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Effect of Sulphur and FYM Application on Performance of Urdbean [*Vigna Mungo* (L.) Hepper] and Soil Properties

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted at the Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (U.P.), India, during the *kharif* season of 2020 to assess the effect of farmyard manure (FYM) and sulfur on the performance of urdbean [*Vigna mungo* (L.)] and soil properties. The experiment was designed as a Randomized Block Design (RBD) with seven treatments, consisting of different doses of FYM and sulfur, replicated three times. The test variety used was Shekhar-2. The results revealed that the combined application of FYM and Sulphur exhibited significant influence on the growth, yield attributes and yields of

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urdbean as compared to control during the year of experimentation. Significant improvement in viz. Plant height (cm), Number of Trifoliate Leaves, Dry matter accumulation, Test weight (g), Grain yield (q ha^{-1}), Number of root nodule, Protein content (%), Protein yield (kg ha^{-1}) and soil properties was noticed with the application of RDF + FYM @ 2.5 t ha^{-1}+ S @ 10.0 kg ha^{-1}, which established its superiority over rest of the FYM and Sulphur treatments. Increase of 91.61% in grains was recorded with the application of RDF + FYM @ 2.5 t ha^{-1} + S @ 10.0 kg ha^{-1} over control. The application of RDF + FYM @ 2.5 t ha^{-1} + S @ 10.0 kg ha^{-1} resulted in higher protein yield (274.58 kg ha^{-1}). Based on these findings, it can be concluded that the application of RDF + FYM @2.5 t ha^{-1} + S @ 10.0 kg ha^{-1} is recommended for sustainable urdbean production.

Keywords: Sulphur; FYM; growth parameters; yield attributes; urdbean.

1. INTRODUCTION

Pulses are the major constituent of Indian diet for providing protein rich food to vegetarian masses. Apart from this, pulses provide high quality feed and fodder to livestock and improve the soil health. The pulses are important source of dietary protein and have unique property of maintaining and restoring soil fertility through biological nitrogen fixation as well as conserving and improving physical properties of soil by virtue of their deep root system and leaf fall.

Urdbean [*Vigna mungo* (L.) Hepper] is one of the most important pulse crops of rainfed areas grown throughout the country. This crop is grown in different cropping system as a mixed crop, catch crop, sequential crop in the country. Urdbean seed contains 25-26 % proteins, 60 % carbohydrates, 1.5% fat, and minerals combination, amino acid, and essential vitamins *etc*. In India urdbean is very popularly grown in Andhra Pradesh, Bihar, Madhya Pradesh, Maharashtra, U.P., West Bengal, Punjab, Haryana, and Karnataka. It is used as nutritive fodder specially for milch cattle. It is also used as a green manuring crop. Black gram (urdbean) is native of India and originated from Phaseolus sublobatus, a wild plant. In India total Urdbean production was estimated 1.90 million tonnes from 3.11 million hectare area with a productivity of 642 kg/ha [1].

Sulphur is considered to be the fourth major plant nutrient and hence important as nitrogen, phosphorus and potassium. With the use of high analysis fertilizer and continuous depletion of Sulphur from soil by crop removal and leaching, S is becoming a limiting factor in crop growth. In India, sulphur responses have been obtained from pastures, pulses and oilseed. In recent years, the deficiency of Sulphur has increased in the country mainly due to declining organic matter in soil which is a source of Sulphur. Sulphur stimulates cell division, photosynthetic process as well as formation of chlorophyll and also promotes the root nodules in legumes. It is involved in protein synthesis and is considered indispensable for the synthesis of cysteine, cystine and methionine. It resulted in higher plant height and number of branches per plant and ultimately helped in realization of higher grain and straw yield [2-4]. With the immense benefits of Sulphur on pulse production and lower level of S in Indian soil it is important to supplement S in plant nutrition. The application of Sulphur in integrated approach may be beneficial therefore present investigation was carried out.

