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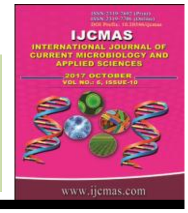

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Yield Performance and Economic Studies of Cabbage (*Brassica oleracea* var. *capitata*) as Influenced by Different Sources and Levels of Sulphur

R. Bhat[1], Shahid B. Dar[2*] and R. Zahida[2]

[1]Division of Vegetable Sciences, SKUAST-Kashmir, FOA, Wadura-193201, J&K, India
[2]Division of Agronomy, SKUAST-Kashmir, FOA, Wadura-193201, J&K, India
**Corresponding author*

A B S T R A C T

A field experiment was conducted during *Rabi* 2012-13 and 2013-14 to study economics of cost of cultivation head yield and seed yield of cabbage as influenced by different sources and levels of sulphur. The experiment was laid in a randomized block design with three replications. Three sources of sulphur i.e., gypsum, elemental sulphur and potassium sulphate with three levels i.e., 40, 70 and 100 kg S ha^{-1} for each source were tried in the experiment. Pooled data of two years showed potassium sulphate as a source of sulphur recorded maximum head yield $plot^{-1}$ (30.8 kg) and head yield ha^{-1} (408.4 q) and seed yield per plant (12.9 g), and seed yield per hectare(4.8 q). Further, increasing levels of sulphur up to 70kg ha^{-1} showed significant results. Maximum cost of cultivation (₹ 230577.5 ha^{-1}) and (₹ 242390.0 ha^{-1}) was estimated in application of 100 kg S ha^{-1} as Elemental sulphur and minimum (₹ 130577.5) and (₹ 130577.5) under control for head yield and seed yield of cabbage, respectively. Optimum dose of sulphur registered net returns of ₹ 404251.3 ha^{-1} and of ₹ 271457.3 ha^{-1} with B: C ratio of 3.4 and 2.5 for cabbage head and seed production respectively. Economic studies indicated that fertilizer source Potassium Sulphate @ 70 kg S ha^{-1} gave maximum net returns of ₹ 485925.8 ha^{-1} and ₹ 3210128.0 ha^{-1} with B:C ratio of 4.1 and 3.0 for cabbage head and seed production respectively.

Keywords

Cabbage, Seed yield, Head yield, Sulphur and Economics.

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Introduction

Cabbage (*Brassica oleracea* var. *capitata*) is the second most important cole crop after cauliflower, which was originated in Europe and in the Mediterranean region, evolved from a leafy mustard herb "Caboche" a French word believed to be the root of the English name of cabbage and is derived from the Normanno picard word which means "head". Cabbage falls under cole group and all cole crops have one common trait i.e., genetic potential to thicken various parts. The seeds of cabbage used to be imported from Europe and the attempts to produce seeds were undertaken during the Second World War when the supply was cut off. It is cultivated in most countries worldwide just like other common cruciferous vegetables like broccoli, brussels sprout and cauliflower which are part of our day to day cooking.

In India, it is grown over an area of 400 thousand hectares with a production of 9039 thousand metric tons, and, the productivity of the crop is quite low 22.6 metric tons/hectare. West Bengal is the largest grower of cabbage and produces2197.4 thousand metric tons on an area of 78.2 thousand hectares which is about 27% of the total of the country. Orissa (14%) and Bihar (9%) occupies second and third position respectively. The other major growers of cabbage are Assam, Karnataka, Maharashtra, and Gujarat (Anonymous, 2011). In J&K, cabbage is grown over an area of 2264 hectares with the production of 69726 t of which Kashmir occupies an area of 750 hectare with the production of 20950 tones (Anonymous, 2012a).

Cabbages are highly responsive to fertilizer application. Fertilizers offer the best means of increasing yield and maintaining soil health. In addition to N, P and K nutrients, sulphur has been found to be very much beneficial (Hara and Sonoda, 1981).

Sulphur is increasingly being recognized as the fourth major plant nutrient after nitrogen, phosphorus and potassium (Jamal *et al* 2010). Sulphur is best known for its role in the synthesis of proteins, oils, vitamins and is associated with the production of superior nutritional and market quality.

