

Short Communication

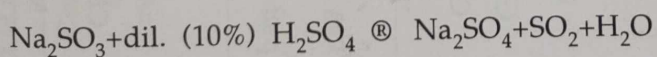
## Effect of Sulphurdioxide on Vigour of Gram Varieties Stored in different Containers under various Conditions of Humidity

S. DHAWAN AND R.S. BRAR

Department of Botany, S.G.N. Khalsa College, Sri Ganganagar 335 001  
sachin.dhawan1@gmail.com

Sulphurdioxide is one of the chief pollutants right on top of the list after CO. In developing countries it is recognized as most deleterious pollutant [1, 2], causing wide spread damages to various plant parts. Many have cited the toxic effect of sulphur on various plants like tomato [3], okra [4], wheat [5], the dual role of sulphur has not been discarded [6] as well. It has been found to be helpful when available to the plant in low concentration [7]. Further, storage container [8] inadvertently affects germination potential of stored seeds coupled with the specific environment of varying humidity [9] and temperature conditions [10]. So to study the cumulative effect of all these factors along with the time period and SO<sub>2</sub> as fumigant, the present problem was taken up.

Seeds of two varieties of gram i.e. GNG 663 and C 235 obtained from Agriculture Research Station, Sri Ganganagar, were surface sterilized with 0.01% HgCl<sub>2</sub> solution for 5 minutes and then washed thoroughly and repeatedly with distilled water before drying. The seeds were then kept in three different containers, viz. aluminium bag, polythene bag and craft paper bag, further under humid conditions of 45 per cent and 75 per cent RH and then treated with four different concentrations of gaseous pollutant SO<sub>2</sub> and maintained along with the control. The gas was produced as described by Rao and Blank [11] using equation:



As per equation 1 mole (126 mg) of sodium

sulphite on complete reaction with 10 per cent dilute sulphuric acid would produce 1 mole (64 mg) of sulphur dioxide gas. Using the same equation 51, 152, 254, 356 mg/m<sup>3</sup> of gaseous concentrations were produced and the seeds were treated one time for 3h with respective concentrations. Germination test was conducted in three replicates of 25 seeds each following ISTA rules [12] at 25°C. Seedling vigour was measured as dry weight of 10 normal seedlings taken randomly per replication after the final count. Seedlings were dried at 90°C for 18-24 hours and weight was taken. Changes in vigour was calculated by multiplying germination percentage to seedling dry weight [13], recorded after 15, 30, 45 and 60 days of storage. The experiment has been analysed statistically [14] under split plot design with gaseous treatment as main plot, storage containers as sub-plot and storage time period as sub-sub-plot.

Vigour decreased in both varieties with increase in concentration of gas during accelerated aging in all the containers, at both the humidities, which is similar to the results obtained in seed of sorghum by Prasad [15] when he compared the treated seed with the untreated one. Values of Table 2 and 4 show that a decrease of 47 per cent and 31.6 per cent in vigour over control occurred for variety GNG 663 and C 235 respectively, when the seeds were stored in craft paper, treated with the highest concentration (356 mg/m<sup>3</sup>) of gas and planted for germination after 60 days of storage at low humidity. But at high humidity vigour was nil for

Table 1. Effect of sulphur dioxide on germination of gram (var. GNG 663) stored in different containers and under various conditions of humidity

