International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
www.agronomyjournals.com
2024; 7(1): 179-182
Received: 08-10-2023
Accepted: 12-11-2023

BV Borane
M.Sc. Scholar, Department of Soil Science and Agricultural Chemistry, College of Agriculture, DBSKKV, Dapoli, Maharashtra, India

Dr. NA Meshram
Scientist, All India Coordinated Research Project on Agroforestry (AICRP on Agroforestry), DBSKKV, Dapoli, Maharashtra, India

Dr. SB Dodake
Head, Department of Soil Science and Agricultural Chemistry, College of Agriculture, DBSKKV, Dapoli, Maharashtra, India

Dr. AV Dahiphale
Associate Professor, Department of Agronomy, College of Agriculture, DBSKKV, Dapoli, Maharashtra, India

Dr. PS Sawant
Associate Professor (CAS), Department of Soil Science and Agricultural Chemistry, College of Agriculture, DBSKKV, Dapoli, Maharashtra, India

Dr. RR Rathod
Assistant Professor, Department of Plant Pathology, College of Agriculture, DBSKKV, Dapoli, Maharashtra, India

JS Chavan
M.Sc. Scholar, Department of Soil Science and Agricultural Chemistry, College of Agriculture, DBSKKV, Dapoli, Maharashtra, India

VN Kale
M.Sc. Scholar, Department of Agronomy, College of Agriculture, DBSKKV, Dapoli, Maharashtra, India

Corresponding Author:
BV Borane
M.Sc. Scholar, Department of Soil Science and Agricultural Chemistry, College of Agriculture, DBSKKV, Dapoli, Maharashtra, India

Effect of zinc solubilizing fungi on growth, yield attributes and quality of groundnut

BV Borane, Dr. NA Meshram, Dr. SB Dodake, Dr. AV Dahiphale, Dr. PS Sawant, Dr. RR Rathod, JS Chavan and VN Kale

DOI: https://doi.org/10.33545/2618060X.2024.v7.i1c.204

Abstract
An experiment was conducted on "Effect of zinc solubilizing fungi on growth, yield attributes and quality of groundnut" at Dr. BSKKV, Dapoli, Dist. Ratnagiri, Maharashtra, during 2022-23. The pot culture experiment was framed in completely randomized design (CRD) with 9 treatments and 3 replications. Regarding the growth attributes study, significantly highest plant height (23.26 cm), plant spread (32.42 cm), and number of nodules per plant (103.61), were observed by the application of 100% RDF + ZnSF at 2.5 L ha^{-1} (T_5) followed treatments T_7, T_8, and T_3 which were found be at par with T_5. Furthermore, in the case of yield attributes, the application of treatment 100% RDF + ZnSF at 2.5 L ha^{-1} (T_5) showed significantly higher dry pod yield (33.24 q ha^{-1}), kernel yield (23.97 q ha^{-1}), dry haulm yield (44.84 q ha^{-1}), shelling percentage (72.12%), number of mature pods, weight of mature pods per plant, weight of dry pods per plant, and weight of haulms per plant, and treatments T_3, T_7, and T_8 were found at par with T_5. Significantly higher oil content (50.12%) and protein content (24.88%) in groundnut were recorded by 100% RDF + ZnSF-2 at 2.5 L ha^{-1} (T_5) and treatments T_3, T_7, and T_8 were found to be at par with T_5. The application of 100% RDF along with zinc solubilizers at 2.5 L ha-1 (ZnSF2-*Aspergillus terreus*) demonstrated significant superiority in the growth, yield attributes, yields, and quality of groundnut compared to other applications. This proved to be useful for adaptations in farmers' fields.