Cabbage for seed production is a winter biennial crop and sulphur also provides winter hardiness and drought tolerance besides control of insects, pests and diseases. Optimum use of fertilizers containing sulphur improves utilization of nutrients, especially nitrogen. Keeping these aspects in view, the present investigation was undertaken.

Materials and Methods

Field experiments were carried out at Vegetable Experimental Farm, Division of Vegetable Science *Rabi* season of 2012-13 and 2013-14 located at 34.1^0N and 74.89^0 E at an altitude of 1587 m above MSL, in order to work influence of level and source of sulphur for obtaining higher head and seed yield of cabbage. The soil (0-15 cm) of experimental site was well drained silty clay loam in texture with pH 7.00, high in organic carbon (0.97%), medium in available N (242.6 kg/ha), available P (21.5 kg/ha), available K (165.6 kg/ha) and available S (22.6 kg/ha). The experiment was laid in a randomized block design with three replications having 10 treatments comprising different combinations of sulphur levels and sulphur sources *viz*, 40 kg S ha^{-1} through Gypsum (T_1), 70 kg S ha^{-1} through Gypsum (T_2), 100 kg S ha^{-1} through Gypsum(T_3), 40 kg S ha^{-1} through Elemental sulphur (T_4), 70 kg S ha^{-1} through Elemental sulphur (T_5), 100 kg S ha^{-1} through Elemental sulphur (T_6), 40 kg S ha^{-1} through Potassium sulphate (T_7), 70 kg S ha^{-1} through Potassium sulphate (T_8), 100 kg S ha^{-1} through Potassium sulphate (T_9) and control (T_{10}). A uniform dose of nitrogen @150 kg N ha^{-1}, Phosphorus @ 60 kg P_2O_5 ha^{-1}, Potassium @ 60 kg K_2O kg ha^{-1} and FYM @ 30 t ha^{-1} was applied to each plot. Sulphur through different sources and levels as per treatment was applied as basal dose. Elemental sulphur was applied 15 days prior to transplanting of seedling. Cabbage (Golden Acre) was transplanted at 60 × 45 cm spacing during first fortnight of April and harvested at fully matured stage. Selected and tagged plants were left in the field for seed production during winter. All other cultural practices were followed as per standard recommendations. The economics of different cultural practices, input and returns for cabbage variety Golden Acre under each treatment combination was worked out to find the most effective and economical treatment.

The details of cost of cultivation of head yield and seed yield of cabbage ha^{-1}, treatment wise added cost and treatment wise cost of cultivation are presented in tables 5 and 6, respectively. The data were analyzed as per the standard procedure for Analysis of Variance (ANOVA) as described by Gomez and Gomez, (1984). The difference in the treatment mean was tested by using critical difference (CD) at 5% level of probability.

Results and Discussion

Head yield (q ha^{-1})

Results showed significant influence of sources and levels of sulphur on head yield (q ha^{-1}). Among different sulphur sources, potassium sulphate (Table 1) recorded maximum head yield $plot^{-1}$(30.80), head yield ha^{-1} (408.40 q ha^{-1}), seed yield $plant^{-1}$ (12.90) and seed yield $hectare^{-1}$ (4.80 q) followed by Gypsum and the lowest head yield $plant^{-1}$ (17.70 kg), head yield ha^{-1} (234.60 q ha^{-1}), seed yield $plant^{-1}$ (6.00 g) and seed yield $hectare^{-1}$ (2.25 q). The superiority of potassium cabbage could be attributed to highly soluble nature and readily available sulphur (sulphate) in potassium sulphate as compared to Gypsum and Elemental sulphur (Tandon,1989), (Tandon and Messick, 2002). Similar observations have been reported by Samui and Bandopadhyay (1997) in cauliflower.