Container	Conc. of gas (mg/m <sup>3</sup> )	RH 45 %			RH 75 %			Mean	CD (P = 0.05)											
		15	30	45	60	15	30			45	60									
Aluminium bag	51	100.0	100.0	97.5	97.5	97.5	98.8	0.30	Container(C)	76.3	72.5	75.0	77.5	80.0	77.5	75.0	72.5	76.3	Container (C)	1.05
	152	97.5	97.5	95.0	92.5	92.5	95.6	0.37	Conc.of gas(G)	65.6	60.0	65.0	67.5	70.0	67.5	65.0	60.0	65.6	Conc.of gas (G)	3.72
	254	97.5	95.0	95.0	92.5	92.5	95.0	0.09	Time(days)(T)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Time(days)(T)	0.20
	356	90.0	90.0	87.5	85.0	88.1	88.1	0.65	C*G	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	C*G	6.44
	Control	100.0	100.0	97.5	97.5	98.8	98.8	0.15	C*T	99.1	98.0	98.3	98.0	100.0	100.0	98.3	98.0	99.1	C*T	0.34
Mean	97.0	96.5	94.5	93.0	95.3	95.3	0.19	T*G	48.2	46.1	47.7	46.1	50.0	49.0	47.7	46.1	48.2	T*G	0.44	
								C*T*G											C*T*G	N.S.
Polythene bag	51	100.0	100.0	100.0	97.5	99.4	99.4			71.3	65.0	70.0	75.0	75.0	75.0	70.0	65.0	71.3		
	152	97.5	97.5	97.5	95.0	96.9	96.9			40.6	25.0	35.0	40.0	62.5	40.0	35.0	25.0	40.6		
	254	95.0	95.0	92.5	92.5	93.8	93.8			4.4	0.0	2.5	7.5	7.5	7.5	2.5	0.0	4.4		
	356	92.5	90.0	90.0	87.5	90.0	90.0			3.1	0.0	2.5	5.0	5.0	5.0	2.5	0.0	3.1		
	Control	100.0	98.8	97.5	96.3	98.1	98.1			98.9	97.3	98.3	100.0	100.0	100.0	98.3	97.3	98.9		
Mean	97.0	96.3	95.5	93.8	95.6	95.6			43.7	37.5	41.7	45.5	50.0	45.5	41.7	37.5	43.7			
Craft paper bag	51	100.0	97.5	95.0	92.5	96.3	96.3			47.5	42.5	45.0	47.5	55.0	47.5	45.0	42.5	47.5		
	152	97.5	95.0	92.5	90.0	93.8	93.8			37.5	30.0	37.5	40.0	42.5	40.0	37.5	30.0	37.5		
	254	92.5	90.0	87.5	85.0	88.8	88.8			3.8	0.0	2.5	5.0	7.5	5.0	2.5	0.0	3.8		
	356	90.0	90.0	87.5	82.5	87.5	87.5			1.9	0.0	0.0	2.5	5.0	2.5	0.0	0.0	1.9		
	Control	100.0	98.8	97.5	96.3	98.1	98.1			98.9	97.3	98.3	100.0	100.0	100.0	98.3	97.3	98.9		
Mean	96.0	94.3	92.0	89.3	92.9	92.9			37.9	34.0	36.7	39.0	42.0	39.0	36.7	34.0	37.9			

Table 2. Effect of sulphur dioxide on vigour of gram (var. GNG 663) stored in different containers and under various conditions of humidity

