

**RESPONSE OF WHEAT (TRITICUM AESTIVUM L.)  
VARIETIES TO DIFFERENT LEVELS OF  
NITROGEN AND PHOSPHORUS**

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SUBMITTED TO THE  
GUJARAT AGRICULTURAL UNIVERSITY  
IN PARTIAL FULFILMENT OF THE REQUIREMENTS  
FOR THE AWARD OF THE DEGREE**

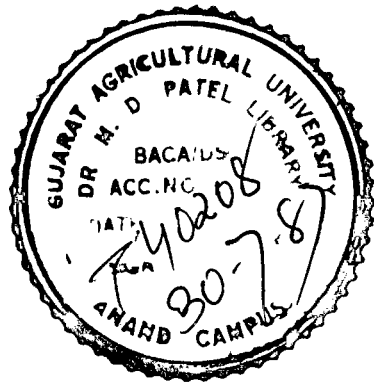
**OF  
Master of Science  
( AGRICULTURE )**

**IN  
AGRONOMY**

**BY  
NAROTTAMBHAI M. PATEL  
B. Sc. ( Agri. )**

**B. A. COLLEGE OF AGRICULTURE  
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## ABSTRACT

### RESPONSE OF WHEAT (TRITICUM AESTIVUM L.) VARIETIES TO DIFFERENT LEVELS OF NITROGEN AND PHOSPHORUS

Name of the Student  
Shri H. H. Patel

Name of Major Advisor  
Dr. R. B. Patel

B. A. College of Agriculture  
Gujarat Agricultural University  
Anand Campus, Anand

An experiment was conducted at the College Agronomy Farm of B. A. College of Agriculture, Anand Campus, Anand during rabi season of the year 1985-86 with a view to study the response of wheat varieties (T. aestivum L.) to different levels of nitrogen and phosphorus.

Eighteen treatments involving combinations of two varieties viz., GM-120 and GM-405, three levels of nitrogen (30, 120 and 160 kg/ha) and three levels of phosphorus (0, 40 and 80 kg/ha) were studied in split plot design with four replications.

Both the wheat varieties viz., GM-120 and GM-405 performed equally in respect of grain yield, straw yield, plant height, total as well as effective tillers, length of earhead, number of spikelets/earhead, number of grains/earhead whereas variety GM-405 was significantly superior

to GU-120 in respect of grain weight/earhead, test weight and protein content of grain. GU-405 gave higher net profit of Rs.108 per hectare than GU-120.

Application of 120 and 160 kg N/ha produced significantly higher grain and straw yield over 80 kg N/ha. The former two levels did not differ themselves in respect of of these two characters as well as yield attributes like number of grains/earhead, total and effective tillers/metre row length and plant height, while there was significant increase in grain weight/earhead, test weight and protein content in grains with increasing rates of nitrogen. The length of earhead and number of spikelets/earhead were not affected significantly with application of nitrogen.

Application of 40 and 80 kg  $P_2O_5$ /ha produced significantly higher grain and straw yield by producing more number of grains and grain weight per earhead, higher test weight, more number of total and effective tillers per metre row length than 0 kg  $P_2O_5$ /ha. The former two levels were at par in grain and straw yields as well as total and effective tillers/metre row length, number of grains/earhead and grain weight/earhead. Significant increase in test weight and protein content of grains was observed with application of each level of phosphorus. There was

non significant difference in plant height, length of ear-head and number of spikelets/earhead with application of phosphorus.

Based on the above findings it is concluded that both the dwarf wheat varieties are suitable for late sown conditions in the middle Gujarat region and should be fertilised with 120 kg N and 40 kg  $P_2O_5$ /ha for higher yield and maximum net profit.

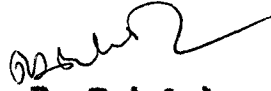
Dr. R. B. Patel  
Research Scientist (Agronomy)  
National Agril. Research Project (Bhal)  
ARNEJ

CERTIFICATE

This is to certify that the thesis entitled "Response of wheat (Triticum aestivum L.) varieties to different levels of nitrogen and phosphorus" submitted by Shri Harottambhai Mohandas Patel in partial fulfilment of the requirements for the degree of Master of Science (Agriculture) in Agronomy of the Gujarat Agricultural University is a record of bonafide research work carried out by him under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma or other similar title.

Place : ANAND

Date : February 28, 1967

  
( R. B. Patel )  
Major Advisor

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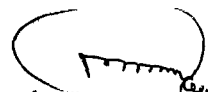
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# **INTRODUCTION**

## CHAPTER - 1

### INTRODUCTION

Among the cereals, wheat is one of the important staple foods for about one billion people in as many as 43 countries of the world. It provides about 20 per cent of the total food calories for the human race. The important wheat growing countries in the world are USSR, USA, China, Canada, France, India, Pakistan and Australia, which together account for 65 per cent of the world production. In India it is next to rice in respect of quantitative production of food grains.

Wheat is grown primarily for the grain and utilized in the form of flour or whole meal called 'atta'. The flour is used for making breads, cakes, cookies, crackers, etc. On an average, the grain of this crop contains 11.8 per cent protein which is the highest among all the important cereals, i.e. rice, sorghum, maize and bajra. The grain is also rich in calcium, phosphorus and other minerals (Thakur, 1979). Wheat straw is also served as scarcity fodder in many parts of the country. Thus, it has varied uses.

This crop occupies a dominant position, as its grains are consumed by majority of the population in the country. It is grown in about 23.6 million hectares with the total production of 44.25 million tonnes in India (Anon., 1985 a). Gujarat ranks eighth in respect of area and seventh

in production. In the state irrigated wheat (Triticum aestivum L.) was grown in 3.24 lakh ha and dry <sup>land</sup> wheat (Triticum durum L.) in 1.03 lakh ha in the year 1985-86 (Anon., 1986). The bread wheat (T. aestivum L.) is grown almost in all the districts of the state. The state average production of the crop was 2248 kg/ha (Anon., 1986), while it was 1873 kg/ha in the country (Anon., 1985 a).

This brings to the fact that, though wheat is a major cereal crop of the country, the average yield per hectare in comparison to that in the advanced countries is considerably low. The main reasons are the lack of adoption of superior varieties and unsatisfactory cultivation practices, such as proper time of sowing, spacing, seed rate, weed control, method and time of fertilizer application and irrigation etc. Population exploitation in the country has forced to increase food grain production per unit area per unit time as the land is limited.

Improved variety plays important role in boosting the yield. The maxion dwarf wheat varieties introduced in India during 1963-64 and subsequent improved made on them have opened a new avenue for boosting production of wheat in the country. This has helped the nation to raise the food grain production and achieve self-sufficiency. These varieties respond well to applied fertilizers and irrigation. In Gujarat state two new high yielding varieties viz., GW-120

(Inia - Cho x Inia - Bb / Y-50 E - Kal<sup>3</sup>) and GW-405 (Inia - Cho x Bb / Cho - KPI - 62 - GU)<sup>3</sup> have been released by the central variety release committee in 1985. They are suitable for sowing under late sown conditions. In intensive cropping area the fields of paddy, bajra and other monsoon crops get ready at later date. These varieties, therefore, hold a good promise for cultivation among the farmers of such area.

Fertilizer is an other major factor governing the yield. The wheat crop removes 95 kg N, 36 kg P<sub>2</sub>O<sub>5</sub>, 88 kg K<sub>2</sub>O, 8 kg sulphur and 56 g of zinc per hectare from the soil (Anon., 1983 ). Moreover, the major nutrients are exhausted from the soil of the region where an intensive cropping is followed. This results in the deficiency of nutrients in the soils. Most of the soils in Gujarat are low to medium in available nitrogen and available phosphorus but fairly rich in available potash (Kansaria and Patel, 1985). It is therefore, necessary to replenish the soil with the deficient nutrients for securing higher yields. These basic facts were considered while planning the experiment. The information on the fertilizer need of the new high yielding dwarf varieties of wheat is lacking for the middle Gujarat. The research on evolution of agronomic practices and other aspects should go parallel with the development of new varieties. There was an urgent need to explore the

response of these two varieties to application of nitrogen and phosphorus. This would help the farmers in proper selection of a variety to get the maximum economic yield with the optimum fertilizer dose.

Thus, with the above considerations, a field experiment was planned and conducted at the College Agronomy Farm, B. A. College of Agriculture, Gujarat Agricultural University, Anand Campus, Anand during the rabi season of the year 1985-86 with the following broad objectives.

- (1) To test the relative performance of two new high yielding, late sown wheat varieties viz., GW-120 and GW-405 under middle Gujarat conditions.
- (2) To find out the optimum and economic dose of nitrogen and phosphorus for these two varieties.
- (3) To find out the best combination of varieties, nitrogen, and phosphorus for obtaining maximum economic output of wheat.
- (4) To study the effect of different levels of nitrogen and phosphorus on protein content of wheat varieties viz., GW-120 and GW-405.

**REVIEW  
OF  
LITERATURE**

## CHAPTER - 2

### REVIEW OF LITERATURE

The improvement in wheat has been started since long but the mexican dwarf wheat varieties were first introduced in India during 1963. It was realized that the agronomic practices developed for the indigenous tall wheat varieties did not suit the growth and development rhythm of the dwarf wheats. As a result of this fact, numerous experiments were conducted at various places in India to develop the optimum agronomic technology to secure the maximum yield of the dwarf wheat varieties. Due to concentrated research work during the last two decades, voluminous research literature is available on various aspects, such as fertili and irrigation requirements, date of sowing, seed rate, spacing etc. The literature pertinent to the research problem is reviewed under the following heading.

#### 2.1 Performance of wheat varieties

1. Grain and straw yield
2. Yield attributes
3. Grain protein

#### 2.2 Effect of nitrogen

1. Grain and straw yield
2. Yield attributes
3. Grain protein

#### 2.3 Effect of phosphorus

1. Grain and straw yield
2. Yield attributes
3. Grain protein

## 2.4 Interaction effects on yield and yield attributes

1. Variety x Nitrogen
2. Variety x Phosphorus
3. Nitrogen x Phosphorus
4. Variety x Nitrogen x Phosphorus

## 2.1 Performance of wheat varieties

India has made great strides in the production of wheat. The increased yield has been ascribed mainly to availability of new high yielding, fertilizer responsive dwarf wheat varieties. The potentialities of these varieties vary with the differences in their genetic characters as well as soil and climatic conditions. Therefore, there is a need to compare relative performance of the various varieties under different agroclimatic conditions. Lot of work has been done on this aspect in the country and abroad. An attempt is made to review it in the following paragraphs.

### 2.1.1 Grain and straw yield

While working with dwarf and local wheat varieties, Khare (1968) observed remarkable differences in their performance. The dwarf varieties gave more than double yield as was given by the local variety. The yield of the local variety ranged from 2075 to 2665 kg/ha, while that of Sonora-64 from 3194 to 6421 kg/ha and Lerma Rojo from 3443 to 6916 kg/ha.

Sharma et al. (1970) conducted an experiment at Pantnagar to compare the performance of wheat varieties. They reported that the grain yield of Sonora-64 and Lerma Rojo was nearly double as compared to that of C-306, a tall variety.

