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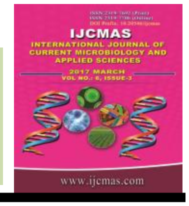

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Soil Acidity Management and an Economics Response of Lime and Sulfur on Sesame in an Alley Cropping System

Sandeep Kumar[1,2]*, Ram Swaroop Meena[2,4], Achyutanand Pandey[2] and Seema[3]

[1]Department of Agronomy, CCS Haryana Agricultural University, Hisar, Haryana, India - 125004
[2]Department of Agronomy, [3]Soil Science and Agril. Chemistry, Banaras Hindu University, Varanasi (UP)-221 005, India-2210 05
[4]School of Environment and Natural Resources, The Ohio State University, Columbus, OH, USA- 43210
**Corresponding author*

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A field experiment was carried out to evaluate the economic aspects of sesame cultivati acidic soil and its management with the application of sulfur and lime during the summer (*K* seasons of 2014. The experiment was laid out in factorial randomize block design with four of sulfur (0, 15, 30 and 45 kg ha^{-1}) and four doses of lime ($CaCO_3$) (0, 100, 250 and 350 kg The results indicated that at *P*=0.05 significantly higher seed (285.75 and 286.08 kg ha^{-1}) and (359.84 and 358.28 kg ha^{-1}) yield of sesame was noted with the sulfur and lime level of 3 250 kg ha^{-1}, respectively. The considerably more net return (Rs.18660.89) and B: C ratio (3. sesame was recorded under sesame + guava alley system with application of 30 kg S ha^{-1} ov sole cropping of sesame. Similarly, on lime levels, the higher net returns (Rs.19642.72) and ratio (3.81) of sesame was observed under sesame + guava alley system with application of 2 lime ha^{-1}. Although, under alley system the seed yield, stalk yield, net return, and B: C ratio sulfur and lime levels of 30 and 250 kg ha^{-1}were at par with 45 kg S and 350 kg lime respectively. Sesame + guava alley system had a more monetary advantage over sole croppi sesame.

Introduction

Sesame (*Sesamum indicum*) is one of the important and oldest indigenous oilseed crops belonging to genus *Sesamum* with the longest history of its cultivation in India. Its seed contains the highest oil compared to any other oilseed to the extent of 50% and above (Hwang, 2005). India is still the world leader in the maximum (25.8%) production from the largest (29.8%) area in the world. Sesame seed is qualitative, nutritious and highly rich in protein and essential amino acid (e.g. methionine) essential for human body. Sesame seed is also an excellent source of vitamins (e.g. E, A, B_1, B_2, and niacin) and mineral nutrients like calcium (1450 mg/100 g) and phosphorous (570 mg/100 g) (Shah *et al.*, 2013). The sesame oil is mostly used for edible purpose due to its superior quality because it contains less amount of eurocic acid and high amount of linoleic acid which is beneficial for human health.

Sulfur plays a key role in production of oilseed crops. Sesame is sulfur loving crop in the presence of that the quantity and quality of sesame produce can be enhanced. Approximately 12 kg S is required to produce one ton of oil seed (Ghosh *et al*., 2000). Sulfur is one of the dominant factors for yield and oil content of sesame, research in this line is important for increasing yield of this crop as sulfur deficiency alone reduces crop yield by 10-20% (Bhuiyan and Shah, 1990). Also, the pH of the soil affects the bioavailability of plant nutrients and so, indirectly, crop growth and development. Soil acidity is ameliorated by applying lime or other acid-neutralizing materials. Liming to recommended soil pH values increases productivity, benefits soil structure, improves degraded soils and, when used with other appropriate management practices, can benefit crop biodiversity (Goulding, 2016).