Container	Conc. of gas (mg/m <sup>3</sup> )	RH 45 %			RH 75 %			Mean	CD (P = 0.05)						
		Days	15	30	45	60	Days				15	30	45	60	
Aluminium bag 51	51	389.0	362.2	350.5	336.9	359.6	3.45	Container(C)	250.1	233.4	218.2	199.5	225.3	Container(C)	4.56
	152	367.8	351.1	338.6	306.4	341.0	Conc.of gas(G)	5.12	207.1	175.4	158.0	129.2	167.4	Conc.of gas(G)	14.01
	254	359.9	317.5	308.1	288.4	318.5	Time(days)(T)	1.06	0.0	0.0	0.0	0.0	0.0	Time(days)(T)	0.83
	356	280.1	269.8	244.8	225.3	255.0	C*G	8.88	0.0	0.0	0.0	0.0	0.0	C*G	24.27
	Control	393.4	378.2	356.3	344.2	368.0	C*T	1.84	393.4	378.2	359.0	345.9	369.1	C*T	1.44
Mean	358.0	335.8	319.7	300.2	328.4	T*G	2.38	170.1	157.4	147.0	134.9	152.4	T*G	1.86	
						C*T*G	N.S.							C*T*G	N.S.
Polythene bag	51	386.9	362.6	354.3	316.2	355.0			225.1	224.6	213.2	159.4	205.6		
	152	304.3	292.3	269.8	242.8	277.3			153.4	64.4	42.5	25.4	71.4		
	254	285.6	243.2	226.6	212.8	242.1			2.5	2.4	0.2	0.0	1.3		
	356	275.7	220.9	212.8	184.9	223.6			1.1	0.9	0.2	0.0	0.5		
	Control	396.0	381.0	372.6	361.2	377.7			396.0	385.8	375.5	365.0	380.6		
Mean	329.7	300.0	287.2	263.6	295.1			155.6	135.6	126.3	109.9	131.9			
Craft paper bag 51	51	377.5	350.2	337.6	297.3	340.7			121.7	100.7	87.3	74.0	95.9		
	152	357.1	324.6	297.9	280.9	315.1			83.0	58.2	47.2	34.9	55.8		
	254	288.4	271.4	261.4	214.2	258.8			2.4	0.8	0.2	0.0	0.8		
	356	268.5	253.4	230.6	192.3	236.2			1.1	0.2	0.0	0.0	0.3		
	Control	396.1	386.6	378.8	369.1	382.7			396.1	391.5	381.7	373.0	385.6		
Mean	337.5	317.2	301.2	270.8	306.7			120.9	110.3	103.3	96.4	107.7			

Table 3. Effect of sulphur dioxide on germination of gram (var. C 235) stored in different containers and under various conditions of humidity

Container	Conc. of gas (mg/m <sup>3</sup> )	RH 45 %			Mean	CD (P=0.05)	RH 75 %			Mean	CD (P = 0.05)			
		15	30	45			60	15	30			45	60	
Aluminium bag	51	100.0	100.0	95.0	97.5	Container(C)	0.16	90.0	90.0	87.5	85.0	88.1	Container(C)	2.09
	152	97.5	97.5	95.0	95.6	Conc.of gas(G)	0.33	87.5	87.5	85.0	80.0	85.0	Conc.of gas(G)	2.86
	254	97.5	97.5	92.5	95.0	Time(days)(T)	0.08	50.0	47.5	47.5	45.0	47.5	Time(days)(T)	0.24
	356	90.0	90.0	87.5	88.8	C*G	0.56	50.0	47.5	45.0	42.5	46.3	C*G	4.95
	Control	100.0	100.0	98.8	99.1	C*T	0.13	100.0	100.0	100.0	98.0	99.5	C*T	0.42
Mean	97.0	97.0	93.8	95.2	T*G	0.17	75.5	74.5	73.0	70.1	73.3	T*G	0.55	
					C*T*G	N.S.							C*T*G	N.S.
Polythene bag	51	100.0	97.5	97.5	97.5			85.0	80.0	72.5	67.5	76.3		
	152	97.5	97.5	95.0	95.6			75.0	75.0	70.0	65.0	71.3		
	254	96.3	97.5	95.0	95.3			60.0	42.5	37.5	27.5	41.9		
	356	92.5	90.8	87.5	89.3			47.5	27.5	20.0	15.0	27.5		
	Control	100.0	98.8	97.5	98.1			100.0	100.0	98.8	95.0	98.4		
Mean	97.3	96.4	94.5	95.2			73.5	65.0	59.8	54.0	63.1			
Craft paper bag	51	97.5	97.5	97.5	96.9			80.0	80.0	75.0	70.0	76.3		
	152	95.0	95.0	92.5	93.8			75.0	75.0	70.0	65.0	71.3		
	254	92.5	92.5	92.5	91.9			17.5	17.5	7.5	5.0	11.9		
	356	90.0	90.0	87.5	88.8			10.0	7.5	0.0	0.0	4.4		
	Control	100.0	98.8	97.5	97.8			100.0	100.0	100.0	100.0	100.0		
Mean	95.0	94.8	93.5	93.8			56.5	56.0	50.5	48.0	52.8			

Table 4. Effect of sulphur dioxide on vigour of gram (var. C 235) stored in different containers and under various conditions of humidity

