MATERIALS AND METHODS

3.1. Experimental Site.

The investigation was carried out in the Experimental Farm of the Department of Agricultural Botany, Gauhati University during the Rabi seasons of 1969, 1970, 1971 and 1972. The site selected for the experimental work was well drained. The soil type was sandy-loam. The entire plot was evenly elevated and was exposed to uniform sunlight.

3.2. Climate and Weather Condition.

Gauhati University, Assam lies on 26°11’ North Latitude and 90°45’ East Longitude with an altitude of about 180 feet from sea level. It has a humid, subtropical climate with wet warm summer and dry cold winter. The average annual rainfall is about 1612 mm, most of which is received between June and September. The winter rainfall, on an average, is about 57 mm (Table 3.1(a)).

The weather data of the experimental years as recorded by the Meteorological Observatory of the Gauhati Aerodrome are presented in Table 3.1(a). A graphical presentation of the same is shown in Fig. 3.1a.
Table 3.1. Monthly distribution of Temperature, Rainfall and Relative Humidity at Gauhati.

<table>
<thead>
<tr>
<th>Season</th>
<th>Months</th>
<th>Temperature °C</th>
<th>Rainfall In</th>
<th>Relative humidity in p.c.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>January</td>
<td>57.5</td>
<td>14.17</td>
<td>0.38 0.97 91</td>
</tr>
<tr>
<td></td>
<td>February</td>
<td>61.6</td>
<td>16.44</td>
<td>1.17 2.97 82</td>
</tr>
<tr>
<td></td>
<td>March</td>
<td>69.5</td>
<td>20.83</td>
<td>1.99 5.05 73</td>
</tr>
<tr>
<td></td>
<td>April</td>
<td>75.2</td>
<td>24.00</td>
<td>5.71 14.50 76</td>
</tr>
<tr>
<td></td>
<td>May</td>
<td>78.5</td>
<td>25.83</td>
<td>9.29 23.60 82</td>
</tr>
<tr>
<td></td>
<td>June</td>
<td>81.4</td>
<td>27.44</td>
<td>12.30 31.24 85</td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>82.6</td>
<td>28.11</td>
<td>12.28 31.19 86</td>
</tr>
<tr>
<td></td>
<td>August</td>
<td>82.6</td>
<td>28.11</td>
<td>10.26 26.06 86</td>
</tr>
<tr>
<td></td>
<td>September</td>
<td>81.6</td>
<td>27.56</td>
<td>6.59 16.74 85</td>
</tr>
<tr>
<td></td>
<td>October</td>
<td>77.1</td>
<td>25.06</td>
<td>2.78 7.06 86</td>
</tr>
<tr>
<td></td>
<td>November</td>
<td>68.0</td>
<td>20.00</td>
<td>0.55 1.40 89</td>
</tr>
<tr>
<td>Winter</td>
<td>December</td>
<td>59.5</td>
<td>15.28</td>
<td>0.16 0.41 92</td>
</tr>
</tbody>
</table>

N.B. 30 years average data collected from Gauhati Aerodrome Observation at 8.30 A.M.
FIG. 3-i: MONTHLY DISTRIBUTION OF TEMPERATURE, RAINFALL AND RELATIVE HUMIDITY AT GAUHATI.

TEMP IN $^\circ$C = 0
RAINFALL IN C.M = [ ]
R.H
IN P.C = [ ]

100
90
80
70

0.97 2.97 5.05 14.5 23.6 31.24 34.19 26.06 16.74 7.06 1.40 0.41
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
Table 3.1(a). Climatic condition during the experimental period.

