Bangladesh J. Bot. **45**(3): 553-560, 2016 (September)

GROWTH INHIBITING AND BLEACHING EFFECTS OF STREPTOMYCIN ON RICE (*ORYZA SATIVA* L.) GENOTYPES

SWARNALATA DAS*

Department of Plant Breeding and Genetics, College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar, Orissa, India

Key words: Rice, Streptomycin, Growth inhibition, Bleaching and yield potential

Abstract

Thirty six rice genotypes of three different maturity groups were treated with 500 ppm of streptomycin (SM) solution for 48 hrs to study the growth inhibiting and bleaching effects on them. Growth inhibiting and bleaching effects were expressed in terms of seedling growth inhibition and bleaching index, respectively. Growth inhibiting effect of streptomycin was the highest on mid-early genotypes followed by mid-late genotypes and the lowest on late maturing genotypes of rice. Bleaching effect was low on mid-early genotypes and higher on those of mid-late and late genotypes. Correlation study and 2 × 2 contingency classification method revealed that most of the rice genotypes having high seedling growth inhibition or high degree of bleaching were found to be high yielder. Results of the present study indicated that high SM-sensitivity of genotypes in terms of seedling growth inhibition index or bleaching index could be used as an indicator of high yield potential in rice.

Introduction

Streptomycin (SM) is an amino-glycoside antibiotic and acts as a protein synthesis inhibitor. It induces bleaching by inhibiting chlorophyll synthesis and also inhibits seedling growth. The diverse effects of this chemical has been thoroughly reviewed by Kirk and Tilney-Bassett (1978). Research work on use of SM as a chemical aid in germplasm evaluation is very limited. Sinha and Satpathy (1979) reported that high yielding varieties of rice were more sensitive to bleaching action of SM than low yielding rice varieties. This would suggest the possible use of SM as a chemical aid in preliminary laboratory screening for yield potential. Therefore, in the present investigation an attempt has been made to study the growth inhibiting and bleaching effects of streptomycin on rice genotypes and to find out the relationship of these two parameters with the yielding ability and adaptability of rice genotypes.

Materials and Methods

Thirty six rice genotypes of three different maturity groups: 11 mid-early (115-125 days), 13 mid-late (126 - 145 days) and 12 late group (146 - 165 days) were used. The list of genotypes was presented in Table 1. Fifty seeds of each genotype were soaked in 10 ml of 500 ppm SM solution for 48 hrs and for control, 50 seeds were soaked in distilled water for the same period. After 48 hrs, the treated and control seeds were washed and put on moist blotting paper in Petri dishes for germination. The blotting paper in Petri dishes was moistened periodically with just enough water to allow proper germination and growth. Observations were recorded on SM-induced seedling bleaching on the 9th day using a random sample of 30 seedlings per genotype and on root length (longest root) and shoot length in each treatment and control on the 9th day following treatment, using a random sample of 10 seedlings per treatment and control. The experiments on streptomycin were repeated four times at intervals of 15 - 20 days during July, 2004 to April, 2005.

---

*Author for correspondence: <swarnalata1967@rediffmail.com>.

Reduction in root and shoot length due to SM treatment, compared to the control, were expressed as percentage of the control. For each genotype, a combined parameter of seedling growth inhibition index was estimated as the average of per cent reduction in root length and per cent reduction in shoot length.

Bleaching of seedlings in each genotype was scored in a 0 - 2 scale: 0 for green/normal, 1 for partially bleached and 2 for fully bleached seedling. SM induced bleaching of each treatment and control was measured in terms of bleaching index and it was calculated following Sinha and Satapathy (1977) as follows.

$$BI = \frac{n_1 \times 0 + n_2 \times 1 + n_3 \times 2}{2N}$$

where n_1, n_2 and n_3 are numbers of green, partially bleached and fully bleached seedlings, respectively, in a genotype and N is total number of seedlings scored for bleaching.

Three multi-location-year trials were conducted for the three duration groups of rice. The genotypes were evaluated at 4 different locations of Orissa (Bhubaneswar, Chiplima, Jeypore and Ranital), over 3 years during 2003-2005 in *kharif* season using a randomized block design with three replications. In all trials, data were recorded on net plot grain yield. The yield data were used to determine adaptability parameter regression coefficient (b) following the linear regression model of Eberhart and Russell (1966).

