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Chenepalli Lohitha
M.Sc. Scholar, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Biswarup Mehera
Professor, Dean, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Prateek Kumar
Ph.D. Scholar, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Shasank Singh
Ph.D. Scholar, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Chenepalli Lohitha
M.Sc. Scholar, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Effect of sulphur and phosphorus on economics of little millet

Chenepalli Lohitha, Biswarup Mehera, Prateek Kumar and Shasank Singh

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Abstract
A field experiment was conducted during *Zaid* season of 2024-25 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences to determine "Effect of Sulphur and Phosphorus on economics of Little millet". The treatments consisted of two levels of Sulphur (20, 30 and 40 kg/ha) and Phosphorus (15, 30 and 45 kg/ha) along with recommended doses of fertilizer and a control (40-20-20 kg N-P-K/ha). The results revealed that the significantly higher seed yield (1186 kg/ha), and higher stover yield (2474 kg/ha) were recorded with treatment 6 (Sulphur 30 kg/ha + Phosphorus 25 kg/ha). The maximum gross return (119680.00 INR/ha), net return (71607.14 INR/ha) and B:C ratio (1.48) were also recorded with application of Sulphur 30 kg/ha + Phosphorus 25 kg/ha (treatment 6) was found to be productive as well as economically feasible.

Keywords: Little millet, economics, growth, sulphur, yield and phosphorus

1. Introduction

Millets are small seeded coarse cereals; belong to Poaceae family, widely grown in the world, predominantly in Eurasia and Africa in tropical and arid conditions. Minor millets were key food crops in the past and currently claimed as the future foods keeping ill effects of global warming and climate change more highlighted in fragile ecological settings. These are suited to grow in wide ranges of temperature, moisture-regime and input conditions and can be a potential candidate for feeding millions of smallholders of drylands and domestic animals. Furthermore, as C4 plant, millets sequester carbon and hence contribute to CO2 reduction opportunities, support enhanced agro-biodiversity by their diversities and permit intercropping of benefitting each other by the intercrop with other critical crops (Brahmachari et al. 2018) [4]. The critical small millets cultivated in India are finger millet, Kodo millet, little millet, foxtail millet, barnyard millet and common millets. The area of small millets has reduced at the rate of 3.27 percent annually and production has reduced at the rate of 2.83 per cent per annum from 1950 to 2014(Vilas, 2017) There has been uniform decline in area of small millets between 1949- 1950 (7.63 million ha) and 1994-1995 (3.69 million ha). The production has ranged between 3.82 and 3.30 metric tons during the same period. Sulphur enhanced uptake of nutrient that facilitated the plants to produce optimum growth. Similar, results were found by Yadav and Nand (2004) [21].

The origin of little millet is not well recorded and regarded as Indian origin. The crop has a name in all the vernacular languages of India. This millet was grown or naturalized in India and Sri Lanka, and grown in neighbouring countries and no diversity and related wild species are reported outside India, indicative of Indian origin. In the archaeological excavations of Gujarat of 2000-1500 BC presence of little millet seeds was indicated (Venkatesh Bhat et al, 2018) [20]. The cultivation of little millet is predominantly seen in the states of Karnataka, Madhya Pradesh, Andhra Pradesh, Odisha, Tamil Nadu, Gujarat, Chattisgarh and Maharashtra. Similar to other small millets, little millet is also nutritious. Little millet is a dependable catch crop due to its earliness and resistance to unfavorable agroclimatic conditions. It is usually eaten as rice and any dish that requires staple rice are often made with little millet. It will produce some grain and useful fodder under very poor conditions.

The area of small millets in India is approximately 7.0 lakh ha with productivity of 633 kg /ha (Anbukkani *et al*. 2017) [1] Millets are a group of highly variable small seeded grasses, grown extensively across the globe as cereal crops or grains for fodder and human food. Typically, these are rainfed crops grown in low rainfall areas and hence assume greater significance for sustained agriculture and food security.

The crops are utilized due to their productivity and brief period of growth in dry and high- temperature conditions The productivity of the crops is lower than that of other major cereals since these crops are grown predominantly in abiotic stress regions with poor nutrient soils. The small millets are, therefore, poor man's food especially in the arid tracts of the country, where food crops other than these cannot be grown. They are referred to as Nutri-cereals of their su priority in supply of proteins, minerals, fibre etc. Area of small millets in India is 649,000 ha with production of 390,000 tonnes, with productivity of 602 kg/ha, production 1,000 tonnes and productivity 1,000 kg/ha (Annual Progress Report, ICAR-AICRP on Small Millets 2017-18).

Each 100 g little millet grain contains 65.5 g carbohydrate, 10.1 g protein, 3.89 g fat, 346 Kcalenergy, 7.7 g dietary fibre, 16.1 mg calcium, 130 mg phosphorus, 91 mg magnesium, 1.8 mg zinc, 1.2mgiron,0.26 mg thiamin, 0.05 mg riboflavin, 1.3 mg niacin and 362µg folic acid (Venkatesh Bhat *et al*. 2018) [20].

