

SALT TOLERANCE STUDIES AT GERMINATION. III.  
JOWAR (*SORGHUM VULGARE*), MUNG (*PHASEOLUS  
AUREUS*) AND TOBACCO (*NICOTIANA TABACUM*)  
VARIETIES

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SUMMARY

Eighteen varieties of jowar and six, each of mung and tobacco were studied for the relative salt and alkali tolerance at germination stage. Twenty-five irrigation waters of varying levels of salinity (4-64 me/l) and sodium adsorption ratio (5-100) were used in this investigation. It was found that germination was delayed and decreased with increase in salinity or SAR or both. Tobacco varieties in general were found to be more salt and alkali tolerant than either mung or jowar, the former being more tolerant than the latter. Variety S. 832 of jowar, and var. Krishna II of mung were medium salt and low alkali tolerant, whereas vars. Hicks F. C. and D. R. 1 of tobacco were medium salt and high alkali tolerant.

INTRODUCTION

The salinity status of irrigated soils depends upon the quality of irrigation water, texture, permeability, original level of salt content and the pre-existing deposits in the sub-soil, if any. Thus, success of irrigated agriculture depends largely upon maintaining good soil productivity in spite of leaching down of nutrients, accumulation of salts and dispersion of salt colloids.

Seed emergence and early growth are intimately connected with the later development and crop yield. Plant growth is adversely affected by salinity and its salt resistant property varies with the species, and stage of growth (Allison, 1965; Bhumla *et al.*, 1966; Pearson and Bernstein, 1959; Ota and Yasue, 1957).

Extensive studies conducted in U.S.A. and other parts of the world have revealed the relative salt tolerance of field, fruit, forage and vegetable crops (Richards, 1954; Vander Berg, 1950).

But keeping in view the severity and magnitude of salinity problem in salt affected areas of the country in relation to plant growth, information on salt tolerance of Indian crops is meagre. Recently Maliwal and Paliwal (1966, 1967) reported varietal differences in bajra, wheat and barley in their salt and alkali tolerance at germination.

It is, therefore, proposed to study salt tolerance at germination stage for some varieties each of mung, jowar and tobacco. Some experimental observations are presented here.

#### MATERIALS AND METHODS

This study involves observations on 18 varieties of jowar (*Sorghum vulgare*), six of mung (*Phaseolus aureus*) and six of tobacco (*Nicotiana tabacum*). Twenty-five artificial irrigation waters were of five salinity levels 4, 8, 16, 32 and 64 me/l (designated as C<sub>1</sub>, C<sub>2</sub>, C<sub>3</sub>, C<sub>4</sub> and C<sub>5</sub>) and each with five levels of sodium adsorption ratio ( $SAR = (Na / (Ca + Mg))^{1/2}$ ) i.e. 5, 10, 25, 50 and 100 (designated as S<sub>1</sub>, S<sub>2</sub>, S<sub>3</sub>, S<sub>4</sub>, and S<sub>5</sub>) respectively. The proportion of calcium to magnesium was kept at 4:1. The germination studies were made on Petri-dishes by the technique described earlier (Maliwal and Paliwal, 1966). Salt tolerance of each variety was judged on the basis of critical difference.

#### RESULTS AND DISCUSSION

Results on germination percentage and least significant differences of germination count at different salinity and SAR levels for all the varieties of jowar are shown in Table I and for mung and tobacco in Table II. The limits of salt and alkali tolerance of these varieties are presented in Table III.

Data in Tables I and II show significant differences in germination percentage of various strains of jowar, mung and tobacco. Some tolerated salts to a greater degree and germinated quite well even at much higher salt concentration whereas others failed to grow even at much lower salinity levels. This differential behaviour of these varieties to salinity and SAR levels is quite evident from a wide range of germination percentage at the level of salinity or alkalinity. It may also be pointed out that the germination percentage of each variety decreases with increase in salinity or alkalinity or both. None of the varieties of these crops grew satisfactorily above a salinity level of 16 me/l and in most cases germination percentage

Table I. Germination percentage of different varieties of jowar at different salinity and S.A.R. levels

