Original Research Article

YIELD ENHANCEMENT OF FIELD PEA *(Pisumsativum)* THROUGH ZINC SOLUBILIZING MICROORGANISM

Abstract

In the rabi season of 2022-223, a field experiment was conducted at Instructional Farm, School of Agriculture, SanjeevAgrawal Global Educational(SAGE) University Bhopal (Madhya Pradesh) to assess the impact of zinc (zn) and ZSB (Zinc Solubilizing Bacteria)solubilizers on the performance of field pea crops. The resultsof the experiment revealed that the application of 100% of the recommended dose of fertilizer in combination with zinc led to the highest values in various growth and yield parameters.

Specifically, the treatment of 100% Recommended dose fertilizer + Zincstatistically ($p<0.05$) compared to mean values demonstrated the maximum plant height, dry matter accumulation (in grams), of branches per plant, number of pods per plant, number of seeds per pod and seed yield (1060 kg/ha). Additionally it resulted in a straw 2130 kg/ha., a biological yield of 4243 kg/ha, a net return of 1639 Rs/ha, and abenefit-to-cost (B:C) ratio of 1.12. It is worth noting that the performance achieved with theapplication of 100% ZSB was statistically on par with the treatment involving 100%Recommended Dose Fertilizer + Zinc.Overall, all of the treatments applied in the experiment had a significant positive impact on thegrowth, yield, and economic aspects of field pea cultivation in comparison to the controlgroup.

Keywords: Field pea, Zinc, ZSB (Zinc solubilizing bacteria), Growth and yield. .

Introduction:

Field pea (*Pisumsativum*), a primary winter grain legume crop, primarily thrives in cooler temperate regions. This versatile crop serves various purposes, including providing food, animal feed, and vegetables. It ranks as the third most popular rabi crop globally, following chickpea and arhar, making it a significant pulse crop.

In the order to enhance both the production and productivity of field pea, there's apressing need for improved nutrient management practices. Field pea has a positive response to the application of fertilizers. Never the less, the constituent use of chemical fertilizer in modern agriculture practices adverse consequence for thew population of beneficial native soil microorganisms and overall soil health. An alternative to chemical fertilizer is the use of bio-fertilizers, which are organic products containing living cells. Bio-fertilizer plays a crucial role in converting nutrients from unavailable forms to available ones, as indicated by Itelima*et al.* 2018: Ikeh*et al*. 2023 [1-9].

These organic solutions encompass microorganisms and growth hormone which boost crop productivity through process biological nitrogen fixation, zinc solubilization, and the regulation of growth factorsessential for plants growth and development.

Bio fertilizer is more sustainable in managing soil fertility (Ikeh*et al.* 2023) [11]. In this context, the combination of nutrient management and bio-fertilizers is emerging as a commercially viable and environmentally responsible approach to fertilization, as suggested by Kaur and Purewal, 2019 [2] and Ikeh*et al.* 2023 [10].

Materials and Method

The current investigation was conducted in small experimental plots at SAGE University, Bhopal (Madhya Pradesh). The study aimed to assess the impact of zinc (Zn) and zinc solubilizers on thegrowth and development of field pea, with a focus on the selected variety, Prakash IPFD 1-1. This
particular variety is known for its large seeds and resistance to powdery mildew. Its distinct yellowovoid grains are noteworthy for their exceptionally high protein content. The sowing of field pea
took place on November 23, 2022, in the rabi season of 2022-2023.

The experimental design followed a randomized block format(RBD), with six different treatments. Eachplot had an area of 6 square meters. The experimentation was carried out at the Instructional CumResearch Farm, School of Agriculture, SAGE University, Bhopal, situated in the central region ofIndia, characterized by a latitude of 23.2599° N and a longitude of 77.4126° E. Bhopal, oftenreferred to as the "city of lakes," is nestled in the lowlands near the Vindhya mountain range on theMalwa plateau.

In four of the treatments, the recommended doses of nitrogen, phosphorus, and potassium (16.6g at the basal dose) were applied, with ZSB (Zinc Solubilizing Bacteria) being a common componentin all treatments.The sowing date was November 23, 2022, and manual harvesting was conducted onMarch 24, 2023.

Data collections were taken from each randomly selected plot at 30, 60, 90, days after planting (DAS) and at harvesting. As well asduring the harvest of the crop. Throughout the growth period of the field pea, various observationswere systematically collected from each plot, with proper tagging for future reference.The observations encompassed key growth and yield attributes of the field pea, including plantheight (in centimetres), the number of branches per plant, the number of pods per plant, thenumber of seeds per pod, and seed yield. For plant height, number of branches per plant, numberof pods per plant, and number of seeds per pod, measurements were taken from five randomlyselected plants, and the mean value was computed. The weight of 1,000 seeds was recorded ingrams. The seed, straw, and biological yield were measured in kilograms per hectare, and theharvest index was calculated. Net returns and the benefit-to-cost (B:C) ratio were computed toevaluate the economic aspects of the field experiment.

