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Influence of zinc and seaweed sap on economics and yield of little millet (*Panicum sumatrens* L.)

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Abstract
A field experiment was conducted during *Kharif* season of 2024 at Crop Research Farm Department of Agronomy, SHUATS, Prayagraj (U.P.), India. The treatment consisted of 3 Different level of Zinc (10 kg/ha, 20 kg/ha and 30 kg/ha) and Different level Seaweed Sap (5%, 10% and 15%) along with recommended dose of fertilizers (120:60:40 kg NPK/ha), this experiment was laid out in a Randomized Block Design with 10 treatment and replications thrice with application Zinc and Seaweed Sap. The result showed that significantly yield attributes such as effective seeds/ear head (308.00), test weight (50.87 g), seed yield (1111.20 kg/ha), straw yield (3126.90 kg/ha), harvest index (26.23%), was recorded significantly higher in treatment 9 (Zinc 30 kg/ha along with Seaweed sap 15%). and highest gross return (INR 1,00,008.00/ha), net return (INR 66,308.00/ha) and benefit cost ratio (1.97) was obtained in treatment 9 (Zinc 30 kg/ha and Seaweed sap 15%). It was concluded that application of Zinc 30 kg/ha along with Seaweed sap 15% for performed better in terms of yield and economic returns.

Keywords: Economics kharif, little millet, seaweed sap, yield, zinc

Introduction
Little Millet (*Panicum Sumatrense* L.) is one of the minor millet, which belongs to the family *Poaceae*. It is a short-duration, fast-growing crop that is resistant to water logging and drought. It is a significant crop that is cultivated for feed and food. India and a Karnataka traditional crop People of all ages can benefit from this fantastic millet. It treats all stomach-related issues and helps avoid constipation. Consuming little millet, which is high in cholesterol, strengthens the body and raises healthy cholesterol in the body, making it ideal for growing children. For diabetics, its complex carbohydrates' slow digestion is highly beneficial. It grows all over. In South-Eastern Asia and Northern India, it grows wild. In extremely bad conditions, it will produce some grain and useful feed (Rajput *et al*. 2022) [6]. Tribal and economically disadvantaged segments of the population rely on the crop as a staple and well-balanced diet. It offers affordable proteins, vitamins, and minerals as sustainable food. By strengthening disease resistance and fostering tolerance to harsh weather conditions like heat or drought, little millet plays a vital role in supplying nutraceutical components like phenols, tannins, and phytates along with other minerals to increase crop resilience and adaptation. (2024) Ranjan *et al*. [5]
For every 100 grams of grain, the small millet has 8.7 grams of protein, 75.7 grams of carbohydrates, 5.3 grams of fat, 1.7 grams of minerals, and 9.3 mg of iron. Its high fiber content aids in lowering the body's fat deposits. Cattle can benefit from the stover. 65.5 g of carbohydrates, 10.1 g of protein, 3.89 g of fat, 346 Kcal of energy, 7.7 g of dietary fiber, 16.1 mg of calcium, 130 mg of phosphorus, 91 mg of magnesium, 1.8 mg of zinc, 1.2 mg of iron, 0.26 mg of thiamin, 0.05 mg of riboflavin, 1.3 mg of niacin, and 362µg of folic acid are all present in 100 g of little millet grain. In 2022–2023, 4.23 lakh hectares of India were planted to minor millets, yielding 3.75 lakh tonnes and 885 kg/ha of productivity. In Karnataka, the little millet crop is cultivated on 36,856 hectares, yielding 30,841 tons and 880 kilograms of productivity per hectare. Gujarat leads the state in small millet productivity, with 1988 kg/ha. With an area of 0.89 lakh hectares and a production of 0.77 lakh tonnes in 2022–2023, Madhya Pradesh leads the world in small millet production (APEDA, 2023).
Micronutrients are essential for preserving soil health and boosting crop yields. Very little of

this is required. Zinc is particularly important for plants' normal, healthy growth and reproduction. Zinc is an essential structural component or regulatory co-factor of several enzymes in numerous vital metabolic processes in plants. According to Pedler *et al*. (2000) [18] and Ranjan *et al*. (2024) [7], zinc is the primary nutrient that connects certain enzymes, such as alcohol dehydrogenase, carbonic anhydrase, and superoxide dismutase.

An inexpensive organic fertilizer is seaweed extract. Numerous writers have documented the use of seaweeds as fertilizers and their significance in crop productivity. It has been demonstrated that seaweed extracts include a variety of bioactive compounds that positively impact crop quality and productivity. Along with critical macro- and micronutrients, they also contain a number of plant growth regulators, including gibberellins, cytokinins, choline chloride, glycine betaine, and IAA, which are in charge of triggering a variety of physiological reactions in plants. Singh and associates (2015) [13].