Gupta (1971) conducted an experiment at the Agricultural College Para, Junagadh with some dwarf and tall varieties of wheat. He reported that, among the different varieties Kalyansona produced the highest grain yield. The per cent increase in grain yield of this variety was 8.5 and 12.70 over that of J-1 and NP-824, respectively.

Agarwal et al. (1972) reported that Kalyansona gave the highest grain yield but it was at par with Sonalika, and significantly superior to Sarbati Sonora.

Singh and Singh (1973) observed that among three wheat varieties, S-227 gave significantly higher yield than S-306 and Sonora-64 but the later two were at par.

Sewaram et al. (1973) from the Agricultural Research Station of the I.A.R.I. at Karnal reported that Kalyansona gave significantly higher grain yield than Sonalika and Sarbati Sonora.

Garg and Saraswat (1974) conducted an experiment in the Chambal Command Area at Baroda in M.P. and reported that Kalyansona and RR-21 turned out to be significantly superior to S-307, S-331 and HY-633. The corresponding

grain yields of these varieties were 39.96, 38.06, 30.52, 34.34 and 25.89 q/ha, respectively. The former two were at par.

Singh and Singh (1975 a) reported that Kalyansona produced significantly higher grain and straw yield than Hira, the percentage increase being 7.0 and 24.2, respectively.

Patel (1976b) carried out testing of wheat varieties J-1-7 and Kalyansona in 49 replicated trials at the different Agricultural Research Stations situated in the various agro-climatic zones of Gujarat during the period of 1969-70 to 1971-72. The overall results revealed that the variety J-1-7 gave 9.30 per cent higher grain yield over Kalyansona.

Shekhawat and Singh (1976) carried out an investigation at Durgapura (Rajasthan) for two years with three wheat varieties viz., Lalbahadur, HD-1925 and RAJ-911. The results showed that Lalbahadur and HD-1925 gave significantly higher grain and straw yield than RAJ-911 while both the former varieties were at par in both the years.

Singh and Agarwal (1976) carried out an experiment at Narsan (U.P.) for two years with three wheat varieties. They found that Sonalika and Kalyansona were at par but they proved significantly superior in respect of grain yield to Chhoti Lerma in both the years. However, the varieties did not differ significantly in respect of straw yield. While Bhardwaj (1977) reported that Kalyansona and Sonalika

varieties did not differ significantly in grain and straw yields.

Patel (1977) concluded that out of five varieties, J-24 gave 9.20, 10.40, 2.40 and 4.10 per cent higher grain yield than Kalyansona, J-1-7, J-40 and Sonalika, respectively at the Agricultural College Farm, Navsari.

An investigation was carried out at Vijapur under the All India Co-ordinated Wheat Improvement Project to test nine varieties under normal and late sown conditions. Under normal sown conditions, variety HD-2236, RAJ-1482, LOK-1 and J-142 yielded 43.60, 43.10, 42.40 and 41.50 q/ha, respectively. Under late sown conditions variety RAJ-1482, HD-2204, Sonalika, HD-2236 and LOK-1 gave yield of 41.20, 40.20, 39.80, 38.10 and 35.20 q/ha, respectively (Anon., 1979).

In varietal trials conducted at Junagadh (Anon., 1980), varieties MPO-190, J-142 and RAJ-911 gave yields of 37.92, 34.66, 31.04 q/ha, respectively which were significantly higher than that by Kalyansona 24.91 q/ha under early (30th October) sown conditions. Variety LOK-1 was the best under normal sown (1st November) conditions and yielded 52.50 q/ha. None of the varieties was found better than Sonalika under late sown (1st December) conditions. This variety gave grain yield of 47.88 q/ha. The overall observations of all three sowing conditions revealed that yields were significantly reduced by early sowing of the crop.

Jadon and Savalia (1980) reported the results of various trials conducted in the Central Zone of India (M.P., Gujarat, some parts of U.P. and Rajasthan). The results of these trials indicated that LOK-1 was superior to Kalyansona as the former gave 17 per cent more yield than the latter. Thus, it was concluded that LOK-1 was suitable for normal sowing time.

Based on the results of an experiment on the relative performance of three varieties viz., LOK-1, HD-2236 and J-24, Patel et al. (1982) concluded that LOK-1 performed better by producing 36.29 q/ha yield than varieties HD-2236 and J-24, which produced 30.3 and 32.4 q/ha, respectively. Similarly Sadhu (1982) also reported superiority of LOK-1 in respect of grain and straw yield over Sonalika.

Parauha (1984) while working on the performance of five wheat varieties (WH-147, WH-157, HDM-1553, HDM-1593 and LOK-1) under Rewa conditions of M.P. reported that among all the varieties tested, WH-147 gave significantly the highest yield of 20.36 q/ha and the maximum net income of 1676.27 Rs/ha.

Singh et al. (1984) carried out an investigation at Pantnagar with wheat varieties viz., Sonalika, VI-421 and UP-368. They failed to obtain significant differences in grain and straw yield of the different varieties.

The average grain of GW-405 obtained under different Co-ordinated and State trials the highest (35.41 q/ha)

as compared to LOK-1 (33.50 q/ha) and Sonalika (30.36 q/ha). In Gujarat state it has given 6.5 and 13.9 per cent higher yield than LOK-1 and Sonalika, respectively. It has also been found superior in resistance to all the diseases, at par in protein content with other varieties with medium sized amber coloured grains. To overcome the problems of present late sown varieties, this variety is identified as superior and hence released for cultivation in Central Zone and Gujarat (Anon., 1985 b)

From the Regional Research Station of I.A.R.I. at Samastipur in Bihar, Kumar (1985) reported that HD-1379 gave the highest grain yield of 38.2 q/ha, while HD-1267, HP-1209, Sonalika and HW-135 were at par and yielded 35.5, 33.2, 31.4, 31.3 q/ha, respectively.

Bharodia et al. (1986) reported the results of an experiment conducted at different locations in Gujarat, Rajasthan and Haryana for three years (1981-82 to 1983-84). The overall results revealed that the wheat variety GW-120 gave 14.75 per cent higher grain yield than Sonalika. The results of the same experiment conducted at different locations in Gujarat state showed that GW-120 gave 13.3 per cent and 11.3 per cent higher grain yield than Sonalika and LOK-1, respectively. They further stated that GW-120 had good combination of higher yield, good stability, adaptability for yield, disease-resistance and food grain quality and hence suitable for replacing the existing varieties.

Naidu et al. (1986) carried out an investigation at Gurgon (Haryana) during 1984-85. They obtained 48.5, 44.0, 36.50 and 36.0 q/ha grain yield from the wheat varieties, Kalyansona, HD-2281, HD-2285 and HD-1553, respectively. It was further observed that Kalyansona and HD-2281 produced significantly higher grain yield over HD-2285 and HD-1553.

### 2.1.2 Yield attributes

Gupta and Singh (1971) observed that variety Kalyansona gave the maximum number of grains/spike which was significantly higher than those of S-331 and Sonalika, while 1000 grain weight was significantly low in Kalyansona than that in Sonalika.

Sharma and Singh (1971) studied with three wheat varieties viz., Kalyansona, Sonalika and Chhoti Lerma. They found that Kalyansona had significantly higher grain weight/spike and number of grains/spike than Sonalika and Chhoti Lerma. Emergence counts/m<sup>2</sup> were highest with variety Chhoti Lerma, while 1000 grain weight was highest with variety Sonalika (56.6 g).

Sharma et al. (1972) observed that among six dwarf wheat varieties, Kalyansona produced highest grain weight/spike, which was significantly superior to UP-301, EA-222-1, HD-1944 and HD-1949, however, it was at par with Sonalika.

Sewaram et al. (1973) conducted an experiment at I.A.R.I., New Delhi with three wheat varieties viz., Kalyansona, Sonalika and Sarbati Sonora. They found that the number of tillers and plant height were significantly higher with variety Kalyansona than Sarbati Sonora; however, it was at par with Sonalika.

Khaspara (1974) reported that J-1-7 produced significantly more productive tillers than all other varieties except J-24, which was at par with the former. In respect of test weight, J-24 was significantly superior over all the other varieties i.e. J-1-7, J-17, Kalyansona, HD-1499 and HD-1925.

Sewaram et al. (1975) from Karnal reported that Kalyansona was at par with Sarbati Sonora but it produced significantly higher number of grains/spike and tillers/plant than Sonalika.

Singh and Singh (1975<sub>a</sub>) reported that wheat variety Kalyansona produced significantly more spike length and number of grains/spike than Hira.

Patel (1976<sub>a</sub>) from Anand studied with four wheat varieties viz., J-1-7, J-24, HDM-1553 and S-227. He found that J-1-7 gave significantly more number of total tillers, effective tillers, spikelets/spike, length of spike and plant height than the other three varieties. J-24 had highest 1000 grain weight.

Singh and Agarwal (1976) at Narsan (U.P.) worked with wheat varieties viz., Sonalika, Kalyansona and Chhoti Lerma. They observed that length of spike, number of grain/spike and 1000 grain weight were higher in Sonalika and Kalyansona than Chhoti Lerma.

Sadhu (1982) from Anand reported that LOK-1 was found significantly superior to other varieties in respect of grains/spike, total and effective tillers/plant, whereas Sonalika was superior to other varieties in respect of plant height and length of spike.

Of the two varieties studied at Anand, LOK-1 was found significantly superior to Sonalika in respect of test weight, number of grains/spike, spikelets/spike, number of total and effective tillers/metre row length whereas the latter was superior to the former in respect of plant height and length of spike. LOK-1 gave higher net profit per hectare (Amin, 1983).

Patel (1984) from Anand reported that variety Kalyansona was significantly superior to HD-2236 in respect of plant stand, plant height, total as well as effective tillers and number of grains/spike. While the latter variety was superior to the former in respect of spike length and 1000 grain weight.

Singh et al. (1985) at Sehore (M.P.) worked with three newly released wheat varieties viz., HD-2236, RAJ-1555 and WH-147 during 1980-81. They observed that RAJ-1555 and

WH-147 produced higher number of effective tillers/plant, longer spikes and higher test weight than HD-2236.

Singh and Dixit (1985) carried out investigation at Faizabad (U.P.) with five wheat varieties viz., Sonalika, HUW-12, HUW-55, HP-1102 and HI-784. The results of the experiment showed that HUW-12 and HUW-55 produced significantly higher number of effective tillers than the other varieties. The bold grain variety Sonalika recorded the maximum 1000 grain weight of 48.35 g which was significantly higher than that of all the other varieties. The lowest test weight of 35.83 g was recorded with variety HUW-55.

Naidu et al. (1986) reported that Kalyansona produced more effective tillers/metre row length and number of grains/spike than HD-2281, HD-2285 and HD-1553. The highest 1000 grain weight was recorded with variety HD-2281.

### 2.1.3 Grain protein

Singh et al. (1970) carried out an experiment at Ludhiana to evaluate the protein content of different wheat varieties viz., Lerma Rojo, S-308, Kalyana-227, PU-18 and C-275. The highest grain protein of 13.9 per cent was recorded with Lerma Rojo and the lowest of 11.16 per cent with PU-18.

