CHAPTER III
MATERIALS AND METHODS

For attainment of different objectives of the project "Studies on the mineral nutrition and variability in quality characteristics of rice" materials used and methods adopted are discussed here under:

I. FIELD EXPERIMENTATION

(1) Site of the experiments

The field experiment for studying the effect of N, P and Mn on nutrient uptake, dry-matter and grain production, harvest of economic products and quality characteristics in dwarf rice 'Patra' was conducted at the Fertilizer Research Farm, Pura, Uttar Pradesh, Institute of Agricultural Sciences, Kanpur during the kharif seasons of 1972-73 and 1973-74.

The district Kanpur is a part of lower doab lying sandwiched between the river Gange and Yamuna. Geographically, the district lies between the parallels of 25°26' and 26°58' north latitude and 79°31' and 80°34' east longitude. It slopes gently from northwest to southeast and the fall of gradient is very gradual dropping from 135 meters in the extreme north to about 119 meters above sea level in the extreme south.

(11) Season and climate

The seasonal conditions for the entire growing season (i.e. 1972-73 & 1973-74) as indicated by weather data on monthly average basis, are depicted in figure 1.
Fig. 1 WEATHER CHART FOR EXPERIMENTAL PERIOD SHOWING MONTHLY AVERAGE FIGURES

Atmospheric Temperature

Wind Velocity in km/hr.

Relative Humidity

Evaporation in mm per Day

H = Relative Humidity, Ev = Evaporation, M1 = Maximum Temperature °C, M2 = Minimum Temperature °C
W = Wind Velocity, Rainfall in mm (Monthly Totals) has been shown by bars.
(iii) Soil of the field experiment

Before starting the experiment, surface soil samples (0-10 cm) were drawn with the help of a screw auger from several spots selected randomly on the field at Pura and a composite sample was obtained by mixing them thoroughly which was subsequently used for analysis of N, available P, K and Mn, mechanical composition, single value physical constants, organic carbon and exchange capacity. The results are reported in Table 1.

Table 1: Physical and chemical characteristics of experimental soil.

(a) Mechanical composition

<table>
<thead>
<tr>
<th>Texture</th>
<th>Coarse sand</th>
<th>Fine sand</th>
<th>Silt</th>
<th>Clay %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandy loam</td>
<td>0.52 %</td>
<td>80.66 %</td>
<td>12.12%</td>
<td>5.64 %</td>
</tr>
</tbody>
</table>

(b) Physico-chemical analysis

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH (1: 2.5)</td>
<td>7.8</td>
</tr>
<tr>
<td>EC x 10^3 (1: 5)</td>
<td>0.60 millimhos Om^-1 at 25°C</td>
</tr>
<tr>
<td>Exchangeable Ca</td>
<td>8.22 m.e./100 g soil</td>
</tr>
<tr>
<td>Exchangeable Mg</td>
<td>1.46</td>
</tr>
<tr>
<td>Exchangeable K</td>
<td>1.53</td>
</tr>
<tr>
<td>Exchangeable Na</td>
<td>0.84</td>
</tr>
<tr>
<td>(by difference)</td>
<td></td>
</tr>
<tr>
<td>C.E.C.</td>
<td>12.10</td>
</tr>
</tbody>
</table>

(c) Single value physical constants

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparent specific gravity</td>
<td>1.45 g/ccn.</td>
</tr>
<tr>
<td>True specific gravity</td>
<td>2.83 g/ccn.</td>
</tr>
</tbody>
</table>
Pore space 43.79%
Water holding capacity 44.15%
Field capacity 19.14%
Saturation percentage 40.29%

(d) Others
Organic carbon 0.44%
Total nitrogen 0.049%
Available phosphorus (as P) 8.0 kg/ha
Available potassium (as K) 170.0 kg/ha
Available Mn 25.5 ppm

The soil of the experimental plot may thus be characterised as sandy loam, low in nitrogen and available phosphate and medium in available K. Results of chemical and physico-chemical analyses indicated that the soil was a normal one having no salinity, sodium or alkalinity hazards.

(iv) Plan of layout
(a) Design of experimental layout: Factorial experiment was laid out in randomized block design with three replications.
(b) Treatments: 24 treatment combinations as shown below:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Treatment</th>
<th>Level of</th>
<th>Particulars of</th>
<th>Symbol</th>
<th>Source of fertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nitrogen</td>
<td>Without nitrogen</td>
<td>No</td>
<td>Urea</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>60 kg N/ha</td>
<td>N₁</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>120 kg N/ha</td>
<td>N₂</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>180 kg N/ha</td>
<td>N₃</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Phosphorus</td>
<td>Without phosphorus</td>
<td>Po</td>
<td>single super phosphate</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td>P₁</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>60 kg P₂O₅/ha</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Contd.
3. Manganese 3 Without Mn Mo Manganese
20 kg MnSO₄/ha M₁ sulphate
40 kg MnSO₄/ha M₂

An uniform basal dose of 60 kg K₂O/ha was applied to all the plots.

