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NITROGEN AND CARBOHYDRATE STATUS AND THEIR ACCUMULATION IN THE PLANT - PARTS OF EARLY RICE CULTURE, 24-20

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Information on the status of nitrogen and carbohydrates and their accumulation in the plant - parts of early maturing varieties of rice at successive stages of growth is very meagre. It has been observed that the content of nitrogen and carbohydrates among the plant - parts of rice vary markedly at different stages of growth (Togari *el al.*, 1954). The major constitutents that are involved in the metabolism of the plant are nitrogen and carbohydrates. Their status in the plant at different stages of growth are influenced mainly by the varietal characteristics and the level of nitrogen fertilisation. (Takahashi *et al.*, 1955; Tanaka *et al.* 1964). A critical study of the status of nitrogen and carbohydrates in the plant-parts at successive stages of growth only can provide a better understanding about their synthesis, translocation and contribution to the development of the ear. Investigation to elucidate the above aspects of the rice culture, 24-20, was therefore taken up and the results are presented in this paper.

Materials and Methods

Plant samples collected from the investigation reported earlitr (Kuriakose and George, 1973), were processed and used in this study. Nitrogen content was determined adopting the method of Poidevin and Robinson, (1964). Sugars and starch were estimated following the procedure described by Yoshida *et al* (1971),

Results and Discussion

Data on the percentage content of nitrogen, sugars and starch and their accumulation in the plant-parts are presented in tables 1, *2* and 3.

The nitrogen content of lamina increased gradually on application of higher levels of nitrogen at different growth stages (Table 1). Tanaka and Garcia, (1965) observed increases in the nitrogen content of each plant -part on increased nitrogen uptake. Nitrogen content of lamina was the highest at tillering with a mean value of 4.532 per cent. The per cent content of nitrogen in the lamina was higher than that of other plant - parts at all stages of growth except the ear at harvest. A slight reduction was noticed after flower initiation and it declined further to 3.161 per cent and 1.001 per cent at flowering and harvest stages respectively, Murayama, (1964) also observed higher nitrogen content in the lamina than that of

Table 1

Nitrogen content and its accumulation in the plant-parts of rice, Triveni at different growth stages

Nitrogen Levels Kg/ha	Nitrogen content (per cent)				Nitrogen accumulated (gm) in the plant-parts of five hills				Nitrogen accumulated (gm) (Two hills)
	Lamina	Sheath	Culm	Ear	Lamina	Sheath	Culm	Ear	
(a) Tillering stage									
30	4.024	1.547	-	-	0.186	0.047	-	-	0.233
60	4.306	2.093	-	-	0.238	0.088	-	-	0.326
90	4.823	2.457	-	-	0.293	0.113	-	-	0.406
120	4.914	2.475	-	-	0.286	0.120	-	-	0.406
Mean	4.532	2.143	-	-	0.251	0.092	-	-	0.343
(b) Flower initiation stage									
30	3.676	1.274	-	-	0.314	0.088	-	-	0.402
60	4.095	1.365	-	-	0.436	0.102	-	-	0.538
90	4.186	1.372	-	-	0.489	0.118	-	-	0.607
120	4.331	1.547	-	-	0.529	0.157	-	-	0.686
Mean	4.072	1.390	-	-	0.442	0.116	-	-	0.558

temporarily the surplus products of photosynthesis to a greater degree than leaf - sheath. At harvest, carbohydrates in the leaf - sheath or culm depleted considerably presumably due to translocation of the substances to the growing ear.

The ear at flowering contained more sugars than starch. At harvest, the ear contained 47.16 per cent of starch and less than one per cent of sugars. This indicated that the translocated sugars are converted as starch and stored in the ear. Among the plant - parts, the culm contributed maximum (1.745 gm) to the total of 4.872 gm of sugars plus starch accumulated at flowering (Table 3). The sugars plus starch that ascumulated in the plant at harvest was 30.935 gm, the major portion of which was held in the ear. These results revealed that only 15.7 per cent of the carbohydrates accumulated in the plant was produced at flowering and 84.3 per cent was synthesised after flowering. It is inferred that the assimilation products were more actively synthesised after heading and that the rice culture was not much dependant on the carbohydrates stored at flowering for grain formation. This corroborates the finding that the grain yield of the early line IR 747 B2–6–3 was much less dependant on the carbohydrates accumulated before flowering (Anon, 1970).