Gupta (1971) from Junagadh observed significant differences in protein content of different wheat varieties. The varieties viz., Kalyansona, J-1 and NP-824 had 15.5,

14.7 and 13.4 per cent protein content. The differences were significant with each other.

Misra and Singh (1971) at Varansi noted the highest protein content of 13.96 per cent in grain of Sonora-64 followed by 12.7 per cent in Lerma Rojo and 12.02 per cent in K-68.

Thimmegowda and Gajanana (1975) compared the relative protein content of eight wheat varieties at Bangalore. It was observed that among the different wheat varieties, Bijaga yellow recorded the highest protein percentage of 15.39. The other varieties contained protein in this order : Chhoti Lerma (14.93 %), Hira (14.59 %), UP-301 (14.12 %), Sonalika (14.19 %), Narmada-4 (14.08 %), Safed Lerma (13.97 %) and Gamut (13.34 %).

Patel (1976a) from Anand reported considerable variation in protein content in grain of different wheat varieties viz., J-1-7, HDM-1553, S-227, and J-24. It varied from 16.6 to 13.85 per cent. The variety J-1-7 was found significantly superior to rest of the three varieties. The grains of J-1-7 contained the highest protein of 16.66 while those of J-24 contained the lowest of 13.85 per cent.

Amin (1983) at Anand estimated the protein content from grains of Sonalika and LOK-1 varieties of wheat. The variety Sonalika gave significantly higher grain protein content (13.10 %) than LOK-1 (12.20 %). In the subsequent year, varieties Kalyansona and HD-2236 were evaluated

for their protein content at the same place (Patel, 1984). In this case both the varieties did not differ significantly in the protein content. The variety Kalyansona had grain protein content of 15.08 per cent, while the variety HD-2236 had 15.02 per cent.

Based on the estimation of protein content of a number of grain samples collected from different localities Bharodia et al. (1986) reported that the grains of the newly released wheat variety GW-120 contained 13.53 per cent protein.

## 2.2 Effect of nitrogen

Nitrogen is the most important element among all macronutrients needed for plant growth and development (Bonner, 1950). It is obvious that nitrogen is an essential constituent of protein and thus of the protoplasm itself. Without it no life is possible (Black, 1957). The vegetative growth and green colour are closely associated with availability of nitrogen to the plant. The deficiency of nitrogen results into chlorosis and stunted growth, thereby adversely affecting the quality and quantity of grains. Excessive quantities of nitrogen render the crop susceptible to disease or lodging of the plants. This emphasizes the need of judicious use of nitrogenous fertilizers. The available literature about the effect of nitrogen on wheat crop is reviewed and presented below.

### 2.2.1 Grain and straw yield

Bajpai and Dhakar (1971) conducted an experiment on wheat variety S-227 under loamy sand soil conditions at Jobner (Rajasthan) during the year 1968-69 and reported that the application of 90, 140, 190 or 240 kg N/ha increased grain yields of wheat by 23.1, 47.3, 50.0 and 21.2 per cent, respectively, over no nitrogen. The optimum level was found to be 140 kg N/ha.

✓ Dubey and Lal (1971) conducted an experiment to study the response of wheat S-308 to different levels of nitrogen at the Regional Research Station, Kuthalia Farm, Rewa. The application of 80 kg and 120 kg N/ha yielded the average grain of 31.29 and 38.22 q/ha, respectively. The increase in grain yield was 22.2 per cent due to 120 kg N/ha over 80 kg N/ha.

Mathur et al. (1971) conducted an experiment on wheat varieties Lerma Rojo and Sonora-64 and reported that application of 80, 120 and 160 kg N/ha gave 36.4, 54.4 and 61.0 per cent more grain yield over 40 kg N/ha. No significant difference was observed between the effect of 120 and 160 kg N/ha, but both these doses were significantly superior to 80 kg N/ha. The application of 120 kg N/ha was found to be optimum dose.

Misra and Singh (1971 a) reported that the grain yield increased from 18.70 to 45.00 q/ha in Lerma Rojo whereas 17.8 to 53.9 q/ha in Sonora-64 with the increasing rate from 0 to 200 kg N/ha.

Singh and Dastane (1971) studied the response of dwarf wheat varieties Kalyansona, Safed Ierna and Sonalika to 50, 100 and 150 kg N/ha. The pooled results indicated non significant difference between 100 and 150 kg N/ha, but both were significantly superior to 50 kg N/ha in respect of grain yield.

Singh and Shrivastava (1971) reported that application of 60, 100, 140 and 180 kg N/ha to wheat S-308 gave grain yield of 40.50, 51.20, 57.70 and 58.70 q/ha, respectively. Three levels of nitrogen 100, 140 and 180 kg/ha were at par with each in their effect on grain and straw yield, but were significantly superior to 60 kg N/ha. The optimum level was found to be 100 kg N/ha.

✓ Mehta and Shekhawat (1972) studied the effect of different doses of nitrogen at two locations in Madhya Pradesh. It was found that application of 33.2, 67.2, and 100.8 kg N/ha to wheat variety RS-31-1 increased grain yield by 24.6, 31.1 and 44.0 per cent, respectively over no nitrogen application at Mandore. While at Ora (M.P.) the corresponding increase in the yield due to these nitrogen doses were 49.8, 65.8 and 82.2 per cent.

On a loamy soil of Indhiana, Sandhu and Gill (1972) found that increasing the rate of nitrogen from 0 to 200 kg/ha increased the grain yield of both the varieties viz., C-306 and Kalyansona. The nitrogen dose upto 120 kg/ha

significantly increased the grain yield in both the varieties, but the doses greater than this tended to reduce the yield.

✓ Sharma et al. (1972) reported that wheat varieties viz., Kalyansona, Sonalika, U.P.-301, EA-222-1, HD-1944 and HU-1943 responded to nitrogen upto 120, 120, 120, 150 and 160 kg/ha, respectively.

In Rajasthan Shekhawat and Shekhawat (1973) observed that application of 0 to 160 kg N/ha increased the grain yield of three dwarf varieties viz., Kalyansona, Sonalika and Sarbati with its increased dose. The optimum nitrogen rate was worked out to be 120 kg N/ha.

✓ Chaudhary and Pandey (1975) observed that wheat variety Kalyansona showed linear response to nitrogen application upto 120 kg/ha. Application of no nitrogen, 60 kg N and 120 kg N/ha gave grain yields of 16.6, 29.7 and 38.4 q/ha, respectively.

The results of an experiment conducted with three dwarf wheat varieties viz., HD-1941, UP-301 and Kalyansona, Singh and Singh (1975 c) revealed that application of 40, 80, 120, 160 and 200 kg N/ha, increased grain yield by 9.0, 16.5, 25.9, 29.5 and 31.2 q/ha, respectively over no nitrogen application. The application of 120 kg N/ha was found to be optimum dose.

Bhardwaj et al. (1976) conducted an experiment at I.A.R.I., New Delhi with 12 treatment combinations

comprising of six levels of nitrogen viz., 0, 40, 80, 120, 160 and 200 kg/ha and two varieties viz., HD-1944 and Moti. In this study, the grain yield of triple gene dwarf wheat Moti and HD-1944 was found to increase significantly with the increasing levels of nitrogen from 0 to 120 kg N/ha.

Singh et al. (1976) reported that application of 160 kg N/ha gave the maximum grain yield of wheat varieties Kalyansona, Lalbahadur and HD-1950, but 120 kg N/ha appeared to be an economical dose for all the varieties.

Bhardwaj (1977) studied the effect of different levels of nitrogen viz., 80, 120 and 160 kg/ha. The highest grain yield was recorded due to 120 kg N/ha which was significantly superior to 80 kg N/ha.

Khan et al. (1977) stated that nitrogen application at the rate of 80, 120 and 160 kg/ha increased grain yield by 18.7 q/ha (98.68 %) 23.57 q/ha (124.64 %) and 27.37 q/ha (144.73 %) over no nitrogen application. The effect of nitrogen on straw yield was identical to that of grain yield. The application of 80, 120 and 160 kg N/ha showed an increase in straw yield of 34.46 q/ha, 49.98 q/ha and 63.94 q/ha, respectively over no nitrogen.

Agarwal and Moelani (1978) conducted an experiment on wheat variety Kalyansona at the Research Farm of Haryana Agricultural University, Hissar during the winter season of 1969-70 and reported that the magnitude of

increase in grain yield with the application of 80 and 120 kg N/ha was 25 and 47 per cent and that of straw yield 19 and 38 per cent, respectively, over 40 kg N/ha. Almost similar effect of nitrogen on wheat yield in another experiment in Haryana was reported by Agarwal and Yadav (1978).

Patil and Khuspe (1978) studied the response of wheat variety HDM-1553 to the application of 50, 75 and 100 kg N/ha and reported linear response in both grain and straw yields. Similarly Verma (1978) observed linear trend by obtaining average grain yield of wheat which ranged from 18.30 to 46.20 q/ha with N level ranging from 0 to 200 kg/ha.

Malik (1981) reported that wheat varieties HD-2009 and RAJ-821 gave grain yields of 13.40, 28.50, 38.20, 45.70 and 44.90 q/ha with nitrogen rates of 0, 40, 80, 120 and 160 kg/ha, respectively.

Dhiman et al. (1982) studied the effect of rates of nitrogen. The mean grain yields of 30.1, 45.2, 55.7, 61.7, 62.6, 57.5 and the mean straw yields of 50.2, 65.0, 84.1, 88.3, 95.3, 97.5 were recorded with 0, 40, 80, 120, 160 and 200 kg N/ha, respectively. The significant increase in grain yield was noted only upto 120 kg N/ha.

Patel et al. (1982) reported that increase in N rates from 0 to 120 kg/ha increased the yield from 29.7 to 36.0 q/ha. Further it was observed that the application of 120 kg N/ha significantly excelled the rest of the

nitrogen levels by recording grain yield of 36.0 q/ha and straw yield of 58.2 q/ha.

The response of nitrogen by wheat variety Sonalika was studied at Saharanpur by Singh and Agarwal (1982). It was observed that application of 60 and 120 kg N/ha increased the grain yield by 47 and 66 per cent and straw yield by 42 and 57 per cent, respectively over no nitrogen. With similar N levels Singh et al. (1983) found that increasing the rate of applied nitrogen from 0 to 120 kg/ha increased grain yield from 32.0 to 51.4 q/ha and straw yield from 44.8 to 71.9 q/ha, respectively.

While studying with varying levels of N viz., 0, 40, 80 and 160 kg/ha on four wheat varieties Kapur et al. (1985) reported that the average grain yield increased from 8.1 to 44.4 q/ha with increasing N rates from 0 to 160 kg/ha. The increase in the yield was significant only upto 120 kg N/ha.

Kumar (1985) conducted an experiment at I.A.R.I. Regional Station, Pusa to find out nitrogen requirement of wheat under late sown conditions. The results indicated that increasing the N levels upto 120 kg N/ha significantly increased grain yield. The yield obtained with 0, 60, 120, and 180 kg N/ha were 18.0, 31.2, 42.1 and 43.7 q/ha, respectively.

