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RESEARCH ARTICLE

# IMPACT OF SULPHUR FERTILIZATION FOR ENHANCING PRODUCTIVITY AND PROFITABILITY OF MUNGBEAN (*Vigna radiata* (L.) WILCZEK)

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## ABSTRACT

Mungbean (*Vigna radiata*(L.) Wilczek*)* is an important grain legume in India. India ranks first among pulse growing countries with 24.5 million hactare area. It is uses as whole or split seeds as Dal (soup) but mostly, sprouted seeds are widely used as vegetables. It containing almost triple amount of protein as compare to rice. The green plants are used as animal feed and the residues as manure. It synthesized nitrogen in symbiosis with rhizobia and enriches the soil. Mungbean also fixed nitrogen in soil by 63-342 kg/ha/season. Its root breaks the plough pan of puddled rice field and goes deep in search of water and nutrients. Sulphur is the major plant nutrient and as important as nitrogen, phosphorus and potassium. Sulphur (Sanskrit, sulvere; Latin, sulphurium) was known to the ancients, being referred to as brimstone in the Bible (Genesis). Sulphur, also spelled as “sulfur” is a nonmetallic, odorless, tasteless chemical element, insoluble in water, having the Periodic Table atomic symbol of “S”. Sulphur may appear as a gas, liquid, or solid. A field experiment was conducted at crop research centre of Sardar Vallabhbhai Patel University of Agriculture and Technology Meerut Uttar Pradesh during spring season 2009-10. The genotype tested for mungbean was SML-668. The effect of sulphur had remarkable affect on growth and yield behavior of mungbean. 100% NPK+S was obtained maximum plant height, number of trifoliate, dry matter accumulation, number of branches and also superior on phenological stages viz. days taken to flowering, podding, maturity and root studies, RuBP Carboxylase and leg-haemoglobin content. 100% NPK+S also increased number of pods plant$^{-1}$**,** number of grains pod$^{-1}$, 1000 grain weight and grain yield plant$^{-1}$. The NPK content and uptake by mungbean varying significantly but maximum in 100% NPK+S.

**K**ey **W**ords : Productivity, RuBP carboxylase, Productivity, Profitability, Sulphur doses

Pulses constitute the most widely component of Indian diet as a rich source of protein. Its seed contain 20 – 33 percent protein which is nearly three times more than that of major cereals. Therefore, pulses can play a vital role in solving the protein malnutrition problems in India with increase in population, on one hand and stagnation in pulses production, on the other hand the Per capita availability of the pulses in the country gone down from 64 g/day during 1950-51 to 45 g/ day during 1970 as per the report of the WHO (1976). Yield of same variety of mungbean widely depending on season and environmental condition etc., such uncertainty makes it difficult for a farmer to risk his limited land capital and labour on mungbean production. It is, therefore, necessary to strive to develop varieties with stable and uniform yields because pulse crop presently require multiple harvests. It is also to seek varieties that make more efficient use of available solar energy. Mungbean *(Vigna radiata (L.)Wilczek)* is an important pulse crop having high nutritive value. Its not only plays an important role in human diet but also in improving the soil fertility by fixing the atmospheric nitrogen. Its seed is more palatable, nutritive, digestible and non- flatulent than other pulses. Mungbean production is often undertaken on small farms using marginal soils low in nitrogen, phosphorus and sulphur with minimal technical inputs. Fertilizer is one of the most important factors that affect crop production. Fertilizer recommendation for soils and crop is a dynamic process in view of the generation of the new knowledge, change in soil nutrient status, change in plant and planting pattern as associated management practices (Ali and Kumar, 2005). The management of fertilizers is one of the important factors that greatly affect the growth, development and yield of mungbean. Nitrogen, phosphorus and sulphur are integral component of virtually all the biochemical compounds that make plant life possible. There is no conceivable alternative for such elements to constructing the biochemical machinery of plants. It is absolutely clear that both nitrogen and phosphorus are essential elements in their structural, biochemical and physiological roles contributing to crop growth.