Salinity	Irrigation water levels																			
	S.A.R.	Varieties																		
		S.A.R.	Virangam	Beef builder	Sweet-sudan	Type No. 263	S-832	R.S. 610	E. Hegari	Combine	Pokaran	Merta	R.S. 630	Jowar Pali	Texasmilo	R.S. 501	Coastal	Delhi I.S. 541	Soundia 1049	D. 55
4	5	50	50	50	90	40	96	44	64	44	88	56	50	36	50	36	30	50	90	50
4	10	50	40	46	90	40	96	44	64	44	88	56	50	32	46	36	30	50	90	50
4	25	40	40	46	90	40	96	44	64	40	88	54	50	32	46	32	30	46	88	50
4	50	36	44	44	90	40	96	44	60	40	84	54	44	30	46	24	18	40	76	36
4	100	32	40	40	90	36	90	42	54	36	80	52	40	26	46	24	18	36	76	30
8	5	50	40	36	90	40	96	26	52	40	84	56	50	32	40	28	28	40	76	40
8	10	46	36	36	90	32	90	26	36	40	84	52	44	28	36	28	24	36	72	40
8	25	46	36	36	88	28	80	26	36	38	76	52	44	28	36	28	24	36	72	30
8	50	46	32	32	80	28	70	24	24	36	76	48	40	24	34	20	12	24	50	14
16	5	50	32	32	70	32	80	18	50	30	76	54	40	24	38	24	28	36	60	40
16	10	44	28	28	50	32	70	16	44	30	70	54	32	24	38	18	20	30	56	40
16	25	42	28	28	50	30	70	16	38	30	64	54	24	24	36	16	20	30	56	40
16	50	42	26	26	48	28	64	12	36	30	64	52	24	20	32	16	20	24	54	38
16	100	42	26	26	44	28	64	10	30	30	62	52	24	20	38	16	20	20	40	38
32	5	44	28	28	28	28	40	6	36	28	56	36	28	20	28	18	10	24	36	20
32	10	38	28	28	28	28	40	6	36	28	50	36	26	20	28	18	10	24	36	20
32	25	24	26	28	28	26	30	4	36	26	50	34	24	16	28	12	10	24	24	20
32	50	22	26	26	26	26	26	4	34	22	34	30	16	12	22	10	8	14	22	14
32	100	22	28	28	26	26	26	4	34	22	32	30	14	8	16	8	8	10	16	10
64	5	30	10	20	20	28	42	0	28	20	28	28	10	8	16	16	8	20	24	6
64	10	28	10	20	20	28	20	0	20	12	28	20	8	6	16	16	6	20	10	4
64	25	20	10	20	28	28	18	0	20	12	14	16	10	0	14	12	4	16	6	4
64	50	20	10	22	28	28	12	0	20	10	12	16	10	0	16	14	4	12	6	0
64	100	14	6	20	26	26	8	0	20	10	12	10	4	0	14	8	4	10	4	0
L.S.D.		4.96	2.21	6.23	2.82	7.48	1.80	11.87	2.71	5.41	3.18	4.11	3.71	3.43	3.20	4.68	1.86	5.38	6.51	
at 5%		S.A.R. 4.96	2.21	—	2.82	7.48	1.80	11.87	2.71	5.41	3.18	4.11	3.71	—	3.20	4.68	1.86	5.38	6.51	

Table II. Germination percentage of different varieties of mung and tobacco at different salinity and S.A.R. levels