Keywords: *Aspergillus terreus*, zinc solubilizing fungi, groundnut, acid soil

1. Introduction

Zinc is a crucial micronutrient for plant growth, but deficiencies are widespread globally, affecting soil and crop productivity. Zinc plays a vital role in various plant metabolic processes, and its deficiency can lead to stunted growth, reduced yield, and poor quality of harvested products. The Konkan region's acidic soil conditions make it suitable for native soil microorganisms, especially fungi, to solubilize zinc effectively. The use of zinc-solubilizing fungi offers a sustainable solution to enhance zinc availability in the soil and improve growth attributes and crop production (Dinesh *et al.*, 2015, Dhaked *et al.*, 2017 and Naz *et al.*, 2016) [5, 4, 9]. The use of zinc-solubilizing fungi is a promising approach for cost-effective biofortification, aligning with sustainable agricultural practices and contributing to improved soil health and crop productivity in the long term. The majority of the Konkan region's soil in Maharashtra is acidic in nature and zinc deficient (> 27%) (Malewar, 2005) [6], which has a direct impact on the optimal development of crops, soil ecosystems, soil quality, and crop yields. Instead of relying on synthetic fertilizers, the application of zinc-solubilizing fungi alongside inorganic sources presents a highly viable and sustainable option for farmers to achieve optimal crop yields and effectively rectify zinc deficiency in the soil. As stated by Cakmak and Hoffland (2012) [2], inadequate bioavailability of zinc not only reduces agricultural productivity but also significantly reduces the quality of the harvested product. Groundnut (*Arachis hypogaea* L.) is a major cash crop, significant food legume, and oil seed crop in Kokan Region and India. The seeds of groundnut are rich in minerals, vitamins, and proteins known as the "poor man's almond," with 349 calories per 100 grams. With this background and the urgent needs, native zinc solubilizers could help improve the production of crops in zinc deficient soil.

2. Materials and Methods

A pot culture experiment was carried out at the Research Farm of AICRP on Agroforestry, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra, in the Alfisols. The experimental soil has been sandy loam in texture, moderately acidic in nature, with a very high level of organic carbon. It has medium nitrogen availability, low phosphorus availability, and a high content of potassium in the soil, making it ideal for groundnut cultivation. The present experiment was framed completely block design (CRD) in consisting nine treatment combinations in three replications. The treatments combinations were: T_1 - Absolute control, T_2 - 100% RDF (without zinc), T_3 - 100% RDF + $ZnSO_4$ @ 25 kg ha^{-1} (100% zinc), T_4 - 75% RDF + $ZnSO_4$ @ 18.75 kg ha^{-1} (75% zinc), T_5 - 100% RDF + ZnSF (Zinc solubilizing fungi @ 2.5 L/ha), T_6 - 75% RDF + ZnSF (Zinc solubilizing fungi @ 1.875 L/ha), T_7 - 75% RDF + ZnSF (Zinc solubilizing fungi @ 2.5 L/ha), T_8 - 100% RDF + ZnSF (Zinc solubilizing fungi @ 1.875 L/ha), T_9 - ZnSF Only (Zinc solubilizing fungi @ 2.5 L/ha). The variety of groundnut used for the investigation was Konkan Bhuratna. The recommended dose for groundnut (var- Konkan Bhuratna) was 30:60:30 kg N: P_2O_5: K_2O ha^{-1} used. Growth attributes of groundnut, such as the height of plant samples, were measured by scale from the base of the plant, i.e., from ground level up to the collar of the fully opened leaf of the plant, and average plant spread in (cm) also recorded. While considering yield attributes such as the number of mature pods counted at harvest from the observational plant, the average was worked out. The pods with fully developed kernels were considered mature pods. The mature pods from observational plants were collected, and their weight was taken, from which the average weight of mature pods per plant was computed. The mature pods from observational plants were airdried and their weight was taken from which the average weight of dry pods $plant^{-1}$ was computed. The haulm from observational plants were airdried, and their weight was taken, from which the average weight of dry haulm $plant^{-1}$ was computed. The treatment wise samples of 50 g of pods were collected from each treatment. Then it was shelled, and the weights of the kernels were recorded and the shelling percentage was calculated. Yield parameters such as dry pod yield, kernel yield and haulm yield were calculated (Reddy, 2011) [14]. The number of nodules also studied by uprooting plants was washed, and bold nodules per plant were separated, counted, and expressed on an average basis. The oil content of groundnut was determined by the Soxhlet extraction method using petroleum ether as an extractant (Plummer, 1998) [12]. The nitrogen content in seed was determined by Micro-Kjeldhal's method, and the protein content was calculated by multiplying the percent nitrogen by the factor 6.25 for groundnut (AOAC, 1990) [1]. The experimental data was subjected to analysis of variances (ANOVA) and treatment means were compared and significant differences were tested at the 5% significance level as per Panse and Sukhatme (1985) [11].