### 2.2.2 Yield attributes

Bathkal and Patil (1970) concluded that increase in the rates of nitrogen from 50 to 150 kg/ha increased the number of productive tillers per unit area and 1000 grain weight of dwarf, semi-dwarf and tall varieties of wheat.

Gupta and Singh (1971) concluded that application of 120 kg N/ha to wheat varieties Sonalika, Kalyansona and S-331 significantly increased the number of grains/earhead and length of earhead over 0, 40 and 80 kg N/ha. But this dose was at par with 160 and 200 kg N/ha.

Misra and Singh (1971 a) observed that application of nitrogen from 0 to 200 kg/ha to wheat variety Lerma Rojo increased linearly the length of earhead from 8.33 to 10.10 cm and 1000 grain weight from 34.7 to 39.2 g, while such linearly increase in number of grains/earhead from 114 to 171 was noted only upto 120 kg N/ha.

Sandhu and Gill (1971) in an investigation carried out with six levels of nitrogen viz., 0, 40, 80, 120, 160 and 200 kg/ha on wheat Kalyansona and C-306 observed that each dose of nitrogen produced significantly more tillers, increased plant height as well as number of grains per earhead than control.

Singh and Dustane (1971) reported that the application of 100 kg N/ha, being at par with 150 kg N/ha, gave significantly more number of ears and number of grains/earhead than application of 50 kg N/ha.

Singh and Anderson (1975) conducted an experiment on sandy loam soils of the I.A.R.I. Farm at New Delhi with 0, 50, 100 and 150 kg N/ha applied to Kalyansona and Sarbati Sonora wheat. They found that increased N application increased the number of tillers/plant, number of ears/plant, plant height and number of grains/ear. But decrease in the 1000 grain weight was noted when N was applied at the rate of 100 kg/ha and 150 kg/ha.

Singh and Singh (1975 a) reported that the application of 150 kg N/ha significantly increased the number of fertile tillers/metre row length, length of spike, number of spikelets/spike, number of grains/spike and grain weight/spike over 50 and 100 kg N/ha, but test weight remained unaffected.

Singh and Singh (1975 b) observed that application of 120 and 160 kg N/ha, both being at par, produced significantly more spikelets/spike and 1000 grain weight than 80 kg N/ha.

Singh et al. (1976) studied the effect of different levels of nitrogen viz., 0, 40, 80, 120, 160 and 200 kg/ha on wheat varieties Kalyansona, Lalbahadur and HD-1950. They reported that earbearing shoots, ear head length and number of grains/earhead increased significantly upto 160 kg N/ha over no nitrogen application.

Chandramohan et al. (1977) studied the effect of three levels of nitrogen viz., 0, 90 and 180 kg/ha on wheat variety RR-21. They found that length of ear and number of grains/earhead increased significantly upto 180 kg N/ha, while number of ears/m<sup>2</sup> and test weight increased significantly only upto 90 kg N/ha.

Dhingra et al. (1979) studied the effect of 0, 40, 60, 80 and 120 kg N/ha on wheat and found that the number of tillers/metre row length and number of grains/earhead increased significantly upto 120 kg N/ha. Each of the levels also differed significantly among themselves, whereas 1000 grain weight increased significantly only upto 80 kg N/ha.

Borse and Mahajan (1980) reported that in wheat variety Sonalika, number of productive tillers/plant, length of earhead, number of grains/earhead and 1000 grain weight increased significantly with the application of 100 kg N/ha over 50 kg N/ha and the difference between 100 kg and 150 kg N/ha were at par.

Gill and Singh (1980) concluded that application of 120 kg N/ha resulted in significant increase in the number of tillers, number of grains/ear, grain weight/ear and 1000 grain weight over no nitrogen application.

Malik (1981) reported that ear length, effective tillers/square meter and grains/earhead increased with increasing levels of nitrogen from 0 to 160 kg/ha.

Dhiman et al. (1982) carried out an experiment with six levels of nitrogen viz., 0, 40, 80, 120, 160 and 200 kg/ha on wheat variety WH-296. They reported that increased levels of nitrogen upto 80 kg N/ha significantly increased the effective tillers/metre row length and 1000 grain weight over 0 and 40 kg N/ha. The levels 80, 120 and 160 kg N/ha were at par for these characters. While spikelets/spike and weight of grains/earhead significantly increased upto 120 kg N/ha over 0, 40 and 80 kg N/ha.

Sadhu (1982) conducted a trial at Anand on sandy loam soil and observed that the application of 150 and 200 kg N/ha produced significantly higher ear length and more number of effective tillers per plant than 100 kg N/ha.

Halikatti (1983) in a field trial conducted on black clay loam soil at Dharwad to study the effect of 80 and 120 kg N/ha found that application of 120 kg N/ha increased the plant height, number of earheads/metre row, grain number/earhead, number of spikelets/earhead and 1000 grain weight over the application of 80 kg N/ha.

Singh et al. (1983) while studying the effect of nitrogen viz., 0, 60, 120 kg/ha on wheat at I.A.R.I., New Delhi, found that the average 1000 grain weight was 34.2, 35.5, 35.6 g while average number of ear bearing tillers/metre were 102, 144.2, 156.4 with respective level of nitrogen. The differences between 60 and 120 kg N/ha were not significant. While they were significantly superior to control.

Singh (1986) recorded significantly more number of spikes and number of grains/spike in wheat with the application of 120 kg N/ha than those recorded with 60 kg N/ha.

### 2.2.3 Grain protein

Dutta and Seth (1970) stated that the application of 140 kg N/ha gave 13.14 and 2.02 per cent protein in grain and straw, respectively, while the corresponding figures were 10.15 and 1.46 per cent for 60 kg N/ha.

Sharma et al. (1970) reported that applied nitrogen from 0 to 135 kg/ha increased protein content of dwarf wheat from 13.79 to 18.58 and that of tall wheat from 11.86 to 15.22.

Misra and Singh (1971 a) concluded that with the increase in nitrogen rate from 0 to 200 kg/ha, there was a linear increase from 10.4 to 17.06 per cent in protein content of wheat varieties Sonora-64 and <sup>1/4</sup>ha Rejo.

Lopes and Grabe (1973) found that wheat grain showed protein content from 6.6 to 10 per cent with increase in nitrogen from 0 to 244 kg/ha.

Subbain and Morachan (1971) reported that protein content of wheat grain increased from 10.74 per cent with no nitrogen application to 14.5 per cent with 150 kg N/ha.

According to Kozhevnikova (1976) protein content in wheat grain increased from 11.3 per cent in no nitrogen treatment to 14.0 per cent with 160 kg N/ha.

Pal and Sharma (1977) noted that increasing the nitrogen rates to wheat variety Hira from 40 to 160 kg/ha increased crude protein content from 11.96 to 15.14 per cent.

Kalra and Dhiman (1978) investigated the effect of nitrogen rates on protein content of grains. They observed that increase in the rates of nitrogen increased the grain protein content. The grains contained protein per cent of 11.31, 12.84, 14.12 and 14.25 with the nitrogen levels of 0, 25, 50 and 75 kg/ha, respectively.

Patil and Khuspe (1978) reported that increasing the nitrogen rates from 50 to 100 kg/ha increased the grain protein content of wheat variety HDM-1553 from 9.2 to 11.2 per cent.

Sadhu (1982) concluded that various levels of nitrogen significantly affected the protein content in grain. The application of 150 (12.81 %) and 200 kg N/ha (12.69 %) produced significantly more protein content than that of 100 kg N/ha (12.18 %), however, the former levels of N were at par in this respect.

Anin (1983) studied the influence of different levels of nitrogen on protein content. It was observed that the effect of nitrogen levels was significant. The four levels of nitrogen viz., 0, 60, 120 and 180 kg N/ha on an average gave 11.54, 12.08, 13.02 and 13.97 per cent protein content, respectively.

Patel (1985) stated that increasing the nitrogen rates of wheat variety LOK-1 from 80 to 160 kg/ha increased protein content from 12.41 to 13.65 per cent.

### 2.3 Effect of phosphorus

Phosphorus is classed as one of the major nutrient elements for plant cell, essential for cell division and development of meristematic tissues. Besides, it is associated with early maturity of the crop, particularly the cereals. Phosphorus proliferates and enhances the root-growth extensively. The deficiency of this element leads to reduction in yield. Soils of India and particularly of Gujarat are generally deficient in phosphorus (Ghosh and Hasan, 1979 and Kanwar and Patel, 1985). Therefore, there is good crop response to applied phosphatic fertilizers. Important findings pertaining to wheat response to phosphorus are summarized below.

#### 2.3.1 Grain and straw yield

Sharma et al. (1971) worked out the phosphorus requirement of wheat with five rates of phosphorus viz., 0, 20, 40, 60 and 80 kg/ha at Agriheri in Prag district and Dhanora Farm in Panchnagar district. The results revealed that 60 kg  $P_2O_5$ /ha was the optimum dose for the wheat in soils with low available phosphorus.

Dev and Bajwa (1972) conducted an experiment on three dwarf wheat varieties with the application of 0, 30,

60 and 90 kg  $P_2O_5$ /ha with the common dose of 120 kg N and 60 kg  $K_2O$  on a loamy sand of Ludhiana. They reported that with increasing the rate of applied phosphorus from 0 to 90 kg/ha, there was a linear increase in average grain yields from 17.95 to 27.30 q/ha.

Sinha et al. (1973) obtained 13.33, 25.46, 28.88 and 30.16 q/ha grain yield with 0, 13, 26 and 39 kg  $P_2O_5$ /ha, respectively. The increase in yield upto 26 kg/ha was significant, but yield obtained with 26 and 39 kg  $P_2O_5$ /ha was at par.

Randhawa et al. (1974) carried out an investigation at Gurdaspur (Punjab) to determine phosphorus requirement of dwarf wheat varieties viz., Kalyansona, Sonalika, Safed Lerma and Chhoti Lerma. The yield realized was 25.75, 29.82, 34.95, 35.34 and 34.23 q/ha with 0, 30, 60, 90 and 120 kg  $P_2O_5$ /ha, respectively. An increase in the yield was observed upto 90 kg  $P_2O_5$ /ha which was at par with 60 kg/ha. Hence the dose of 60 kg  $P_2O_5$ /ha observed to be economical.

Sinha and Rai (1976) at the I.A.R.I., New Delhi studied the effect of 0, 40, 80 and 120 kg  $P_2O_5$ /ha on wheat. It was found that there was an increase in grain yield with every increase in the levels of phosphorus. The increase in yield due to phosphorus application over control was significantly superior. The differences in grain yield due to different levels of phosphorus (40, 80 and 120 kg/ha) were not significant.

Varshney (1976) from Pussa obtained 32.8, 42.4, 51.5 and 47.3 q/ha yield of wheat grain with the application of 0, 30, 60 and 90 kg  $P_2O_5$ /ha, respectively. There was successive increase in yield upto 60 kg  $P_2O_5$ /ha but thereafter it declined.