Result and Discussion

Plant height observations were made at 60 and 90 days after sowing (DAS). The results indicated that plant height was at its minimum up to 30 DAS but subsequently increased during the 60 DASmark and at harvest, as the crop aged. Plant height varied between 65.20 cm and 84.34 cm atharvest. The treatment of recommended dose fertilizer + 100% Zn (9 gm.), denoted as

T2,significantly exhibited the highest plant height, reaching 84.34 cm at harvest, surpassing all othertreatments.

Regarding dry matter accumulation (g/plant) at harvest, the application of recommended dosefertilizer + 100% Zn (19.68 gm.) resulted in significantly higher values compared to the othertreatments (Table 1). The data (Table 2) demonstrates that the application of Zn and ZSB (ZincSolubilizing Bacteria) levels significantly increased the number of branches per plant, pods perplant, and seeds per pod. The treatment of recommended dose fertilizer + 100% Zn led to themaximum branches per plant (2.46), pods per plant (16.61), and seeds per pod (6.85) among all thetreatments.

The results showed that the application of the recommended dose of fertilizer (RDF) + 100% Zn(T2) significantly increased seed, straw, and biological yield compared to the control. Themaximum seed yield (1060 kg/ha), straw yield (2130 kg/ha), and biological yield (4243 kg/ha)were obtained with the application of recommended dose fertilizer + 100% Zn (Table 2). Thetreatment of recommended dose fertilizer + 100% Zn was statistically superior, especially whenused in conjunction with Zinc Solubilizing Bacteria (ZSB) at 100%, possibly due to its positiveimpact on the number of pods per plant, seeds per pod, seed, straw, and biological yield.Economically, the data (Table 2) revealed that among the Zn and ZSB Solubilizer fertilizertreatments, the recommended dose of fertilizer + 100% Zinc resulted in the highest and statisticallysignificant net return (1639 Rs/ha) and benefit-to-cost (B:C) ratio (1.12). Similar findings were inline with those reported by Venkatrao et al. (2017) [8] and Kuniya et al. (2018) [4]. The beneficial effects of zinc solubilizing bacteria on yield attributes were also consistent with the findings ofKothyari et al. (2017) [3] and Raut (2018) [5]. Notably, test weight did not show significantdifferences concerning various Zn fertilizers and their solubilizer levels. Economic analysis (Table2) indicated that, among the Zn fertilizer treatments, the recommended dose of fertilizer + 100%Zinc yielded the highest and statistically significant net return (1639 Rs/ha) and B:C ratio (1.12),which aligns with the results reported by Serawat et al. (2018) [6] and Singh et al. (2018) [7].

Table.1 Impact of Zinc solubilizing microorganisms on plan growth of field pea

Treatments	At harvesting time plant Height in cm.	Dry matter Accumulation (gram per plant) at harvest	Number of branches per plant at harvest	Number of pods per plant at harvest	Seed per pods at harvest	Test weight (1000 seed) (g)
Zn and ZSB Levels						
control (T_1)	65.20	13.12	1.04	9.94	4.42	175.36
Recommended Dose Fertilizer + Zn (100%) (T_2)	84.34	19.68	2.46	16.61	6.85	189.54
Zinc solubilizing bacteria (ZSB) (100%) (T_3)	80.53	19.61	2.15	15.53	6.24	185.62

Recommended dose fertilizer + Zn +ZSB (75%) (T_4)	75.20	17.82	1.78	13.78	5.78	182.41
Recommended dose fertilizer + Zinc +ZSB (50%)	71.48	15.7	1.70	12.63	5.23	179.45
Recommended dose fertilizer + Zinc +ZSB (25%) (T_6)	69.91	14.9	1.25	11.5	4.5	176.69
SE(m)	1.52	0.46	0.07	0.31	0.18	3.84
CD at 5%	4.65	1.34	0.23	0.95	0.57	NS