Container	Conc. of gas (mg/m <sup>3</sup> )	RH 45 %			RH 75 %			Mean	CD (P = 0.05)						
		15	30	45	60	15	30				45	60			
Aluminium bag 51	899.5	863.4	799.1	761.1	830.8	Container (C)	7.47	659.3	643.8	600.2	557.4	615.2	Container (C)	12.51	
	152	831.0	811.3	759.2	730.0	782.9	Conc.of gas (G)	7.42	609.9	606.4	546.3	462.3	556.2	Conc.of gas (G)	28.59
	254	799.3	795.0	708.9	707.7	752.7	Time(days)(T)	2.08	216.9	194.2	185.7	155.3	188.0	Time(days)(T)	2.37
	356	670.7	685.8	661.7	626.7	661.2	C*G	12.85	201.0	185.1	151.4	132.5	167.5	C*G	49.52
	Control	902.8	889.6	860.6	834.3	871.8	C*T	3.61	902.8	889.6	871.5	838.6	875.6	C*T	4.10
Mean	820.7	809.0	757.9	732.0	779.9	T*G	4.66	518.0	503.8	471.0	429.2	480.5	T*G	5.30	
						C*T*G	N.S.						C*T*G	N.S.	
Polythene bag 51	881.0	856.8	846.6	709.6	823.5			576.5	530.3	432.0	315.8	463.6			
	152	840.8	800.2	778.8	669.0	772.2		491.3	484.4	401.0	268.1	411.2			
	254	801.3	791.2	756.0	657.0	751.4		281.7	152.0	122.0	74.4	157.5			
	356	754.4	720.7	642.7	604.2	680.5		213.8	75.9	41.4	26.9	89.5			
	Control	909.7	878.8	854.1	799.2	860.4		909.7	889.9	865.1	788.8	863.4			
Mean	837.5	809.5	775.6	687.8	777.6		494.6	426.5	372.3	294.8	397.0				
Craft paper bag 51	821.5	774.4	714.3	676.2	746.6			535.6	514.0	446.9	414.9	477.8			
	152	764.1	738.1	658.5	640.8	700.4		479.6	461.9	408.4	332.7	420.7			
	254	719.0	667.2	665.3	605.3	664.2		26.0	23.3	6.6	4.0	14.9			
	356	639.3	635.9	541.0	572.8	597.2		9.1	6.7	0.0	0.0	3.9			
	Control	891.4	880.1	867.1	834.5	868.3		891.4	891.2	889.3	878.4	887.6			
Mean	767.1	739.1	689.2	665.9	715.3		388.3	379.4	350.2	326.0	361.0				

the same set of conditions. Mean values show that effect of SO<sub>2</sub> was much more pronounced at high humidity as compared to low one. At low humidity vigour got reduced by 63 per cent and 77 per cent for variety GNG 663 and C 235 respectively after 60 days of storage with respect to the control, but effect of SO<sub>2</sub> at high humidity was more lethal, it reduced vigour merely to 0.07 per cent in variety GNG 663 and to 9 per cent in variety C 235 when the seeds were treated with 356 mg/m<sup>3</sup> of SO<sub>2</sub> concentration, after 60 days of storage.

Effect of containers was also significant. For most of the combinations, aluminium bag was best storer, followed by polythene bag and craft paper bag respectively. Except, for variety C 235 at low humidity, where aluminium bag was at par with polythene bag, still proving better over craft paper bag. At high humidity though aluminium bag retained better vigour content for the lower concentrations of SO<sub>2</sub> but in case of variety GNG 663 once the level of 152 mg/m<sup>3</sup> of SO<sub>2</sub> crossed, SO<sub>2</sub> proved lethal for the seeds irrespective of the containers. Any concentration beyond 254 mg/m<sup>3</sup> after 30 days of storage was proving lethal in case of seeds stored in craft paper bag at high humidity for both the varieties.