Sulphur is the major plant nutrient and as important as nitrogen, phosphorus and potassium. The occurrence and causes of sulphur deficiencies could be attributed to insufficient supply of such element. The causes of deficiencies are the crop removal of sulphur, the great use of high analysis fertilizers sulphur free, increasing depletion of soil sulphur by leaching. About 10 – 15 kg $ha^{-1}$ was removed by crops and may be upto 75 kg $ha^{-1}$ in intensive cropping sequences. Sulphur play an important role on plant growth, metabolism, sulphur containing amino acid and protein. It also activate certain photolytic enzymes, vitamins, co-enzymes A and glutathione are in there constituents (Hsiao, 1983). Critical levels of sulphur in mungbean was obtained when they were grown in sub soils possessing $SO_4$–S about 10–13 ppm. Spring season is preceded by extremely dry and warm summer whereas succeeded by cool winter, thus sandwiched between extremes of weather variation. Pulses are comparatively more sensitive to weather changes particularly soil moisture regimes, temperature and photoperiod. Early sowing may subject flowering and podding stage to rains leading to poor pod setting and even sprouting and podding in pods. Delayed sowing may expose crop to low temperature condition again influence flower initiation and pod formation. Better nodulation under long days that the short days have been reported in legumes. Thus, mismatch and variation between crop growth and environmental conditions is the major cause of poor yields in field crop in general, and pulses in particular. Sowing time management is one of the most important non-monetary inputs to enhance crop performance by way of exposure to varying set of weather condition commensuration with different crop growth stage.

## MATERIALS AND METHODS

The field experiment was conducted at Crop Research Center of Sardar Vallabhbhai Patel University of Agriculture and Technology Meerut (Uttar Pradesh) during the spring season in the year 2009-10. Geographically the center is situated at $29^0$ 05' 19" N Latitude, $77^0$ 41' 50" East longitude and at an altitude of 237 meters above the mean sea level. The climate of the area is semi-arid, with an average annual rainfall of 805 mm (75–80% of which is received during July to September), minimum temperature of $4^0$C in January, maximum temperature of 41 to $45^0$C in June, and relative humidity of 67 to 83% throughout the year. In general the soil of the experimental site was sandy loam in texture with medium fertility status. The particle size distribution of 0-20 cm soil layer is 64.2 % sand, 18.5 % silt and 17.3 % clay. The soil samples were taken at 0-15 cm soil layer from top of the beds in permanent beds and within the row in flats. The bulk density of 1.40 Mg $m^{-3}$, weighted mean diameter of soil aggregates 0.58 mm, infiltration rate 23 mm $hr^{-1}$.

**Variety and fertilizer:**

SML-668 was released and notified in India and evaluated at Indian Institute of Pulses Research, Kanpur. This is a short duration variety and matured only 55-60 days. This variety has some specific characteristics viz. short plant height (cm), anthocynine colour, early growth habit, stem colour and stem pubescences, leaflet lobe (terminal), leaf shape (terminal), dark greenish to brown leaf colour, yellowing vein colour, light yellowish to light green petiole colour, short and round leaf size, minimum days to flowering, light greenish to brown flowering colour of petal and brownish black to mature pod colour etc. The recommended dose of fertilizers in mungbean (N, P, K and S were 20, 30, 20 and 20 $kgha^{-1}$, respectively) required were calculated as per the treatments. Measured quantity of the fertilizer was applied in the respective treatments and mixed manually.

**Labor Analysis :**

Human labor use for tillage, sowing, irrigation, fertilizer and pesticide /insecticide application, weeding, and harvesting etc., in mungbean was measured in the study. Time (hr) required to complete one field operation in a particular treatment was recorded and was expressed as person-day $ha^{-1}$, considering 8 hr's to be equivalent to one person-day. Similarly, time (hr) required by a tractor-drawn machine to complete a field operation such as tillage, sowing, harvesting and threshing etc. was recorded and expressed as hr's $ha^{-1}$. Time (hr) required to irrigate a particular plot and consumption of diesel (L $h^{-1}$) by the pump was also recorded. Labor and machine requirements have a component of site-specificity as they depend on the existing soil, crop and climatic conditions, and the efficiency and skill of operation.

## RESLTS AND DISCUSSION

**Crop yields :**

The various tillage and crop establishment techniques had a significant effect on mungbean yield. The grain yield recorded the highest value in 100%NPK+S ($T_{15}$) and the lowest was in control ($T_{17}$). Treatment $T_{15}$ was found to be significantly superior to all the treatments which recorded maximum strover

(2696 kg $ha^{-1}$) and minimum strover was recorded in control (635 kg $ha^{-1}$). The maximum and minimum biological yield was recorded in treatment (4220 kg $ha^{-1}$) and control treatment (1021 kg $ha^{-1}$).