<table>
<thead>
<tr>
<th>Months</th>
<th>Temperature in °C.</th>
<th>Rainfall in mm.</th>
<th>Relative humidity in p.c.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum</td>
<td>Minimum</td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>29.8</td>
<td>20.1</td>
<td>51.3</td>
</tr>
<tr>
<td>November</td>
<td>27.0</td>
<td>15.7</td>
<td>21.2</td>
</tr>
<tr>
<td>December</td>
<td>25.8</td>
<td>10.0</td>
<td>Nil</td>
</tr>
<tr>
<td>January</td>
<td>23.5</td>
<td>8.8</td>
<td>25.0</td>
</tr>
<tr>
<td>February</td>
<td>26.2</td>
<td>11.6</td>
<td>18.2</td>
</tr>
<tr>
<td>March</td>
<td>31.2</td>
<td>13.1</td>
<td>31.3</td>
</tr>
<tr>
<td>April</td>
<td>33.0</td>
<td>20.8</td>
<td>51.0</td>
</tr>
<tr>
<td>November</td>
<td>27.0</td>
<td>16.8</td>
<td>11.6</td>
</tr>
<tr>
<td>December</td>
<td>24.9</td>
<td>11.5</td>
<td>Nil</td>
</tr>
<tr>
<td>January</td>
<td>23.0</td>
<td>10.6</td>
<td>2.8</td>
</tr>
<tr>
<td>February</td>
<td>25.9</td>
<td>10.0</td>
<td>3.6</td>
</tr>
<tr>
<td>March</td>
<td>31.6</td>
<td>15.4</td>
<td>21.3</td>
</tr>
<tr>
<td>November</td>
<td>29.5</td>
<td>10.5</td>
<td>18.5</td>
</tr>
<tr>
<td>December</td>
<td>26.2</td>
<td>9.0</td>
<td>Nil</td>
</tr>
<tr>
<td>January</td>
<td>23.7</td>
<td>9.5</td>
<td>10.4</td>
</tr>
<tr>
<td>February</td>
<td>25.0</td>
<td>10.0</td>
<td>9.1</td>
</tr>
<tr>
<td>March</td>
<td>30.6</td>
<td>15.7</td>
<td>32.2</td>
</tr>
<tr>
<td>November</td>
<td>28.5</td>
<td>12.5</td>
<td>14.5</td>
</tr>
<tr>
<td>December</td>
<td>26.8</td>
<td>7.0</td>
<td>Nil</td>
</tr>
<tr>
<td>January</td>
<td>24.0</td>
<td>6.5</td>
<td>3.8</td>
</tr>
<tr>
<td>February</td>
<td>25.8</td>
<td>10.4</td>
<td>8.5</td>
</tr>
<tr>
<td>March</td>
<td>30.8</td>
<td>13.5</td>
<td>30.0</td>
</tr>
</tbody>
</table>
FIG. 3A: CLIMATIC CONDITION OF EXPERIMENTAL PERIOD.

1969-70

1970-71

1971-72

1972-73

TEMP.

RELATIVE HUMIDITY

RAINFALL IN MM

MAX. TEMP. IN O°C

MIN. TEMP. IN O°C

RELATIVE HUMIDITY

TEMP.

R.H. IN %

R.H. IN %
3.3. Soil Analysis: Mechanical and Chemical.

A detailed study of the soil of the experimental plots in regard to texture, fertility status, and soil reaction was made. Soil samples were taken from the top 23 cm layer from 15 places in the main plot before laying out the experiment. Composite samples were analysed in the Soil Testing Laboratory, Gauhati - 7, for the mechanical and chemical attributes. The results of the mechanical and chemical analysis are shown in Table 3.11 and 3.11(a) respectively.

Table 3.11. Mechanical Analysis of Soil of the Experimental Plot.

<table>
<thead>
<tr>
<th>Particulars</th>
<th>In p.c.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse sand</td>
<td>1.5</td>
</tr>
<tr>
<td>Fine sand</td>
<td>38.1</td>
</tr>
<tr>
<td>Silt</td>
<td>26.0</td>
</tr>
<tr>
<td>Clay</td>
<td>34.2</td>
</tr>
</tbody>
</table>

The mechanical analysis of the soil sample showed that the soil of the experimental plot was sandyloam.
Table 3.11(a): Chemical analysis of the soil of the experiment plot during the four crop seasons.