Irrigation water levels		Tobacco Varieties						Mung Varieties					
Salinity	S.A.R.	Delcrest	Harrison Special	Virginia Gold	Hicks F.c.	K.Y. 58	D.R. 1	103-53	103-52	Krishna II	Mung Jodhpur	R.S. 4	R.S. 9
1	2	3	4	5	6	7	8	9	10	11	12	13	14
4	5	100	90	70	90	15	90	72	60	80	48	80	60
4	10	100	90	70	90	15	90	72	60	80	44	76	60
4	25	100	90	70	90	15	90	72	60	80	44	60	60
4	50	100	90	70	90	10	90	72	64	80	44	60	60
4	100	100	90	70	90	10	90	64	64	80	44	40	48
8	5	90	90	70	90	10	90	72	72	80	40	40	40
8	10	90	90	70	90	10	90	72	68	72	36	32	32
8	25	87	90	60	90	8	90	60	60	72	32	24	24
8	50	86	90	60	90	5	90	56	60	72	40	36	24
8	100	86	70	60	90	5	90	80	56	72	44	32	16
16	5	88	80	60	70	10	75	60	60	72	44	40	32
16	10	75	65	60	70	8	75	56	52	72	32	40	24
16	25	75	65	50	70	8	75	56	40	64	28	40	28
16	50	65	50	50	60	4	75	56	20	80	28	40	36
16	100	65	40	30	55	4	30	52	36	64	24	20	36
32	5	65	40	25	45	5	30	40	36	60	20	20	32
32	10	52	35	15	30	5	30	40	36	52	20	20	32
32	25	52	25	15	25	2	25	24	36	52	16	20	28
32	50	35	20	15	22	2	15	20	28	52	16	20	16
32	100	23	20	15	20	2	15	20	48	48	12	16	16
64	5	22	20	10	10	5	7	20	16	40	16	8	4
64	10	16	15	10	10	2	6	12	4	24	12	8	4
64	25	16	15	8	10	1	5	12	0	20	12	8	4
64	50	15	10	7	5	1	4	8	0	16	8	4	4
64	100	15	10	6	5	1	4	8	0	14	4	0	0
L.S.D. at 5%	Salinity	9.37	8.98	7.12	6.32	1.48	12.11	9.07	10.36	6.99	5.38	9.35	7.84
	S.A.R.	9.37	8.98	7.12	—	1.48	—	—	—	6.99	5.38	9.35	—

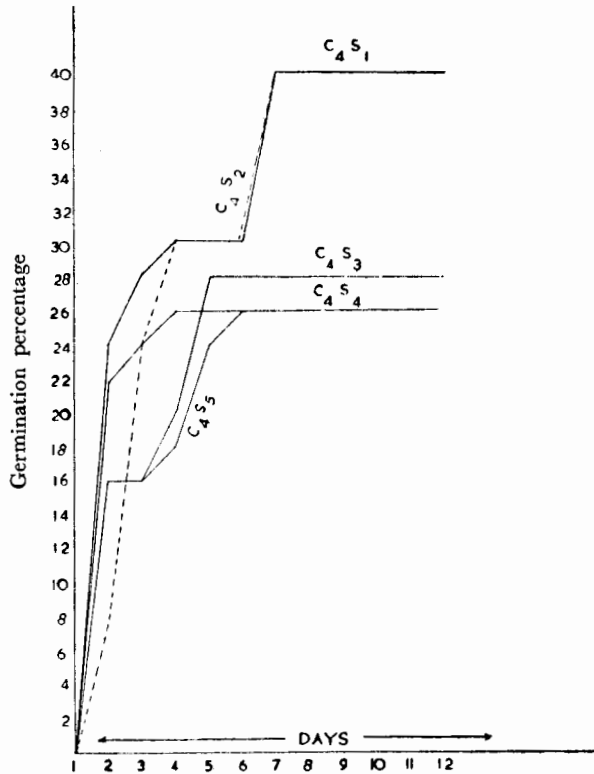


FIG. 1. Jowar S. 832  
Germination Percentage at various levels of salinity and S.A.R.

dropped down abruptly (4 to 10 per cent) at a salt concentration of 32 me/l and above, and there is further decrease at higher SAR levels. This adverse behaviour of crops as caused by increasing level of alkalinity at a particular salinity on germination percentage has been presented for jowar (var. S-832), mung (var. Krishna II) and tobacco (var. Hicks F.C.) in figures 1 to 3. These can be taken as typical presentations of the whole data. These curves are of sigmoid type which indicates that the germination percentage increased slowly with time. The nature of the curve was observed as a straight line generally after 8 to 10 days, indicating the maximum germination percentage and there was no further increase in germination after the tenth day. It was also noted that the emergence time was delayed with the degree of salinity or alkalinity or both. Similar observations were made by Maliwal and Paliwal (1966, 1967)

