research article | International Journal of Plant Sciences, (July to December, 2009) Vol. 4 Issue 2 : 527-530

Effect of sulphur dioxide on the growth, yield and chlorophyll content of hybrid rice (*Oryza sativa* L.)

VIBHA SINGH, R.K. SHARMA AND K.P.S. ARYA

Accepted : May, 2009

SUMMARY

The effect of sulphur dioxide was studied on height, productive tillers, number of leaves, leaf area, fresh weight per plant, dry weight per plant, yield of seed per plant and chlorophyll content of hybrid rice (*Oryza sativa* L.). Two varieties – Pragathi-1111 and Diamond-22 were selected for the study. The present experiment was conducted at S.S.V. (P.G.) College, Hapur (Ghaziabad), U.P. in the year 2008. Simple Randomized Block Design was followed with five concentrations of sulphur dioxide such as 1mg/m^3, 2mg/m^3, 4mg/m^3, 6mg/m^3 and , 8mg/m^3 along with control and four replications. The results were found significant. Fumigation with 6mg/m^3 and 8mg/m^3 doses of SO_2 were found toxic for both the varieties of hybrid rice. The chlorophyll content in green leaves of hybrid rice was studied on 60th day of transplanting of seedlings.

Key words : Sulphur dioxide (SO_2), *Oryza sativa*, Pragathi-1111, Diamond-22, Chlorophyll and Chlorosis

Rice (*Oryza sativa* L.) (2n = 24) is an Asian cultivated species. Rice is one of the most important cereal food crop of the world with occupying first place in world agriculture. Especially grown in tropics, it is the staple food for more than 60 per cent world population. In Asia, 90 per cent of world rice is produced and consumed, where it contributes 45 to 60 per cent of dietry energy.

In respect of area India ranks first followed by China. In annual production India ranks second after China. China contributes (185.6 m. tonnes followed by India 136.8 m. tonnes) in 2006. In U.P. total area in lakh hectares was 62.35 and total production in lakh m tonnes was 125.40 in 2005-2006 (Kushwah and Nigar, 2006).

By recognizing the potential of hybrid rice as a proven means to enhance production and productivity, Indian Council of Agriculture Research (I.C.A.R.), has initiated the national programme on hybrid rice breeding in 1989 in collaboration with IRRI, Philippines.

G.B. Pant University of Agriculture and Technology has developed and released rice hybrid (Pant Shankar Dhan-l) in 1997. It was a first public sector hybrid of entire Northern India.

Man's industrial activities, space programmes and aviation are altering the chemical composition of the atmosphere, upper atmosphere and inner atmosphere. The latest danger to threaten the mankind is the rising radio-activity which may go beyond the safe level. Nuclear tests carried out by the advanced countries may be responsible for this. Unrelenting pollution of the earth resulting from rapidly growing population and industry, is one of the most serious problems confronting mankind. We must now deal with a wide array of toxic substances, including gases, particulates and radioactive materials, which affect our food supply, health and economy. In particular the yields of practically all crop plants and structure of natural ecosystems are adversely affected by atmospheric pollutants. Woodwell (1970) showed that accumulation of toxic substances in the biosphere is causing serious changes in the structure and function of natural ecosystem.

Among the various air pollutants, the oxides of sulphur (SO_x) are probably the most widespread and intensively studied. They include sulphur monoxide (SO), sulphur dioxide (SO_2) sulphur trioxide (SO_3), sulphur tetraoxide (SO_4) sulphur sesquioxide (S_2O_3) and sulphur heptoxide (S_2O_7) which is produced mainly from burning of inorganic sulphides and sulphur bearing organic compounds in coal and oil. Of these, sulphur dioxide (SO_2) is one of the principal contaminants of air.

In the atmosphere, sulphurous acid is easily converted to sulphuric acid which is the major acidic component of "acid rain". SO_2 is acidic in nature and acts as an oxidixing agent, reducing agent and wet bleaching agent with temporary effect. Sulphur dioxide is emitted mainly from stationary sources that burn fossil fuels (coal, oil) such as power plants and refineries, or in the production of materials from sulphur bearing ores, such as copper smelting, sulphuric acid plants, fertilizer and paper industries. Wood, natural gas, propane, and other common fuels used for home heating do not contain significant quantities of sulphur and, therefore, are not

Correspondence to:
K.P.S. ARYA, R.M.P. (P.G.) College, Narsan, HARIDWAR (UTTARAKHAND) INDIA
Authors' affiliations:
VIBHA SINGH AND R.K. SHARMA, S.S.V. College, Hapur, GHAZIABAD (U.P.) INDIA

considered to be a major source of SO_2 whereas diesel fuel and to a lesser extent gasoline, contain sulphur and are considered a contributor to sulphur dioxide in the ambient air. This gas is highly corrosive and affects almost all materials such as metal, paper, clothing, paints and leather.