Materials and Methods

A field experiment was carried out in alluvial soil at the Crop Research Farm of the Department of Agronomy, SHUATS, Prayagraj, U.P., during the *Kharif* season of 2024. It is located at 25^0 24 42 N latitude, 81^0 50 56 E longitude and 98 m altitude above the mean sea level. This area is situated on the right side of the river Yamuna by the side of Prayagraj Rewa Road about 5 km away from Prayagraj city. A composite soil sample was collected at a depth of 0- 30 cm. It was air dried, crushed, and tested for physical and chemical properties. The soil was sandy clay loam in texture with soil reaction of (pH 7.6), 0.69 organic matter (0.72%), available nitrogen (152.7 kg/ha), phosphorus (10.4 kg/ha), potassium (174.0 kg/ha) on 18^{th} July 2024, little millet seeds (CLMV 1) were planted with a 45 cm x 15 cm spacing. Experiments were carried out in a Randomized block design. There were ten treatment combinations compression with Different levels of Zinc in soil application (10, 20 and 30 kg/ha) and foliar application of Seaweed Sap (5%, 10% and 15%) and along with RDF 80:40:40 kg NPK/ha. the treatment combination are as follows. (T_1- Zinc 10 kg/ha + Seaweed sap – 5%, T_2- Zinc 10 kg/ha + Seaweed sap - 10%, T_3- Zinc 10 kg/ha + Seaweed sap - 15%, T_4- Zinc 20 kg/ha + Seaweed sap - 5%, T_5- Zinc 20 kg/ha + Seaweed sap – 10%, T_6- Zinc 20 kg/ha + Seaweed sap - 15%, T_7- Zinc 30 kg/ha + Seaweed sap- 5%, T_8- Zinc 30 kg/ha + Seaweed sap – 10%, T_9- Zinc 30 kg/ha + Seaweed sap - 15%, T_{10} - Control (120:60:40) NPK kg/ha. To apply nutrients as a spreading method, 4-5 cm deep furrows were dug along the seed rows using a hand hoeing. Ten days after sowing, the gaps were filled by transplanting once germination took place. Where necessary, seedlings were trimmed out to maintain 30 cm x10 cm spacing. In order to reduce crop density, weed competition, intercultural operations were carried out between 25 and 40 days intervals. On 12^{th} October 2024, harvesting of the crop was done. At regular intervals from germination to harvest, plant growth parameters such as plant height (cm), dry weight (g/plant), CGR and RGR were assessed. At harvest, yield metrics such as tiller/plant, seeds/tiller, test weight (g), seed yield (kg/ha), straw yield (kg/ha), and harvest index (%) were measured at 20, 40, 60 and 60 DAS. Analysis of variance (ANOVA), as it relates to randomized block design, was used to statistically examine the observed data of ten treatments (Gomez and Gomez, 1984 and Mohan *et al*. 2024) [5].

Results and Discussions

Growth parameter

Yield attributes

The data pertaining to yield-attributing characters are presented in Table 2. The maximum number of tiller/plant (3.67) was recorded with the application of Zinc 30 kg/ha + Seaweed sap 15% seed which was found to be statistically at par to all treatment. Significantly higher number of Seed/tiller (309.07) and test weight (3.04 g) were recorded with application of Zinc 30 kg/ha + Seaweed sap 15% seed were statistically at par with the highest. The probable reason for these results attributed to seeds inoculated with seaweed sap are well-nourished and able to transport enough nutrients and metabolites to the growing seedling. (Malhotra *et al.,* 2018 and Reddy *et al.* 2022) [17, 8].

Grain yield

The statistical data in Table 2 showed that significantly highest grain yield (1378.29 kg/ha) was recorded in treatment 9 (Zinc 30 kg/ha + Seaweed sap 15%), which was statistically at par with treatments 6 (1261.53 kg/ha). These results might be due to better seed germination and a larger root system for nutrient uptake, which are the results of the early nourishment offered to the seeds by seaweed sap in the form of growth-promoting chemicals was reported by Mohan *et al*. (2024) [5]. Seaweed sap and Zinc is a major plant nutrient that influences cell division, germination of seeds, flowering, fruiting, synthesis of fat and starch. Besides, the nutrient take part in various biochemical activities is involved in the regulation of metabolic pathways inclusive of enzyme reactions (Malhotra *et al.*, 2018) [17].

Straw Yields

The data in Table 2 showed that a significantly maximum stover yield (2453.36 kg/ha) was recorded with the application of (Zinc 30 kg/ha + Seaweed sap 15%), whereas treatments 6, (2270.75 kg/ha) found to be statistically at par with the highest. The application of Zinc 30 kg/ha + Seaweed sap 15% resulted in significantly higher stover yield; this might be due to improved growth in terms of seedling emergence, plant height, and dry matter accumulation, which raises photosynthetic efficiency. Greater photosynthetic accumulation in vegetative components leads to superior vegetative development and hence the stover yield increases is similar to Yadav *et al.* and Mohan *et al*. (2024) [5].