Results and Discussion

Rice genotypes treated with streptomycin showed varying degrees of bleaching in seedlings and there was no bleaching in control. The BI value of the 11 mid-early genotypes varied from 0.23 to 0.56 with a mean of 0.44 (Fig. 1). It revealed that bleaching effect of streptomycin was low in genotypes OR 1739-47(V1), OR 1916-19 (V2), OR 1929-4 (V3), Lalat (V10) and Bhoi (V11) of mid-early group and these genotypes were considered as lowly sensitive (LS); rest six genotypes had BI values greater than group average and considered as highly sensitive (HS). The BI value of the 13 mid-late genotypes varied from 0.31 to 0.83 with a mean of 0.53 (Fig. 2). The genotypes OR 1681-11(V1), OR 1914-8 (V3), OR 1967-15(V5), OR 2156-15(V6), OR 2310-12 (V7) and Gouri (V9) showed low degree of bleaching, while bleaching effect was high (BI > 0.53) in OR 1912-25(V2), OR 1964-8 (V4), Pratikshya (V8), Surendra (V10), Gajapati(V11), Kharavela (V12) and MTU 1001 (V13). BI values of the 12 late-group genotypes ranged from 0.36 to 0.74 with a mean of 0.54 (Fig. 3) and bleaching effect was low in genotypes OR 1885-16-34 (V1), OR 1898-2-15 (V2), Savitri (V8), Salivahan (V9), Mahanadi (V10) and Jagabandhu (V12) while it was high on rest six genotypes (BI > 0.54). This result revealed that rice genotypes showed wide variation in their bleaching response. Mean BI value of the mid-early genotypes was 0.44, while those of mid-late and late groups were 0.53 and 0.54, respectively indicating that the bleaching effect was generally low in mid-early group and hence chlorophyll synthesis was less affected in mid-early genotypes than in mid-late and late genotypes.

Treatment of rice genotypes with SM caused reduction in root and shoot length and thus, affected seedling growth, which was measured in terms of seedling growth inhibition index (SGI %). Growth response of mid-early rice genotypes is presented in Fig. 4. SGI values of the mid-early genotypes ranged from 22.1 to 51.8% with a mean of 39.3%. Seedling growth inhibition was low in genotypes OR 1739-47, OR 1916-19, OR 1929-4, Lalat and Bhoi and high in rest of the genotypes. Growth response of mid-late rice genotypes is shown in Fig. 5. The SGI values of the 13 mid-late genotypes ranged from 13.4 to 50.3% with a mean of 34.9%. The genotypes OR 1912-25, OR 1967-15, OR 2156-15, OR 2310-12, Pratikshya, Kharavela and MTU 1001 had high SGI value and were more sensitive to growth inhibition action of SM and rest were less sensitive. Growth response of late rice genotypes is presented in Fig. 6. SGI values of the 12 genotypes ranged from 14.2 to 35.6% with a mean of 26.1%. The genotypes OR 1885-16-34, OR 1898-2-15, OR 1901-14-32, OR 1901-14-32, Savitri and Kanchan had low SGI values, while Salivahan, Mahanadi and Jagabandhu had high SGI values (>26.1%). Considering the mean SGI values of the three maturity groups of rice, it was observed that seedling growth reduction was the highest (39.3%) in mid-early group and the lowest (26.1%) in late group.

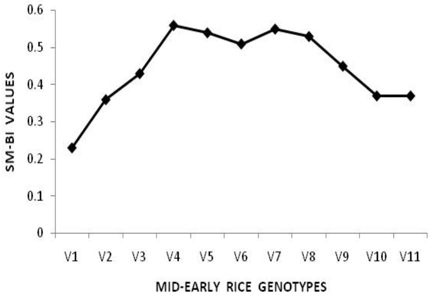

Fig. 1. SM-bleaching response of mid-early rice genotypes.

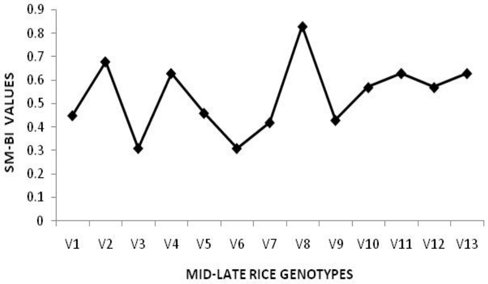

Fig. 2. SM-bleaching response of mid-late rice genotypes.