**Table 1: Treatment details**

| S. No. | Treatment combinations | Symbols |
|---|---|---|
| 1. | 50% RD of N P + S | $T_1$ |
| 2. | 75% RD of NP + S | $T_2$ |
| 3. | 100% RD of NP + S | $T_3$ |
| 4. | 125% RD of NP + S | $T_4$ |
| 5. | 50% RD of NK + S | $T_5$ |
| 6. | 75% RD of NK + S | $T_6$ |
| 7. | 100% RD of NK + S | $T_7$ |
| 8. | 125% RD of NK + S | $T_8$ |
| 9. | 50% RD of NPK | $T_9$ |
| 10. | 75% RD of NPK | $T_{10}$ |
| 11. | 100% RD of NPK | $T_{11}$ |
| 12. | 125% RD of NPK | $T_{12}$ |
| 13. | 50% RD of N PK +S | $T_{13}$ |
| 14. | 75% RD of NPK +S | $T_{14}$ |
| 15. | 100% RD of NPK +S | $T_{15}$ |
| 16. | 125% RD of NPK +S | $T_{16}$ |
| 17. | Control | $T_{17}$ |

**Economic analysis (Cost of cultivation):**

The cost of cultivation was calculated by taking into account costs of seed, fertilizers, biocide and the hiring charges of labour and machines for land preparation, irrigation, fertilizer application, plant protection, harvesting and threshing, and the time required per hectare to complete an individual field operation. Cost of irrigation was calculated by multiplying time (hr) required to irrigate a particular plot by consumption of diesel by the pump (L $ha^{-1}$) cost of diesel, the price of human and machine labour. Gross income was calculated by the minimum support price offered by the Government of India for mungbean and net income was calculated as the difference between gross income and total cost.

Profitability of mungbean was remarkably higher with 100%NPK+S due to higher productivity and less cost of production compared to all treatments (Table 2). The data revealed that every successive improvement in nutrient supply increased the cost of cultivation and the highest and lowest cost of cultivation was recorded under $T_{15}$ and $T_{17}$ treatments, respectively.

**Conclusion:**

The result presented in preceding chapter produced a detailed account of the performance in the terms of growth, development, Physico-chemical activities, yield and yield

**Table 2: Productivity of mungbean under various dose of fertilizer application.**

| Crop treatment details | Grain yield (kg $ha^{-1}$) | Strover yield (kg$ha^{-1}$) | Biological yield (kg $ha^{-1}$) | Harvest index |
|---|---|---|---|---|
| 50% N P + S | 917 | 1349 | 2266 | 40.5 |
| 75% NP + S | 1192 | 1794 | 2986 | 40.0 |
| 100% NP+S | 1387 | 2182 | 3569 | 39.0 |
| 125% NP + S | 1308 | 1953 | 3261 | 40.1 |
| 50% NK + S | 658 | 965 | 1623 | 41.0 |
| 75% NK + S | 543 | 845 | 1388 | 39.1 |
| 100% NK + S | 879 | 1215 | 2094 | 42.0 |
| 125% NK + S | 463 | 742 | 1205 | 38.4 |
| 50% NPK | 798 | 1072 | 1870 | 36.1 |
| 75% NPK | 987 | 1477 | 2464 | 40.1 |
| 100% NPK | 1123 | 1663 | 2786 | 40.3 |
| 125% NPK | 1093 | 1584 | 2677 | 41.0 |
| 50% N PK +S | 1265 | 1856 | 3121 | 41.0 |
| 75% NPK +S | 1425 | 2160 | 3585 | 40.0 |
| 100% NPK +S | 1524 | 2696 | 4220 | 43.0 |
| 125% NPK +S | 1482 | 2517 | 3999 | 37.1 |
| Control | 386 | 635 | 1021 | 34.4 |
| S.E.± | 0.661 | 0.452 | 0.305 | 0.017 |
| C.D.(P=0.05) | 2.053 | 1.827 | 2.084 | 0.018 |