Rana et al. (1978) in an experiment carried out at Ludhiana found that increasing rates of applied phosphorus from 0 to 90 kg/ha increased average grain yield from 34.9 to 44.2 q/ha. The application of 60 kg  $P_2O_5$ /ha gave significantly higher yield (42.9 q/ha) over control (34.9 q/ha) but it was at par with 90 kg  $P_2O_5$ /ha (44.2 q/ha).

Singh et al. (1980) conducted a trial at the I.A.R.I. Farm, New Delhi with 0, 30 and 60 kg  $P_2O_5$ /ha with a constant level of nitrogen (120 kg N/ha). The yield recorded was 49.2, 54.37 and 59.03 q/ha with 0, 30 and 60 kg  $P_2O_5$ /ha, respectively. The increase in yield was progressively significant with increase in phosphorus levels.

Vyas et al. (1980) conducted trial at Jobner (Rajasthan) with three varieties of wheat viz., Kalyansona, RR-21 and S-308 and three levels of phosphorus viz., 25, 37.5 and 50 kg  $P_2O_5$ /ha. A significantly progressive increase in grain yield upto the highest level of phosphorus was observed.

Prasad et al. (1981) conducted an experiment on wheat at Dholi (Bihar) with 0, 45, 90 and 135 kg  $P_2O_5$ /ha

for two years. They observed significant increase in grain yield only upto 45 kg  $P_2O_5$ /ha.

Singh et al. (1983) at the I.A.R.I. Farm, New Delhi found that phosphorus application from 0 to 34 kg/ha increased the grain yield from 41.7 to 44.5 and straw yield from 58.4 to 62.3 q/ha, respectively.

Yadav and Verma (1983) conducted a trial on wheat with different levels of phosphorus viz., 0, 20, 40 and 60 kg/ha at the crop research station, Masodha of the Narendra Dev. University of Agriculture and Technology, Faizabad (U.P.). They reported that phosphorus application increased the grain and straw yield significantly upto 40 kg  $P_2O_5$ /ha. Further increase in phosphorus rates did not affect the yield significantly.

Parauha (1984) studied the effect of three levels of phosphorus viz., 0, 20, 40 kg/ha on yield of wheat grown on sandy loam soil with medium fertility level at the College Farm, Rewa (M.P.). They found that increasing levels of phosphorus significantly increased the yield. The highest level of 40 kg  $P_2O_5$ /ha gave the maximum grain yield of 19.33 q/ha.

Sinha and Rai (1984) conducted an experiment at I.A.R.I., New Delhi with three levels of  $P_2O_5$  viz., 0, 30 and 60 kg/ha. They found that with increase in phosphorus levels there was a corresponding increase in yield of wheat

grain and straw. The difference between any two consecutive levels of phosphorus attained the significance level both for grain and straw. The average grain yields were 39.8, 45.4 and 49.1 q/ha and straw yield were 73.6, 81.8 and 89.9 q/ha with 0, 30 and 60 kg  $P_2O_5$ /ha, respectively.

Rana et al. (1985) conducted an experiment on cultivators' fields for three years in Gurdaspur district. The compilation of the results of 122 experiments about the phosphorus response on varied phosphorus status soils, revealed that the response per unit of phosphorus applied in the presence of 40, 80 and 120 kg N/ha, varied from 13.8 to 14.7, 8.1 to 13.2 and 5.2 to 11.9 kg grain in low, medium and high  $P_2O_5$  status of the soil, respectively.

### 2.5.2 Yield attributes

Patel et al. (1971) conducted an experiment during three consecutive years at Anand on wheat variety NP-824 with 30, 45 and 60 kg  $P_2O_5$ /ha. They found that application of 45 kg  $P_2O_5$ /ha increased number of tillers/plant, number of grains/ear head and 1000 grain weight over 30 kg  $P_2O_5$ /ha.

Samui et al. (1975) noted non significant effect of applied phosphorus (0, 80, 160 and 240 kg/ha) on ear length and number of grains per ear head but it had increased the plant height, number of ears/sq meter and 1000 grain weight.

Sharma et al. (1977) reported significant increase in fertile tillers/meter row length, ear length, number of grains/earhead and 1000 grain weight upto 20 kg  $P_2O_5$ /ha, while the higher levels of  $P_2O_5$  viz. 40 and 80 kg  $P_2O_5$ /ha were at par in their effect on these parameters. However, Tiwari and Singh (1969) noted a progressive increase in plant height, number of tillers/plant and number of grains/earhead with an increase in the rate of phosphorus from 11.76 upto 47.04 kg  $P_2O_5$ /ha.

Prasad et al. (1981) conducted a trial at Dholi Farm (Bihar) with the levels of 0, 45, 90 and 135 kg  $P_2O_5$ /ha. They reported significant increase in plant height, number of effective tillers/50 cm, length of earhead, grain weight/spike and 1000 grain weight due to phosphorus application only upto 45 kg/ha. The effect of higher levels of  $P_2O_5$ /ha was at par in respect of these characters.

Amin (1983) investigated phosphorus requirement of dwarf wheat varieties LOK-1 and Sonalika with three rates viz., 0, 60 and 120 kg  $P_2O_5$ /ha at Anand. He observed significant increase in total tillers/meter row length, effective tillers/meter row length, plant height, length of earhead, spikelets/earhead and grains/earhead due to phosphorus application upto 60 kg/ha, but the effect of this level of phosphorus on these attributes was at par with that of 120 kg  $P_2O_5$ /ha.

The results of a study conducted by Parauha (1984) indicated significant increase in plant height, effective tillers/meter row length, length of earhead, spikelets/earhead and grains/earhead due to different levels of phosphorus viz., 0, 20 and 40 kg/ha. Phosphorus exhibited non significant effect on plant population.

Reddy and Bhardwaj (1984) reported that application of 25 kg  $P_2O_5$ /ha produced more number of ears along with higher ear weight and 1000 grain weight in both the years. The differences in total spikelets/ear, length of earhead and grains/ear were not significantly affected by the levels of phosphorus viz., 0, 25, 50 kg  $P_2O_5$ /ha in both the years.

Patel (1985) studied three levels of phosphorus viz., 40, 60 and 80 kg  $P_2O_5$ /ha on yield attributes of wheat LOK-1 at Talod in Gujarat. He observed that plant height, length of spike, number of effective tillers/meter row length and number of grains/spike were not influenced significantly with the various levels of phosphorus. Significantly more test weight was recorded under 80 kg  $P_2O_5$ /ha over 40 kg  $P_2O_5$ /ha which was at par with 60 kg  $P_2O_5$ /ha.

### 2.3.3 Grain protein

Ahmed and Khan (1977) reported that grain protein content increased from 10.25 per cent with no phosphorus to 10.96 and 11.41 per cent with application of 44.80 and 89.60 kg  $P_2O_5$ /ha, respectively.

Amin (1983) from Anand, studied the effect of applied phosphorus on the protein content of wheat grain. It was observed that protein content of grain increased significantly with application of phosphorus. The mean protein contents of 12.50, 12.71 and 12.74 per cent were obtained with 0, 60 and 120 kg  $P_2O_5$ /ha, respectively. Effect of 120 and 60 kg  $P_2O_5$ /ha was at par in this respect.

Yadav and Verma (1983) observed that increase in the phosphorus rates from 0 to 60 kg/ha increased the protein content of grain from 7.2 to 10.8 per cent. Similarly, Patel (1985) also found increase in protein content of grain of LOK-1 from 12.79 to 13.29 per cent with the application of phosphorus from 40 to 80 kg  $P_2O_5$ /ha.

## 2.4 Interaction effects on yield and yield attributes

### 2.4.1 Variety x nitrogen

Singh and Verma (1965) studied response of two varieties of wheat R3-31-1 and PB-591 to six levels of nitrogen viz., 0, 22.5, 45.0, 67.5, 90 and 112.5 kg/ha, at Jobner in Rajasthan. The results did not show any significant interaction between variety and nitrogen levels.

Singh and Verma (1970) examined the effects of 0, 40, 80, 120, 160 and 200 kg N/ha on two wheat varieties viz., Lerma Rojo and Sonora-64. They observed that interaction between variety x nitrogen was non significant and significantly highest yield was obtained with 120 kg N/ha in both the varieties.

Gill et al. (1971) at Ludhiana found that grain yield of wheat varieties Kalyansona, Sonalika and Sarbati Sonora increased with increasing rates of nitrogen upto 200 kg N/ha. However, the optimum dose of nitrogen for three varieties was worked out to be 180, 125 and 119 kg/ha, respectively.

Misra and Singh (1971) found that wheat varieties Sonora-64 and Lerma Rojo gave significantly higher yield at 135 kg N/ha than wheat K-68 which produced significantly highest yield with 90 kg N/ha.

Swaminathan (1971) studied response of eleven varieties of wheat to graded doses of nitrogen starting from 0 to 200 kg N/ha. He reported that only five varieties viz., Sarbati Sonora, S-308, Chhoti Lerma, Sonora-63 and Sonora-64 exhibited a positive response to 120 kg N/ha. Among these five varieties, Sarbati Sonora, showed the best response to nitrogen at all the levels upto 160 kg/ha, followed by Sonora-64. Varieties S-227 and S-331 also responded favourably upto 120 kg N/ha. Variety C-306 showed the lowest response at all levels of nitrogen.

Agarwal and Moolani (1975) studied the response of two wheat varieties viz., Kalyansona and HD-1949 to six nitrogen levels viz., 0, 40, 80, 120, 160 and 200 kg/ha at Hissar. It was observed that Kalyansona showed the highest response at 120 kg N/ha, while HD-1949 continued to respond even upto 200 kg N/ha.

An experiment involving four levels of nitrogen (0, 50, 100 and 150 kg/ha) and two varieties (Sarbatl Sonora and Kalyansona) of wheat was conducted at I.A.R.I., New Delhi (Singh and Anderson, 1975). Both the varieties performed equally with the application of nitrogen.

Malik (1981) taken up an experiment at Sangaria with 0, 40, 80, 120 and 160 kg N/ha and two wheat varieties viz., HD-2009 and RAJ-821. The results did not indicate significant interaction between variety x nitrogen in respect of grain yield, effective tillers, length of earhead, grain/earhead and test weight.

An experiment was conducted at Junagadh to test the different wheat varieties for their nutrient requirements during 1980-82. The results revealed that the yield differences due to variety x nitrogen interaction were non-significant (Anon., 1982).

Ial (1984) studied the interaction effects of levels of nitrogen and wheat varieties at I.A.R.I., New Delhi. The interaction between levels of nitrogen and varieties was significant. Among the eight varieties, RAJ-1482 gave highest yield with 0 and 40 kg N/ha, while DWL-5023 gave the highest yield with 80 kg N/ha.

Patel (1984) conducted an experiment at Anand during the year 1982-83 with four levels of nitrogen viz., 90, 120, 150 and 180 kg N/ha and two wheat varieties viz.,

Kalyansona and HD-2236. The interaction effects between variety x nitrogen in respect of grain yield, plant height, number of total tillers, length of earhead, number of grains/earhead, test weight grain to straw ratio and protein content of grain were found non significant.