Among sulphur levels, 70 kg S ha^{-1} recorded maximum head yield $plot^{-1}$ (28.00 kg), head yield ha^{-1} (371.90 q ha^{-1}), seed yield $plant^{-1}$ (11.90 g) and seed yield $hectare^{-1}$ (4.4 q) but exhibited statistically at par results with 70 kg S ha^{-1} with head yield $plant^{-1}$ (27.90 kg), head yield ha^{-1} (370.20 q ha^{-1}), seed yield $plant^{-1}$ (11.40 g) and seed yield $hectare^{-1}$ (4.2 q). The increase in head yield and seed yield might be due to the important role of sulphur in lowering the pH of soil resulting in increased availability of many nutrients (Hossan and Olsen, 1966). Sulphur application increases the yield, since it is a constituent of amino acid and protein production (Ahmed 1998). Increase in crop yield by the application of sulphur was reported by Tandon (2002).

Sulphur helps in energy transformation and activation of enzymes in carbohydrate metabolism and greater partitioning of photosynthates in yield contributing attributes. The increase in yield attributes was probably due to source and sink relationship which ultimately increased head and seed yield. Increase in seed yield by application of sulphur are in confirmation with the results obtained by Khanpara *et al.*, (1993), Jat and Kangarot (2000), Narwal *et al.*, (1991), Hunashikatti *et al.*, (2000).

Table.1 Yield performance of cabbage as influenced by different sources and levels of sulphur

Treatment	Head yield $plant^{-1}$	Head yield ha^{-1}	Seed yield $plant^{-1}$	Seed yield ha^{-1}
Sulphur sources				
Gypsum	25.50	338.10	11.20	4.10
Elemental sulphur	23.30	310.00	9.00	3.30
Potassium sulphate	30.80	408.40	12.90	4.80
Graded levels of sulphur ha^{-1}				
40 kg	23.70	314.60	9.80	3.65
70 kg	27.90	370.20	11.40	4.2
100 kg	28.00	371.90	11.90	4.4
Control versus rest control mean	17.70	234.60	6.00	2.25
Sources CD ($p \leq 0.05$)	**0.25**	**3.20**	**0.14**	**0.05**
Levels	**0.25**	**3.20**	**0.14**	**0.05**
Control versus rest	**0.10**	**1.40**	**0.06**	**0.02**

Table.2 Interaction effect of seed yield plant^{-1} as influenced by different sources and Levels of sulphur

Treatment	**Sulphur Levels (kg ha^{-1})**		
	Seed yield plant^{-1} (g plant-^{1})		
Sulphur sources	**40**	**70**	**100**
Gypsum	9.80	11.70	12.10
E. sulphur	7.60	9.42	10.00
P. sulphate	12.20	13.20	13.40
CD ($p \leq 0.05$)		**0.08**	

Table.3 Cost of cultivation of cabbage head production (Hectare basis)

Cost involved on variable and fixed factors		**₹ha^{-1}**
A.	Nursery raising/preparation/sowing, management (10 Labourers at ₹ 150.0 labour^{-1}	1500.00
Total A		**1550**
B.	Preparatory tillage (Three ploughings at ₹ 3000.00 ha^{-1})	9000.00
	Clod breaking/leveling (20 labourers at ₹ 150.0 labour^{-1})	3000.00
	Preparation of beds/channels (35 labourers at ₹ 150.00 labour^{-1})	5250.00
	Planting of seedlings (35 labourers at ₹ 150.0 labour^{-1})	5250.00
Total B		**22500.00**
C.	Irrigation (20 labourers at ₹ 150.0 labour^{-1})	3000.00
D.	Cultural operations (five hand weedings/hoeings 55 labourers at ₹ 150.0 labour^{-1})	8250.00
E.	After care operations (15 labourers at ₹ 150.00 labour^{-1})	2250.00
F.	Harvesting, and related operations (15 labourers at ₹ 150.00 labour^{-1})	2250.00
Total (C+D+E+F)		**15750.00**
Total (A+B+C+D+E+F)		**39750.00**
	Incidental charges at 5% of the working capital	1987.5
	Total labour component involved in total cost of cultivation	41737.5
G.	Cost of seed at 1000 kg^{-1} for 500g seed ha^{-1}	500.00
Total G		**500.00**
Variable cost (labour + cost of seed)		42237.5
Land rent at ₹ 900 kanal^{-1}		18000.00
Land tax		80.0
Depreciation of implements		800.0
Total		**18880.00**
Interest at 6.5% on fixed factor		1227.2
Total fixed cost (18880+ 1227.2)		20107.2