Reduction in seed vigour was further significant with advance in time. The values of Tables 2 and 4 shows that vigour decreased with increase in time in all the containers, for both the varieties with respect to control as reported by Patra *et al.* [16] in case of groundnut seeds. Reduction in vigour was even more at high humidity. After 15 days of storage average reduction in vigour for the two varieties at low humidity was just 14 per cent, where as at high humidity the reduction was of 68 per cent. Variety C 235 retained best vigour (28%) at low humidity after 60 days of storage. Variety GNG 663 retained least vigour (14 %) at high humidity after 60 days of storage with respect to control.

So it can be safely deduced that effect of SO<sub>2</sub> is deleterious at the considered concentrations, but it is even more lethal as the concentration was increased, coupled with increased humidity. Of containers, seeds contained in aluminium bags retained maximum vigour as compared to polythene bag and craft paper bag.

## REFERENCES

1. KUMAR, N. & V. SINGH (1985). Effect of SO<sub>2</sub> and NO<sub>2</sub> pollution on *Cicer arietinum*. *Ind. J. Eco.*, **12**: 183-188.
2. GUPTA, V., Y.S. TOMAR & G. PRAKASH (1993). Effect of SO<sub>2</sub> fumigation on *Lagentaria siccraria* L., *Acta Bot. Ind.*, **21**: 230-237.
3. SHARMA, T.K. & G. PRAKASH (1991) Effect of SO<sub>2</sub> on *Lycopersicon esculentum*. *J. Ind. Bot. Soc.*, **70**: 201-205.
4. TOMAR Y.S., V. GUPTA & G. PRAKASH (1993). Assessment of growth, yield, and biochemical components in *Abelmoschus esculentus* on exposure with SO<sub>2</sub>. *J. Ind. Bot. Soc.*, **72**: 119-126.
5. MADHOOLIKA, A., V. MADJU, M. AGARWAL & M. VERMA (1997). Amelioration of SO<sub>2</sub> phytotoxicity in wheat cultivars by modifying NPK nutrients. *J. Environ. Manag.*, **49**: 231-244.
6. LALLU & H.K. SAXENA (1995). Influence of sulphur on growth, metabolism and yield of mustard (*Brassica juncea*, L. Czern & Coss). *Indian J. Pl. Physiol.*, **38**(4): 317-319.
7. SEXENA, D.K., A. SEXENA, P. GUPTA & KAMAKSHI (2001). Effect of short term fumigation of SO<sub>2</sub> on seedling growth of *Cicer arietinum*. *J. Ind. Bot. Soc.*, **80**: 63-66.
8. SINHA, S.N. & P.B. SINGH (1998). Effect of containers and joint action of insecticides and fungicides on insect infestation and viability of wheat seed. *Seed Res.*, **26**(2): 161-167.
9. AMABLE, R.A. & R.L. OBENDORF (1986). Soyabean respiration during preharvest deterioration. *Exp. Bot.*, **37**: 1364-1375.
10. SRIMATHI, P., K. MALARKODI & T.V. KARIVARADARAJU (2001). Storage media and temperature on storability of recalcitrant Jamun seed. *Seed Res.*, **29**(2): 183-188.
11. RAO, D.N. & F. LeBLANC (1966). Effect of SO<sub>2</sub> on lichens, algae with special reference to chlorophyll. *Bryologist*, **69**: 69-75.
12. ANONYMOUS (1985). International rules for seed testing. *Seed Sci. & Technol.*, **13**: 299-355.
13. ABDUL-BAKI, A.A. & J.D. ANDERSON (1973). Vigour determination in soyabean seed by multiple criteria. *Crop. Sci.*, **13**: 630-633.
14. PANSE, V.S. & P.V. SUKHATME (1967). *Statistical Method for Agricultural Workers*, ICAR, New Delhi.
15. PRASAD, G.S.V.R (1998). Effect of fumigation on viability and vigour of stored seed of sorghum cultivars. *Seed Res.*, **26**(1): 57-61.
16. PATRA, A.K., S.K. TRIPATHY & R.C. SAMUI (2000). Effect of drying and storage methods on seed quality of summer groundnut (*Arachis hypogea*). *Seed Res.*, **28**(1): 32-35.