#### 2.4.2 Variety x phosphorus

Vyas et al. (1980) conducted trials at Jobner with three dwarf wheat varieties viz., Kalyansona, RR-21 and S-308 alongwith three levels of phosphorus viz., 25, 37.5 and 50 kg/ha. Variety x phosphorus interaction was found significant. The highest average yield of 34.51 q/ha was recorded with the variety RR-21 fertilized with 50 kg  $P_2O_5$ /ha whereas the lowest yield of 25.64 q/ha was observed with S-308 fertilized with 25 kg  $P_2O_5$ /ha.

Amin (1983) reported the results of the experiment conducted at Anand involving three levels of phosphorus viz. 0, 60, and 120 kg/ha on two varieties of wheat. The interaction effect of variety x phosphorus in respect of grain yield, plant height, length of earhead, number of spikelets/earhead, number of grains/earhead and test weight was found non significant.

#### 2.4.3 Nitrogen x phosphorus

Randhawa et al. (1969) studied the effect of nitrogen, phosphorus and potash on wheat for two years at Punjab Agricultural University, Ludhiana. They found that

nitrogen and phosphorus increased the yield of wheat grain, significantly but the interaction of nitrogen x phosphorus was absent.

Mathur et al. (1971) studied the response of two varieties viz., Sonora-64 and Lerma Rojo of wheat to four levels of nitrogen viz., 40, 80, 120 and 160 kg/ha and three levels of phosphorus viz., 0, 40 and 80 kg/ha. They worked out 120 kg N + 80 kg  $P_2O_5$ /ha as the optimum dose for dwarf wheat. The interaction between nitrogen x phosphorus was not found to be significant.

Sinha et al. (1973) conducted an experiment at I.A.R.I., New Delhi on variety Kalyansona with four levels of nitrogen (0, 60, 120 and 180 kg N/ha) and four levels of phosphorus (0, 13, 26 and 39 kg  $P_2O_5$ /ha) on the soil having low phosphorus status under late sown condition. Among all combinations, optimum yield was obtained with the combination of 120 kg N + 39 kg  $P_2O_5$ /ha (34.73 q/ha). In absence of phosphorus, wheat did not show any significant response to nitrogen application.

Mehta and Shekhawat (1972) studied the response of wheat to four levels viz., 0, 33.6, 67.2 and 100.8 kg/ha each of nitrogen and phosphorus alone and in combinations. They did not observe interactions effect between nitrogen and phosphorus on yield or yield attributes.

Yousef et al. (1977) in a study on wheat variety Sidimishri-1 grown on sandy soil under irrigated condition with 0, 60, 120 and 180 kg N/ha and 0, 30 and 72 kg  $P_2O_5$ /ha did not find any interacting effect of nitrogen x phosphorus on yield and yield attributes.

Rana et al. (1982) from Ludhiana, based on a three year study on response of variety Kalyansona to N and P found that the highest yield of 47.20 q/ha was obtained with 120 kg N + 60 kg  $P_2O_5$ /ha, while with 120 kg N alone it was only 37.12 q/ha.

Singh and Rajat(1982) from an eight years study reported that wheat required more than 120 kg N/ha to get optimum grain yield. Application of 19 kg  $P_2O_5$ /ha found to be optimum rate. The interaction between nitrogen and phosphorus was significant in all the years.

Amin (1983) worked at Anand with 0, 60, 120 and 180 kg N/ha and 0, 60 and 120 kg  $P_2O_5$ /ha. He did not found significant interaction between nitrogen x phosphorus in respect of total tillers/meter row length, effective tillers/meter row length, plant height, length of earhead number of spikelets/earhead, test weight and protein content.

Dixit et al. (1984) tested different combinations of N and P on soil analysis basis and worked out the optimum dose for wheat. According to the results, application of

100 per cent of soil test recommendation (STR) i.e. 120 kg N + 40 kg  $P_2O_5$ /ha recorded significantly higher grain yield of 44.69 and 42.52 q/ha at Neolikalan and Saharwa, respectively as compared to the fertilizer doses based on lower percentage (25, 50 and 75) of STR. However, the former dose of fertilizer was at par with that based on the higher percentage (125 per cent) of STR which produced the grain yield of 46.72 and 42.82 q/ha at Neolikalan and Saharwa, respectively.

Patel (1985) worked at Taled (Gujarat) with 80, 120 and 160 kg N/ha and 40, 60 and 80 kg  $P_2O_5$ /ha during the year 1982-83 on wheat LOK-1. The results revealed that interaction between nitrogen x phosphorus was not significant in respect of grain yield, effective tillers, plant height, number of grains/spike, test weight and protein content.

#### 2.4.4 Variety x Nitrogen x Phosphorus

A trial was planned at Anand to find out the response of certain high yielding wheat varieties viz., S-227, HDM-1553, Sarbati Sonora, RR-21, HDM-1593, and J-1 to different levels of nitrogen and phosphorus. The results revealed that the interaction variety x nitrogen x phosphorus was found to be non significant in respect of grain and straw yield (Anon., 1971 a).

Gill and Abiohandani (1974) investigated the response of different varieties of wheat to different levels of nitrogen and phosphorus at I.G.P.R.I., Jhansi. Among

different treatment combinations, S-227 gave highest yield when it was fertilized with 120 kg N + 30 kg P<sub>2</sub>O<sub>5</sub>/ha whereas Sarbati Sonora with 60 kg N + 60 kg P<sub>2</sub>O<sub>5</sub>/ha and K-68 with 60 kg N/ha only.

Amin (1983) reported that interaction of variety x nitrogen x phosphorus was not significant in respect of grain yield, straw yield, total and effective tillers/metre row length, plant height, length of earhead, number of spikelets/earhead, number of grains/earhead, test weight and protein content of grain.

**MATERIALS  
AND  
METHODS**

## CHAPTER - 3

### MATERIALS AND METHODS

To investigate the performance of newly released wheat varieties and their nitrogen and phosphorus requirement, an experiment was conducted at the College Agronomy Farm, Anand during rabi season of the year 1985-86. The materials used and experimental techniques adopted in the present investigation are presented in this chapter.

#### 3.1 Experimental site

The experimental site was located at the College Agronomy Farm, B. A. College of Agriculture, Gujarat Agricultural University, Anand Campus, Anand.

#### 3.2 Soil characteristics

The soil of the experimental field was sandy loam. It is originally alluvial, deep, well drained and fairly retentive to moisture. The depth of water table is more than ten metres. Composite soil sample was drawn from 0-30 cm depth before sowing and analysed to know physical and chemical properties of the soil which are given in Table 1. The soil is poor in organic matter and nitrogen content, medium in available phosphorus and rich in available in potash. It is responding well to irrigation and applied manuring.

#### 3.3 Cropping history of the experimental plot

A general crop of sunnhia jowar (S-1049) was grown during the kharif 1985-86, to bring in the uniformity of plot. The details of cropping history of the experimental plot are given in Table 2.

Table 1 : Physical and chemical properties of the soil  
of the experimental plot

Sr. No.	Particulars	Value 0-30 cm depth	Method employed	Reference
1	Mechanical composition			
	(i) Coarse sand (%)	0.45	Inter- national Pipette Method	Piper (1950)
	(ii) Fine sand (%)	82.00	..	..
	(iii) Silt (%)	10.25	..	..
	(iv) Clay (%)	5.25	..	..
2	pH (1 : 2.5 soil : water ratio)	7.50	Baekman p <sup>H</sup> meter	Jackson (1967)
3	Organic matter (%)	0.30	Walkley Back Method	..
4	Total nitrogen (%)	0.035	Kjeldahl's method	..
5	Available phosphorus (kg/ha)	52.30	Olsen's method	..
6	Available potash (kg/ha)	380.25	Flame Photometric method	..

Table 2 : Cropping history of the experimental plot

Year	Season	Crop	Fertilizer applied (kg/ha)		
			N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
1983-84	<u>Kharif</u>	Fallow	-	-	-
	<u>Rabi</u>	Indian bean	20	40	-
1984-85	<u>Kharif</u>	Sundhia jowar	50	-	-
	Summer	Water melon	80	50	-
1985-86	<u>Kharif</u>	Sundhia jowar	20	10	-

### 3.4 Experimental details

The details of the experiment are given below.

The plan of layout is depicted in Figure 1.

#### 3.4.1 Details of layout :

- (1) Design of experiment : Split Plot Design
- (2) Total treatment combinations : 18
- (1) Main plot treatment : Variety : Two
- (11) Sub plot treatment : (a) Levels of nitrogen : Three
- (b) Levels of phosphorus : Three
- (3) Number of replications : Four



- (4) Spacing between two rows : 22.5 cm
- (5) Plot size : Gross : 5 m x 2.7 m  
Net : 4 m x 1.8 m
- (6) Area of the plot : (1) Gross : 13.5 sq.m  
(11) Net : 7.2 sq.m
- (7) Area of one replication (including channels) : 275.4 sq.m
- (8) Area of four replications (including channels) : 1101.6 sq.m
- (9) Total area of experimental field (including channels and road) : 1420.65 sq.m
- (10) Number of rows in each plot : 12
- (11) Total number of plots : 72

#### 5.4.2 Treatments

Eighteen treatment combinations involving two varieties of wheat and three levels each of nitrogen and phosphorus were included in this experiment as detailed below :

Factors	No. of levels	Treatment symbol	Levels
Variety (V)	2	V <sub>1</sub>	GW-120
		V <sub>2</sub>	GW-405
Nitrogen(N)	3	N <sub>80</sub>	80 kg N/ha
		N <sub>120</sub>	120 kg N/ha
		N <sub>160</sub>	160 kg N/ha
Phosphorus(P)	3	P <sub>0</sub>	0 kg P <sub>2</sub> O <sub>5</sub> /ha
		P <sub>40</sub>	40 kg P <sub>2</sub> O <sub>5</sub> /ha
		P <sub>80</sub>	80 kg P <sub>2</sub> O <sub>5</sub> /ha

### 3.4.3 Treatment combinations

In all, there were 18 treatment combinations involving two wheat varieties, three levels of nitrogen and three levels of phosphorus as detailed below :

Sr. No.	Treatment combinations			Treatment symbol
	Variety	Nitrogen (kg/ha)	Phosphorus (kg/ha)	
1	GW-120	80	0	$V_1 N_{80} P_0$
2	..	80	40	$V_1 N_{80} P_{40}$
3	..	80	80	$V_1 N_{80} P_{80}$
4	..	120	0	$V_1 N_{120} P_0$
5	..	120	40	$V_1 N_{120} P_{40}$
6	..	120	80	$V_1 N_{120} P_{80}$
7	..	160	0	$V_1 N_{160} P_0$
8	..	160	40	$V_1 N_{160} P_{40}$
9	..	160	80	$V_1 N_{160} P_{80}$
10	GW-405	80	0	$V_2 N_{80} P_0$
11	..	80	40	$V_2 N_{80} P_{40}$
12	..	80	80	$V_2 N_{80} P_{80}$
13	..	120	0	$V_2 N_{120} P_0$
14	..	120	40	$V_2 N_{120} P_{40}$
15	..	120	80	$V_2 N_{120} P_{80}$
16	..	160	0	$V_2 N_{160} P_0$
17	..	160	40	$V_2 N_{160} P_{40}$
18	..	160	80	$V_2 N_{160} P_{80}$

### 3.5 Sowing material

Two wheat varieties were utilized in this investigation. The details of these varieties are as below.

