SHORT COMMUNICATION

SULPHUR MANAGEMENT IN URDBEAN (*VIGNA MUNGO*)-INDIAN MUSTARD (*BRASSICA JUNCEA*) CROPPING SYSTEM IN VERTISOLS

Baldev Ram[1*], S. S. Punia[1], J. P. Tetarwal[1], D. S. Meena[1], R. S. Narolia[1] and P. R. Raigar[2]

AICRP on MULLaRP, Agricultural Research Station (MPUAT), Ummedganj, Kota-324001(Rajasthan)
[1] Email-baldev.ram@gmail.com*

Abstract: A field experiment was conducted during two consecutive seasons of *kharif* and *rabi (*2005-06 & 2006-07) at Agricultural Research Station, Ummedganj, Kota to evaluate the optimum dose of sulphur for increasing the productivity and profitability of urdbean and mustard under urdbean-mustard cropping sequence. The experiment was comprised of 3 levels of sulphur (0, 20 and 40 kg/ha) to each urdbean and mustard and consisted of 9 treatment combinations (U_0-M_0, U_0-M_{20}, U_0-M_{40}, U_{20}-M_0, U_{20}-M_{20}, U_{20}-M_{40}, U_{40}-M_0, U_{40}-M_{20} and U_{40}-M_{40} kg/ha) were tested in randomized block design with four replications. Sulphur fertilization to urdbean 40 kg/ha significantly increased plant height/plant, branches/plant, nodules/plant, nodule dry weight, number of pods/plant, seeds/pod and test weight, seed yield, straw yield, net return and B: C ratio over no sulphur application while it remained statistically on par with 20 kg S/ha. The respective increase was in the magnitude of 7.7, 33.1, 39.5, 23.6, 35.6, 33.9, 8.4, 13.6, 16.2, 55.0 and 9.6 % over no sulphur. Maximum and significantly higher plant height, primary and secondary branches/plant, siliquae/plant, length of siliqua, seeds/siliqua, test weight, seed, stover yield, net return and B: C ratio were recorded in mustard with application of U_{40}-M_{40} kg S/ha remained on par with U_{20}-M_{40} and U_{40}-M_{20} kg/ha over no sulphur, U_0-M_{20}, U_0-M_{40}, U_{20}-M_{20} and U_{40}-M_{20}. Treatment U_{20}-M_{40} kg S/ha recorded significantly higher urdbean equivalent yield to the tune of 1107 kg/ha, net return ₹16267/ha, total S uptake 14.21 kg/ha and higher buildup of S 7.49 kg/ha over U_0-M_0 (no sulphur).

Keywords: Cropping system, Mustard, Net return, Sulphur, Uptake, Urdbean, Yield

INTRODUCTION

In each season of every year application of sulphur to individual crop is not economical and advisable, because nutrient use efficiency of sulphur is very low and it did not lost from soil and had a residual effect on succeeding crop. The maintenance of optimum sulphur levels in fertility is an important consideration for obtaining higher and sustainable yield due to large turnover of nutrients in soil-plant system as compared to prevailed fallow-mustard cropping system. Urdbean-mustard cropping sequence in south humid eastern plain zone of Rajasthan is the next best option after soybean-wheat cropping sequence and had gaining importance due to its economic viability. Similarly, Tripathi and Rathi (2003) have found significantly higher mustard seed equivalent in urdbean-mustard system over fallow-mustard.

Due to intensification of agriculture, particularly use of improved varieties, irrigation and high grade analysis fertilizer i.e. single or two major sources of nutrients are leading to crop production but failed to sustain long term productivity. The Indian soils are becoming deficient in secondary/micronutrient deficiency particular in sulphur. Apart from the secondary nutrients, S had limiting the yield and quality of urdbean and mustard. Sulphur plays a significant role in pulses and oilseed crops particularly where the sink material is largely sulphur containing amino acids. Sulphur has specific vital role in growth, development and quality of pulses and oilseed crops. Hence, an introduction of pulses in the system was found more beneficial in pulse-oilseed based cropping sequence. Therefore, an attempt was made to evaluate the optimum dose of sulphur for urdbean-mustard cropping sequence for increasing the sequence productivity.