(v) Cultural operations

Recommended normal cultural practices including plant protection measures were adopted. Total amount of the fertilizers were applied as basal in accordance with the treatment combinations. The crop was irrigated with normal tubewell water at the critical stages of plant growth when no adequate rains were observed.

(vi) Crop variety and observations

'Katna' variety of rice was selected for the field experiment. A very good grain type was the overriding merit of this variety. For kharif season this variety has been found suitable particularly for Uttar Pradesh, Punjab and Haryana provinces. This variety has been more widely accepted in other provinces of India too. It fits rice wheat rotation well.

For chemical analysis plants were selected randomly at late tillering, panicle emergence and harvest stages. Per hectare total dry-matter at late tillering and panicle emergence stages was calculated on the basis of plant population. The grain and straw samples were collected separately at the final harvest. The yields of grain and straw were recorded on 14% moisture and dry matter basis respectively.
2. COLLECTION OF GRAIN SAMPLES OF RICE FROM DIFFERENT LOCATIONS FOR QUALITY STUDIES

To study the effect of agro-climatic conditions and variety upon the variability in the quality characteristics of rice grain samples of promising rice varieties of different grades and maturity groups grown at Regional Agricultural Research Stations of Uttar Pradesh during the kharif season of 1978-79 were collected. The site and climate of such stations are given hereafter:

I. Faizabad

The district lies between the parallels of 28°09' and 28°30' north latitude and 81°04' and 83°08' east longitude. The cold weather lasts longer and during summer months the thermometer does not generally rise so high. Mean annual rainfall has been 1070.61 mm. The prevalent soils are generally light loam.

II. Haridwari

The district Haridwari lies between the parallels of 26°53' and 27°47' north latitude and 79°41' and 80°49' east longitude. Temperatures vary from 15° C during December and January to 45.5° C in May and June months. The mean annual rainfall has been about 889.0 mm. The soils are generally loam and clay.

III. Mathura

Mathura district lies between parallels of 27°14' and 27°53' north latitude and 77°17' and 78°12' east longitude. Climate is dry and hot. Mean annual rainfall for the district has been about 620.00 mm bulk of which occurs in July and
August. Soils are predominantly loam and sandy loam.

IV. AMROKH (JHANSI)

The district Jhansi lies in the extreme south west corner of Uttar Pradesh between the parallels of 24°11' and 25°50' north latitude and 78°10' and 79°25' east longitude. The climate of Jhansi is characterised by extreme dryness and by heat considerably above the average of the province. Mean annual temperature and mean annual rainfall have been 26.39°C and 977.90 mm respectively. The soils of the district may be broadly distinguished as well known, Mar, Kabar, Farwa and Rakar which occur throughout Bundelkhand division.

V. NAWABGANJ (BAREILLY)

The district Bareilly lies between the parallel of 28°1' and 23°54' north latitude and 78°53' and 79°47' east longitude. Cold weather is of longer duration. The influence of tarai is illustrated by the relative dampness of the climate and moderate heat in summer. Mean annual rainfall has been 1238.75 mm. The soils are predominantly clay loam.

VI. Rudrapur (NAINITAL)

Nainital district is situated between the parallels of 23°51' and 29°37' north latitude and 78°43' and 80°5' east longitude. Endless varieties of climate are found in different parts of the district. The average rainfall of the tarai belt where this station was situated has been 1472.43 mm annually. Soils of tarai tract vary from clay loam to sandy loam.

8. ANALYTICAL PROCEDURES

(A) SOIL ANALYSIS

The following standard methods were adopted for
determining various soil constituents and other values as
described by Piper (1950):

Mechanical analysis: International pipette method
Total nitrogen: Kjeldahl's method
Organic carbon: Walkley and Black's rapid titration
method.
Exchangeable calcium: Oxalate procedure in \(N\) NaCl extract.
Exchangeable magnesium: Magnesium ammonium phosphate procedure
in \(N\), NaCl extract.
Exchangeable K: Cobaltinitrite method in ammonium
acetate extract.
Exchangeable Na: By difference
Cation exchange capacity: Neutral normal ammonium acetate method.