#### 3.5.1 GW-120

This variety was evolved at the Main Wheat Research Station, Gujarat Agricultural University, Vijapur (North Gujarat) in 1985 from the cross Inia-Cho x Inia-Bb/Y-50 E-Kal<sup>3</sup>. It is early in maturity, two gene dwarf, semi erect wheat variety with hard, attractive and medium sized amber grains. It has profuse tillering ability with synchronised growth. The ears are with long medium dense, glabrous white glumes and medium test weight. This variety gives higher yield with good quality of grain as well as straw. It has good resistance to rusts, smuts and kernal bunt. It is also resistant to lodging and shattering. It is suitable for late sown, good fertility and irrigated conditions. It matures in 99 to 109 days.

#### 3.5.2 GW-405

This is also two gene dwarf variety of wheat derived from Inia-Cho x Bb/Cho- x PI-62-Gallow at the Main Wheat Research Station, Vijapur in the year 1985. It has semi erect and early growing habit, very good tillering capacity with deep green foliage, fully beared earhead and glabrous white glumes. The grains are hard, medium in size and attractive amber in colour. It has good resistance to

rusts, smuts and kernal bunt. It matures in about 110 days. This variety is also suitable for late sowing, high fertility and irrigated conditions.

### 3.6 Cultivation operations

#### 3.6.1 Preparation of land

After harvesting the previous crop of S-1049 jowar, the experimental field was cultivated twice with a tractor drawn cultivator in cross wise direction when the soil came in 'Vapsa' condition. Stubbles of the previous crop were collected and removed and finally the field was smoothened and levelled by the operation of planking.

#### 3.6.2 Application of fertilizers

The furrows were opened at a distance of 22.5 cm with the help of Kudali in each of the experimental plot. Entire quantity of phosphorus in the form of super-phosphate and half the quantity of nitrogen in the form of urea as per treatment need were applied in furrows as basal dose. Potash was applied uniformly at the rate of 40 kg  $K_2O$ /ha in the form of muriate of potash along with the other fertilizers in furrows as basal dose and covered with soil with the help of a rake. Twenty five per cent of the total nitrogen was applied in the form of urea 21 days after sowing as a top dressing and the remaining twenty five per cent was applied in the same form 35 days after sowing according to the treatment need.

### 3.6.3 Seed and sowing

The wheat seeds, treated with Aldrin and Ceresan were sown manually in the furrows at the rate of 120 kg/ha in each of the experimental plots. The sowing was done on 29th November 1985. It was followed by light planking (by rack) for covering the seeds and light levelling. The light irrigation was given just after sowing to ensure even germination.

### 3.6.4 After care

Two hand weedings were carried out during the crop season. In all nine irrigations were given during the life of the crop to maintain the favourable soil moisture supply for the plant growth. The second irrigation was given after 21 days from the date of sowing and other irrigations were given at an interval of 10 to 13 days.

### 3.6.5 Harvesting and threshing

After the crop had shown signs of maturity, the border area was harvested and removed from the plot first and later on the net area was harvested and left for drying for two days in each of the plots. The harvested produce was then tied into bundles and weighed to ascertain yield of grains and straw. Threshing and cleaning of the produce were done plot-wise. Grains obtained from each of the plots were weighed and recorded separately. All these operations were done by manual labour.

### 3.6.6 Calendar of operations

The agricultural operations carried out from land preparation to harvesting are as shown in Table 3.

Table 3 : Calendar of cultural operations

Sr. No.	Date of operation	Particulars	Remarks
1	18-11-85	Irrigation	For land preparation
2	21-11-85	Tractor cultivations	..
3	21-11-85	Removal of stubbles and roots of previous crops	..
4	22-11-85	Planking	..
5	28-11-85	Layout of experiment, preparing ridges and furrows and application of fertilizer	50 per cent nitrogen and whole $P_2O_5$ as per treatment and whole $K_2O$
6	29-11-85	Sowing of the seed	
7	29-11-85	First light irrigation	
8	19-12-85	Second irrigation	
9	20-12-85	Top dressing of urea	25 per cent nitrogen (as per treatment)
10	27-12-85	Interculturing	
11	27-12-85	Weeding	
12	1-1-86	Third irrigation	
13	2-1-86	Top dressing of urea	Remaining 25 per cent nitrogen (as per treatment)

Table 3 (Contd.)

Sr. No.	Date of operation	Particulars	Remarks
14	10-1-86	Fourth irrigation	
15	21-1-86	Fifth irrigation	
16	31-1-86	Weeding	
17	1-2-86	Sixth irrigation	
18	14-2-86	Seventh irrigation	
19	26-2-86	Eighth irrigation	
20	11-3-86	Ninth irrigation	
21	27-3-86	Harvesting of wheat	
22	29-3-86	Threshing, winnowing and weighing of grain and straw	

### 3.7 Plant characters studied

The yield of a crop is governed by the growth of the attributes. The following plant characters were therefore, studied along with yield during the course of the investigation.

#### 3.7.1 Plant height

Five plants were chosen at random and tagged in each plot for this purpose. The plant height was measured in cm from the base of the plant to the base of the earhead at the time of harvest. Subsequently mean plant height was worked out and recorded separately for each of the plots.

### 3.7.2 Total tillers per metre row length

All the shoots and tillers with or without ears were counted separately in one metre row length at five places, randomly selected in each of the experimental plots in all the replications at the time of harvesting. The mean of the total number of tillers per metre row length was then worked out and recorded separately for each of the plots.

### 3.7.3 Effective tillers per metre row length

The shoots and tillers with well matured grains in earheads were considered as "effective tillers". Such tillers were counted separately in one metre row length at the same five places which were randomly selected for counting total tillers in each of the plots in all the replications at the time of harvesting. The mean number of effective tillers per metre row length was then calculated and recorded separately for each of the plots.

### 3.7.4 Length of earhead

The five plants used for plant height measurement were also used to study this character. The mean length of the earhead of the same plants was measured in cm and recorded plot wise, at the time of harvest.

### 3.7.5 Number of spikelets per earhead

The same five earheads that were used for measuring the length were also used for counting the number of spikelets per earhead and recorded plot-wise at the time of harvest.

### 3.7.6 Number of grains per earhead

The same five earheads that were used for counting number of spikelets per earhead were used to study this character. The ear heads were removed and grains were separated by hand threshing. The grains obtained from the individual earheads were counted and their mean number per earhead for the individual plots was calculated and recorded separately.

### 3.7.7 Grain weight per earhead

The same five earheads that were used for counting number of grain per earhead were also used to study this character. The grains from the earheads were weighed separately and the average grain weight in g per earhead was worked out and recorded plot-wise.

### 3.7.8 Test weight

One thousand grains of wheat were counted from the composite wheat sample of grains drawn from the grain produce of each of the experimental plots. They were weighed in g and recorded separately.

### 3.7.9 Grain yield

The grain and straw yields are two principal economic parameters in which the farming community in general is interested. The produce of each of the treatment net plots was threshed separately and grain was separated, cleaned, weighed and recorded for each of the plots. The

yield of grain per hectare was then calculated by applying multiple factor.

#### 3.7.10 Straw yield

Plot-wise figures of straw yields were obtained by deducting figures of grain yield from that of the total dry matter production and recorded accordingly. The straw yields were inclusive of stems, leaves and chaff. Further, yield of wheat straw was calculated on hectare basis by applying multiple factor and recorded separately for each of the experimental treatments.

#### 3.7.11 Protein content of grain

Composite grain samples were prepared from the produce of each of the treatment plots and chemically analysed for estimation of nitrogen to serve the purpose. Protein content in each of the sample was determined by estimating nitrogen content of grains and multiplying the figures of percentage nitrogen in grain by 6.25 (protein content (%) = N content x 6.25). Kjeldahl's method (Jackson, 1967) was employed for estimation of nitrogen in wheat grain.

#### 3.8 Statistical method employed

The data generated on yield, quality and various characters were subjected to statistical analysis using "analysis of variance techniques". The value of calculated 'F' was worked out and compared with the value of table 'F'

at the five per cent level of significance. Where the treatment differences were significant, value of C.D. was worked out to compare the treatment effects (Snedecor and Cochran, 1967).

### 3.9 Economics

The gross monetary realization was worked out on the basis of the data on the yield of grain and straw for all the treatments. Price of wheat grains and straw as prevailed in the market in May 1985 was taken into consideration for this purpose. The cost of cultivation of the crop under each of the treatments was worked out by taking into consideration the cost of all the operations beginning from the preparatory tillage to harvesting and threshing including winnowing and preparing the produce for market. The cost of cultivation also included cost of seeds, fertilizers and irrigation per hectare. The net realization was worked out by deducting the total cost of cultivation from the gross realization per hectare for each of the treatments.

### 3.10 Climatological data

The climate of the character tract of the middle Gujarat in which the Anand Campus of the Gujarat Agricultural University is located is sub-tropical. Anand is situated on 22°-25' North latitude and 72°-55' East longitude. It is 45.11 metres high above the mean sea level.

The summer is fairly dry and hot, while the winter is fairly cool and dry. The rainy season that commences in June and ends in September is warm with moderate humidity. The regular winter season starts by the end of October and reduces by the end of February. The coldest months of winter season are December and January. The summer season commences in the beginning of March and concludes by the end of June. May is hottest months of the year.

There was no unseasonal rain fall received during the crop season. Overall, climate was cold and dry and the season was normal during the time of investigation. No severe attack of pests and diseases was observed in crop during the period of investigation.

The standard week wise mean data on meteorological parameter recorded at the College Farm Observatory at Anand Campus, Anand for the period of investigation (November 1985 to March 1986) are presented in Table 4.

Table 4 : Standard week wise mean data on maximum and minimum temperature, relative humidity and rainfall during the year 1985-86 at Anand

Meteorological week	Mean temperature, °C		Relative humidity % 7.30 a.m.	Rainfall (mm)
	Maximum	Minimum		
45 Nov., 1985	34.8	15.7	78	0.00
46 ..	33.7	14.8	75	0.00
47 ..	31.9	13.9	85	0.00
48 ..	32.4	14.7	82	0.00
49 Dec., 1985	31.6	12.8	75	0.00
50 ..	29.1	14.6	84	0.00
51 ..	31.1	14.5	80	0.00
52 ..	29.4	12.4	79	0.00
1 Jan., 1986	27.0	11.5	59	0.00
2 ..	28.8	11.7	64	0.00
3 ..	29.0	11.3	83	0.00
4 ..	29.8	12.5	76	0.00
5 ..	28.9	11.8	80	0.00
6 Feb., 1986	29.1	13.5	78	0.00
7 ..	30.4	12.1	77	0.00
8 ..	31.2	13.9	59	0.00
9 ..	34.2	15.4	56	0.00
10 Mar., 1986	37.0	17.1	75	0.00
11 ..	36.6	15.2	70	0.00
12 ..	34.4	16.1	67	0.00
13 ..	37.7	18.1	51	0.00

## **RESULTS**

## CHAPTER - 4

### EXPERIMENTAL RESULTS

An investigation was carried out during the year 1985-86 to study the performance of high yielding late sown varieties of wheat to various levels of nitrogen and phosphorus. The data obtained during course of study are presented along with statistical inferences in the subsequent pages of this chapter.