2. MATERIALS AND METHODS

The field experiment was conducted at the Crop Research Centre (CRC) of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (UP) during *kharif* season of 2020. The experimental soil was sandy loam in texture, alkaline in reaction having low in nitrogen, Sulphur medium in phosphorous and potassium. The experiment was laid out in a randomized block design with seven treatments and three replication: T_1 (Control), T_2 (RDF), T_3 (RDF + FYM @ 2.5 t ha^{-1}),T_4 (RDF + S @ 10.0 kg ha^{-1}), T_5 (RDF + FYM @ 5.0 t ha^{-1}), T_6 (RDF + S @ 20 kg ha^{-1}), T_7 (RDF + FYM @ 2.5 t ha^{-1} + S @ 10 kg ha^{-1}). Recommended dose of NPK (20:60:00) in the experiment was applied through urea, DAP, FYM and elemental S was applied as per treatment. For preparing experimental field one deep ploughing and two harrowing were done. Treated Urd seed @ 15 kg/ha was sown in plant geometry 30 cm × 10 cm row to row and plant to plant. Soil was analysed for soil pH (1:2) soil EC (dSm^{-1}) at 25°C of 1:2 for soil water solution, organic carbon by wet oxidation method [5]; available nitrogen by alkaline potassium permanganate method [6] available phosphorus by colorimetric method [7]; available potassium

by 1N NH_4OAC extraction [8] and available sulphur by turbidimetric method (Chesnin and Yien, 1950).

3. RESULTS AND DISCUSSION

3.1 Effect on FYM and Sulphur on Growth and Yield of Urdbean

The effect of different treatments on plant height (Table 1) was assessed, and it was observed that the application of recommended dose of fertilizer (RDF) did not result in a significant difference compared to the control group. However, when sulfur (S) or farmyard manure (FYM) was supplemented along with RDF, a significant improvement in plant height was observed. Among the two supplements, the application of S along with RDF showed a better effect compared to FYM. The application of either level of S or FYM over RDF did not have a significant impact. However, when both S (10 kg/ha) and FYM (2.5 ton/ha) were applied together over RDF, a significant improvement in plant height was noticed. The better effect of S compared to FYM could be due to the specific nutrient composition or mode of action of sulfur in promoting plant height. Additionally, the conjoint application of S and FYM at specific levels may have synergistic effects, resulting in a significant improvement in plant height Dubey et al., [9].

Number of Trifoliate Leaves (Table 1) at harvest stage, the maximum number of trifoliate leaf plant^{-1} was noticed in T_7 (RDF + FYM @ 2.5 t ha^{-1} + S @ 10.0 kg ha^{-1}) treatment which remained statistically at par T_6 (RDF + S @ 20.0 kg ha^{-1}) and T_5 (RDF + FYM @ 5.0 t ha^{-1}) but significantly higher than rest of the treatments. Significantly lower number of trifoliate leaf plant^{-1} (5.95 and 4.90 plant^{-1}) was recorded with control treatment. The presence of FYM and S may have provided essential nutrients, promoting leaf development and resulting in a higher number of trifoliate leaves. In contrast, the lower number of trifoliate leaves in the control treatment could be due to nutrient deficiencies or suboptimal conditions for leaf growth [10].

Dry matter accumulation (Table 1) per plant differ significantly under different treatments. Fertilization over control resulted a significant effect on dry matter accumulation. Application of lower level of S and FYM over RDF could not brought any remarkable variation but a significant variation in dry matter accumulation was noticed with the application of higher level of S and FYM over RDF. The lower level of S and FYM may not have provided a substantial additional nutrient supply, resulting in no remarkable variation in dry matter accumulation compared to RDF alone. However, the higher levels of S and FYM likely supplied an optimal nutrient balance, leading to a significant increase in dry matter accumulation per plant [11].

Test weight (Table 1) remained unaffected by the application of RDF compared to the control group. However, the conjoint application of S and FYM over RDF resulted in a significant improvement in test weight. the significant improvement in test weight with the conjoint application of sulfur (S) and farmyard manure (FYM) over RDF suggests that these supplements may have provided additional nutrients or beneficial effects that positively impacted the test weight parameter [9].