Sesame is widely accepted crop for dryland agriculture. Alley cropping system is increasingly viewed as an effective means towards increasing crop and fruit tree productivity under the acidic soil. Therefore, the location specific according to agro-ecological zones selection of an appropriate combination of fruit and arable crop in alley cropping in crucial. A major objective of alley cropping is to attain stability in crop yield while maintaining or enhancing the soil productivity and sustainability. Alley cropping of *Psidium guajava* (Guava) with arable crops like sesame is more remunerative than the sole crop of sesame in acidic soils (Kumar *et al*., 2013). In such problematic soils, the net return from a unit land area under alley cropping is considerably higher than those from the annual sole crop (Malavia and Patel, 1989). The results on such aspects have revealed better return from unit land compared to a traditional practicing system. Therefore, need to focus on alley copping system because of low input required & high price of produce. The present experiment was laid out with the hypothesis that sulfur and lime application can improve the yield and economics of sesame under alley cropping with guava planted on acidic soils of eastern Uttar Pradesh, India.

Materials and Methods

Site Description and Experimental Details

The research was conducted in summer season of 2014 in sandy loam soils at Agronomy Farm of RGSC, Banaras Hindu University, situated at Barkachha, Mirzapur, India having latitude, longitude and altitude above mean sea level of 25^0 05’, 82^0 59’ and 89 meters, respectively the Northern Gangetic alluvial plains. The experiment was laid out in factorial randomized block design in three replicate times with 16 treatment combinations, comprising four levels of sulfur (0, 15, 30 and 45 kg ha^{-1}) and four levels of lime (0, 100, 250 and 350 kg ha^{-1}) with net plot size of 4.4 m x 3.4 m.

Cultural Practices

The experiment was conducted under rainfed area; hence the seedbed was prepared on the already stored moisture regime by rainfall. Elemental sulfur (S^0-S) and lime ($CaCO_3$) was applied 15 days before the sowing of crop according to the treatment requirements and thoroughly incorporated into the soil with the help of spade. The sowing was performed on August 06, 2014 using country plough by keeping row to row distance of 30 cm with 2.5 cm depth and seed rate of 4 kg ha^{-1}. The sowing was done between the alleys of 8 years old guava spaced at 7 m x 7 m distance which was planted in August 2006. After attaining constant emergence count, thinning was done at 15 days after sowing to maintain the plant to plant distance of 10 cm. Fertilizers at the rate of 30 kg N, 60 kg P and 30 kg K were applied as basal dose through Urea, Di-ammonium phosphate and Muriate of potash.

Weeds were removed manually at 20 days after sowing.

At maturity, total plants present in each net plot were harvested after removing the border rows, tied into bundles, numbered and left out in the field to dry for 4-5 days. After proper cleaning and winnowing the seed weight of each plot was recorded separately. The cost of cultivation including weeding and harvesting of the fruit tree were considered common in all treatments while the cost of various mulching practices varied due to their requirement as per treatment. Gross income was worked out by multiplying grain and stalk yields of the crop and yield of fruit trees with their prevailing market prices. Calculations were made as per normal rates prevalent at the Research Farm, RGSC (BHU). The cost of lime and sulfur was taken as per prevailing market prices. Net return (Rs. ha^{-1}) and benefit: cost ratio was calculated with the help of the following formulas:

Net return (Rs. ha^{-1}) = Gross return (Rs. ha^{-1}) – Cost of cultivation (Rs. ha^{-1})

$$\text{B: C ratio} = \frac{\text{Net return (₹/ha)}}{\text{Cost of cultivation (₹/ha)}}$$

Statistical analysis: All the data recorded were statistically analyzed by standard procedures of factorial randomized block design (Gomez and Gomez, 1984). Analysis of variance (ANOVA) was used to short out total variance and estimate variance component and to test the predominant hypothesis. Once F ratio was significant, a multiple mean comparison was performed using Fisher's Least Significance Difference Test at 0.05 probability level (Fischer, 1954).