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Experimental plots</th>
<th>Method of analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Soil P&lt;sub&gt;M&lt;/sub&gt;</td>
<td>6.4</td>
<td>6.5</td>
</tr>
<tr>
<td>2. Organic carbon (in p.c.)</td>
<td>0.84</td>
<td>0.75</td>
</tr>
<tr>
<td>3. Available P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt; (lb/acre)</td>
<td>16.0</td>
<td>10.5</td>
</tr>
<tr>
<td>4. Available K&lt;sub&gt;2&lt;/sub&gt;O (lb/acre)</td>
<td>152.0</td>
<td>142.0</td>
</tr>
<tr>
<td>5. Total Nitrogen (in p.c.)</td>
<td>0.093</td>
<td>0.079</td>
</tr>
</tbody>
</table>

The chemical analysis of the soil showed that the soil is acidic, high in nitrogen content, medium in K<sub>2</sub>O, low to medium in P<sub>2</sub>O<sub>5</sub>, and medium to high in organic carbon.

3.4. Preparation of Land.

The cultural practices were adopted as done in case of wheat cultivation. The plots were ploughed with M. B. plough and planked. This was followed by repeated ploughings. The soil was brought to a fine tilth after five to six ploughings. Normally, wheat cultivation requires one soil inversion with a soil turning plough and four to five ploughings with desi plough to prepare the land for sowing of wheat.
3.5. Manuring.

The field was given a basal dressing of Farmyard manure at the rate of 50 qtl/h prior to the respective experiment. The required amount of manures was uniformly applied to each plot and thoroughly incorporated in the soil a fortnight prior to the respective dates of sowing.

3.6. Sowing of Seed.

Timely sowing has a marked influence on the yield of wheat crop. As the coleoptile of wheat seed is short, the depth of sowing is another important point to be considered. At the time of sowing, the seeds were placed in furrows at a depth of about 2.5 cm. Seeds were covered with soil after sowing. Furrows were spaced 25 cm apart. After 15 days of sowing, a uniform plant to plant spacing of 10 cm was maintained.

3.7. Irrigation.

The crop was irrigated as and when needed. Altogether 3 to 5 irrigations were given according to the need of each crop year. 3 cm deep irrigation was given each time.

3.8. Intercultivation.

This was done mainly to eradicate weeds and to help the soil well aerated. Two intercultivations were given after the first two irrigations respectively. Hand weeders (Khurpi) were used for the purpose.

Crops were free from pests and diseases in all the four years. So, plant protection measures were not found necessary.


The plotwise harvesting was done when the plants became fairly dry. In the first experiment the four varieties matured at different times. So, the harvesting was done varietywise. After the harvest, the crop was removed to the threshing floor. The produce from each plot was threshed, winnowed, dried and weighed separately.

3.11. Sampling and Collection of Data.

A. Pre-harvest studies.

Sampling techniques - Ten plants were selected at random in each plot using random table for recording observations on plant height, number of tillers, number of leaves, ear emergence and maturity, number of earhead, and spike length.

Plant height - The plant height was taken at an equal interval from sowing till harvest. It was measured from the upper surface of the soil touching the stem to the growing point minus the length of ear in cm.

Number of tillers - Number of tillers per plant in each of the ten samples were counted and recorded separately. This observation was taken along with the plant height.
Number of leaves - Number of leaves per plant were counted and recorded in a similar manner as in case of number of tillers.

Ear emergence and maturity - Observation on ear emergence and maturity were recorded on the same ten observational plants. Ear emergence was taken when 80 p.c. of the plants came to boot stage. While maturity was recorded when the crop was ready for harvest.

Number of ear - Number of ears per plant in each of the ten samples were counted and recorded separately. This observation was taken just before harvesting.

B. Post-harvest studies.

Sampling technique - The plants which were selected for pre-harvest studies were harvested separately from each plot and properly tagged. The ears of all the samples plants were taken out, mixed together and random samples of 25 ears were taken from the sample plants of each plot and were utilized for post-harvest studies.

Length of earhead - Length of each of 25 ears was measured treatmentwise in centimeters. The average of these gave the average length of the ear under each treatment.

Thousand grain weight - A representative sample of 1000 grain was taken from the grain Yield of each treatment and the weight was taken in gm.
Number of grain - Number of grains from all the 25 ears were counted and then number of grain per plant or per ear was recorded treatmentwise.

Weight of grain - Weight of all the grains from 25 ears was taken and weight of grain per plant was taken treatmentwise.