Grain yield (Table 1) which differ significantly under different treatment ranged from 5.98 to 11.46 q ha^{-1}. Application of RDF over control resulted 39 percent increase in grain yield while application of S @ 10kg ha^{-1}, FYM @ 2.5 ton ha^{-1},S @ 20kg ha^{-1}, FYM @5.00 ton ha^{-1} over RDF resulted a significant increase of 14.4, 17.1, 27.3 and 31.9 percent respectively. Conjoint application of sulphur and FYM over RDF improved the grain yield by 37.9 percent. Number of trifoliate leaves increased significantly with the application of higher level of S or FYM over RDF. Among the S and FYM, application of S exerted much effect on trifoliate leaves than FYM. The application of S ulfur (S) and farmyard manure (FYM) at specific levels over RDF led to further improvements in grain yield, with S showing a greater effect on grain yield and the number of trifoliate leaves compared to FYM. The conjoint application of S and FYM over RDF further enhanced grain yield, likely due to the combined effect of improved nutrient availability and plant growth stimulation [12].

Root nodules (Table 1) which are sites of nitrogen fixation, also showed significant improvement with the application of higher levels of S and FYM over RDF. Both S and FYM levels differed significantly in terms of the number of root nodules per plant, with higher levels resulting in significantly more root nodules than lower levels higher levels of S and FYM likely provided an enriched nutrient environment, promoting the development of more root nodules per plant [10].

Table 1. Effect of FYM and sulphur on plant height, number of trifoliate leaves, dry matter accumulation, test weight, grain yield, number of root nodules per plant

Treatment	Plant height (cm)	Number of Trifoliate Leaves	Dry matter accumulation	Test weight (g)	Grain yield (q ha^{-1})	Number of Root nodule $Plant^{-1}$
T_1	44.54	4.90	9.09	28.34	5.98	21.3
T_2 RDF	49.15	6.43	12.02	31.28	8.31	28.0
T_3 RDF + FYM @ 2.5 t ha^{-1}	50.88	6.82	11.77	31.67	9.51	29.7
T_4 RDF + S @ 10.0 kg ha^{-1}	52.13	7.01	12.35	32.18	9.73	30.8
T_5 RDF + FYM @ 5.0 t ha^{-1}	53.18	7.78	13.08	33.81	10.58	33.3
T_6 RDF + S @ 20.0 kg ha^{-1}	53.95	7.87	13.10	33.99	10.96	34.2
T_7 RDF + FYM @ 2.5 t ha^{-1} + S @ 10.0 kg ha^{-1}	55.10	8.06	13.88	34.34	11.46	36.3
SEM	1.6	0.23	0.38	1.04	0.30	1.02
CD (P=0.05)	5.1	0.68	1.05	3.04	0.88	3.04

3.2 Effect of FYM and S on pH, EC and Organic Carbon Content of Soil

The results reveal that (Table 2) the application of FYM and S ulphur significantly affected organic carbon, and non-significantly soil pH and EC. Highest organic carbon and EC (0.52% and 0.34 dSm^{-1}) were found in T_7 (RDF + FYM @ 2.5 t ha^{-1}+ S @ 10.0 kg ha^{-1}) while, lowest (0.43% and 0.26 dSm^{-1}) under control (T1). These results are obvious because more availability of nutrients, will favor vigorous growth of roots and plants and will add organic matter to the soil. After the decomposition of organic matter produced organic acids will dissolve the insoluble mineral in the systems and consequently increases the EC. FYM and S ulphur have an acidifying effect on soil pH. The results obtained in the present investigation are inconformity with the findings of Basumatary [13] and Kantva et al. (2019).

