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Effect of Waterlogging on Growth and Yield Components in Rice

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The grain yield was reduced by 16-32 per cent in different rice varieties under water-logged conditions. The yield was affected mostly by reduction in panicles per unit area. However, cultivar *NC.* 1281 showed even an increase in yield under water-logged soil. Water-logging had impaired growth constituents like TDW, LAI and nitrogen uptake. The adoptability of *NC.* 1281 to water-logged habit was attributed to the production of high dry matter at flowering and its contribution to grain yield.

The low rice production in India may be ascribed to vast areas under the crop being subject to the vagaries and vicissitudes of weather. Thus, during the monsoon season nearly six million hectares become water-logged (Dakshinamurthi *et al.*, 1973) and yield under such conditions is poor depending upon the duration and depth of water stagnation (Rao *et al.*, 1971). Though the changes in structure and chemistry of the soil brought out by waterlogging are fairly known, the physiological changes in the crop leading to lower yield are little understood. The present investigation was undertaken to assess the effect of water logging on yield and nitrogen uptake in different rice cultivars.

MATERIALS AND METHODS

The experiments were conducted during the *kharif* season (July-December, 1971) at the CRRI farm, Cuttack. Thirty five day old seedlings of 6 cultivars viz., IR. 8, *Jagannath*, *Manoharsali*, *T.* 141, *NC.* 1281 and *Prasadbhog* were transplanted on two different fields; one was a well drained field and the other was water-logged, especially during the tillering phase with water stagnant to a depth of 30 cm. In each field there were four replications. The plot size consisted of 9 60 m x 2.70 m and the spacing 20 cm x 15 cm. The plots received 40 kg N and 20 kg each of P_2O_5 and K_2O/ha as basal dressing.

Plant samples from eight were collected at maximum tillering, flowering and harvest. The samples were separated into leaf, culm and panicle depending upon the growth stage. After measurements of leaf area (L x B x 0.695) the material was dried at 80°C for 72 hr and the dry weight recorded. The N per cent different plant parts was estimated for assessing total N uptake by the crop. Periodical growth observations were taken and at harvest different yield components and yield were recorded.

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RESULTS AND DISCUSSION

Yield and yield components: Under water-logged conditions, yield was significantly reduced in all the varieties except in *NC.* 1281 and the percentage of reduction ranged between 16 and 32. The yield decrease was due to reduction in number of panicles/m² (by 15 per cent) and in grain number / panicle (by 9 per cent) especially in *Mancharsali*, *T.* 141 and *Prasadbhog*. Both grain number and test grain weight recorded significant in *NC.* 1281 under water-logged conditions with marginal increase (6.7 per cent) in yield (Table).

Tillers/m²: At maximum tillering, the number of tillers under water-logged treatments was only about one-third (38 per cent) of that under normal condition. However, under normal treatment, the tiller number declined from maximum tillering to flowering due to mortality. Under water-logged conditions, there was subsequent regeneration of tillers with the recession of flood after maximum tillering with the result that the differences between the two treatments narrowed down to 20 per cent at flowering from 62 per cent at maximum tillering stage.

Total dry weight (TDW): Water-logged condition had significantly reduced TDW (by 23 per cent). However, in *NC.* 1281, the reduction was minimal especially at flowering and harvest. It was further seen that this variety

TABLE. Growth and yield components under normal (N) and water-logged (W) conditions

Variety		Yield kg/ha	Panicles /m²	Grains/ panicle	1000-grain weight	Tillers/m²		TDW g/m²			HI	LAI	
						MT	F	MT	F	H		MT	F
IR. 8	N	2659	248	45	24.4	510	564	212	740	793	33.0	2.0	2.6
	W	1796	198	38	23.9	189	322	153	531	558	38.9	1.5	2.2
Jagannath	N	3033	258	66	18.2	514	267	169	836	922	37.6	1.9	2.6
	W	2532	229	63	17.9	162	248	105	601	649	39.0	1.1	2.0
Manoharsali	N	3502	191	70	26.7	467	210	184	894	1042	33.1	1.9	2.6
	W	2508	170	55	27.7	155	248	105	601	649	39.0	1.1	2 0
T. 141	N	2691	226	70	17.3	462	240	204	773	865	31.4	2.2	2.6
	W	1923	185	61	16.9	193	233	162	641	807	35.0	1.6	2.1
NC. 1281	N	2744	162	82	21.1	378	183	217	1089	1125	28.3	2.5	2.4
	W	2930	148	91	22.2	163	150	158	901	1030	34.5	1.5	2.2
Prasadbhog	N	2430	222	66	16.9	473	261	212	776	858	33.8	2.2	2.4
	W	1738	179	58	16.5	196	235	176	556	614	33.1	1.6	1.6
Mean	N	2843	218	67	20.8	467	287	200	846	934	32.8	2.1	2.5
	W	2238	185	61	20.9	176	230	144	648	720	36.5	1.4	12.0
W/N x 100		78	85	91	100	38	80	72	76	77	112	66	80
C. D. 5%													
Variety		203	13	6	0.36	—	—	39	65	107	—	NS	NS
Treatment		117	8	3	NS	—	—	23	37	62	—	0.2	0.2
V x T		287	NS	8	0.51	—	—	NS	NS	NS	—	NS	NS