Table.4 Cost of cultivation of seed production in cabbage (Hectare basis)

Cost involved on variable and fixed factors		₹ ha^{-1}
A.	Nursery raising/preparation/sowing, management (10 Labourers at ₹ 150.0 $labour^{-1}$	1500.00
Total A		**1500**
B.	Preparatory tillage (Three ploughings at ₹ 3000.00 ha^{-1})	9000.00
	Clod breaking/leveling (20 labourers at ₹ 150.0 $labour^{-1}$)	3000.00
	Preparation of beds/channels (35 labourers at ₹ 150.0 $labour^{-1}$)	5250.00
	Planting of seedlings (35 labourers at ₹ 150.0 $labour^{-1}$)	5250.00
Total B		**22500.00**
C.	Irrigation and drainage (45 labourers at ₹ 150.00 $labour^{-1}$)	12750.00
D.	Cultural operations (fifteen hand weedings/hoeings 85 labourers at ₹ 150.00 $labour^{-1}$)	5250.00
E.	After care operations (15 labourers at ₹ 150.0 $labour^{-1}$)	2250.00
F.	Harvesting, drying, curing, threshing, winnowing, cleaning & packaging of seed and related operations (35 labourers at ₹ 150.0 $labour^{-1}$)	5250.00
Total (C+D+E+F)		**27000.00**
Total (A+B+C+D+E+F)		**51000.00**
	Incidental charges at 5% of the working capital	2550.00
	Total labour component involved in total cost of cultivation	53550.00
G.	Cost of seed at 1000 kg^{-1} for 500g seed ha^{-1}	500.00
Total G		**500.00**
Variable cost (labour + cost of seed)		54050
Land rent at ₹ 900 $kanal^{-1}$		18000.00
Land tax		80.00
Depreciation of implements		800.00
Total		**18880.00**
Interest at 6.5% on fixed factor		1227.2
Total fixed cost (18880.0 + 1227.2)		20107.2

Table.5 Treatment wise comparative economics of cost of cultivation of cabbage (Hectare basis)

Treatment	**Fixed cost (₹ ha^{-1})**	**Variable cost (₹ ha^{-1})**	**Total added cost (₹ ha^{-1})**	**Total variable cost (₹ ha^{-1})**	**Total cost of cultivation (₹ ha^{-1})**	**Pooled Head yield (q ha^{-1})**	**Gross returns (₹ ha^{-1} @ ₹ 1500 q^{-1})**	**Net returns (₹ ha^{-1})**	**Returns per rupee**
40 kg S through Gypsum	20107.20	42237.50	72232.40	114469.90	134577.10	301.70	452550	317972.90	3.30
70 kg S through Gypsum	20107.20	42237.50	75232.40	117469.90	137577.10	355.80	533700	396122.90	4.10
100 kg S through Gypsum	20107.20	42237.50	78225.20	120462.70	140569.90	357.30	535950	395380.10	3.80
40 kg S through Elemental sulphur	20107.20	42237.50	108232.80	150470.30	170577.50	273.70	410550	239972.50	2.40
70 kg S through Elemental sulphur	20107.20	42237.50	138232.80	180470.30	200577.50	327.40	491100	290522.50	2.40
100 kg S through Elemental sulphur	20107.20	42237.50	168232.80	210470.30	230577.50	329.10	493650	263072.50	2.10
40 kg S through Potassium Sulphate	20107.20	42237.50	82396.00	124633.50	144740.70	368.40	552600	407859.30	3.80
70 kg S through Potassium Sulphate	20107.20	42237.50	93829.50	136067.00	156174.20	427.40	641100	**485925.80**	**4.10**
100 kg S through Potassium Sulphate	20107.20	42237.50	105341.00	147578.50	167685.70	429.40	644100	476414.30	3.80
Control	**20107.20**	**42237.50**	**68232.80**	**110470.30**	**130577.50**	**234.60**	**351900**	**221322.50**	**2.70**