The little millet is rich in nutritive values with respect to proteins, carbohydrates and minerals. Proximate analysis of little millet per 100g edible portion shows that it contains 9.7% of proteins, 60.9% of starch, 5.2% of fats, 7.6% of crude fibers, 4.9% ash,17.0 mg of calcium (McDonough *et.al* 2000). The dietary fiber and starch in little millet exhibit low glycemic index and hypolipidemic effects. Millet’s antioxidants for example polyphenols, tannins, phenolic compounds, flavonoids play a major role in improving health by reducing the chances of diseases such as cardiovascular disease, diabetes, cataract, gastrointestinal and inflammation problems. Little millet contains high fat, comprising mainly of the healthy polyunsaturated fatty acids (PUFA).

In pearl millet potassium plays vital role in enzyme activities, water and energy metabolism, translocation of assimilates photosynthesis, protein and starch synthesis (Mengel). Potassium involves in water uptake and efficiency and also impart resistant against drought, pest and diseases of pearl millet (Chaudhary *et. al* 2014) [6].

Sulphur is crucial in the production of pearl millet. Its most well-known role is in protein synthesis, oil development, and vitamin development in the crop. Sulphur also aids in the development of the crop with improved nutritional value and improved quality for the market (Chaudhary *et al.* 2014) [6].

phosphorus plays a crucial role in millet production. The significant increase in grain and stover yield of pearl millet was largely a function of improved growth and the consequent increase in different yield attributes as noted above. This positive impact may be due to the fact that P is particularly renowned for acting as 'Energy currency' and is an essential player in development and energy conversion in a range of vitally critical metabolic pathways in the plant (Singh *et al.* 2017) [5]. Phosphorus fertilisation could have led to higher vegetative growth, which could have been due to the extensive root system of the plant efficiently gathering and utilizing other nutrients. Grain yield influences biological yield. Due to this, the addition of phosphorus to a crop has the ability to increase biological yields by a significant amount. Likewise, Jakhar *et al.* [6], Bhuva and Sharma [10] and others have also achieved similar findings.

2. Materials and Methods

The experiment was conducted during zaid season 2024 at crop research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of the experimental field was sandy loam in texture, with soil (PH 7.8), low level of organic carbon (0.72%), available N(178.48 Kg/ha), P(27.80 Kg/ha), k(233.24 Kg/ha). The treatment consists of three levels of Sulphur along with the combination of phosphorus. The experiment was laid out in RBD with 10 treatments each replicated thrice. The treatment combinations are T_1 - Sulphur (20kg/ha) + Phosphorus (15 kg/ha), T_2 - Sulphur (20 kg/ha) + Phosphorus (20 kg/ha), T_3 - Sulphur (20 kg/ha) + Phosphorus (25 kg/ha), T_4 - Sulphur (30 kg/ha) + Phosphorus (15 kg/ha), T_5 - Sulphur (30 kg/ha) + Phosphorus (20 kg/ha), T_6 - Sulphur (30 kg/ha) + Phosphorus (25 kg/ha), T_7 - Sulphur (40 kg/ha) + Phosphorus (15 kg/ha), T_8 - Sulphur (40 kg/ha) + Phosphorus (20 kg/ha), T_9 - Sulphur (40 kg/ha) + Phosphorus (25 kg/ha), T_{10} - Control N:P:K(40:20:20 Kg/ha).

Treatment Combinations

Treatment 1	Sulphur 20 kg + Phosphorus 15 kg/ha
Treatment 2	Sulphur 20 kg + Phosphorus 20 kg/ha
Treatment 3	Sulphur 20 kg + Phosphorus 25 kg/ha
Treatment 4	Sulphur 30 kg + Phosphorus 15 kg/ha
Treatment 5	Sulphur 30 kg + Phosphorus 20 kg/ha
Treatment 6	Sulphur 30 kg + Phosphorus 25 kg/ha
Treatment 7	Sulphur 40 kg + Phosphorus 15 kg/ha
Treatment 8	Sulphur 40 kg + Phosphorus 20 kg/ha
Treatment 9	Sulphur 40 kg + Phosphorus 25 kg/ha
Treatment 10	Control (RDF) - 40:20:20 NPK kg/ha

3. Results and Discussion

3.1 Yield Attributes

Seed Yield (kg/ha)

Treatment-T_6 produced a significantly maximum grain yield 1186 kg/ha among all the treatments, whereas a significantly lower grain yield (919 kg/ha) was recorded with the control-T_{10}. However, treatment- T_7 with grain yield 1052 kg/ha was statistically at par with treatment-T_6.

Increase in yield attributes of varieties might be due to the genetic makeup of the plant, its wider adaptability under varied environments, good responsiveness to high input management and excellent agronomics and consistency. This also might be due to better root development of these varieties which helped in better absorption of nutrients and water which resulted in more plant stand with better growth for contributing higher yield attributes and yield. These results are in close conformity with those of Divya *et al.* (2017) [8].