Yield of grain - Harvested wheat plants from each plot were threshed, winnowed and dried separately and plotwise yields of grains were recorded in kg. This included the weight of grain from sample plants also. Ultimately yield in quintal per hectare was recorded.

Yield of straw - Straw obtained after taking the grains was weighed for each plot and recorded separately in quintal per hectare.

Dry weight of root - Roots of the sample plants from each plot were taken out, cleaned, dried and weighed separately in gms.

Protein content of grain - Grains from each treatment were taken, powdered and percentage of protein was estimated separately by Kjeldahl's method.

Details of the observations recorded are given along with the respective experiments.
3.12. Experimental Details.

The investigation comprised of four experiments as described below -

Experiment I - Effect of sowing dates on four varieties of wheat.

Four wheat varieties were tested in this experiment under four dates of sowing. The experiment was conducted in the Rabi season of 1969 to find out the variety with maximum yield potential under suitable date of sowing.

Layout and experimental design.

There were altogether sixteen treatment combinations which were laid out in a randomised block design with three replications. The layout plan of the experiment is presented in Fig. 2a. The sixteen treatments were placed at random in sixteen plots under individual replication. Details are given below.

Factors : 2

<table>
<thead>
<tr>
<th>(a) Sowing dates.</th>
<th>(b) Varieties.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) $S_1$ - October 31</td>
<td>(1) $V_1$ - 'Kalyan Sona'</td>
</tr>
<tr>
<td>(2) $S_2$ - November 15</td>
<td>(2) $V_2$ - 'Sonalika'</td>
</tr>
<tr>
<td>(3) $S_3$ - November 30</td>
<td>(3) $V_3$ - 'Sharbati Sonora'</td>
</tr>
<tr>
<td>(4) $S_4$ - December 15</td>
<td>(4) $V_4$ - 'Safed Lerma'</td>
</tr>
</tbody>
</table>

Treatment combination - $4 \times 4 = 16$

Replication = 3

Total plots $16 \times 3 = 48$. 
Spacing.

(i) Net plot size = 4m x 3m.
(ii) Space between plots = 30 cm.
(iii) Space between replications = 50 cm.
(iv) Field border = 1 m.
(v) Total area under the experiment = 27.6m x 28.1m
    = 0.077 hectare.

Wheat varieties used.

Altogether four varieties of wheat were tried. These are described below.

(a) 'Kalyan Sona' - It is a selection made from the population of 'S-227', derived from the Cross Penjamo Sib x Gabo 55. The selection was done mainly at three places, namely, Punjab Agricultural University (P.A.U.), Ludhiana, I.A.R.I., New Delhi, and Uttar Pradesh Agricultural University (U.P.A.U.), Pantnagar. 'Kalyan Sona' was derived from the merging of the two separately developed mass select seed lots, viz., (i) 'Kalyan 227' by P.A.U. and (ii) 'Sona 227' by I.A.R.I. and U.P.A.U. from the original 'S-227'. It is a two gene dwarf with profuse tillering capacity and grows to a height of about 90 cm. It takes 140-150 days to mature. Ears bold, erect, grain with good chapati making quality and resistant to three rusts. The 1000 grain weight is about 34.5 gm and the grain yield is about 6000-8000 kg per hectare. This variety is suitable for timely sowing in all wheat growing areas of the country including the hilly regions.
(b) 'Sonalika' - It is a selection from an impure line known as sample no. 308 or 'S-308', introduced with the other material in 1963-64. The selection was made by the Breeding Section of I.A.R.I., New Delhi. This variety is early maturing compared with 'Lerma Rojo' as it takes 120-130 days to mature, and is as early as 'Sonora-64'. It is one gene dwarf and has shown wide adaptibility particularly in the Gangetic Plain of India. This crop grows 110-120 cm high and is resistant to lodging and rusts. The 1000 grain weight is about 47.3 gms, and grain yield is 5500-6000 kg per hectare.

(c) 'Sharbati Sonora' - It is an amber seeded mutant variety produced at the I.A.R.I. by the mutation breeding group using irradiation on red grained 'Sonora-64'. It is two gene dwarf and appears to have an increase percentage of protein over its red grained parents. It takes 110-120 days to mature and grows up to 90 cm high. The 1000 grain weight is about 36.2 gms and yield of grain is reported to be 5000-5500 kg per hectare.