3. Result and Discussion

The zinc solubilizing fungus ZnSF-2 had a significant effect on groundnut growth and nodulation. Application of 100% RDF + ZnSF (zinc solubilizing fungi) at 2.5 L ha^{-1} (T_5) was recorded to have the significantly highest plant height (23.26 cm), plant spread (32.42 cm), number of nodules $plant^{-1}$ (103.61), whereas treatments T_7, T_8, and T_3 were found at par with T_5 (Table 1). the production of organic acids by fungus decreases the pH of rhizospheric soil, which helps in the mobilization of insoluble macro- and micronutrients that can be readily taken up by plants and thus promotes profuse growth and increases the yield of groundnut. Vidyashree *et al.* (2018) [16] concluded that tomato seedlings inoculated with *Bacillus* sp. (PAN-TM1) recorded the highest growth parameters, *viz*. plant height (94.1 cm), number of branches per plant (27.6), stem girth (2.05 cm), and total biomass (30.7 g) (Table 1). Chattopadhyay and Dutta (2003) [3] noted that seed inoculation with *Rhizobium* or PSB and the combined inoculation resulted in profuse nodulation leading to increased N fixation.

Table 1: Effect of ZnSF and inorganic sources on plant height, average plant spread and nodulation of groundnut.

Treatment details	Plant height (cm)	Plant spread (cm)	Number of nodules $plant^{-1}$
T_1 - Absolute control	13.61	17.93	48.51
T_2 - 100% RDF (without zinc)	19.11	27.12	82.26
T_3- 100% RDF + $ZnSO_4$ @ 25 kg ha^{-1} (100% zinc)	21.86	30.46	98.87
T_4- 75% RDF + $ZnSO_4$ @ 18.75 kg ha^{-1} (75% zinc)	19.54	27.61	87.23
T_5- 100% RDF + ZnSF-2* (Zinc solubilizing fungi @ 2.5 L/ha)	23.26	32.42	103.61
T_6- 75% RDF + ZnSF-2* (Zinc solubilizing fungi @ 1.875 L/ha)	19.76	28.96	91.42
T_7- 75% RDF + ZnSF-2* (Zinc solubilizing fungi @ 2.5 L/ha)	21.12	29.87	95.24
T_8- 100% RDF + ZnSF-2* (Zinc solubilizing fungi @ 1.875 L/ha)	22.14	31.15	101.24
T_9- ZnSF-2* Only (Zinc solubilizing fungi @ 2.5 L/ha)	17.51	25.76	73.56
SE±(m)	0.86	0.92	2.83
CD at 5%	2.58	2.76	8.49

(* ZnSF-2: *Aspergillus terreus*)

Application of 100% RDF + ZnSF (zinc solubilizing fungi) at 2.5 L ha^{-1} had a significantly higher number of mature pods $plant^{-1}$ (14.76), weight of mature pods $plant^{-1}$ (15.78), weight of dry pods $plant^{-1}$ (14.96) and weight of haulms $plant^{-1}$(20.18) of groundnut, and treatments T_7, T_8, and T_3 were found at par with the T_5 treatment (Table 2). The increase in the number of pods, weight of pods, weight of dry pods, and weight of haulms of groundnut at harvest may be due to production plant growth-promoting attributes such as IAA production and ammonia production by the fungus. Panneerselvam *et al.* (2013) [10], who found that among all isolates, application of *P. putida* with *G. mosseae* significantly increased seedling height, fresh and dry shoot and root weight, total biomass as compared to other treatments.

Table 2: Effect of ZnSF and inorganic sources on number of pods, weight of pods, weight of dry pods and weight of haulms of groundnut at harvest.

Treatment details	No. of mature pods plant^{-1}	Weight of mature pods plant^{-1} (g)	Weight of dry pods plant^{-1}(g)	Weight of haulms plant^{-1}(g)
T_1 - Absolute control	6.41	7.03	6.07	11.03
T_2 - 100% RDF (without zinc)	10.31	11.21	10.42	15.64
T_3- 100% RDF + $ZnSO_4$ @ 25 kg ha^{-1} (100% zinc)	13.24	14.66	13.87	19.09
T_4- 75% RDF + $ZnSO_4$ @ 18.75 kg ha^{-1} (75% zinc)	11.56	12.69	11.95	17.17
T_5- 100% RDF + ZnSF-2* (Zinc solubilizing fungi @ 2.5 L/ha)	14.76	15.78	14.96	20.18
T_6- 75% RDF + ZnSF-2* (Zinc solubilizing fungi @ 1.875 L/ha)	12.16	13.54	12.67	17.89
T_7- 75% RDF + ZnSF-2* (Zinc solubilizing fungi @ 2.5 L/ha)	13.08	14.16	13.44	18.66
T_8- 100% RDF + ZnSF-2* (Zinc solubilizing fungi @ 1.875 L/ha)	14.01	15.02	14.24	19.46
T_9- ZnSF-2* Only (Zinc solubilizing fungi @ 2.5 L/ha)	9.18	8.96	8.03	13.37
SE±(m)	0.63	0.54	0.54	0.51
CD at 5%	1.89	1.62	1.63	1.53