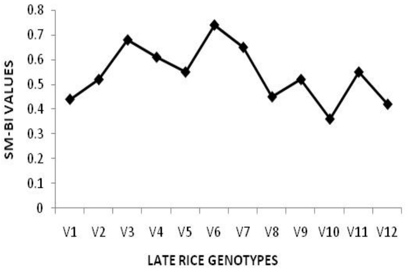

Fig. 3. SM-bleaching response of late rice genotypes.

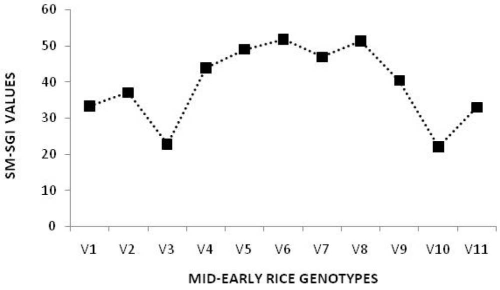

Fig. 4. SM-seedling growth response of mid-early rice genotypes.

Mean yield of mid-early, mid-late and late group genotypes over 12 environments (3 years and 4 locations) and adaptability parameter (b) were estimated (Table 1) in order to find if there is any relationship between SM induced effects (SGI and BI) and yield and adaptability.

Correlation study was made for each maturity groups separately to find out the relationship of BI/SGI parameter with yield and adaptability. Correlation study (Table 2) indicated that BI parameter showed positive correlation (high but non-significant) with yielding ability and negative correlation with adaptability parameter (b) for all the three maturity groups. SGI parameter showed positive correlation with yielding ability and adaptability parameter (b) for all the three maturity groups. Correlation study by combining each maturity group is not possible as the yield level of each maturity group is different. Therefore a 2 × 2 contingency classification method was followed to analyze the relationship. For SGI/BI parameter, the genotypes in each maturity group were classified into two classes - those having above average SGI/BI value as highly sensitive

Table 1. Mean yield and b-values of mid-early, mid-late and late rice genotypes.

Genotype	Mean yield (q/ha)	b
Mid-early		
1. OR 1739-47	36.04	0.78
2. OR 1916-19	34.95	0.94
3. OR 1929-4	35.24	0.76
4. OR 1976-11	37.63	0.99
5. OR 2006-12	37.72	0.92
6. OR 2168-1	35.07	0.69
7. OR 2172-7	37.82	1.23
8. OR 2200-5	37.87	1.47
9. Konark	36.87	1.35
10. Lalat	38.42	1.08
11. Bhoi	34.41	0.79
Average	**36.55**	**1.00**
Mid-late		
1. OR 1681-11	41.30	0.58
2. OR 1912-25	47.45	0.83
3. OR 1914-8	40.84	1.08
4. OR 1964-8	42.41	1.01
5. OR 1967-15	40.11	1.17
6. OR 2156-15	43.05	0.59
7. OR 2310-12	42.66	0.97
8. Pratikshya	46.05	0.93
9. Gouri	39.60	0.93
10. Surendra	42.71	0.93
11. Gajapati	39.61	1.49
12. Kharavela	38.27	1.31
13. MTU 1001	44.08	1.08
Average	**42.16**	**1.00**
Late		
1. OR 1885-16-34	32.15	0.71
2. OR 1898-2-15	37.02	1.06
3. OR 1898-3-16	43.94	1.12
4. OR 1901-14-32	44.45	0.68
5. OR 2001-1	40.72	0.93
6. OR 2109-2	42.99	0.92
7. OR 2119-13	41.46	0.39
8. Savitri	38.59	1.61
9. Salivahan	35.87	1.33
10. Mahanadi	41.50	0.84
11. Kanchan	37.26	1.64
12. Jagabandhu	42.65	0.77
Average	**39.88**	**1.00**

(HS) and those having below average SGI/BI value as lowly sensitive (LS). Similarly, for yield the genotypes in each maturity group having above average yield were classified as high yielder (HY), and those having below average yield were classified as low yielder (LY); for adaptability the genotypes were classified as adapted to rich environments ($b > 1$) and poor environments ($b < 1$). The observed and expected frequencies of genotypes in the 4 contingency classes of yield and adaptability were determined for each maturity group. Then the frequencies of genotypes in the 4 contingency classes of each maturity group were combined to get a single 2 × 2 contingency table. The relationship of SGI/BI parameter with yield and adaptability parameters was inferred from χ^2 test. A significant χ^2 value indicated the presence of relationship.