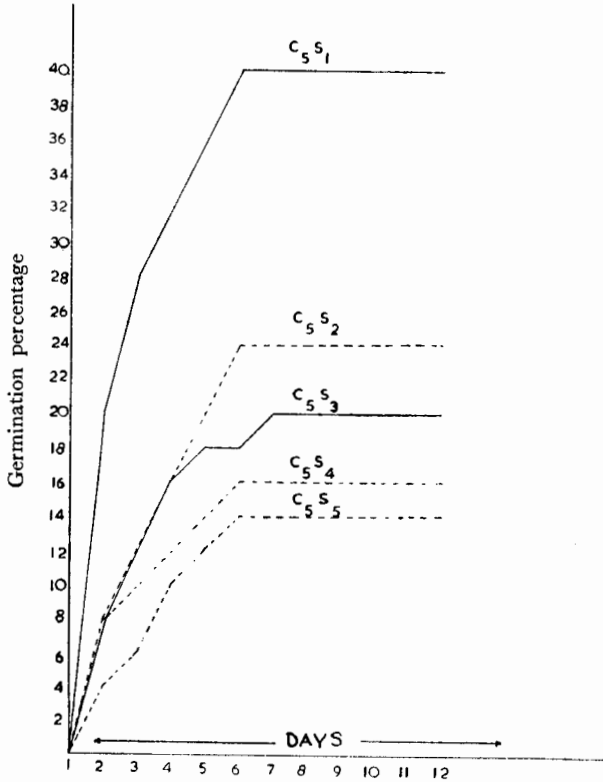


FIG. 2. Mung—Krishna II  
Germination Percentage at various levels of salinity and S.A.R.

on several varieties of wheat, barley and bajra under identical experimental conditions and salt concentration limits. Both osmotic pressure and specific ion effects seem to be related with the decrease in germination percentage (Mehta and Desai, 1957; Dotzenko and Dean, 1959; Dewey, 1960).

It is seen from Table III that jowar varieties in general have low salt tolerance and do not show significant varietal differences. Out of 18 varieties, 14 tolerate salinity up to 4 me/l; three (vars. Sweet-sudan, Pokaran, Soundia 1049) up to 8 me/l and only one (var. S. 832) up to 16 me/l salt concentration. None of the varieties tested, tolerates beyond a level of 16 me/l. These varieties seem to be very sensitive to alkali. Sixteen varieties germinated satisfactorily only up to a level of 5 SAR. This suggests that jowar varieties, in general are highly sensitive both to salinity and alkalinity. These limits

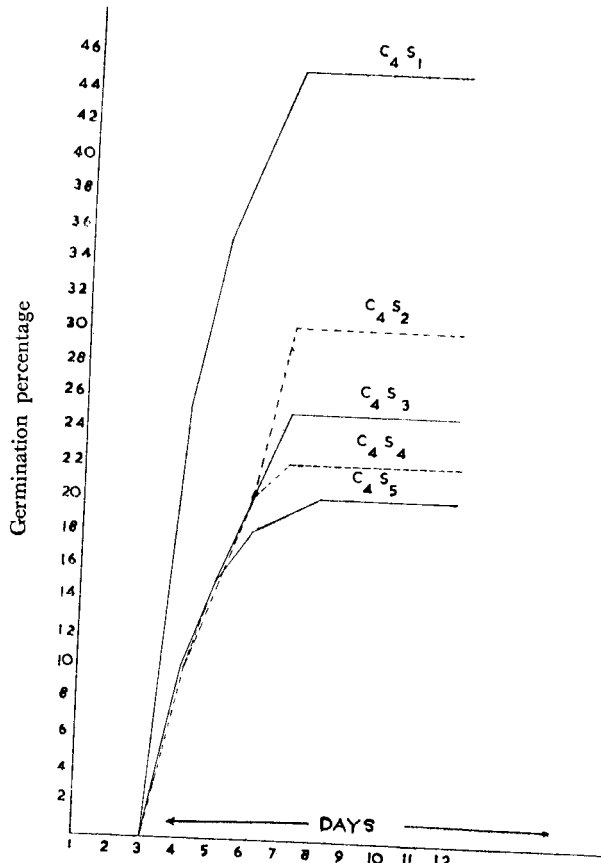


Fig. 3. Tobacco Hicks F.C.  
Germination Percentage at various levels of salinity and S.A.R.

in general, are in agreement with those of Abhichandani and Bhatt (1965) in spite of variation in methodology and medium of germination. Results of these varieties (vars. Pokaran, Sweet sudan, Delhi I.S. 541 and Texas Millo I.S. 25745) which are common to them fairly agree in their salt tolerance limits.