(* ZnSF-2: *Aspergillus terreus*)

Application of the zinc solubilizing fungus ZnSF-2 had a significant impact on various yield parameters and shelling percentages of groundnut. Application of treatment 100% RDF + ZnSF (zinc solubilizing fungi) at 2.5 L ha^{-1} (T_5) showed significantly higher dry pod yield (33.24 q ha^{-1}), kernel yield (23.97 q ha^{-1}), dry haulm yield (44.84 q ha^{-1}), shelling percentage (72.12%), and treatments T_3, T_7, and T_8 were found at par with T_5 (Table 3). Enhancements in plant nutrient uptake and its transport from root to aerial parts, along with the production of plant stimulators such as IAA by fungi, could have resulted in higher photosynthetic rates needed to generate enough energy for the observed growth response. Sable and Ismail (2017) [15] reported that kernel and haulm yield of groundnut and net returns were increased with the inoculation of zinc-solubilizing microorganisms along with the recommended dose of fertilizers over the uninoculated control.

Table 3: Effect of ZnSF and inorganic sources on dry pod yield, kernel yield, dry haulm yield and shelling percentage of groundnut.

Treatment details	Dry Pod yield (q ha^{-1})	Kernel yield (q ha^{-1})	Dry Haulm yield (q ha^{-1})	Shelling percentage (%)
T_1 - Absolute control	13.49	7.12	24.51	52.81
T_2 - 100% RDF (without zinc)	23.16	15.15	34.76	65.41
T_3- 100% RDF + $ZnSO_4$ @ 25 kg ha^{-1} (100% zinc)	30.82	21.56	42.42	69.96
T_4- 75% RDF + $ZnSO_4$ @ 18.75 kg ha^{-1} (75% zinc)	26.56	17.61	38.16	66.32
T_5- 100% RDF + ZnSF-2* (Zinc solubilizing fungi @ 2.5 L/ha)	33.24	23.97	44.84	72.12
T_6- 75% RDF + ZnSF-2* (Zinc solubilizing fungi @ 1.875 L/ha)	28.16	19.02	39.76	67.54
T_7- 75% RDF + ZnSF-2* (Zinc solubilizing fungi @ 2.5 L/ha)	29.87	20.56	41.47	68.82
T_8- 100% RDF + ZnSF-2* (Zinc solubilizing fungi @ 1.875 L/ha)	31.64	22.33	43.24	70.58
T_9- ZnSF-2* Only (Zinc solubilizing fungi @ 2.5 L/ha)	17.84	10.39	29.71	58.24
SE±(m)	1.21	1.14	1.15	1.48
CD at 5%	3.63	3.42	3.45	4.44

(* ZnSF-2: *Aspergillus terreus*)

The Zn solubilizing fungus (ZnSF-2) significantly influenced oil and protein content in the kernel. The results showed that treatment T_5 receiving 100% RDF + ZnSF (zinc solubilizing fungi) at 2.5 L ha^{-1} had a significantly higher oil (50.12%) and protein content (24.88%) of groundnut over all other treatments, and treatments T_3, T_7, and T_8 were found to be at par with T_5 (Table 4). The microbial cultures act as PGPR and enhance the availability of nutrients to the crops in a sustainable way, increasing yields and improving quality attributes. Raut *et al.* (2019) [13], who reported that treatment T_4 receiving 100% GRDF along with zinc solubilizing bacteria had a significantly higher oil content of 40.96% over all the treatments. The good quality of soil and balanced nutrition provide sufficient amounts of nutrients for crops to achieve optimum productivity and quality (Meshram *et al.*, 2018 and Meshram *et al.*, 2019) [7-8].

Table 4: Effect of ZnSF and inorganic sources on oil and protein content of groundnut.