A field experiment was conducted at Shivamogga, Karnataka in acidic sandy loam soils indicated that the application of 30 kg N and 20 kg P2O5 with or without 10 kg K2O performed better for achieving growth and yield

components and grain and straw yields (Divyashree *et al.* 2018b) [9].
Similar positive response of S on plant growth and yield attributes have also been reported by Kumar *et al.* (2014) [11].

3.1.1 Stover yield (kg/ha)
Significantly higher stover yield with 2474kg/ha and significantly lower stover yield (1803kg/ha) was recorded with control-T_{10}. However, treatment-T_5 with stover yield of 2371 kg/ha was statistically at par with treatment-T_6.
The significant increase in grain and stover yield of pearl millet was largely a function of improved growth and the consequent increase in different yield attributes as mentioned above. This favourable effect might be owing to the fact that P is well known for its role as 'Energy currency' and plays a key role in development and energy transformation in various vitally important metabolic processes in the plant (Singh *et al*., 2017) [5].

3.1.2 Harvest index (%)
higher harvest index (36.1%) was recorded with treatment-T_7. whereas the lower harvest index (31.7%) was recorded with treatment- T_5.

3.2 Economics
The results revealed that maximum gross return (119680.00 INR/ha), net return (71607.14 INR/ha) and B:C ratio (1.48) were recorded in treatment 6 [Sulphur (30 kg/ha) + Phosphorus (25 kg/ha)] as compared to other treatment Cost of cultivation increased with increasing levels of phosphorus. Maximum gross returns (119680.00 INR/ha), net returns (71607.14 INR/ha) and B:C ratio (1.48) of little millet were recorded.

Table 1: Effect of Sulphur and Phosphorus on the yield attributes of Little millet

Sr. No.	Treatment combinations	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest Index (%)
1.	Sulphur 20 kg + Phosphorus 15 kg/ha	988	1927	34.2
2.	Sulphur 20 kg + Phosphorus 20 kg/ha	961	1952	32.9
3.	Sulphur 20 kg + Phosphorus 25 kg/ha	1007	1814	35.7
4.	Sulphur 30 kg + Phosphorus 15 kg/ha	991	1834	35.0
5.	Sulphur 30 kg + Phosphorus 20 kg/ha	1103	2371	31.7
6.	Sulphur 30 kg + Phosphorus 25 kg/ha	1186	2474	32.1
7.	Sulphur 40 kg + Phosphorus 15 kg/ha	1052	1857	36.1
8.	Sulphur 40 kg + Phosphorus 20 kg/ha	942	1896	33.1
9.	Sulphur 40 kg + Phosphorus 25 kg/ha	1092	1984	35.5
10.	Control (RDF) - 25:40:50 NPK kg/ha	919	1803	33.8
	F Test	S	S	NS
	SEm (±)	48.98	77.55	1.28
	CD (p=0.05)	145.53	230.41	-

Table 2: Effect of nutrient management on economics of Little millet

S. No	Treatment combination	Cost of cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C ratio
1.	Sulphur 20 kg + Phosphorus 15 kg/ha	46295.66	98316.67	52021.00	1.12
2.	Sulphur 20 kg + Phosphorus 20 kg/ha	46621.76	96400.00	49778.24	1.06
3.	Sulphur 20 kg + Phosphorus 25 kg/ha	46947.86	98726.67	51778.80	1.10
4.	Sulphur 30 kg + Phosphorus 15 kg/ha	47420.66	97673.33	50252.67	1.05
5.	Sulphur 30 kg + Phosphorus 20 kg/ha	47746.76	111956.70	64209.90	1.34
6.	Sulphur 30 kg + Phosphorus 25 kg/ha	48072.86	119680.00	71607.14	1.48
7.	Sulphur 40 kg + Phosphorus 15 kg/ha	48545.66	102760.00	54214.34	1.11
8.	Sulphur 40 kg + Phosphorus 20 kg/ha	48871.76	94326.67	45454.90	0.93
9.	Sulphur 40 kg + Phosphorus 25 kg/ha	49197.86	107200.00	58002.14	1.17
10.	Control (RDF) - 25:40:50 NPK kg/ha	43067.66	91550.00	48482.34	1.12

Summary
Seed yield (1186 kg/ha), stover yield (2474 kg/ha) was recorded in treatment T_6 Sulphur 30kg + Phosphorus 25 kg/ha. Maximum gross return (INR 119680.00), net return (INR 71607.14) and B:C ratio (1.48) were also recorded in treatment 6 Sulphur 30kg + Phosphorus 25 kg/ha.

Conclusion
It is concluded that with the application of Sulphur 40kg/ha along with Phosphorus 25 kg/ha (Treatment 6), was observed with higher yield attributes and benefit cost ratio in Little millet

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