Single value physical constants were determined by
standard procedures (Piper 1950). True density, apparent density
and pore space were determined by usual procedure (USDA Handbook
60, 1954). pH in 1:2.5 soil water suspension was determined
by glass electrode method using Beckman's pH meter. Toshniwal's
conductivity measuring apparatus was used for determination of
electrical conductivity in 1:5 soil water suspension. While
available phosphorus was determined by Olsen's method the
turbidimetric method after extraction with Morgan's reagent
was followed for available potassium as outlined by Muhr et al.
(1965). Ammonium dihydrogen orthophosphate extraction method
of Hoff and Mederski (1963) as described by Chapman and Pratt
(1961) was adopted for determination of available Mn.

(B) PLANT ANALYSIS

Plant samples were analysed for phosphorus, potassium,
calcium, magnesium and manganese by the following standard procedures as described by Piper (1950):

- **Total phosphorus**: Magnesium nitrate dry ashing Molybdenum blue method.
- **Total potassium**: Dry ashing cobalt-nitrite method.
- **Calcium**: Oxalate procedure.
- **Magnesium**: Gravimetric method in the filtrate from calcium precipitation.
- **Manganese**: Dry ashing periodate method.

The following methods of determination for nitrogen, crude protein, starch and mineral matter in plant samples were adopted:

- **Total nitrogen**: Modified macro-Kjeldahl's procedure (Jackson, 1953)
- **Crude protein**: It was obtained by multiplying the total nitrogen with 6.25.
- **Starch**: Total starch in plant samples was determined by a reducing sugar analysis of ground, defatted samples which had been subjected to enzymatic and acid hydrolysis according to the official AOAC method.
- **Mineral matter**: Official AOAC method.

**B) GRAIN ANALYSIS FOR QUALITY CHARACTERISTICS**

For evaluating the quality characteristics of rice varieties the rice kernels were subjected to the following physical, thermal and chemical tests.
(a) **TESTS FOR PHYSICAL QUALITIES**

(i) **Hullinig percentage**

Ten grams of raw rice was sampled, husks removed by laboratory hulling machine and huskless rice reweighed. Hulling percentage which indicates the recovery of unpolished rice from panicular paddy was then calculated.

(ii) **Size, length/breadth ratio and grades**:

The dimensions of raw rice grains were measured by the dial for thickness measurement and categorised in the grades on the basis of standard limits as described by Govindaswami and Ghosh (1970).

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Long slender (LS)</td>
<td>Length 6.0 mm and above length/breadth ratio 3.0 and above.</td>
</tr>
<tr>
<td>2. Short slender (SS)</td>
<td>Length less than 6.0 mm; length/breadth ratio 3.0 and above.</td>
</tr>
<tr>
<td>3. Medium slender (MS)</td>
<td>Length less than 6.0 mm; length/breadth ratio 2.5 to 3.0 OR length less than 4.5 mm; length/breadth ratio 2.0 or above</td>
</tr>
<tr>
<td>4. Long bold (LB)</td>
<td>Length 6.0 mm and above length/breadth ratio less than 3.0</td>
</tr>
<tr>
<td>5. Short bold (SB)</td>
<td>Length less than 6.0 mm; length/breadth ratio less than 2.5</td>
</tr>
</tbody>
</table>

(b) **TESTS FOR THERMAL QUALITIES**

(1) **COOKING CHARACTERISTICS**

(i) **Water uptake capacity**

Water uptake is the number of millilitres of water
absorbed by 100 grams of rice (husk removed). This test was carried out at 77°C as described by Halick & Kelly (1959).

(ii) **Volume expansion**

The volume expansion of rice after cooking expressed in terms of its original volume was determined by usual laboratory procedure (Halick and Kelly, 1959).

(2) **KERNEL ELONGATION**

It is the expansion of rice in longitudinal direction after cooking. Observations for volume expansion and kernel elongation were recorded after cooking at 82°C for 45 minutes.

(c) **TESTS FOR CHEMICAL QUALITIES**

(1) **Alkali value**

Alkali reaction in terms of extent of disintegration of "head" rice in contact with dilute alkali-24% aqueous KOH solution at 30°C for 28 hours was determined by the method outlined by Little et al. (1953) and values of alkali spreading were recorded.

(ii) **Crude protein**

Crude protein content was estimated from the assay of total nitrogen (Kjeldahl's method) present in the dehusked rice grain and by multiplying the nitrogen percentage thus obtained, with the factor 5.95.

(iii) **Non-protein nitrogen**

Sodium tungstate sulphuric acid method (Kent-Jones and Amoe, 1957).

(iv) **True protein N**

By subtracting the non-protein nitrogen from the
crude protein nitrogen. True protein was obtained by multiplying this nitrogen with the factor 5.95.

(iii) Starch : Official AOAC procedure

(iv) Mineral matter: Official AOAC procedure. It was expressed on oven dry basis.

The values of thermal and chemical qualities except that of mineral matter were expressed on the basis of 14% moisture in the dehusked rice grains.