Table.6 Treatment wise comparative economics of cost of cultivation of seed production in Cabbage (Hectare basis)

Treatment	Fixed cost (₹ ha^{-1})	Variable cost (₹ ha^{-1})	Total added cost (₹ ha^{-1})	Total variable cost (₹ ha^{-1})	Total cost of cultivation (₹ ha^{-1})	Pooled seed yield (q ha^{-1})	Gross returns (₹ ha^{-1} @ ₹100000 q^{-1})	Net returns (₹ ha^{-1})	Returns per rupee
40 kg S through Gypsum	20107.20	54050.00	72232.40	126282.40	146389.60	3.62	362000	135347.90	2.40
70 kg S through Gypsum	20107.20	54050.00	75232.40	129282.40	149389.60	4.32	432000	184947.90	2.80
100 kg S through Gypsum	20107.20	54050.00	78225.20	132275.20	152382.40	4.53	453000	197605.10	2.90
40 kg S through Elemental sulphur	20107.20	54050.00	108232.80	162282.80	182390.00	2.81	281000	38597.50	1.50
70 kg S through Elemental sulphur	20107.20	54050.00	138232.80	192282.80	212390.00	3.48	348000	58947.50	1.60
100 kg S through Elemental sulphur	20107.20	54050.00	168232.80	222282.80	242390.00	3.7	370000	45347.50	1.50
40 kg S through Potassium Sulphate	20107.20	54050.00	82396.00	136446.00	156553.20	4.52	452000	192684.30	2.80
70 kg S through Potassium Sulphate	20107.20	54050.00	93829.50	147879.50	167987.20	4.89	489000	**209000.30**	**2.90**
100 kg S through Potassium Sulphate	20107.20	54050.00	105341.00	159391.00	179498.20	4.98	498000	204239.30	2.70
Control	**20107.20**	**54050.00**	**68232.80**	**122282.80**	**142390.00**	**2.24**	**224000**	**35947.50**	**1.50**

The interaction effect between sources and levels of sulphur on head yield ha^{-1} (q) in pooled data was found to be non-significant. The interaction effect between sources and levels of sulphur seed yield plant^{-1} was found significant (Table 2). The seed yield plant^{-1} varied significantly among different sulphur sources when fertilizer sulphur was applied as Gypsum, Elemental sulphur and Potassium Sulphate. Similarly at 40, 70, and 100 kg S ha^{-1}, seed yield plant^{-1} significantly higher seed yield plant^{-1} in pooled data of 13.20 g was recorded with treatment combination 100 kg S ha^{-1} potassium sulphate which was statistically superior to all other treatment combination.

Economics

Cabbage head production

The data presented in table 3 revealed position of input and output in terms of economics of production. The treatment wise cost of cultivation and returns revealed that maximum net returns of ₹ 485925.8 ha^{-1} were observed with the application of 70 kg S ha^{-1} as Potassium Sulphate followed by ₹476414.3 ha^{-1} with the application of 100 kg S ha^{-1} as Potassium Sulphate with benefit cost ratio of 4.1 and 3.8, respectively. The lowest net returns of ₹ 221322.5 were registered with control with benefit cost ratio of 2.7.

Seed production

The data presented in table 5 revealed position of input and output in terms of economics of production. The treatment wise cost of cultivation and returns revealed that maximum net returns of ₹ 321013.0 ha^{-1} were observed with the application of 70 kg S ha^{-1} as Potassium Sulphate followed by ₹ 300617.6 ha^{-1} with the application of 100 kg S ha^{-1} as Potassium Sulphate with benefit cost ratio of 3.0 and 2.9 respectively. The lowest net returns of ₹ 81610.0 were registered with control with benefit cost ratio of 1.5. Similar results have been reported by Jamre *et al.* (2010) in cabbage and Chippa (2005) in cauliflower.

