0-control) with 0.556.

## Summary:

The present lab experiment entitled ""Effect of seed biopriming on germination & seedling attributes in chickpea (*Cicer arietinum* L)" was conducted at Seed Testing Laboratory, Department of Genetics and Plant Breeding, Naini Agricultural Institute, SHUATS, Prayagraj, (U.P). during *Zaid* season of 2022-2023.

- The study conducted in the seed testing laboratory revealed that germination percent (93%), rate of germination (5.38), mean germination time (11.16), root length (11.73cm), shoot length (13.27cm), seedling length (25.00cm), fresh weight (7.91 gm), dry weight (1.62gm), vigor index-I (2324.91), vigor index – II (135.82), seed density (1.27), electrical conductivity (0.817), seed metabolic efficiency (1.018) were recorded significantly higher in T6 - Bacillus *sp*.(0.5)+ Pseudomonas *sp*(0.5).+ Mesorhizobium *sp*.(0.5) @ 1ml over other treatments and treatment T12- Bacillus *sp*.(0.5)+ Pseudomonas *sp*.(0.5)+ Mesorhizobium *sp*.(0.5) @ 1.5ml was at par with T6.
- Analysis of variance showed significant difference among the treatments for the characters studied of the

Chick pea which indicates significant effect of the treatments on seedling parameters of the crop.

- The salient finding of the experiment is summarized and conclusion is drawn. The study was undertaken to know the effect of seed biopriming treatments on Chick pea seeds have been presented and discussed in the previous chapter. The data was recorded for seedling parameters of Chick pea.

## Conclusion:

Studying indigenous bacteria can improve plant health and plant growth and Inoculating seed with beneficial indigenous bacteria can enhance nutrient availability and protect plants from harmful pathogens. Indigenous bacteria can provide insights into the local microbial community and its role in various ecosystems. They contain unique enzymes or metabolic pathways that can be harnessed for biotechnological applications in crop.

It is concluded from the present study that (T6) treatment in which seeds treated with Bacillus *sp*.(0.5)+ Pseudomonas *sp*(0.5).+ Mesorhizobium *sp*.(0.5) @ 1ml had out performed all treatments in laboratory conditions with highest germination percentage, seedling length, fresh weight, vigor indices, electrical conductivity followed by (T12) treatment in which seeds treated with Bacillus *sp*.(0.5)+ Pseudomonas *sp*.(0.5)+ Mesorhizobium *sp*.(0.5) @ 1.5ml and the lowest were recorded in (T0- control).

## Future prospects:

The bio priming technique can be recommended for priming seeds prior to field planting as an environmentally friendly strategy to improve seed germination and initial seedling growth. Extensive field trials under different environmental conditions, using several seed lots of cultivars, will be necessary in order to establish the efficiency of these strains as potential bio-priming seed treatments for improving Crop productivity

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