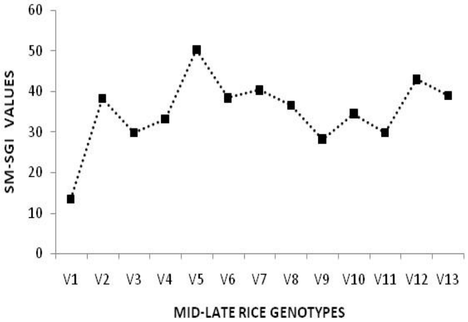

Fig. 5. SM-seedling growth response mid-late rice genotypes.

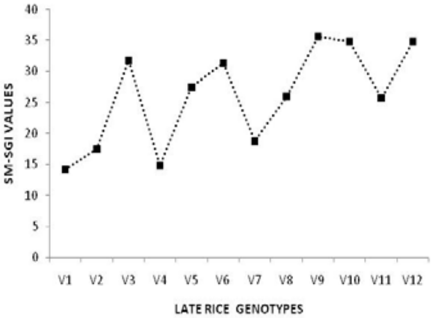

Fig. 6. SM-seedling growth response of late rice genotypes.

Table 2. Correlation of SM-BI and SM-SGI parameters with yield and adaptability parameters.

Genotype	BI	SGI
Mid- early		
Yield	0.445	0.216
b	–0.524	0.309
Mid- late		
Yield	0.480	0.106
b	–0.395	0.365
Late		
Yield	0.443	0.293
b	-0.367	0.320

Table 3 showed the frequency of HY and LY genotypes, frequency of genotypes with b > 1 and b < 1 in HS and LS class of SM-BI /SM-SGI parameter for each maturity group of rice. The HS and LS classes of SM-SGI and SM-BI showed equal number of HY and LY. Fifteen of the 19 HS genotypes were high yielder. In contrast, 12 of the 17 LS genotypes were low yielder.

Contingency Chi-square value was also significant (Table 4) indicating that the distribution was non-random and HS class of both SM-SGI and SM-BI had high frequency of HY genotypes, while LS class had high frequency of LY genotypes.

In conformity, the HS class of both SM-SGI and SM-BI had higher average yield and the LS class had lower average yield (Table 4). The high sensitivity (HS) and low sensitivity (LS) classes of SM-SGI and SM-BI showed almost equal number of genotypes with b < 1 and b > 1 and the contingency chi-square was non-significant, indicating the distributions to be random. Moreover, both HS and LS classes of SM-SGI and SM-BI had very similar class means for b, both close to 1.

Thus, sensitivity to SM-BI and SM-SGI parameters has no significant relationship with adaptability (b-values) of genotypes.

SGI value of rice genotypes of different maturity group showed variation indicating wide differences in growth-inhibition effect of SM. Similar differential growth inhibition of seedlings in different genotypes due to SM treatment has been reported by Das and Sinha (1992) and Das (2001) in rice, Sinha *et al*. (1996) in ragi, Das and Sinha (1995) in wheat and Singh and Nanda (1997) in greengram. Most of the rice genotypes of HS class showing greater seedling growth reduction were high yielder and those of LS class were low yielder. The HS class genotypes also had higher average yield than LS class. Thus, high SM-sensitivity in terms of seedling growth inhibition could be a good indicator of high yield potential of the genotypes in rice. Das and Sinha (1992) reported that rice genotypes showing high SM-sensitivity in terms of seedling growth reduction were generally high yielder and performed better under low land or irrigated conditions. The bleaching effect of SM was first reported by Von Euler (1947) in barley seedlings. The BI value of genotypes of all duration groups in the present study showed wide variation ranging from 0.23 to 0.83, indicating differences in SM-sensitivity of genotypes in terms of bleaching. Similar differences in bleaching effect of SM treatment in different genotypes have been reported by Das (2001) in rice; Sinha and Swain (1978), Sinha and Satapathy (1977) in maize and Singh and Nanda (1997) in greengram. In the present investigation the genotypes present in HS class of SM-BI had higher average yield than LS class. Thus, higher degree of seedling bleaching due to SM treatment would be a good indicator of high yield potential of genotypes in rice. Sinha and Satapathy (1979) reported that

Table 3. Frequency of rice genotypes in SM-BI, SM-SGI, yield and adaptability classes.