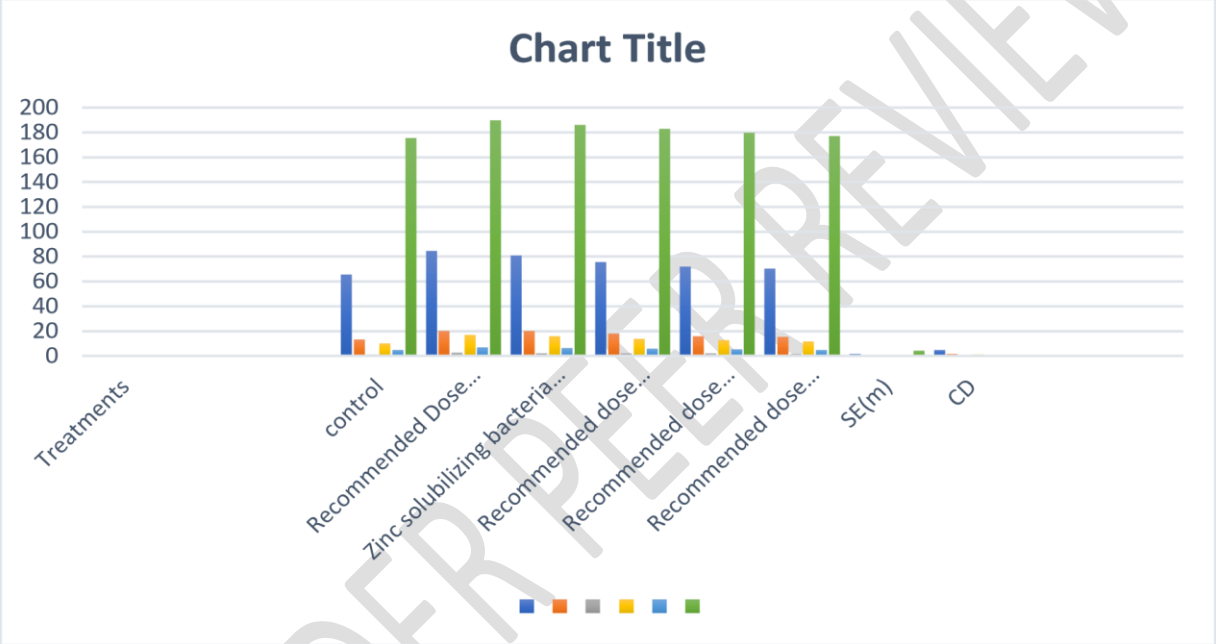

Fig 1: Graphical representation of the treatments

Table.2 Impact of zinc solubilising microorganism on seed yield, straw yield,biological yield and Harvest index

Treatments	Seed yield (kg. per hectare)	Straw Yield (kg. per hectare)	Biological yield (kg. per hectare)	Harvest index (%)	Net return (Rs./ha)	B:C ratio
Zn and ZSB Levels						
Control (T_1)	250	560	1005	30.06	820	0.52
Recommended Dose fertilizer + Zn (100%) (T_2)	1060	2130	4243	32.26	1639	1.12
Zinc solubilizing bacteria (ZSB) (100%) (T_3)	830	1655	3298	32.09	1460	1.03

Recommended dose fertilizer + Zn +ZSB (75%) (T_4)	700	1390	2680	31.45	1234	1.01
Recommended dose fertilizer + Zn +ZSB (50%) (T_5)	480	940	1860	31.15	1140	0.95
Recommended dose fertilizer + Zn +ZSB (25%) (T_6)	380	735	1438	30.62	960	0.76
SE(m)	20.4	40.7	95.3	0.29	161.34	0.02
CD at 5%	61.1	120.3	285.4	0.86	484.05	0.07

Conclusion

In conclusion, the study conducted at SAGE University, Bhopal, focusing on the impact of zinc(Zn) and Zinc Solubilising Bacteria (ZSB) on the growth and yield attributing character of field pea, revealed the data ofplant height, observed at 60 and 90 days after sowing (DAS), exhibited aninteresting growth pattern, minimum height was recordedat 30 DAS, followed by a steady and gradually increase up to60 DAS and at the harvest stage. The treatment involving the recommended dose of fertilizer +100% Zn (9 gm.) outshone all others, reaching a significant plant height of 84.34 cm at harvest.

Furthermore, dry matter accumulation (g/plant) at harvest was significantly higher when therecommended dose of fertilizer was combined with 100% Zn (19.68 gm.), outperforming the othertreatments. The application of Zn and ZSB also had a substantial impact on the number ofbranches per plant, pods per plant, and seeds per pod. Once again, the treatment of recommendeddose fertilizer + 100% Zn excelled, resulting in the highest number of branches per plant (2.46),pods per plant (16.61), and seeds per pod (6.85).

Importantly, the application of the recommended dose of fertilizer (RDF) combined with 100% Zn (T2) significantly increased seed, straw, and biological yields in comparison to the control.Maximum seed yield (1060 kg/ha), straw yield (2130 kg/ha), and biological yield (4243 kg/ha)were achieved with this treatment. The positive impact of combining recommended dose fertilizer
with 100% Zn was further enhanced when used in conjunction with Zinc Solubilizing Bacteria(ZSB) at 100%, contributing to the impressive results across parameters.

Economically, the study demonstrated that the treatment involving the recommended dose offertilizer + 100% Zn yielded the highest net return (1639 Rs/ha) and a significant benefit-to-cost(B:C) ratio of 1.12 among the Zn and ZSB Solubilizer fertilizer treatments. These findings alignwith prior research, reinforcing the economic and agricultural advantages of this approach.

Notably, test weight did not show significant variations among the different Zn fertilizers and solubilizer levels.In summary, the study underscores the effectiveness of the recommended dose of fertilizer incombination with 100% Zn, particularly when supplemented with ZSB, in enhancing

the growth,yield, and economic viability of field pea cultivation, affirming the potential for sustainable andeconomically sound agricultural practices.

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