Treatment details	Oil (%)	Protein (%)
T_1 - Absolute control	38.31	21.31
T_2 - 100% RDF (without zinc)	42.46	22.50
T_3- 100% RDF + $ZnSO_4$ @ 25 kg ha^{-1} (100% zinc)	48.32	23.88
T_4- 75% RDF + $ZnSO_4$ @ 18.75 kg ha^{-1} (75% zinc)	44.56	22.94
T_5- 100% RDF + ZnSF-2* (Zinc solubilizing fungi @ 2.5 L/ha)	50.12	24.88
T_6- 75% RDF + ZnSF-2* (Zinc solubilizing fungi @ 1.875 L/ha)	45.89	23.13
T_7- 75% RDF + ZnSF-2* (Zinc solubilizing fungi @ 2.5 L/ha)	47.52	23.69
T_8- 100% RDF + ZnSF-2* (Zinc solubilizing fungi @ 1.875 L/ha)	49.64	24.56
T_9- ZnSF-2* Only (Zinc solubilizing fungi @ 2.5 L/ha)	40.32	21.75
SE±(m)	0.88	0.41
CD at 5%	2.64	1.23

(* ZnSF-2: *Aspergillus terreus*)

4. Conclusions
It was concluded that the application of 100% RDF + ZnSF-2* (Zinc Solubilizing Fungi, *Aspergillus terreus*) at 2.5 L ha^{-1} showed a significant superiority with respect to enhancing growth, yield attributes, and quality parameters of groundnut and was most effective in zinc deficient acidic soil.

5. Reference

1. A.O.A.C. Official Methods of Analysis. 12th ed. Washington, D.C.: Association of Official Analytical Chemists; c1990.
2. Cakmak I, Hoffland E. Zinc for the improvement of crop production and human health. Plant Soil. 2012;361:1–2.
3. Chattopadhyay A, Dutta D. Response of vegetable cowpea to phosphorus and biofertilizers in old alluvial zone of West Bengal. Recommended publications for legal research. 2003;26(3):196-199.
4. Dhaked BS, Triveni S, Reddy RS, Padmaja G. Isolation and screening of potassium and zinc solubilizing bacteria from different rhizosphere soil. Int J Curr Microbiol Appl Sci. 2017;6(8):1271-1281.
5. Dinesh R, Srinivasan V, Hamza S, Sarathambal C, Anke Gowda SJ, Ganeshmurthy AN, *et al*. Isolation, characterization and evaluation of multi-trait plant growth promoting rhizobacteria for their growth promoting and disease suppressing effects on Ginger. Geoderma. 2015;321:173-186.
6. Malewar GU. Micro-nutrient status in soils of Maharashtra. State Level Seminar, held at DBSKKV, Dapoli; c2005.
7. Meshram NA, Syed Ismail, Pinjari SS. Long-term effect of FYM and inorganic fertilizers on soil quality and sustainable productivity of soybean (*Glycine max*) and safflower (*Carthamus tinctorius*) in Vertisol. Indian J Agric Sci. 2018;88(6):845-50.
8. Meshram NA, Syed Ismail, Shirale ST, Patil VD. Impact of Long-term fertilizer application on soil fertility, nutrient uptake, growth and productivity of soybean under soybean-safflower cropping sequence in Vertisol. Legume Res. 2019;42(2):182-189.
9. Naz I, Ahmad H, Khokhar SN, Khan K, Shah AH. Impact of Zinc Solubilizing Bacteria on Zinc Contents of Wheat. Am Eurasian J Agric Environ Sci. 2016;16:449-454.
10. Panneerselvam P, Saritha B, Mohandas S, Upreti KK, Poovarasan S, Sulladmath VV, Venugopalan R. Effect of mycorrhiza-associated bacteria on enhancing colonization and sporulation of Glomus mosseae and growth promotion in sapota (*Manilkara achras* (Mill) Forsberg) seedlings. Biol Agric Hort. 2013;29(2):118-131.
11. Panse UG, Sukhatme PV. Statistical Methods for Agricultural Workers. New Delhi: I.C.A.R. Publication; c1985. p. 600-603.
12. Plummer D. An Introduction to Practical Biochemistry. 3rd ed. Delhi: Tata McGraw Hall Publication; c1998. p. 150-151.
13. Raut AD, Durgude AG, Kadlag AD, Annapurna MVVI. Chauhan MR. Potential of plant growth promoting bacteria on nutrient availability in soil, nutrient uptake and yield of summer groundnut grown on entisol. Int J Curr Microbiol Appl Sci. 2019;8(2):2326-2335.
14. Reddy SR. Principles of Agronomy. Kalyani Publishers; c2011.
15. Sable P, Ismail S, Pawar A. Effect of different microbial inoculants on yield, microbial population and chemical properties in soil of groundnut grown on vertisol. Int J Microbiol Res. 2017;9(1):831-833.
16. Vidyashree DN, Muthuraju R, Panneerselvam P. Evaluation of Zinc Solubilizing Bacterial (ZSB) Strains on Growth, Yield and Quality of Tomato (*Lycopersicon esculentum*). Int J Curr Microbiol Appl Sci. 2018;7(4):1493-1502.