(d) 'Saied Lerma' - It is a selection from the introduced line 'S-307'. The selection was made by the Breeding Section of the I.A.R.I., New Delhi. It is resistant to rusts, and the grains do not shatter on maturity. It takes 135-145 days to mature. It has shown a slight superiority to 'Lerma Rojo' in yield and straw strength. It is one gene dwarf plant, and grows 110-120 cm high. The weight of 1000 grain is about 40.6 gm and the yield of grain is reported to be 5000-6000 kg per hectare.
Sowing.

The first sowing was done on 31st October, 1969. Subsequent sowings followed according to the schedule mentioned earlier. The seeds used for sowing were collected from the Seed Corporation of India. The sowing was done in rows by hand. N, P, and K fertilizers, at the rate of 60-40-40 kg per hectare were applied as basal dose after one week of each sowing by side dressing.

Harvest.

The plots under different sowing dates attained maturity at different times. In general, the early sown plots were found ready for harvest a little earlier than the late sown one, though in the former case, the life span of the plants was longer. The right time of harvest was indicated when the plants became fairly dry.

Collection of Data.

The observations on the growth and yield characters of the representative plants from each plot were made as given below.

1. Height of plant in cm.
2. Number of tillers per plant.
3. Ear emergence and maturity.
4. Number of earhead per plant.
5. Length of earhead in cm.
6. Number of grains per earhead.
7. Test weight of grain in gm.
8. Yield of grain per hectare.
Experiment II: Individual Effect of Nitrogen, Phosphorus, Potash, and Calcium on the Wheat Variety 'Kalyan Sona'.

In this experiment the variety 'Kalyan Sona' was tried under different doses of N, P, K, and Ca. This particular variety was chosen on the basis of its highest observed yield over the other three varieties in the previous experiment. There were altogether twenty treatment combinations. The experiment was laid out in a randomised block design with three replications. All the treatments were distributed at random. The layout plan of the experiment is presented in the Fig. 2b.

Design - Randomised Block Design.
Treatment - 20
Replication - 3
Total plots - 20 \times 3 = 60.

Factors: 2

(a) Nutrients = 4
N - Nitrogen (Ammonium sulphate)
P - Phosphorus (Super phosphate)
K - Potassium (Muriate of Potash)
Ca - Calcium (Lime)

(b) Doses = 5

<table>
<thead>
<tr>
<th>Nitrogen</th>
<th>Phosphorus</th>
</tr>
</thead>
<tbody>
<tr>
<td>N₀ - No nitrogen</td>
<td>P₀ - No phosphorus</td>
</tr>
<tr>
<td>N₁ - 40 kg per hectare</td>
<td>P₁ - 40 kg per hectare</td>
</tr>
<tr>
<td>N₂ - 80 kg per hectare</td>
<td>P₂ - 80 kg per hectare</td>
</tr>
<tr>
<td>N₃ - 120 kg per hectare</td>
<td>P₃ - 120 kg per hectare</td>
</tr>
<tr>
<td>N₄ - 160 kg per hectare</td>
<td>P₄ - 160 kg per hectare</td>
</tr>
</tbody>
</table>
Potassium

<table>
<thead>
<tr>
<th>Potassium Level</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>$K_0$ - No potassium</td>
<td></td>
</tr>
<tr>
<td>$K_1$ - 40 kg per hectare</td>
<td>40 kg per hectare</td>
</tr>
<tr>
<td>$K_2$ - 80 kg per hectare</td>
<td>80 kg per hectare</td>
</tr>
<tr>
<td>$K_3$ - 120 kg per hectare</td>
<td>120 kg per hectare</td>
</tr>
<tr>
<td>$K_4$ - 160 kg per hectare</td>
<td>160 kg per hectare</td>
</tr>
</tbody>
</table>