SM sensitivity classes	No. of genotypes	Yield		Adaptability	
		LY	HY	Poor Env. (b <1)	Rich Env. (b>1)
SM-BI					
HS class					
Mid early	6	1	5	3	3
Mid late	7	2	5	3	4
Late	6	1	5	4	2
Pooled	**19**	**4**	**15**	**10**	**9**
LS class					
Mid early	5	4	1	4	1
Mid late	6	4	2	4	2
Late	6	4	2	3	3
Pooled	**17**	**12**	**5**	**11**	**6**
SM-SGI					
HS class					
Mid early	6	1	5	3	3
Mid late	7	2	5	4	3
Late	6	1	5	4	2
Pooled	**19**	**4**	**15**	**11**	**8**
LS class					
Mid early	5	4	1	4	1
Mid late	6	4	2	3	3
Late	6	4	2	3	3
Pooled	**17**	**12**	**5**	**10**	**7**

semi-dwarf high-yielding rice varieties showed more SM bleaching than low-yielding tall-indica varieties. Das and Sinha (1986) suggested that selection of ragi genotypes showing more SM-bleaching could lead to identification of lines with early maturity, short height and more tillers per plant. In the present study it is observed that SM-sensitivity in terms of bleaching or seedling growth inhibition does not appear to have any definite relationship with adaptability of genotypes to poorer or rich environments. However, Das and Sinha (1992) reported that rice genotypes belonging to low SM-sensitivity class would show better adaptation to stressful dry land condition and genotypes of high SM-sensitivity class would be more suitable for irrigated medium and lowland conditions. Sinha *et al.* (1996) reported that ragi genotypes showing low SM-sensitivity would show general adaptability.

Table 4. 2 × 2 contingency tables of SM-BI and SM-SGI parameters and yield and adaptability parameter (b) in rice.

Sensitivity parameter	Class	No. of genotypes	Yield class				Adaptability class			
			LY	HY	χ^2	Av. yield (q/ha)	Poor Env. ($b < 1$)	Rich Env. ($b > 1$)	χ^2	Av.b-value
Rice										
SM-BI	HS	19	4	15		40.8	10	9		1.04
	LS	17	12	5	8.92**	38.5	11	6	0.54	0.94
SM-SGI	HS	19	4	15		40.7	11	8		1.02
	LS	17	12	5	8.92**	38.7	10	7	0.01	0.98

**,*indicate significant at 0.5% level.

From this present investigation, it may be concluded that growth inhibiting effect of streptomycin was the highest on mid-early genotypes followed by mid-late genotypes and the lowest on late genotypes of rice. Whereas bleaching effect was low on mid-early genotypes and higher on those of mid-late and late genotypes. High SM-sensitivity in terms of seedling growth inhibition and seedling bleaching could be used as indicators of high yield potential in rice.

References

Das PK and Sinha SK 1986. Relation of a seedling character to yield and yield components in finger millet (*Eleusine coracana).* J. Orissa Bot. Soc. **8**: 49-50.

Das S 2001. Laboratory screening of high yielding rice varieties for drought tolerance. Env. & Eco. 19: 14-18.

Das S and Sinha SK 1992. Use of streptomycin as a chemical aid in the laboratory evaluation of broad adaptation patterns in rice. Pl. Sci. Res. **14:** 17-20.

Das S and Sinha SK 1995. Physiotaxometric studies of adaptation in wheat: I A. Classification of genotypes based on seedling growth response to streptomycin. Current Agric. Res. **8**: 101-106.

Eberhart SA and Russell WA 1966. Stability parameters for comparing varieties. Crop Sci*.*, **6**: 36-40.

Kirk JTO and Tilney-Bassett RAE 1978. The plastids, their chemistry, structure and inheritance (2nd edition). Elsevier North Holland. Biomed, Press.

Singh B and Nanda PR 1997. Prediction of adaptation pattern of some mungbean genotypes based on streptomycin response. Env. & Eco. **15**: 559-561.

Sinha SK and Swain MN 1978. Chemically aided selection in two EMS derived population of ragi. Proc. 65th session of Indian Sci. Congress. p. 3.

Sinha SK and Satpathy MB 1977. Streptomycin induced variation in albinism in inbred maize. Sci. and Culture **43**: 567-568.

Sinha SK and Satpathy MB 1979. An evidence for relationship between streptomycin sensitivity of plastids and high yield potential in rice. Sci. and Culture **45**: 373-374.

Sinha SK, Prusty N and Das S 1996. Laboratory evaluation of adaptation on ragi (*Eleusine coracana* Gaerotn). Numerical classification of seedling response to streptomycin. Pl. Sci. Res**.** **18**: 57-61.

Von Euler M 1947. Einfluss des streptomycin and dischloro phyllibildung. Kem. Arb. **9**: 1-3.

(Manuscript received on 11 October, 2015; revised on 24 January, 2016)