Summary

Nitrogen and carbohydrates (sugars and starch) status and their accumulation in the plant - parts of the rice culture 24-20, were studied at successive stages of growth under four levels of nitrogen. The nitrogen content of lamina, leaf - sheath, culm and ear increased while that of sugars and starch declined on application of higher levels of nitrogen. Nitrogen content of lamina, leaf - sheath and clum gradually declined through flower initiation and flowering and recorded the minimum at harvest. At flowering, accumulation of nitrogen was maximum in the lamina and minimum in the clum. At harvest, ear accumulated maximum quantity of nitrogen the major portion of which was translocated from the lamina.

The percentage content and accumulation of carbohydrates was higher in the culm than lamina and leaf - sheath at flowering. The carbohydrates in the plant - parts were depleted after flowering and were levelled off at harvest. The culm contributed maximum carbohydrates to the development of the ear The major portion of the carbohydrates accumulated in the plant at harvest was synthesised after flowering. The grain formation of the early rice culture was not much dependant on the carbohydrates stored in the plant at flowering.

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other plant-parts. According to him, the nitrogen of the lamina is the source of protein in the grain. The reduction in the percentage content of nitrogen of the lamina observed in the study may therefore be mainly due to translocation to the ear.

The nitrogen content of the leaf blade of an early line IR 747 B2-6-3 (about 100 days duration) was 3.20 per cent at flowering while that of IR_8 was only 1.82 per cent. (Anon, 1970). The high nitrogen content of lamina (3.161 per cent) in the present study suggest that the high nitrogen content of lamina at flowering may be a character associated with early maturing varieties.

It is seen from Table 2, that application of higher levels of nitrogen had a depressing effect on the percentage content of sugars and starch. There was no difference in the sugar content of lamina and sheath at tillering. At subsequent stages, sugar content of lamina was lower than that of leaf - sheath or clum. The percentage content of sugars in the lamina was higher than that of starch at tillering and flower initiation stages. Takahashi *et al.*, 1955) also observed higher percentage content of sugars in the lamina compared to starch at elongation stage of the plants. But at flowering and harvest, the starch content of lamina predominated over sugars. The mean percentage content of sugars plus starch in the lamina was 5.56 at tillering which declined to 2.73 per cent at harvest. The percentage content of starch, sugars plus starch and their accumulation in the lamina were lower than that in the leaf-sheath or clum at tillering, flower initiation and flowering but showed no difference at harvest. According to Murayama, (1964), the lamina ts the photosynthetic organ of the rice plant and is not a storage organ and this explains for the lower content and accumulation of carbohydrates in the lamina.

As was observed in the lamina, content of nitrogen tn the leaf - sheath or culm increased while that of carbohydrates decreased on application of higher levels of nitrogen. (Tables 1 and 2). These observations are in agreement with those cf Takahashi *et al.*, (1955) and Baba,. (1961). At tillering, leaf - sheath contained 2.143 per cent of nitrogen and 7.92 per cent sugars plus starch. At flower initiation, the content of nitrogen declined to 1.390 per cent and that of sugars plus starch rose to 9.61 per cent. The nitrogen content of leaf - sheath further declined to 1.003 per cent at flowering while that of clum was the minimum (0.660 per cent). At this stage, the content of sugars plus starch in the leaf - sheath further rose to 11.47 per cent and that of the clum reached a still higher level of 15.80 per cent. The per cent content of sugars in the leaf - sheath was on par with that of culm at flowering and harvest. The culm contained 9.70 per cent starch at flowering, the highest starch content recorded in any plant - part (except ear at harvest) at any stage of growth. This is in accordance with Murayama, (1964) that the culm stored