Calcium

<table>
<thead>
<tr>
<th>Calcium Level</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Ca_0$ - No calcium</td>
<td></td>
</tr>
<tr>
<td>$Ca_1$ - 40 kg per hectare</td>
<td>40 kg per hectare</td>
</tr>
<tr>
<td>$Ca_2$ - 80 kg per hectare</td>
<td>80 kg per hectare</td>
</tr>
<tr>
<td>$Ca_3$ - 120 kg per hectare</td>
<td>120 kg per hectare</td>
</tr>
<tr>
<td>$Ca_4$ - 160 kg per hectare</td>
<td>160 kg per hectare</td>
</tr>
</tbody>
</table>

Spacing:

1. Net plot size - 4m x 3m.
2. Space between plots - 30 cm.
3. Space between replications - 50 cm.
4. Area around the experiment - 1m.
5. Total area under the experiment = 27.9 m x 34.7 m = 0.09 hectare.

Fertilizer Application.

The variety 'Kalyan Sona' was sown on 15th November, 1970. The fertilizers used to supply the four nutrients - nitrogen, phosphorus, potassium, calcium - were in the form of Ammonium sulphate, super phosphate, muriate of potash and lime respectively. The actual quantity of the fertilizers to be applied to each was first calculated and thereafter applied to the crop after one week of sowing by side dressing. Nitrogenous fertilizer was applied in two split doses. Two third of the amount was applied after sowing along with the other nutrients and the remaining one third was applied just before flowering.
Observation recorded in the experiment are given below.

(1) Height of plant in cm.
(2) Number of tillers per plant.
(3) Number of earhead per plant.
(4) Length of earhead in cm.
(5) Test weight of grain in gm.
(6) Yield of grain in quintal per hectare.
(7) Yield of straw in quintal per hectare.

Experiment III: Individual Effect of Zinc, Boron, and Molybdenum on the Wheat Variety 'Kalyan Sona'.

In the second phase of the experimentation three micro-nutrients - Zinc, Boron and Molybdenum at four doses of each were applied. These micronutrients were tried with the variety 'Kalyan Sona'. This particular variety was chosen on the basis of its highest observed yield over the other three varieties in the previous experiment.

Layout and Experimental Design.

There were altogether twenty four treatment combinations, and each treatment replicated thrice. The treatments were distributed at random to the twenty four plots of each replication. The layout plan of the experiment is presented in Fig. 2.c.
Design - Randomised Block Design.
Factor - 3
Treatment combination - $3 \times 4 \times 2 = 24$
Replication - 3
Total plots - $24 \times 3 = 72$

Spacing.

1. Net plot size - 4m x 3m.
2. Space between plots - 30cm.
3. Space between replications - 50cm.
4. Area around the experiment - 1m.
5. Total area under the experiment - 41.3m x 27.9m = 0.11 hectare.

Factors - 3.

(a) Micronutrients - 3
Zn - Zinc, B - Boron, Mo - Molybdenum.

(b) Doses - 4
Zn\textsubscript{0} - No zinc
Zn\textsubscript{1} - 10 kg per hectare
Zn\textsubscript{2} - 20 kg per hectare
Zn\textsubscript{3} - 30 kg per hectare
Zn\textsuperscript{2} - 30 kg per hectare
Mo\textsubscript{0} - No molybdenum
Mo\textsubscript{1} - 50 gm per hectare
Mo\textsubscript{2} - 100 gm per hectare
Mo\textsubscript{3} - 150 gm per hectare
B\textsubscript{0} - No boron
B\textsubscript{1} - 10 kg per hectare
B\textsubscript{2} - 20 kg per hectare
B\textsubscript{3} - 30 kg per hectare
(c) Sowing dates - 2

$S_1$ - 15th November.

$S_2$ - 15th December.

Wheat Variety Used - 'Kalyan Sona'

Sowing.

The first sowing was done on 15th November, 1970. A basal dose of N, P, K fertilizer at the rate of 60-40-40 kg per hectare were applied as in the previous experiment. Zinc, Boron, and Molybdenum in the form of zinc sulphate, borax, and sodium molybdate were applied as aqueous spray. The varying doses of the three micronutrients were used as shown in the Table 3.III.

Table 3.III : Sources and different doses of micronutrients used.