Review of literature:

The characteristics of SO_2 toxicity in plants (Pea, barley, maize and tomato) is chlorosis *i.e.* death of tips, margins and lamina of leaves. The growth and yield of plants is decreased in SO_2 fumigation with 6mg/m^3 and 8 mg/m^3 (Arya, 1971). Similar effect of SO_2 on *Hordeum vulgare* var. DL 69 plants was observed by Agrawal (1979). Beniwal (1979) reported the toxic effect of SO_2 on the growth, fruit yield and quality of Brijal and tomato. Arya (1971) also observed that some unidentified yellow substance was thickly deposited on the leaves of tomato when plants were fumigated with 6-8 mg/m^3 SO_2 gas. Parthenocarpic (seedless) fruits of tomato were also reported.

SO_2 causes changes in rate of photosynthesis, transpiration and dry matter production. It is absorbed by the plants through "stomata" on leaves and it is then passed into intercellular spaces of mesophyll cells where it combines with water to form sulphurous acid (H_2SO_3) and sulphuric acid (H_2SO_4), In such a case sulphur dioxide would be called primary pollutant since this gas itself is a pollutant and H_2SO_3 and H_2SO_4 as secondary pollutants. These secondary pollutants and the ionic species and free radicals so produced are generally more reactive than the pollutant gas itself. As a result of the reactions of these free radicals and ions with lipids and proteins in the cell walls and membranes, chain reactions are initiated, giving rise to more free radicals, such as superoxide (O_2), singlet oxygen ($^1O_2$)l, hydroxyl (OH^-), etc., which remove or donate electrons from and/or to the neighbouring molecule indiscriminately, hence, disturbing the biological system. (Mandal and Mukherjee, 1998).

Mejstrik (1980) reported significant reduction in the fresh weight of green leaves, shoots and roots, root/shoot ratio, leaf area and dry weight of *Nicotiana tabaccum* and *Cucumis sativus* after fumigation with 0.02 ppm of SO_2 for four weeks. Mishra (1980) exposed plants of Arachis hypogea to SO_2 conc. ranging from 0.06 – 1.00 ppm for 4 hours/day for six weeks and observed necrotic lesions and reduced net primary productivity in concentration 0.25 ppm. Rao and Dubey (1990) observed that stomatal conductance in *Zizyphus mauritiana, Syzygium cumini, Azadirachta indica and Mangifera indica* decreased after exposures to SO_2.

Malhotra (1977) reported that chlorophyll-a is two times more susceptible to SO_2 than chlorophyll-b and four times than carotenoids. High sensitivity of chlorophyll-a to SO_2 hampers the plant growth considerably as it plays a vital role in the process of photosynthesis. Reductions in chlorophyll-a, chlorophyll-b and total chlorophyll content was reported in *Vicia faba* by Kumar (1987).

MATERIALS AND METHODS

The present experiments were conducted at S.S.V. (P.G.) College, Hapur (Ghaziabad) during the year 2008. One month old seedlings of two varieties of hybrid rice were transplanted in research field in Randomized Block Design with four replications. The seeds of hybrid rice were obtained from Chandigarh (Punjab). After 40 days of sowing, the seedlings were fumigated with different concentrations of SO_2.

The concentrations of SO_2 were recorded as 1mg/m^3, 2mg/m^3, 4mg/m^3, 6mg/m^3 and 8mg/m^3. The main characters were studied as height (cm)/plant, productive tillers/plant, number of leaves/plant, leaf area (sq.cm.)/plant, fresh weight (g)/plant, dry weight (g)/plant, yield of seed/plant and chlorophyll content on 60th day of transplanting of seedlings of Pragathi-1111 and Diamond – 22.

The observations were recorded from 3 plants and then averaged for each treatment. The height was recorded with the meter scale and leaf area was measured with the help of planimeter. Statistical analysis was done and the results were interpreted with C.D. at 5% level of significance.

Estimation of total chlorophyll:

The chlorophyll content in fresh leaves of hybrid rice was determined according to Arnon (1949) on the absorption of light by aqueous acetone (80%) extracts of chlorophyll. Organic solvent 4: I acetone and alcohol was used.

0.5 g fresh leaves of control and treated plants were taken with organic solvent in clean specimen tubes. The extracts were centrifuged at 3000 rpm for 15 minutes and each volume was made upto 25 ml of each sample by adding more organic solvent.

Spectra-20 was used at C.C.R. (P.G.) College, Muzaffarnagar and the observations of total chlorophyll content were recorded on 645, 652 and 663 wave lengths, respectively.

Total chorophyll content was calculated by using the following formula (Arnon, 1949).

C = 20.2 D 645 + 8.02 D 663 in mg/g dry weight.