rice culture, 24-20 at different growth stages

Ear			Total accumulated		
Sugars	Starch	Sugars plus starch	Sugars	Starch	Sugars plus starch
—	—	—	0,352	0.250	0.602
—	—	—	0,412	0.311	0.723
—	—	—	0.430	0.288	0.718
—	—	—	0.391	0.240	0.631
—	—	—	0.396	0.272	0.669
—	—	—	0.598	0.605	1.203
—	—	—	0.567	0.620	1.187
—	—	—	0.531	0.654	1.185
—	—	—	0.516	0.684	1.200
—	—	—	0.553	0.641	1.194
D.737	0,501	1.238	2.252	2.394	4.646
0.796	0.530	1.326	2.505	2.502	5.007
0.741	0.525	1.266	2.439	2.535	4.974
0.714	0.494	1.208	2.506	2.354	4.860
0.747	0.513	1.260	2.426	2.446	4.872
0.497	28.291	28.788	1.033	28.781	29.814
0.476	29.727	30.203	0.947	30.212	31.159
0.499	32.234	32.733	1.007	32.667	33.674
0.399	28.039	28.438	0.819	28.473	29.292
0.468	29,573	30,033	0.952	30,041	30.985

	Flowering	Harvest
C. D. at 0.05 for comparison of accumulation of sugars in plant-parts	0.184	0.032
C.D. at 0.05 for comparison of accumulation of starch in plant-parts	0.045	1.812
C. D. at 0,05 for comparison of accumulation of sugars plus starch in plant-parts	0.055	1.798

Table 3 Sugars and starch (gm) accumulated in five hills of

Nitrogen levels kg/ha.	Lamina			Sheath			Clum		
	Sugars	Starch	Sugars plus starch	Sugars	Starch	Sugars plus starch	Sugars	Starch	Sugars plus starch
(a) Tillering stage									
30	0.185	0.108	0 293	0.167	0.142	0.309	—	—	—
60	0.203	0.127	0.330	0.209	0.184	0.393	—	—	—
90	0.212	0.110	0.322	0.218	0.178	0.396	—	—	—
120	0.174	0.090	0.264	0.217	0.150	0.367	—		
Mean	0.194	0.109	0.302	0.203	0.164	0.366	—	—	—
(b) Flower initiation stage									
30	0.255	0.177	0.432	0.343	0.428	0.771	—	—	—
60	0.212	0.193	0.405	0.355	0.427	0.782	—	—	—
90	0.232	0.211	0.443	0.299	0.443	0.742	—	—	—
120	0.212	0.158	0.370	0.304	0.526	0.830	—	—	—
Mean	0.228	0.185	0.413	0.325	0.456	0:781	—	—	—
(c) Flowering stage									
30	0.208	0.216	0.424	0.645	0.596	1.241	0.662	1.081	1.743
60	0.262	0.306	0.568	0.739	0.590	1.329	0.708	1.076	1.784
90	0.222	0.264	0.486	0.814	0.608	1.422	0.662	1.138	1.800
120	0.277	0.247	0.524	0.850	0.626	1.476	0.665	0.987	1.652
Mean	0.242	0.258	0.501	0.762	0.605	1.367	0.674	1.071	1.745
(d) Harvest stage									
30	0.211	0.188	0.399	0.188	0.196	0.384	0.137	0.106	0.243
60	0.166	0.206	0.372	0.179	0.186	0.365	0.126	0.093	0.219
90	0.197	0.203	0.400	0.165	0.143	0.308	0.146	0.087	0.233
120	0.162	0.211	0.373	0.154	0.158	0.312	0.104	0.065	0.169
Mean	0.184	0.202	0.386	0.172	0.171	0.342	0.128	0.088	0.216

	Tillering	Flower initiation
V for accumulation of sugars in plant parts	0.742	6.394
't' for accumulation of starch in plant parts	6.405	7.426
't' for accumulation of sugars plus starch in plant parts	3.506	10.112

of rice culture, 24-20 at different growth stages

Culm			Ear		
Sugar	Starch	Sugars plus starch	Sugars	Starch	Sugars plus starch
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
6.97	11,38	18.35	6.47	4,40	10.87
6.47	9-83	16.30	6.22	4.14	10.36
5.72	9.83	15.55	5.48	3.88	9.36
6.23	7.76	12.99	5,23	3.62	8.85
6,10	9.70	15.80	5.85	4.01	9.86
1.99	1 55	3.54	0.85	48.36	49.21
1.74	1.29	3.03	0.76	47.48	48.24
1.74	1.03	2.77	•0.70	45.24	45.94
1.25	0.78	2.03	0.62	43.5*	44.20
1,68	1.16	2.84	0.73	46.17	46.90