<table>
<thead>
<tr>
<th>Micronutrient</th>
<th>Source</th>
<th>Aqueous spray application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc</td>
<td>Zinc sulphate</td>
<td>0.5 p.c.</td>
</tr>
<tr>
<td>Boron</td>
<td>Borax</td>
<td>0.5 p.c.</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>Sodium molybdate</td>
<td>0.05 p.c.</td>
</tr>
</tbody>
</table>

Observations recorded in the experiment are given below.

(1) Height of plant in cm.

(2) Number of tillers per plant.

(3) Number of ear per plant.

(4) Length of ear in cm.
(5) Number of grain per ear.
(6) Test weight of grain in gm.
(7) Yield of grain in quintal per hectare.
(8) Yield of straw in quintal per hectare.

Experiment IV: Effect of Selected Combinations of N, P, K, and Zn on Wheat Variety 'Kalyan Sona'.

This experiment was treated as the summary experiment of the whole investigation. Here, the best doses of N, P, K fertilizers which produced maximum yield were selected from the previous experiment. The effect of Ca, in comparison to N, P, and K, was not found beneficial in the previous experiment. Therefore, it was not included in this experiment. Zinc as a micronutrient was taken along with N, P, K as it registered increased yield. The experiment was conducted during the Rabi seasons of 1971 and 1972. Altogether ten treatments were made which were replicated thrice. The experiment was laid out in randomised block design. The layout plan of the experiment is presented in the fig. 2.d. All the treatments were distributed to the ten plots of each replication at random. The same layout plan was used for both the years.

Design - Randomised Block Design.

Replication - 3
Treatment - 10
Total number of plots - 10x3 = 30.
FIG: 3-2: LAYOUT PLAN OF THE EXPERIMENT.

DESIGN: RANDOMISED BLOCK
NET PLOT SIZE: 3 M X 4 M

TREATMENT:
(4) VARIETIES.
V1 = KALYAN SONA
V2 = SONALIKA
V3 = SHARBATI SONORA
V4 = SAFED LERMA

(6) SOWING DATES.
S1 = OCTOBER 31
S2 = NOVEMBER 15
S3 = NOVEMBER 30
S4 = DECEMBER 15

DESIGN: RANDOMISED BLOCK
NET PLOT SIZE: 3 M X 4 M

TREATMENT:
NITROGEN LEVELS;
P1 = 40 K$/$ha
P2 = 80 K$/$ha
P3 = 120 K$/$ha
P4 = 160 K$/$ha
P0 = CONTROL

PHOSPHORUS LEVELS;
N1 = 40 K$/$ha
N2 = 80 K$/$ha
N3 = 120 K$/$ha
N4 = 160 K$/$ha
N0 = CONTROL

POTASH LEVELS;
K1 = 40 K$/$ha
K2 = 80 K$/$ha
K3 = 120 K$/$ha
K4 = 160 K$/$ha
K0 = CONTROL

CALCIUM LEVELS;
C1 = 40 K$/$ha
C2 = 80 K$/$ha
C3 = 120 K$/$ha
C4 = 160 K$/$ha
C0 = CONTROL
**EXPT. 3**

**DESIGN:** RANDOMISED BLOCK

**PLOT SIZE:** 3 M X 4 M

**TREATMENTS:**
- **ZINC LEVELS:**
  - \( Z_0 = \text{CONTROL} \)
  - \( Z_1 = 10 \text{Kg/ha} \)
  - \( Z_2 = 20 \text{Kg/ha} \)
  - \( Z_3 = 30 \text{Kg/ha} \)
- **BORON LEVELS:**
  - \( B_0 = \text{CONTROL} \)
  - \( B_1 = 10 \text{Kg/ha} \)
  - \( B_2 = 20 \text{Kg/ha} \)
  - \( B_3 = 30 \text{Kg/ha} \)
- **MOLYBDENUM LEVELS:**
  - \( M_0 = 0 \text{ g/m/ha} \)
  - \( M_1 = 50 \text{ g/m/ha} \)
  - \( M_2 = 100 \text{ g/m/ha} \)
  - \( M_3 = 150 \text{ g/m/ha} \)

