hydroxide with dimethyl sulphate. It is better prepared in good yield by the easier method of refluxing the acetone solution of bixin with dimethyl sulphate and potassium carbonate. After filtering off the potassium salts, the solution is concentrated, stirred with excess of water and allowed to stand when the crystalline labile methyl bixin is obtained. The ester is also easily formed when bixin is treated with ethereal diazomethane. It is obtained as red plates, m.p. 161-62°, λ\textsubscript{max} 502 (log ε, 2.72), 472 (2.79) and 446 (2.65) nm; ε\textsuperscript{KBr} 1720 (s), 1650 (w), 1615 (s), 1560 (m), 1490 (w), 1310 (s), 1290 (m), 1265 (s), 1190 (m), 1165 (s), 1010 (m), 985 (m), and 965 (s) cm\textsuperscript{-1}. This gives a blue colour with conc. H\textsubscript{2}SO\textsubscript{4}.

The nmr spectrum of labile methyl bixin in CDCl\textsubscript{3} showed a broad signal at 1.98 δ (12 H) indicative of four C-Methyl protons. A sharp singlet at 3.77 δ (6 H) was due to the protons of the two carboxymethyls. In the olefinic region, a broad band centered at 6.57 δ (10 H) was observed. Apart from this, there were three doublets, each centered at 5.89 (2 H), 7.41 (1 H) and 7.98 δ (1 H). The first doublet belongs to the 2α protons merging together and the β protons differ, one being at 7.41 and the other at 7.98 δ. Barber et al.\textsuperscript{8} have earlier compared the nmr spectra of labile and stable methyl bixin. They noted that the two spectra agreed in all respects except one. In the stable methyl bixin, both the β-protons gave the same signal at 7.39 δ (2 H). The shifting of a β-proton in labile methyl bixin by 0.56 δ to the lower field was attributed to the proximity of the β-proton at one end of the molecule to the cis 6, 7 double bond. Thus, the nmr supports earlier fixation of the cis double bond by chemical methods.\textsuperscript{4}

The greater solubility of methyl bixin in fats and fat solvents as compared to bixin which is rather sparingly soluble would suggest the use of ester as more suitable for colouring butters. Further, it will not add to the acid value of the butter. By the simplified method given above, it is very easily prepared. However, its titrational value is poor; though λ\textsubscript{max} is the same as for bixin, log ε is markedly low and hence it is not suitable.


INHERITANCE OF 'DYE BINDING CAPACITY' VALUE IN RICE

C. B. SINGH, S. ARORA AND A. K. KAUL

Indian Agricultural Research Institute, New Delhi-12

RECENT work done at the International Rice Research Institute\textsuperscript{1} and at the Indian Agricultural Research Institute\textsuperscript{2} has convincingly proved that, in rice, considerable genetic variation exists for protein content and quality. A number of high protein genotypes have been identified at both places in the world germplasm collection. However, before such variation can be profitably exploited the estimation of heritability and the gene control mechanisms should be worked out under varying conditions to gain maximum genetic advance, through hybridization. Although numerous such studies have been performed in wheat,\textsuperscript{3,4} there is no report available in rice on this aspect. In the present study, an attempt was made to evaluate the inheritance of protein quality and quantity using the micro dye binding technique described earlier.\textsuperscript{5} The single grains of F\textsubscript{2} populations, derived from single plants from crosses between Tainan-3 × IR-8 (japonica × indica) of subsp. Oryza sativa) and IR-8 × Basmati-370 (indica × indica) were studied along with their respective parents. Means and variances were obtained and the frequency distribution was plotted (Fig. 1). Parental variances were used to estimate the environmental component of variation. Before the data was used for estimating the heritability, scale was tested.\textsuperscript{6} Means, vari-
TABLE I
Means, variances, heritability and genetic advance in two crosses

<table>
<thead>
<tr>
<th>Generation</th>
<th>N</th>
<th>Mean (X)</th>
<th>Variance (V)</th>
<th>Heritability (h²)</th>
<th>Genetic advance (Gₐ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P₃ (Tainan-3)</td>
<td>48</td>
<td>0.143</td>
<td>0.0061</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>P₄ (IR-8)</td>
<td>51</td>
<td>0.160</td>
<td>0.0029</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>P₃ (Basmati-370)</td>
<td>48</td>
<td>0.176</td>
<td>0.00067</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>P₃ x P₄ (F₂ population)</td>
<td>96</td>
<td>0.220</td>
<td>0.00090</td>
<td>50.000</td>
<td>0.029</td>
</tr>
<tr>
<td>P₄ x P₃ (F₂ population)</td>
<td>92</td>
<td>0.245</td>
<td>0.00081</td>
<td>47.530</td>
<td>0.027</td>
</tr>
</tbody>
</table>

ances, heritability estimates and genetic advance (at 5% level of selection) are given in Table I.

The formula, \( \frac{\text{VF}_2 - \text{VE}}{\text{VF}_2} \) was used for the calculation of heritability in broad sense wherein, \( \text{VF}_2 = \text{variance of } F_2 \text{ population and } \text{VE} = \frac{\text{VF}_1 + \text{VF}_2}{2} \). The non-fixable components of variation and the genotype environment interactions have not been removed from the \( F_2 \) variance. The data clearly indicate that in both the crosses studied, there is considerable evidence for additive and cumulative gene action for the DBC values (Fig. 1). This is expected, since very diverse parents have been crossed in either case. A large number of genes must be responsible for the determination of 'DBC' values since moderate heritability estimates have been obtained. It is, however, remarkable that the two estimates are almost alike. The genetic advance calculated indicates that \( F_3 \) lines derived from the 5% top \( F_2 \) selections would be 0-03 units higher than the mean of \( F_2 \).

The heritability estimates in the present study compare fairly well with similar studies done in wheat, soybean and other crops. With larger population at hand, it should be possible to breed for high DBC value which in turn would result in genetic advance for protein content and quality.

FIG. 1. Distribution of \( F_2 \) population of two crosses in rice for DBC value.

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RATE COEFFICIENT FOR TWO-BODY N-ATOMS RECOMBINATION

S. N. GHOSH AND S. K. JAIN
J.K. Institute of Applied Physics, Allahabad University, Allahabad

The recombination of N-atoms is important in many phenomena. During discharge through nitrogen, \( N_2 \) molecules are excited, ionized and/or dissociated. The dissociated N-atoms afterwards recombine and produce active nitrogen. Again, in the upper atmosphere, N-atoms are produced by dissociation of \( N_2 \) molecules by solar ultraviolet rays. On reacting with constituent particles of the atmosphere—atoms, molecules, ions and electrons—they produce certain upper atmospheric phenomena. Data for two-body recombination of N-atoms recombination are not available. In this note, two-body recombination of N-atoms is