	Flowering	Harvest
€. D. at 0.05 for comparison of percentage content of sugars in the plant-parts	0.47	0.23
C. D, at 0.05 for comparsion of percentage content of starch in the plant-parts	1.08	1.76
C, D, at 0.05 for comparison of percentage content of sugars plus starch in *the* (plant-parts	1.39	1,97

Table 2 Content of sugars and starch (per cent) in the plant-parts

Nitrogen levels Kg/ha	Lamina			Sheath		
	Sugars	Starch	Sugars plus starch	Sugars	Starch	Sugars plus starch
(a) Tillering stage						
30	398	2.33	6.31	5.48	4.65	10.13
60	3.74	2.33	6.07	4.98	4.40	9.38
90	3.49	1.81	5.30	4.73	3.87	8.60
120	2.99	1.55	4.54	4.48	3.10	7.58
Mean	3.55	2 01	5.56	4.92	4.01	8.92
fb) Flower initiation stage						
30	2.98	2.07	5.05	4.98	6 21	11.19
60	1.99	1.81	3.80	4.73	5.69	10.42
90	1.99	1.81	3.30	3.49	5.17	8.66
120	1.74	1.29	3.03	2.99	5.17	8.16
Mean	2.18	1.75	3.92	4.05	5.56	96i
(c) Flowering stage						
30	2.24	2.33	4.57	6.72	6.21	12.98
60	1.99	2.33	4.32	6.47	5.17	11.64
90	1.74	2.07	3.81	6.23	4.65	10 88
120	1.74	1.55	3.23	5 93	4.40	10.38
Mean	1.93	2.07	4 00	6.35	5.11	11.47
(d) Harvest stage						
30	1.74	1.55	3.29	1 99	2.07	4.06
60	1 25	1.55	2.80	1.74	1.81	3.55
90	1.25	1.29	2.54	1.49	1 29	2 78
120	0.99	1.29	2.28	1.25	1.29	2.54
Mean	1.31	1.42	2.73	1 62	1.62	3 23

	Tillering	Flower initiation
V for percentage content of sugars in the plant parts	2.37	5.64
't* for percentage content of starch in the plant parts	12.25	29.59
't' for percentage content of sugars plus starch in the plant parts	23.83	13.80

(c) Flowering stage									
30	2.281	0.910	0.546	1.092	0.262	0.087	0.052	0.124	0.525
60	2.867	0.910 -	0.637	1.147	0.377	0.104	0.070	0.147	0.698
90	3.476	1.092	0.728	1.165	0.442	0.143	0.084	0.158	0.827
120	3.480	1.100	0.728	1.168	0.544	0.156	0.093	0.159	0.952
Mean	3.161	1.003	0.660	1.143	0.406	0.123	0.075	0.147	0.751
(d) Harvest stage									
30	0.910	0.819	0.364	.0.728	0.110	0.077	0.025	0.426	0.638
60	1.001	0.873	0.418	0.782	0.133	0.090	0.030	0.490	0.743
90	1.019	0.983	0.418	0.928	0.160	0.110	0.035	0.661	0.966
120	1.074	1.002	0.455	0.982	0.176	0.123	0.038	0.632	0.969
Mean	1.001	0.919	0.414	0.855	0.145	0.100	0.032	0 552	0.829

	Tillering	Flower initiation
V for nitrogen content in tha plant-parts	75.647	29.394
't' for nitrogen accumulated in the plant-parts	8.715	8.935
	Flowering	Harvest
C. P. at 0.05 for comparison of nitrogen content in the plant-parts	0.280	0.055
C, D, at 0.05 for comparison of nitrogen accumulated in the plant-parts	0.026	0.041

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