Amongst the six varieties of mung R.S. 9, R.S. 4 and mung Jodhpur are sensitive to salinity and tolerate up to 4 me/l while varieties 133-52 and 103-53 tolerate only up to 8 me and var. Krishna II is slightly more salt tolerant (Table III). None of the varieties tolerates salinity above 16 me/l. Regarding alkalinity, some varieties (133-52, 103-53 and R.S. 9) are more tolerant than others. On combining the salinity and alkalinity limits, varieties 133-52 and 103-53 are quite salt and alkali tolerant

Table III. Salt and alkali tolerance limits of mung, jowar and tobacco varieties

Salt and Alkali Tolerance Limits	Jowar (18 Varieties)	Tobacco (6 Varieties)	Mung (6 Varieties)
High (Up to 32 mg/l)	—	—	—
Medium (Up to 16 mg/l)	S. 332	Hicks F. C. D. R.	Krisna II
Low (Up to 8 mg/l)	Sweet-sudan, Pokaran, Soundia 1049	Delcrest, Harrison Spl. Virginia Gold	133-52 103-53
Sensitive (Up to 4 mg/l)	Beef builder, E. Hegari, R. S. 610, Viramgam, Type No. 263, Combine Shallu, Merta, R. S. 630, Jowar Pali, Texas milo I. S. 25745, R. S. 501, Coastal, Delhi I. S. 541, D. 55	K. Y. 58	R. S. 9 R. S. 4 Mung-Jodhpur
High (Up to 100 SAR)	Sweet Sudan, Texas milo I. S. 25745	Hicks F. C. D. R. 1.	103-53 133-52 R. S. 9
Medium (Up to 50 SAR)	—	—	—
Low (Up to 25 SAR)	—	—	—
Sensitive (Up to 5 SAR)	Beef builder, E. Hegari, R. S. 610, Viramgam, S. 832, Type No. 263, Combine Shallu, Pokaran, Merta, R. S. 630, Jowar Pali, R. S. 501, Coastal, Delhi I. S. 541, Soundia 1049, D. 55	Delcrest, Harrison Special, Virginia Gold, K. Y. 58	Krishna I Mung-Jodhpur R. S. 4.

but keeping only salinity in view var. Krishna II seems to tolerate more. A wide variation in salt tolerance limits exists amongst the mung varieties in general and these can be referred to as a medium saline and highly alkali tolerant. While comparing 14 *Kharif* crops on six saline alkali soils, Mehrotra and Gangwar (1964) also reported mung to be lowsaline and more alkali tolerant crop. Though a critical limit from their data cannot be derived due to limited variation in salinity, alkalinity or other textural



variations but it is agreeable that mung is more salt and alkali tolerant than jowar.

Results on germination data on tobacco varieties show that there is a wide range ( $C_1S_1$ — $C_3S_3$ ) of salt and alkali tolerance (Table III). Except var. K.Y. 58, all are medium to high salt tolerant and amongst the varieties tested Hicks F.C. and D.R. 1 are highly salt and alkali tolerant. Mehta and Desai (1957) found tobacco to be quite salt tolerant at germination stage.

Thus, it can be inferred that tobacco is most salt tolerant followed by mung and jowar. While comparing *Kharif* and *Rabi* crops Mehrotra and Gangwar (1964) concluded *Kharif* crops to be fairly alkali tolerant at germination. These *Kharif* crops can be grown at such places where salts have sufficiently leached down to a safe limit by rains. But in arid and semi-arid regions of Rajasthan where salts accumulated in summer do not sufficiently drop down due to limited rainfall, the germination and later growth of plants will be very poor. It is, therefore, suggested that for the growth of these crops in salt affected areas the salinity status of the soil should be sufficiently lowered by pre-irrigation water.

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