From the above study, it is concluded that the sulphur application improves yield of cabbage irrespective of sources and increasing levels of sulphur showed significant results. In terms of cost of cultivation potassium sulphate as a source of sulphur with a level of 70 kg ha^{-1} proved to be best combination.

References

Ahmad, A., Abraham, G., Gandotra, N., Abrol, Y.P. and Abdin, M.Z. 1998. Interactive effect of nitrogen and sulphur on growth and yield of rapeseed-mustard (*Brassica juncea* [L.] Czern 527 and Coss and *Brassica campestris* L.). *Journal of Agronomy Crop Sciences*, 181: 193-199.

Anonymous, 2011. Technical Note March 2012, Horticulture Unit.

Anonymous, 2012a. Report from Govt. of J&K Directorate of Agriculture, Kashmir.

Chhipa, B.G., 2005. Effect of different levels of sulphur and zinc on growth and yield of cauliflower (*Brassica oleracea* var. *botrytis* L.). *M.Sc. (Ag.) Thesis, S.K.N. College of Agriculture, Jobner, RAU, Bikaner Cripps.*

Gomez, K.A., and Gomez, A.A. 1984. Statistical Procedures for Agricultural Research.2nd edition. John Wiley and Sons, Inc. New York.

Hara, T., and Sonoda, Y. 1981. The role of macro-nutrients in cabbage head formation. *Soil Science and Plant Nutrition*, 27(1): 45-54.

Hossan, N., and Olsen, R.A. 1966. Influence of applied sulphur on availability of soil nutrients of corn (*Zea mays* L.) nutrition. *Proceedings of Soil Science and Society of America*, 30(2): 284-286.

Hunashikatti, M.H., Channal, H.T., Sarangamath, P.A., Manjunathaiah, H.M. and Hebsur, N.S. 2000. Effect of sulphur and molybdenum on the dry matter yield and uptake of S and Mo by cabbage. *Karnataka Journal of Agricultural Science*, 13(4): 840-845.

Jamal, A., Moon, Y.S., and Abdin, M.Z. 2010. Sulphur-A general overview and interaction with nitrogen. *Australian. Journal of Crop Sciences*, 4: 523-529

Jamre, B.R., Nagaich, K.N. and Verma, Hemlata. 2010. Effect of different levels of sulphur and Zinc on growth and yield of cauliflower (*Brassica oleracea* var. *botrytis* L.). *Asian Journal of Horticulture*, 5 (2): 323-325.

Jat, B.L, and Khangarot, S.S. 2000. Responses of mustard (*Brassica Juncea* L.) varieties to different levels of sulphur in loamy sand soil. *Agriculture Science Digest,* 23 (2):149-151, 2003.

Khanpara, V.D., Porwal, B.L., Sahu, M.P and Patel, J.C. 1993. Effect of nitrogen and sulphur on growth and yield of mustard (*Brassica juncea*). *Indian Journal of Agronomy*, 38(2): 266-269.

Narwal, R.P., Gupta, A.P., Ksrwasara, S.P.S and Antil, R.S. 1991. Effect of carriers of sulphur on yield and uptake of sulphur by mustard. *Journal of Indian Society of Soil Science*, 39(2):34-327.

Samui, R.C., and Bandopadhyay, P. 1997. Effect of sources level and method of application of sulphur on Indian mustard (*Brassica juncea*). *Indian Journal of Agricultural Sciences*, 67(8):305-307.

Tandon, H.L.S., 1989. Sulphur fertilizers for Indian Agriculture-A Guide book Fertilizer Development and Consultation Organization. New Delhi.

Tandon, H.L.S., 2002. Sulphur fertilizers for Indian Agriculture-A Guide book Fertilizer Development and Consultation Organization. New Delhi.

Tandon, H.L.S., and Messick. 2002. Practical Sulphur Guide. Connecticut Avenue, N.W., Suite 612 Washington D.C U.S.A. pp. 2-19.

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