MATERIAL AND METHOD

The field experiment was conducted during *kharif* and *rabi* seasons (2005-06 & 2006-07) at Agricultural Research Station, Ummedganj, Kota. The experiment was carried out in randomized block design comprised of 3 levels of sulphur (0, 20 and 40 kg/ha) to each urdbean and mustard and consisted of 9 treatment combinations (U_0-M_0, U_0-M_{20}, U_0-M_{40}, U_{20}-M_0, U_{20}-M_{20}, U_{20}-M_{40}, U_{40}-M_0, U_{40}-M_{20} and U_{40}-M_{40} kg/ha) with 4 replications. The soil of the experimental field was clay loam, slightly alkaline in reaction (pH 7.6), poor in organic carbon (4.2 g/kg), low in available nitrogen (275.5 kg/ha), phosphorus (20 kg/ha), sulphur (16.5 kg/ha) and medium in available potassium (295.5 kg/ha). The recommended dose of nitrogen and phosphorus 20:40 kg/ha to urdbean and 80:40 kg/ha to mustard were given through urea and Diammonium phosphate (DAP). Full dose of phosphorus and half dose of nitrogen was drilled before sowing and remaining 40 kg nitrogen was given to mustard at the time of irrigation. Sulphur was given through gypsum and drilled before the sowing in ear marked plots treatment wise. Urdbean variety 'RBU 38' and mustard 'Pusa bold' was sown on 14th July, 2005 & 8th August, 2006 and 26th October, 2005 & 11th November, 2006 using a seed rate of 20 kg for urdbean and 4 kg/ha for mustard at a row spacing of 30 cm apart. One hoeing and weeding was done 30 days after sowing. One supplemental irrigation was

given to mustard at the time of flowering stage. Post harvest soil analysis for available S in soil and uptake by plant was analysed by Turbidimetric method as per Williams and Steinberg, 1959.

RESULT AND DISCUSSION

Direct effect of sulphur levels on urdbean

Application of 40 kg S/ha increased significantly plant height/plant and branches/plant over no application of sulphur and 20 kg S/ha (Table 1). The increase was to the tune of 7.7 and 33.1 % over no sulphur application. Significant increase in the nodules/plant and nodule dry weight and yield attributing characters such as number of pods/plant, seeds/pod and test weight was observed with every increase in the levels of sulphur up to 40 kg/ha except test weight which was at par with 20 kg S/ha. However, there was no significant differences in between 20 and 40 kg S/ha but significantly superior over control. This may be attributed to better environments of rhizosphere for sulphur mobility and greater photosynthetic activity and chlorophyll synthesis seemed to be promoted vegetative growth and yield contributing characters. These results confirm the findings of Singh *et al.* (1997).

Sulphur fertilization at 40 kg/ha significantly increased seed yield, straw yield, net return and B: C ratio over no sulphur application while it remained statistically on par with 20 kg S/ha. The increase was in the magnitude of 13.6, 16.2, 55.0 and 9.6 % over no sulphur. Though, available sulphur status of the experimental field was low (16.5 kg/ha) hence, sulphur application improved nutritional environment of rhizosphere as well as plant system as evident from greater uptake of nutrients (Table 3) and ultimately metabolic and photosynthetic activity, better development of yield attributes and resulting higher yield. The findings corroborate the results of Singh and Kumar, 1996.

Direct and residual effect of sulphur on mustard

On the basis of two years pooled mean data (Table 2) revealed that application of 40 kg S/ha alone in urdbean and mustard or U_{20}-M_{20}, U_{20}-M_{40}, U_{40}-M_{20} and U_{40}-M_{40} kg S/ha in urdbean and mustard increased plant height and length of siliqua significantly over no sulphur and 20 kg S/ha in urdbean or mustard but remained statistically on par with each other. The maximum plant height and length of siliqua was recorded under direct application of 40 kg S/ha to mustard and urdbean, which was 22.9 and 33.4 % higher over no sulphur application.