3.3 Effect of FYM and S on Available N, P, K and S Content of Soil

Results showed that the availability of nutrients in soil was significantly affected by different treatments of FYM and S ulphur (Table 3). At harvesting stage available nitrogen in soil ranged from 178.4 to 200.2 kg ha^{-1}. Higher available N found in T_7 may be attributed to application of FYM and S ulphur. At harvest available N decline in control and significantly higher N over control was found due to conjoint application of FYM and S ulphur or their higher level along with recommended NPK. Similar results were also found in available phosphorus. At harvest stage available P in soil ranged from 14.1 to 22.2 kg ha^{-1}. At harvest available P decline in control and significant increase over control was found in rest of the treatments. Availability of K increases significantly due to conjoint application of S and FYM over control however rest treatments remain statistically at par. Availability of S increased non significantly due to fertilization over control. Availability of phosphorus increased significantly due to conjoint application of S and FYM over RDF or higher level of S and FYM. FYM and sulphur produces organic acids, which convert tri-calcium phosphate to di and mono calcium phosphate with the net result of the enhanced availability of phosphorus. Adsorption of PO_4^{-3} with higher level availability resulted in a concurrent desorption of SO_4^{-2} anions from colloidal surface therefore, optimum doses of P fertilizer may result in increased mobility and availability of Sulphur in soil. The increment in available nutrient status might be due to favorable conditions for microbial activity as well as chemical activity. These results obtained in the present investigation are in close conformity with the findings of Rambharose et al. [14], Kokani et al. [15], Nagar et al. [16] and Karnavat et al. [17].

Table 2. Effect of FYM and S On pH, EC and organic carbon content of soil

Treatments		Soil pH	EC (dS m^{-1})	Organic Carbon (%)
T_1	Control	7.80	0.26	0.43
T_2	RDF	7.77	0.29	0.46
T_3	RDF + FYM @ 2.5 t ha^{-1}	7.75	0.29	0.47
T_4	RDF + S @ 10.0 kg ha^{-1}	7.72	0.30	0.48
T_5	RDF + FYM @ 5.0 t ha^{-1}	7.69	0.31	0.50
T_6	RDF + S @ 20.0 kg ha^{-1}	7.63	0.33	0.51
T_7	RDF + FYM @ 2.5 t ha^{-1} + S @ 10.0 kg ha^{-1}	7.58	0.34	0.52
SE m (±)		0.2	0.03	0.01
C.D. (P=0.05)		NS	NS	0.03

Table 3. Effect of FYM and sulphur on available nutrient

Treatments		Available nutrients (kg ha^{-1})			
		N	P	K	S
T_1	Control	178.4	14.1	176.5	8.1
T_2	RDF	190.7	18.6	182.5	8.3
T_3	RDF + FYM @ 2.5 t ha^{-1}	191.6	20.5	184.2	8.5
T_4	RDF + S @ 10.0 kg ha^{-1}	192.7	19.4	185.5	8.6
T_5	RDF + FYM @ 5.0 t ha^{-1}	196.5	21.2	191.3	9.1
T_6	RDF + S @ 20.0 kg ha^{-1}	198.6	21.3	192.6	9.3
T_7	RDF + FYM @ 2.5 t ha^{-1} + S @ 10.0 kg ha^{-1}	200.2	22.2	196.6	9.5
SEm±		5.7	0.7	6.3	0.34
CD (P= 0.05)		16.9	2.1	18.7	NS

Table 4. Effect of FYM and sulphur on protein content, and protein yield

Treatment		Protein content (%)	Protein yield (kg ha^{-1})
T_1	Control	21.09	126.12
T_2	RDF	21.90	181.99
T_3	RDF + FYM @ 2.5 t ha^{-1}	22.15	210.65
T_4	RDF + S @ 10.0 kg ha^{-1}	22.40	217.95
T_5	RDF + FYM @ 5.0 t ha^{-1}	23.09	244.06
T_6	RDF + S @ 20.0 kg ha^{-1}	23.52	257.78
T_7	RDF + FYM @ 2.5 t ha^{-1} + S @ 10.0 kg ha^{-1}	23.96	274.58
SEm ±		0.72	7.40
CD (P= 0.05)		NS	21.99

3.4 Effect of FYM and S on Protein Content and Yield of Urdbean

The protein content (Table 4) of urdbean increases non significantly due to different FYM and Sulphur treatments. Highest protein yield 274.58 kg ha^{-1} significantly higher than the other treatments with exception of T_6 was found in T_7. Application of S and FYM over RDF improved protein yield significantly. Protein yield increased significantly with the application of higher level of S and FYM than their lower level.

4. CONCLUSION

In the light of the results summarized as above, it may be concluded that for obtaining higher productivity of urdbean and sustainable soil health the treated seed should be sown with FYM and Sulphur and recommended fertilizers. Since the observation is based on one year experimental data, so it is advisable that the experiment should be repeated for few more years to confirm the findings.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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