Results and Discussion

The application of sulfur and lime levels significantly influenced the seed and stalk yield of sesame (Fig 1). Among the different levels of sulfur, 30 kg S ha^{-1} recorded significantly higher seed (282.75 kg ha^{-1}) and stalk (359.84 kg ha^{-1}) yield of sesame, which was closely followed by 45 kg S ha^{-1}. Even though, the difference between 30 and 45 kg S ha^{-1} for seed and stalk yield was at par. The increased seed and stalk yield up to 30 kg S ha^{-1} were 42.62 and 29.09% over control. The sulfur application at the rate 30 kg ha^{-1} showed the highest gross return (Rs.47136.02), net return (Rs.18660.89) and B: C ratio (3.65) in sesame + guava over the sole crop of sesame (Fig 2 and Tale 1). However, the application of 45 kg S ha^{-1} reported statistically comparable gross return (Rs.46740.21), net return (Rs.19588.41) and B: C ratio (4.26) with 30 kg S ha^{-1} in sesame + guava alley cropping. The increased net return and B: C ratio of sesame + guava up to 30 kg S ha^{-1} was 53.87 and 261.38% over control, whereas, this increased net return and B: C ratio of sole sesame up to 30 kg S ha^{-1} was 227.11 and 202.97% over control. These results are in agreement with the findings of Nehara *et al*. (2006); Singh and Mann (2007); Baviskar *et al*. (2010); Meena and Meena (2013); Meena *et al*. (2013).

Amongst the lime levels, application of 250 kg lime ha^{-1} showed significantly higher seed yield, stalk yield and monetary advantage over rest of lime treatments (Fig 1). The data revealed that the considerably higher seed (286.08 kg ha^{-1}) and stalk (358.28 kg ha^{-1}) yield was obtained from the application of 250 kg lime ha^{-1}. The increased seed and stalk yield up to 250 kg lime ha^{-1} were 55.62 and 26.72% over control. Similarly, more gross return (Rs.42797.85), net return (Rs.19642.72) and B: C ratio (3.81) was in 250 kg lime ha^{-1}, but these were at par with 350 kg lime ha^{-1} under sesame + guava alley cropping (Fig 2 and Tale 1).

Table.1 Effect of sulfur and lime levels on economics of sesame and sesame + guava

Treatment	Sesame			Sesame + guava		
	Cost of cultivation (Rs./ha)	**Gross return (Rs./ha)**	**B:C ratio**	**Cost of cultivation (Rs./ha)**	**Gross return (Rs./ha)**	**B:C ratio**
Sulfur levels (kg/ha)						
Control	18121.53	9710.95	1.01	18121.53	36082.75	1.01
15	23881.67	11914.38	1.71	23881.67	38379.52	1.60
30	32641.53	14327.55	3.06	32641.53	47136.02	3.65
45	36568.33	15005.08	4.98	36568.33	46740.21	4.26
SEm±		1768.31	0.58		1585.05	0.30
CD (P=0.05)		5107.21	1.69		4577.91	0.86
Lime levels (kg/ha)						
Control	22121.27	8396.17	1.09	22121.27	36517.97	1.03
100	26701.67	10790.59	1.82	26701.67	42242.39	1.87
250	27988.40	14476.05	3.25	27988.40	42797.85	3.81
350	34401.73	17295.16	4.91	34401.73	46780.29	3.93
SEm±		1768.31	0.58		1585.05	0.30
CD (P=0.05)		5107.21	1.69		4577.91	0.86