Direct application of incremental and residual effect of sulphur on growth, yield attributes, yield and economics were recorded higher values significantly over no application of sulphur. Maximum and significantly higher primary and secondary branches/plant, siliquae/plant, seeds/siliqua, test weight, seed, stover yield, net return and B: C ratio were recorded in 40 kg S/ha application in both the crops over U_0-M_0, U_0-M_{20}, U_0-M_{40}, U_{20}-M_{20} and U_{40}-M_0 levels of sulphur but remained statistically on par with U_{20}-M_{40} and U_{40}-M_{20}. Which might be owing to gave significantly higher growth parameters, yield attributes, yield and economics over no sulhpur in both the crops and 20 kg S/ha in urdbean. This treatment recorded higher values to the tune of 1127 kg/ha seed yield and Rs. 18973/ha net return over absolute control. It might be due to favourable nutritional environment in rhizosphere crates more mobility of sulphur and increased photosynthetic rate thus increased yield attributes and yield of mustard. The results are in line of Singh *et al.* (1997).

Urdbean equivalent yield (UEY) and economics

The maximum urdbean equivalent yield (UEY) was obtained with the highest dose of sulphur U_{40}-M_{40} kg/ha applied in both the crops, which was at par with that realized under the application of U_{20}-M_{40} and U_{40}-M_{20} kg S/ha (Table 3). These 3 treatments U_{40}-$M_{40,}$ U_{20}-M_{40} and U_{40}-M_{20} kg S/ha significantly out yielded over lower dose combinations for urdbean equivalent yield and net return. The highest UEY of 2940 kg/ha was realized with the application of 40 kg S/ha to both urdbean and mustard crops every year. However, the treatment involving the application of sulphur U_{20} kg/ha to urdbean and U_{20}-M_{40} kg/ha to mustard every year performed equally good as reflected in its statistically on par with the highest yield and net return. The treatment U_{20}-M_{40} kg S/ha recorded significantly higher urdbean equivalent yield and net return to the tune of 1107 kg/ha and ₹16267/ha over no sulphur application in both the crops. The results corroborate the findings of Tripathi and Rathi (2003).

Sulphur uptake

The maximum sulphur uptake was associated with the highest dose of S application to urdbean and mustard crops i.e. 40 kg/ha (Table 3). The S uptake by urdbean in grain and straw was maximum with application of 40 kg S/ha compared to control however, it remained statistically on par with 20 kg S/ha. The increase was recorded to the tune of 19.04 to 47.05 % in grain and 43.24 to 120.83 % in straw over 20 kg S/ha and control, respectively. In mustard, maximum S uptake was recorded in U_{40}-M_{40} treatment to the tune of 210.65 % in grain and 218.4 % in stover over absolute control (U_0-M_0). However, it remained on par with U_{40}-M_{20} in grain and U_{40}-M_{20} and U_{20}-M_{40} in stover, respectively. The treatment U_{20}-M_{40} also significantly increased S uptake by grain and stover of mustard over absolute control. The per cent increase was 201.6 and 208.7 in grain and stover, respectively.

Maximum and significantly higher total S uptake (23.72 kg/ha) was recorded in treatment U_{40}-M_{40} over rest of the treatments except U_{20}-M_{40} and U_{40}-M_{20} and was found statistically at par with each other. The increase was to the tune of 15.35 kg/ha over absolute control. For better S uptake it is essential to apply 20 kg S/ha to urdbean and 40 kg S/ha to mustard crop and harvest higher yield of these crops. This might be due to incremental increases in the concentration of sulphur in grain and straw/stover. The concentration of nutrients also increase due to S fertilization because of improved nutritional environment in rhizosphere and consequently in plant system. These results are in close conformity with the findings of Varavipour *et al.* (1999).

Residual sulphur

Higher sulphur rates along with its repeated applications in both the crops resulted in higher S buildup in the soil. The maximum S buildup was found when both the crops urdbean and mustard were adequately supplied with S (40 kg/ha) every year (Table 3). Maximum and significantly higher buildup of S was recorded in treatment U_{40}-M_{40} (21.25 kg/ha) remained on par with U_{20}-M_{40} over rest of the treatments, which was 69.45 % higher over absolute control. Similar result was reported by Varavipour *et al.* (1999).