**Table 3: Profitability of mungbean under various dose of fertilizer application**

| Crop treatment details | Cost of cultivation | Gross return (Rs $ha^{-1}$) | Net return (Rs $ha^{-1}$) | B:C ratio |
|---|---|---|---|---|
| 50% N P + S | 7415.33 | 18134.33 | 10538.33 | 1.4 |
| 75% NP + S | 7618.33 | 20763.67 | 13145.67 | 1.7 |
| 100% NP+S | 7934.33 | 21040.67 | 13106.67 | 1.6 |
| 125% NP + S | 7753.33 | 21485.33 | 13505.67 | 1.7 |
| 50% NK + S | 7283.33 | 16073.33 | 8790.67 | 1.2 |
| 75% NK + S | 7215.33 | 15532.67 | 8317.67 | 1.1 |
| 100% NK + S | 7368.33 | 17206.00 | 9838.33 | 1.3 |
| 125% NK + S | 7186.67 | 15262.33 | 8075.67 | 1.1 |
| 50% NPK | 7329.33 | 16487.33 | 9158.67 | 1.2 |
| 75% NPK | 7479.33 | 18893.33 | 11414.33 | 1.5 |
| 100% NPK | 7594.00 | 20218.33 | 12624.67 | 1.6 |
| 125% NPK | 7513.00 | 19623.67 | 12110.33 | 1.6 |
| 50% N PK +S | 7681.67 | 21109.67 | 13427.67 | 1.7 |
| 75% NPK +S | 8166.00 | 21175.33 | 13009.67 | 1.5 |
| 100% NPK +S | 8342.33 | 22902.33 | 14560.33 | 1.7 |
| 125% NPK +S | 8236.00 | 21956.67 | 13720.33 | 1.6 |
| Control | 7120.33 | 15027.33 | 7907.33 | 1.1 |
| S.E.± | 0.909 | 0.995 | 0.369 | 0.101 |
| C.D.(P=0.05) | 2.631 | 2.878 | 2.058 | 0.293 |

contributing characteristics of mungbean as influenced by different levels of fertilization treatments. Attempts have been made to evaluate and explain the important observation recorded in the course of present investigation in term of "cause" and "effect" relationship as far as possible in the light of the scientific reasoning and to find out information of practical value.

Nutrient is a major soil factor limiting the range of adsorption for mungbean. Grain yield than appear to be the result of genetic and physiological potentials and higher yield can be reached when high genetic ceiling is combined with high physiological and metabolic potential and efficient source and sink relationships. (Khan et al, 2008). The expression of grain yield is a function of three parameters i.e. genetic potential, soil status and environmental surrounding of the crop.

Thus for introducing a suitable management practice, it is necessary to know the yield reduction level of plant nutrient deficit in the same variety/varieties**.** Such information is necessary for crop planning in various agro-climatic and soil fertility conditions both under irrigated and unirrigated situation of western Uttar Pradesh. Results of this investigation can be extended to irrigated ecosystem and climatic conditions for wide areas in western Uttar Pradesh.

In mungbean, the grain yield per hectare increased with every successive increase in nutrient supply. The highest grain yield for respective crop (1524 kg $ha^{-1}$) were found to be under $T_{15}$ treatment and lowest yield under $T_{17}$ (386 kg $ha^{-1}$) (control) treatment. The grain yield per plant improved with increased nutrient efficiency mainly Increase in per plant yield can be attributed to increase in vegetative growth with increased nutrient supply. Similar trend was observed by Singh and Sekhon (2008). The basal application of 18 kg Nitrogen +46 kg $P_2O_5$ $ha^{-1}$ increased the grain yield (1326 kg $ha^{-1}$) significantly over without application of nutrients (914 kg $ha^{-1}$). A supplemental dose of $ZnSO_4$ @ 15 or 25 kg $ha^{-1}$, Borax @ 5 or 10 kg $ha^{-1}$ and sodium molybdate @ 1 kg $ha^{-1}$ along with 18 kg Nitrogen+46 kg $P_2O_5 ha^{-1}$ tended to increase the grain yields over sole application of 18 kg Nitrogen +46 kg $P_2O_5 ha^{-1}$. Strover per hectare showed significant response to different treatments and treatment $T_{15}$ recorded significantly higher values as compared to other treatments. The increase in the strover of the crops could be attributed to the significant effect of fertilizer on the vegetative growth of the crop plant. Thus the strover increased because of enhancement of vegetative growth under improved fertilizer application. In the current study of grain and strover per hectare a significant aspect was observed at ($T_{15}$) treatment. Grain yield obtained under this treatment was more as compared to control ($T_{17}$) treatments, whereas the corresponding strover per hectare was less. Similar kind of reports on yields has also been given by Khairnar *et al.*, (2009). Vermiwash was superior to water in the enhancement of plant height (57.79 cm), plant spread (37.80

cm), number of functional leaves (14.70 per plant), number of pods per plant (12.89), grain yield (10.42 quintal $ha^{-1}$) and strover (13.11 quintal $ha^{-1}$).[1.0 quintal= 100.0 kg]. Gross return, net return and B: C ratio was significantly influenced by sulphur fertilization. Treatments In general fetched more gross return Rs 22902.33 $ha^{-1}$, net return Rs 14560.33 $ha^{-1}$ and B: C ratio 1.7 in $T_{15}$ Treatments.

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