Fig.1

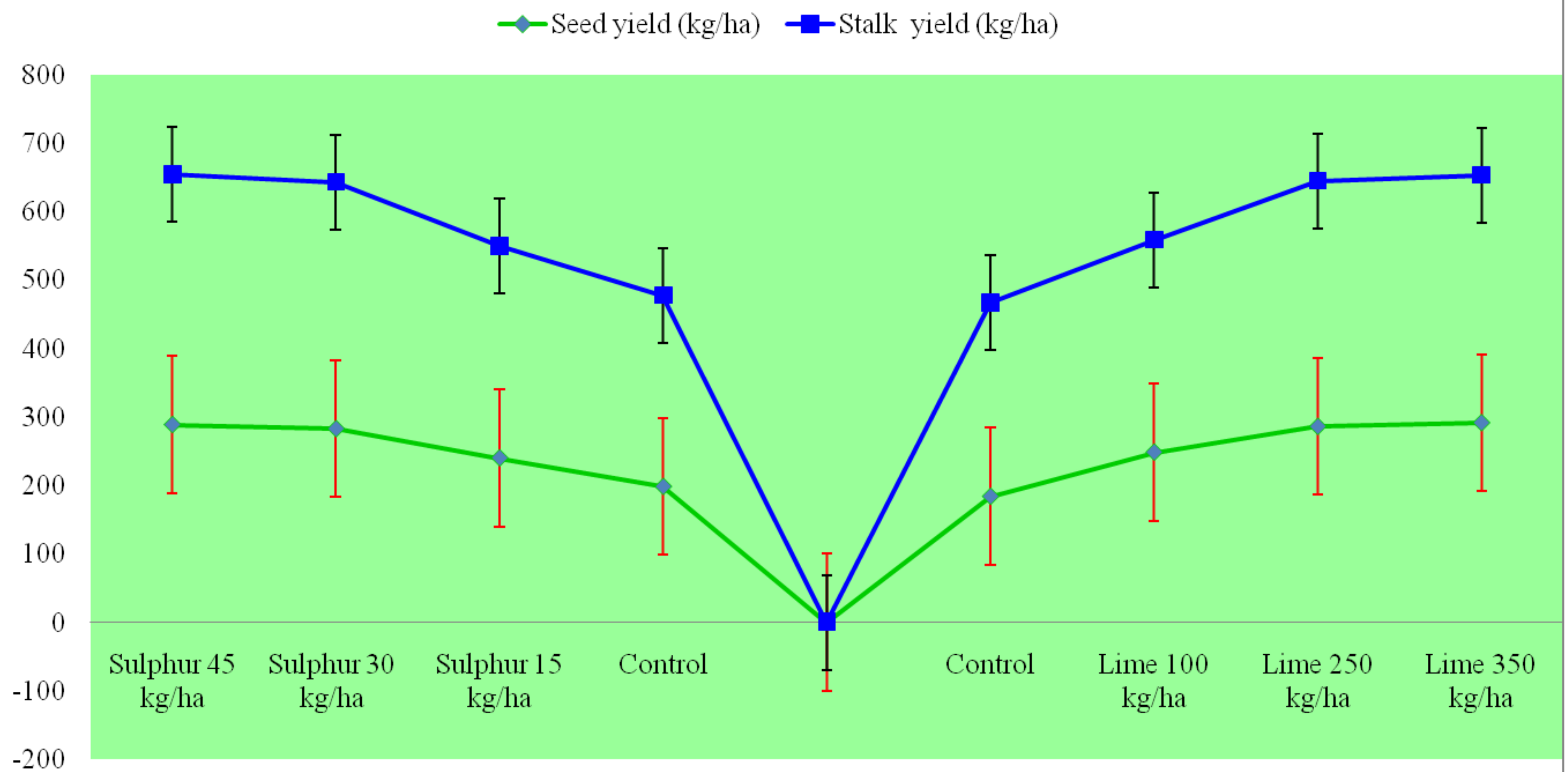

Fig 1. Effect of sulfur and lime levels on seed and stalk yields of sesame

Fig.2

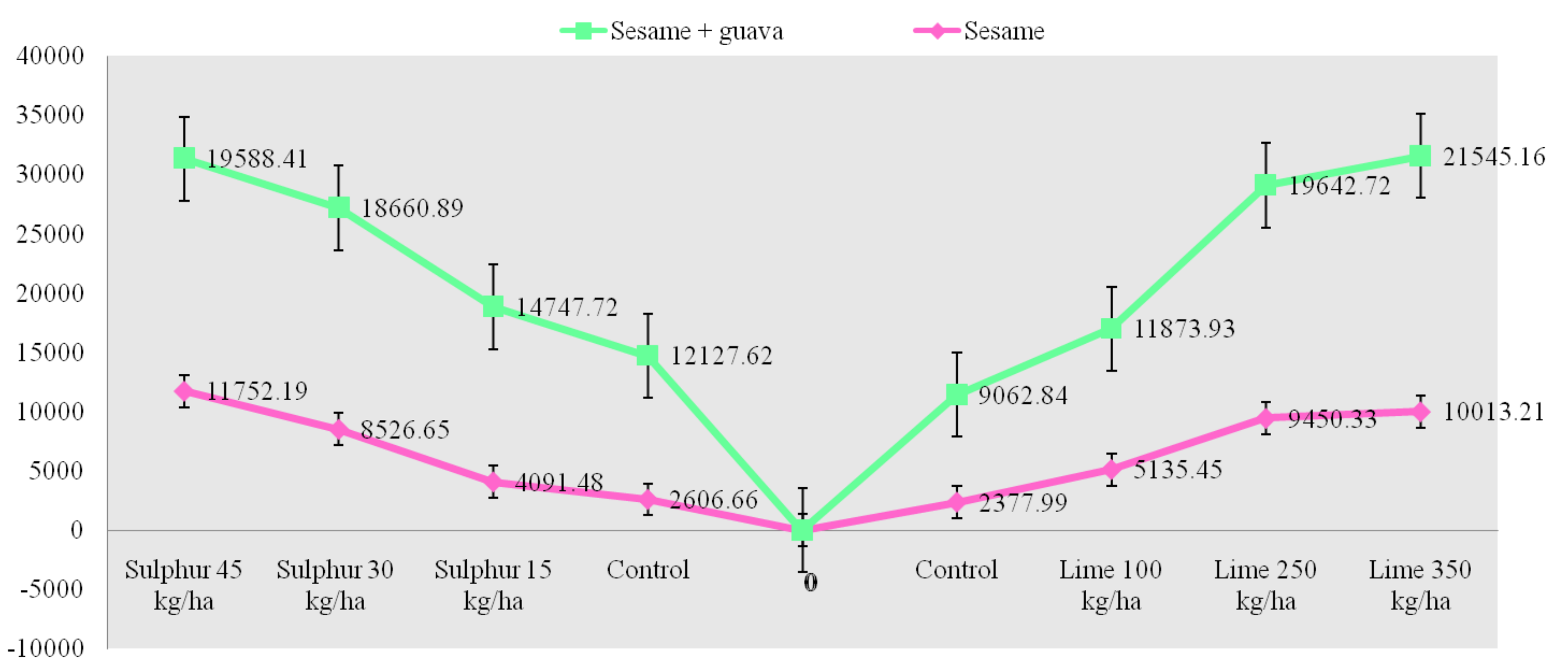

Fig 2. Effect of sulfur and lime levels on net return (₹/ha) of sesame and sesame + guava

The increased net return and B: C ratio of sesame + guava up to 250 kg lime ha-1 was 116.63 and 269.9% over control, whereas, this increased net return and B: C ratio of sole sesame up to 250 kg lime ha-1 was 297.4 and 198.16% over control.

This might be due to higher seed, and stalk yield was produced under the treatment of 250 kg lime ha^{-1}. The monetary advantage in the alley cropping system of sesame + guava was higher than the growing of sesame as a sole crop. The results were close conformity with the findings of Lukina and Epplin (2003); Meena and Varma (2016); Varma *et al*. (2016).

In conclusion, S and lime application enhanced the productivity and economic returns of sesame under sesame + guava alley system in acidic soils of eastern Uttar Pradesh and the sulfur lime level of 30 and 250 kg ha^{-1}, respectively performed better than other treatments. Therefore to attain maximum sesame productivity along with higher net returns and B: C ratio under sesame + guava alley system in acidic soils, sulfur and lime should be apply @ 30 and 250 kg ha^{-1}, respectively.

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