Table1. Effect of direct application of sulphur on growth, yield attributes, yield and economics of urdbean under urdbean-mustard cropping sequence (Pooled mean of 2 years)

Treatment (S kg/ha)	Plant height (cm)	Branches/ Plant (Nos)	Nodules/ Plant (Nos)	Nodule dry weight (mg)	Pods/ plant (Nos)	Seeds/ Pod (Nos)	Test weight (g)	Seed yield (kg/ha)	Straw yield (kg/ha)	Net return (₹/ha)	B : C ratio
U_0	44.78	7.00	29.99	29.31	20.7	5.63	36.82	771	1765	2263	1.24
U_{20}	46.94	8.42	36.98	32.92	24.3	6.48	39.43	859	1989	3377	1.35
U_{40}	48.23	9.32	41.84	36.24	28.1	7.54	39.91	876	2051	3508	1.36
CD (P=0.05)	1.87	0.92	2.07	1.08	1.72	0.90	0.97	46.9	115.4	714	0.07

Table 2. Effect of sulphur on growth, yield attributes and yield of mustard under urdbean-mustard cropping sequence

Treatment (S kg/ha)	Plant height at harvest (cm)	Primary branches/ plant (Nos)	Secondary branches/ plant (Nos)	Length of siliqua (cm)	Siliqua e/plant (Nos)	Seeds/ siliqua (Nos)	Test weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Net return (₹/ha)	B : C ratio
U_0-M_0	168.5	1.98	4.25	4.43	130.2	9.2	4.38	1088	1782	9197	0.97
U_0-M_{20}	186.2	2.78	5.36	5.23	163.2	10.9	4.54	1796	2969	21131	2.18
U_0-M_{40}	190.6	2.96	5.54	5.50	181.8	11.1	4.58	1901	3080	22793	2.32
U_{20}-M_0	176.0	2.13	4.46	4.76	150.7	9.7	4.47	1496	2399	16188	1.71
U_{20}-M_{20}	190.7	3.25	5.85	5.55	191.1	11.4	4.67	2015	3240	24884	2.57
U_{20}-M_{40}	200.5	3.66	6.58	5.78	224.2	11.7	4.72	2215	3641	28170	2.87
U_{40}-M_0	191.1	2.30	4.90	5.00	162.0	10.6	4.47	1697	2788	19637	2.08
U_{40}-M_{20}	201.9	3.55	7.04	5.64	211.0	12.0	4.74	2113	3474	26561	2.75
U_{40}-M_{40}	207.1	3.78	8.44	5.91	244.7	12.4	4.78	2322	3823	30007	3.06
CD (P=0.05)	19.3	0.49	0.88	0.55	24.51	0.83	0.07	242.2	331.8	4154	0.43

Table 3. Effect of sulphur on system use efficiency under urdbean-mustard cropping sequence

Treatment (S kg/ha)	Urdbean system equivalent yield (kg/ha)	Net return (₹/ha)	Benefit: Cost ratio	Sulphur uptake (kg/ha)				Total S uptake by sequence (kg/ha)	Available S (kg/ha)
				Urdbean		Mustard			
				Grain	Straw	Grain	Stover		
U_0-M_0	1718	7191	0.97	1.19	0.72	2.44	4.02	8.37	12.54
U_0-M_{20}	2363	16784	2.18	1.21	0.84	5.38	9.02	16.45	14.87
U_0-M_{40}	2473	18309	2.32	1.20	0.86	6.08	9.86	18.00	17.00
U_{20}-M_0	2176	13940	1.71	1.36	1.10	4.08	6.62	13.16	14.95
U_{20}-M_{20}	2647	20889	2.57	1.40	1.11	6.23	9.96	18.70	17.50
U_{20}-M_{40}	2825	23458	2.87	1.47	1.36	7.36	12.39	22.58	20.03
U_{40}-M_0	2371	16769	2.08	1.64	1.42	4.97	8.27	16.31	17.60

U_{40}-M_{20}	2750	22316	2.75	1.67	1.45	7.07	11.79	21.98	19.80
U_{40}-M_{40}	2940	25063	3.06	1.75	1.59	7.58	12.80	23.72	21.25
CD (P=0.05)	226.3	3440	0.43	0.26	0.30	1.31	1.97	3.30	1.24
Initial soil test values of available S 16.5 kg/ha									

CONCLUSION

The two years results inferred that that application of sulphur U_{20}-M_{40} in system mode of urdbean-mustard cropping sequence produced maximum and sustainable seed yield and economics and saved 20 kg of sulphur for the betterment of soil health and ecological system.

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