Economics

The application of Zinc along with Seaweed sap which increase the grain yield and straw yield among all the treatment. It gives highest gross return (INR 1,00,008.00/ha) among all the treatment and net return (INR 66,308.00/ha) was recorded height compared to other treatment and also recorded height benefit cost ratio (1.97) was obtained in treatment 9 (Zinc 30 kg/ha and Seaweed sap 15%). It was concluded that application of Zinc 30 kg/ha along with Seaweed sap 15% for performed better in terms of yield and economic returns (Rajput *et al*. 2022) [6]. Thus, the little millet produces significantly higher productivity and economic return. However, treatment 9 (Zinc along with Seaweed sap) was found to be highest for millet crop and it performed well which were at par with all treatment and rescored higher economics which was influenced by Zinc and Seaweed Sap. Reported by Bhavani *et al*. (2021) [1] and Debbarma *et al*. (2023) [3].

Harvest index

Data presented in table 2 showed that the highest harvest index (35.97%) was recorded with the application of (Zinc 30 kg/ha + Seaweed sap 15%) T_9 which was statistically at par to all treatment.

Table 1: Influence of Zinc and Seaweed Sap on yield attributes and yield of Little Millet

S. No.	Treatments	No. of tiller/plant	No. of seeds/ tiller	Test weight (g)	Seed yield (kg/ha)	Straw yield	Harvest index
1	Zinc 10 kg/ha + Seaweed sap 5%	2.73	239.73	2.49	653.91	1307.82	33.33
2	Zinc 10 kg/ha + Seaweed sap 10%	2.60	256.60	2.63	701.56	1361.02	34.01
3	Zinc 10 kg/ha + Seaweed sap 15%	3.27	283.07	2.88	1065.01	1991.57	34.84
4	Zinc 20 kg/ha + Seaweed sap 5%	2.60	249.93	2.56	666.48	1272.97	34.36
5	Zinc 20 kg/ha + Seaweed sap 10%	3.27	271.00	2.76	976.86	1846.26	34.60
6	Zinc 20 kg/ha + Seaweed sap 15%	3.47	303.73	2.99	1261.53	2270.75	35.71
7	Zinc 30 kg/ha + Seaweed sap 5%	2.87	263.67	2.67	806.85	1557.22	34.13
8	Zinc 30 kg/ha + Seaweed sap 10%	3.40	290.47	2.91	1153.44	2122.33	35.21
9	Zinc 30 kg/ha + Seaweed sap 15%	3.67	309.07	3.04	1378.29	2453.36	35.97
10	Control (RDF): 120:60:40 NPK kg/ha	2.53	235.00	2.46	583.56	1283.84	31.25
F-test		S	S	S	S	S	NS
SEm±		0.12	2.72	0.04	39.83	75.78	0.001
CD (p=0.05).		0.36	8.08	0.11	118.34	225.15	0.003

Table 2: Influence of Zinc and Seaweed Sap on economics of Little Millet.

S. No.	Treatments	Total cost of cultivation	Gross Return (INR/ha)	Net Return (INR)	B:C ratio
1	Zinc 10 kg/ha + Seaweed sap 5%	25,050	42504.24	19154.24	0.76
2	Zinc 10 kg/ha + Seaweed sap 10%	25,100	45601.14	22251.14	0.89
3	Zinc 10 kg/ha + Seaweed sap 15%	25,150	69225.59	45875.59	1.82
4	Zinc 20 kg/ha + Seaweed sap 5%	26,550	43320.98	19970.98	1.87
5	Zinc 20 kg/ha + Seaweed sap 10%	26,600	63495.76	40145.76	1.51
6	Zinc 20 kg/ha + Seaweed sap 15%	26,650	81999.37	58649.37	2.20
7	Zinc 30 kg/ha + Seaweed sap 5%	28,050	52445.29	29095.29	1.04
8	Zinc 30 kg/ha + Seaweed sap 10%	28,100	74973.47	51623.47	1.84
9	Zinc 30 kg/ha + Seaweed sap 15%	28,150	89588.98	66238.98	2.35
10	Control:- 120:60:40 kg NPK/ha	23,350	37931.50	14581.50	0.62

Conclusion

On the basis of one season experimentation, from the results, it can be concluded that application of (Zinc 30 kg/ha + Seaweed sap 15%) Treatment 9 in Little Millet has recorded highest gross return, net return and benefit cost ratio (B:C Ratio).

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