**SOWING DATES:**
- \( S_1 = \text{NOVEMBER 15} \)
- \( S_2 = \text{DECEMBER 15} \)

---

**EXPT. 4**

**DESIGN:** RANDOMISED BLOCK NET PLOT SIZE: 3 M X 4 M

**TREATMENTS:**
- \( Z_n = 20 \text{ Kg/ha} \)
- \( N = 120 \text{ Kg/ha} \)
- \( P = 80 \text{ Kg/ha} \)
- \( K = 80 \text{ Kg/ha} \)
Treatment Combination:

(1) \( \text{N}_0 \text{P}_0 \text{K}_0 \) - No nutrient (Control plot).
(2) \( \text{P} + \text{K} \) - Phosphorus + potassium.
(3) \( \text{N} + \text{K} \) - Nitrogen + potassium.
(4) \( \text{N} + \text{P} \) - Nitrogen + phosphorus.
(5) \( \text{N} + \text{P} + \text{K} \) - Nitrogen + phosphorus + potassium.
(6) \( \text{P} + \text{K} + \text{Zn} \) - Phosphorus + potassium + zinc.
(7) \( \text{N} + \text{K} + \text{Zn} \) - Nitrogen + potassium + zinc.
(8) \( \text{N} + \text{P} + \text{Zn} \) - Nitrogen + phosphorus + zinc.
(9) \( \text{N} + \text{P} + \text{K} + \text{Zn} \) - Nitrogen + phosphorus + potassium + zinc.
(10) \( \text{N}_0 + \text{P}_0 + \text{K}_0 + \text{Zn}_0 \) - No nutrient (Control plot).

Spacing:

(1) Net plot size - 4m x 3m.
(2) Space between plots - 30 cm.
(3) Space between replications - 50 cm.
(4) Field border - 1 m.
(5) Total area under the experiment - 27.9m x 18.2m.

Wheat Variety Used - 'Kalyan Sona'.

Fertilizer Application.

Nitrogen, phosphorus, potassium and zinc were applied as in the previous experiments. The nutrients, sources and the rates of application are presented in the Table 3.IV.
Table 3. IV. - Details about nutrient application.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Source</th>
<th>Rate of application in kg per hectare</th>
<th>Mode of application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>Ammonium sulphate</td>
<td>120</td>
<td>Soil</td>
</tr>
<tr>
<td>Potassium</td>
<td>Muriate of potash</td>
<td>80</td>
<td>Soil</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Super phosphate</td>
<td>80</td>
<td>Soil</td>
</tr>
<tr>
<td>Zinc</td>
<td>Zinc sulphate</td>
<td>20</td>
<td>Spray</td>
</tr>
</tbody>
</table>

Sowing.

The sowing was done on 15th November, 1972. The crop was harvested between 15th and 17th March, 1971 and 1972. The crop could not be harvested in one day as the plants treated with nitrogen showed slight delay in maturity. Records of the growth and yield characters of the representative plants from each plot were recorded as given below.

1. Height of plant in cm.
2. Number of tillers per plant.
3. Number of leaves per plant.
4. Number of ear per plant.
5. Length of ear in cm.
6. Number of grain per plant.
7. Weight of grain per plant.
8. Test weight of grain.
9. Yield of grain per hectare.
10. Yield of straw per hectare.
11. Dry weight of root in gm.
12. Protein content of grain in percentage.

General analysis -

The experimental data were subjected to statistical analysis for greater reliance of the findings. The usual methods of analysis was followed. To elucidate the nature and magnitude of the effects, emerging out as significant by 'F' test, summary tables were prepared. Critical differences, wherever needed were calculated for the statistical interpretation of the results. Suitable graphical illustrations of these data were given for clearer understanding of the nature and magnitude of effects.

Response curve -

To study the yield function and the profit function a polynomial response curve of second degree in x was fitted in the experiments wherever found appropriate.

Correlation and Path-coefficient analysis -

The correlation coefficients between yield and various yield components and partial correlation coefficients were worked out separately from the two years average values of the characters concerned as affected by different treatments in the experiment IV by Pearson’s Product Moment Method. To analyze correlation coefficients the Path-analysis was done by the method suggested by Dewey and Lu (1959).
3.14. Economics of Cultivation -

The cost of cultivation per hectare for each treatment was worked out and the economics of cultivation together with profit and loss was calculated.