MT=Maximum tillering; F=Flowering; H= Harvest; TDW=Total dry weight;
HI =Harvest Index; LAI= Leaf area index. NS: Not Significant

possessed the maximum TDW at these two stages, being distinctly superior to the other varieties. Harvest index, however, registered an increase under the water-logged condition and such increase was more apparent in *NC.* 1281

Leaf area index (LAI): LAI was significantly reduced under water-logged situation and the reduction was more at maximum tillering (34 per cent) than at flowering (20 per cent).

Nitrogen per cent and N uptake: The N content in leaf blade and culm recorded an increase under the water-logged treatment at all the growth stages studied. However, the increase in culm N per cent in *NC.* 1281 was less marked at both flowering and harvest. The uptake of N was lower under water-logged conditions especially at flowering stage due to reduction in TDW (Fig. 1).

Under the water-logged condition, the panicles/m² were invariably affected in all the varieties. The reduction in panicle number was the outcome of tiller mortality sustained due to submergence during the tillering phase. Such suppression of tillers under water stagnation has been reported earlier (Ghosh and Bhattacharjee, 1959; Tsunoda and Matsushima, 1963; Vamadevan, 1971).

Photosynthetic rate per unit leaf area has been reported to be low under stagnant condition (Koyama *et al.*, 1962; Miyasaka, 1964). Thus, the small LAI and the reportedly retarded leaf photosynthesis might have subscribed to the depleted dry matter production under water-logged conditions.

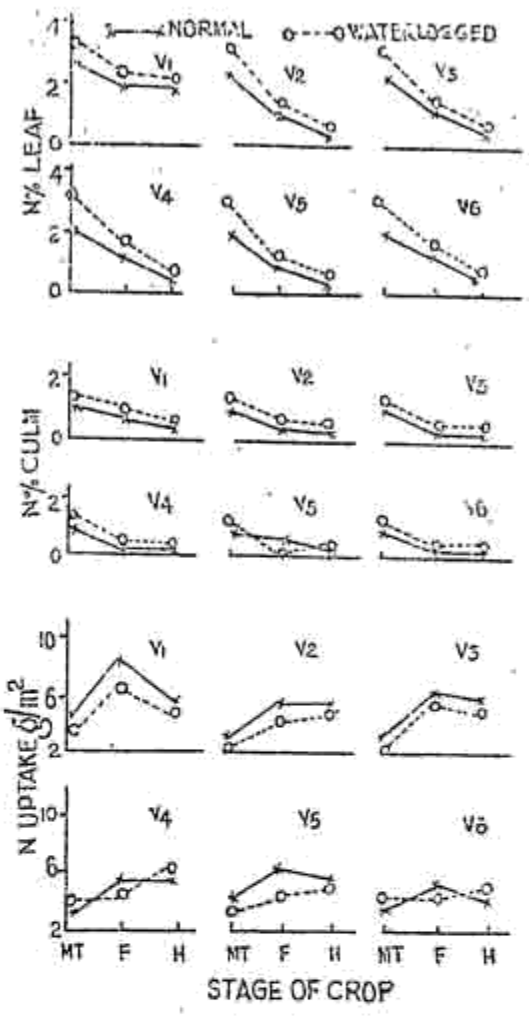

Fig. 1. Effect of waterlogging on N content of leaf and culm and N uptake by rice

V_1=*I.R 8*, V_2=*Jagannath*, V_3=*Manoharsali*
V_4=*T. 141*, V_5=*NC.1281*, V_6=*Prasadbhog*
MT=Maximum tillering, F=Flowering
H=Harvest stages.

Under water-logged conditions the N concentration in leaf and culm was high but the uptake of N per unit area was low due to reduction in the dry matter production. *NC.* 1281 in spite of lower N uptake recorded the highest dry matter both at flowering and har-

vest indicating its efficiency in the utilisation of absorbed N for dry matter production. The better performance of *NC*. 1281 under water-logged conditions might thus, be attributed to its high dry matter production at flowering. In fact, the direct positive effect of TDW at flowering on yield under water-logged condition has already been reported (Raj and Murty, 1975). Using *NC*. 1281 as a donor in breeding programmes for water-logged areas has already yielded encouraging results (Balakrishna Rao, personal communication) and therefore its germplasm could be harnessed in desired types for improvement in yield under water-logged conditions.

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