Table 1 : Mean plant height, productive tillers, number of leaves, leaf area (sq. cm.) per plant of hybrid rice (*Oryza sativa* L.) in the year 2008

Treatments (SO_2)	Height per plant (cm)		Productive tillers per plant		Number of leaves per plant		Leaf area per plant (sq. cm.)	
	Pragathi-1111	Diamond-22	Pragathi-1111	Diamond-22	Pragathi-1111	Diamond-22	Pragathi-1111	Diamond-22
Control	55.14	50.71	10.00	9.00	24.00	21.57	487.0	478.7
1mg/m^3	53.00	49.00	9.33	8.33	22.71	20.14	473.0	463.0
2mg/m^3	49.85	46.28	7.83	7.66	20.85	18.00	455.7	445.3
4mg/m^3	48.14	44.28	7.83	6.83	19.71	17.00	422.6	432.0
6mg/m^3	45.57	41.57	6.66	5.66	17.14	15.00	428.8	419.4
8mg/m^3	42.85	38.57	5.66	5.06	16.00	13.57	416.3	407.3

Table 2 : Mean fresh and dry weight per plant, yield of seed per plant and chlorophyll content of hybrid rice (*Oryza sativa* L.) in the year 2008

Treatments (SO_2)	Fresh weight per plant (g)		Dry weight per plant (g)		Yield of seed (g)		Chlorophyll content mg/g	
	Pragathi-1111	Diamond-22	Pragathi-1111	Diamond-22	Pragathi-1111	Diamond-22	Pragathi-1111	Diamond-22
Control	100.50	96.85	14.28	13.57	110.60	103.75	26.00	25.10
1mg/m^3	89.85	87.00	13.00	12.26	101.35	94.05	24.30	23.15
2mg/m^3	77.85	75.14	11.45	10.57	92.15	84.25	19.35	18.20
4mg/m^3	64.42	62.00	10.14	9.28	70.25	65.75	18.00	17.00
6mg/m^3	54.42	51.71	9.10	8.30	61.20	54.36	12.70	11.62
8mg/m^3	40.71	38.00	6.85	6.28	50.16	42.03	8.35	7.40

RESULTS AND DISCUSSION

The effect of different concentrations of SO_2 on growth, yield and chlorophyll content of hybrid rice was recorded and the results are presented in Table 1 and 2. Plant height, productive tillers, number of leaves, leaf area, fresh and dry weight per plant was found maximum in control and minimum in 8mg/m^3 SO_2 fumigation in Pragathi-1111 and diamond-22. Similar results were also found in yield of seed and chlorophyll content (Tables 2). The results of present studies are similar to the findings of many research workers in various crops. Arya (1971) in two varieties of pea, barley, maize and tomato, Agrawal (1979) in barley var. DL-69 and Beniwal (1979) in brinjal and tomato.

Due to SO_2 toxicity all growth characters were suppressed in higher concentrations *i.e.* 6-8 mg/m^3 fumigation with SO_2 gas. The reduction in height was due to the size of the cells as suggested by Yamazoe (1962). Malhotra (1977) and Kumar (1987) reported the effect of SO_2 on chlorophyll destruction in plants.

REFERENCES

Agrawal, Meera (1979). Ecophysiological effects of NaF and SO_2 on *Hordeum vulgare* under modified conditions of N, P and K nutrition. Ph.D. Thesis (Botany), Meerut University, Meerut, India.

Arnon, D.I. (1949). Copper enzymes in isolated chloroplasts. Polyphenoloxidase in *Beta vulgaris*. *Plant Physiol.*, **24**: 1-15.

Arya, K.P.S. (1971). Ecophysiological and cytogenetical response of certain crop plants to sodium fluoride and sulphur dioxide toxicity, Ph.D. Thesis, B.H.U., Varanasi, India.

Beniwal, K.S. (1979). Response of Brinjal (*Solanum melongena*) and Tomato (*Lycopersicum esculentum*) to sodium fluoride and sulphur dioxide toxicity. Ph.D. Thesis (Hort.) C.C.S. University, Meerut.

Goswami, Ritu (2002). Toxicity of pollution to plants. Ph.D. Thesis (Botany), Department of Botany, Ch. Charan Singh University, Meerut.

Kumar, N. (1987). Age effects of *Vicia faba* to SO_2 and NO_2 pollution, *Geobios*. **14** : 3-6.

Mandal, M. and Mukherji, S. (1998). Roles of ascorbic acid, β-carotene and phenolic compounds in protecting the plants exposed to automobile exhaust pollution. *Res. J. Chem Environ.*, **2**(2): 25-28.

Mejstrik, V. (1980). The influence of low SO_2 concentration on the growth reduction of *Nicotiana tabaccum* cultivar and *Cucumis sativus* cultivar unitak. *Environmental Pollution*, **21**: 73-76.

Mishra, L.C. (1980). Effects of sulphur dioxide fumigation on groundnut (*Arachis hypogea*). *Environmental and Experimental Botany*, **20**: 397-400.

Malhotra, S.S. (1977). Effect of aqueous sulphur dioxide on chlorophyll destruction in *Pinus contorta*. *New Phytologist*, **78**: 101-109.

Rao, N.V. and Dubey, P.S. (1990). Explanation for the differential response of certain tropical trees species of SO_2 under field condition. *Water, Air & Soil Pollution*, **51**: 297-305.

Woodwell, G.M. (1970). Effects of pollution on the structure and Physiology of ecosystems. *Sci.*, **164** : 429-433.

Yamazoe, F. (1962). Symptoms of mechanism of injury to crop exposed to hydrogen fluoride. *Bull. Natl. Inst. Agri. Sci. Ser. B.*, **12**: 1-125.

****
*****