#### 4.1 Grain yield

Mean data on grain yield (kg/ha) as influenced by wheat varieties and various levels of nitrogen and phosphorus are presented in Table 5 and the analysis of variance is furnished in Appendix-I. The data are also depicted in Figure 2.

It was evident from the data that the differences in grain yield due to different varieties were not significant. However, variety GW-405 tended to give higher yield. The mean grain yields as obtained under <sup>GW-120 and</sup> GW-405 were to the tune of 4433 and 4469 kg/ha, respectively.

The effect of various levels of nitrogen on grain yield was significant. Increasing levels of nitrogen generally resulted in increasing the yield of grain. The highest grain yield was under 160 kg N/ha but it did not differ significantly from 120 kg N/ha. Both the levels gave significantly higher grain yield over 80 kg N/ha. Average

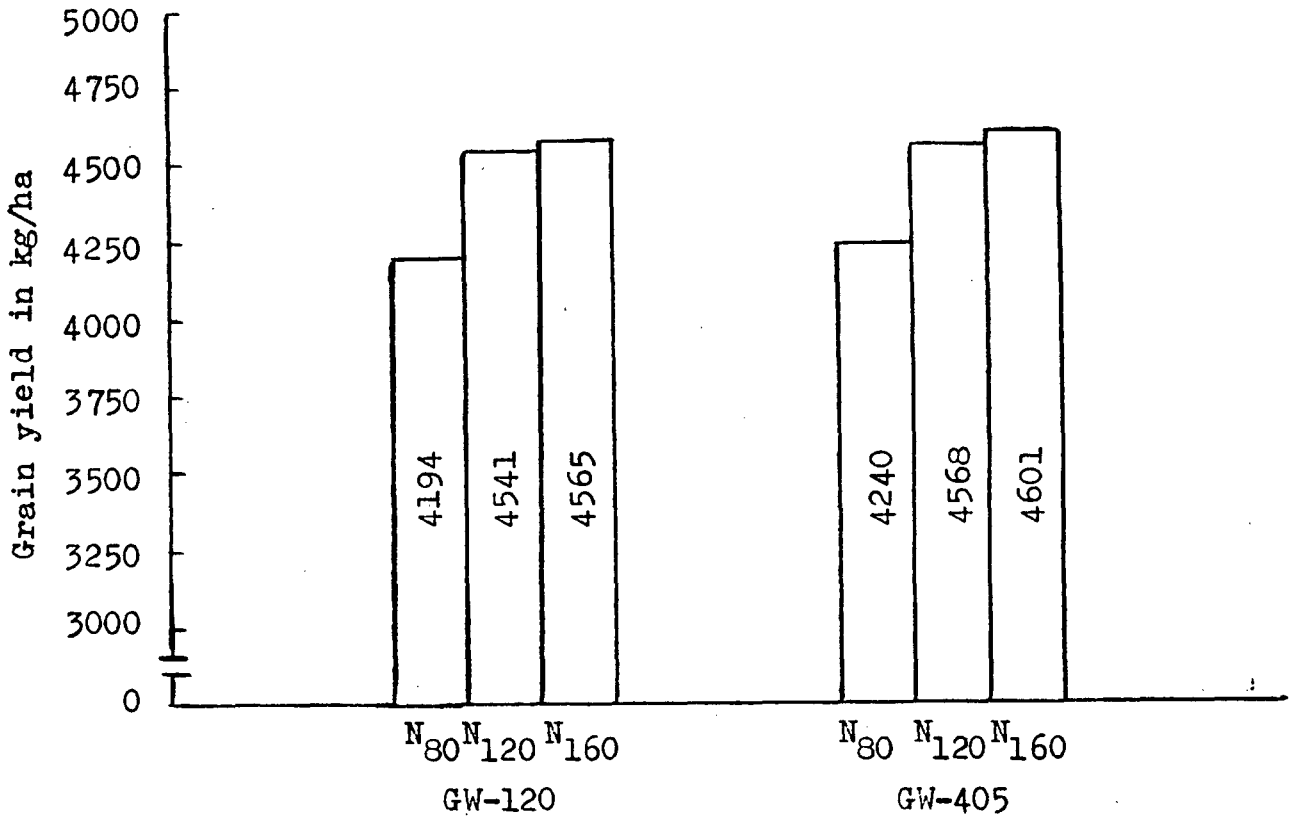
**Table 5 :** Mean grain yield in kg/ha of wheat varieties as influenced by various levels of nitrogen and phosphorus

Varieties (V)	Phosphorus kg/ha (P)	Nitrogen kg/ha (N)			Mean
		N <sub>80</sub>	N <sub>120</sub>	N <sub>160</sub>	
GW-120 (V <sub>1</sub> )	P <sub>0</sub>	4000	4302	4316	4206
	P <sub>40</sub>	4269	4632	4646	4516
	P <sub>80</sub>	4313	4688	4733	4578
	Mean	4194	4541	4565	4433
GW-405 (V <sub>2</sub> )	P <sub>0</sub>	4104	4285	4305	4231
	P <sub>40</sub>	4276	4663	4688	4542
	P <sub>80</sub>	4340	4755	4809	4635
	Mean	4240	4568	4601	4469
Mean	P <sub>0</sub>	4052	4293	4311	4219
	P <sub>40</sub>	4272	4648	4666	4529
	P <sub>80</sub>	4327	4721	4771	4606
	Mean	4217	4554	4583	4451

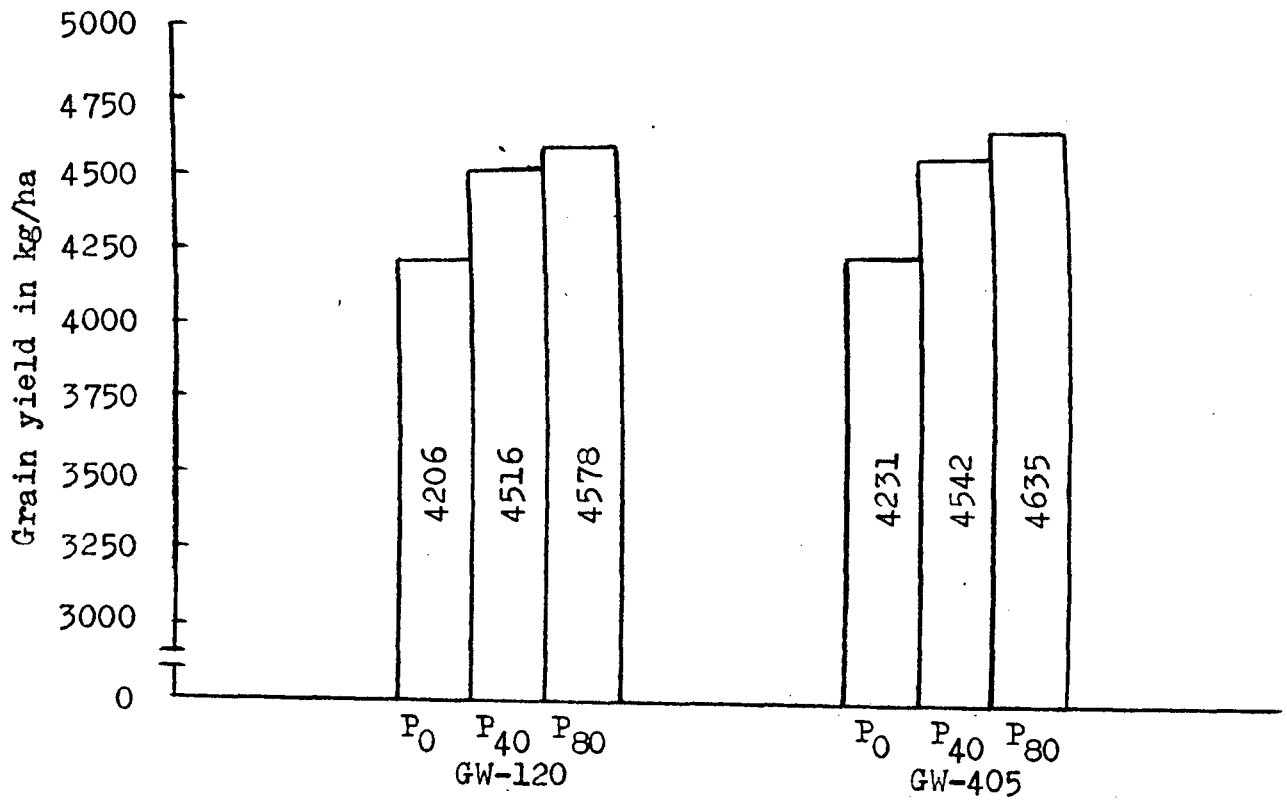
Source	SEM ±	C.D. at 5%	C.V. %
V	68.97	N.S.	Main Plot
N	64.97	184.92	9.3
P	64.97	184.92	Sub plot
V x N	91.88	N.S.	7.15
V x P	91.88	N.S.	
N x P	112.53	N.S.	
V x N x P	159.14	N.S.	

N.S. - Not significant.

Figure 2



Mean grain yield in kg/ha of two wheat varieties as influenced by various levels of nitrogen.



Mean grain yield in kg/ha of two wheat varieties as influenced by various levels of phosphorus.

grain yields of 4217, 4554 and 4583 kg/ha were obtained with the application of 80, 120 and 160 kg N/ha, respectively.

Differences in grain yield due to various levels of phosphorus were significant. Application of 80 kg  $P_2O_5$ /ha was superior, but it was at par with 40 kg  $P_2O_5$ /ha. Both the above levels of phosphorus gave significantly higher grain yield as compared to control (0 kg  $P_2O_5$ /ha). Application of 0, 40 and 80 kg  $P_2O_5$ /ha on an average produced 4219, 4529 and 4606 kg/ha of grain yield, respectively.

None of the interactions was found to be significant.

#### 4.2 Straw yield

The mean data on straw yield (kg/ha) of wheat varieties as influenced by various levels of nitrogen and phosphorus are presented in Table 6 and the analysis of variance is given in Appendix-I. The data are also depicted in Figure 3.

The results indicated that straw yield was not significantly affected by varieties. However, higher straw yield was recorded with variety GW-405. Mean straw yield of 6831 and 6957 kg/ha was obtained with GW-120 and GW-405, respectively.

Differences in straw yield due to various levels of nitrogen were significant. Application of 120 and 160 kg N/ha gave significantly higher straw yield over 80 kg N/ha. The highest straw yield was obtained with 160 kg N/ha but it

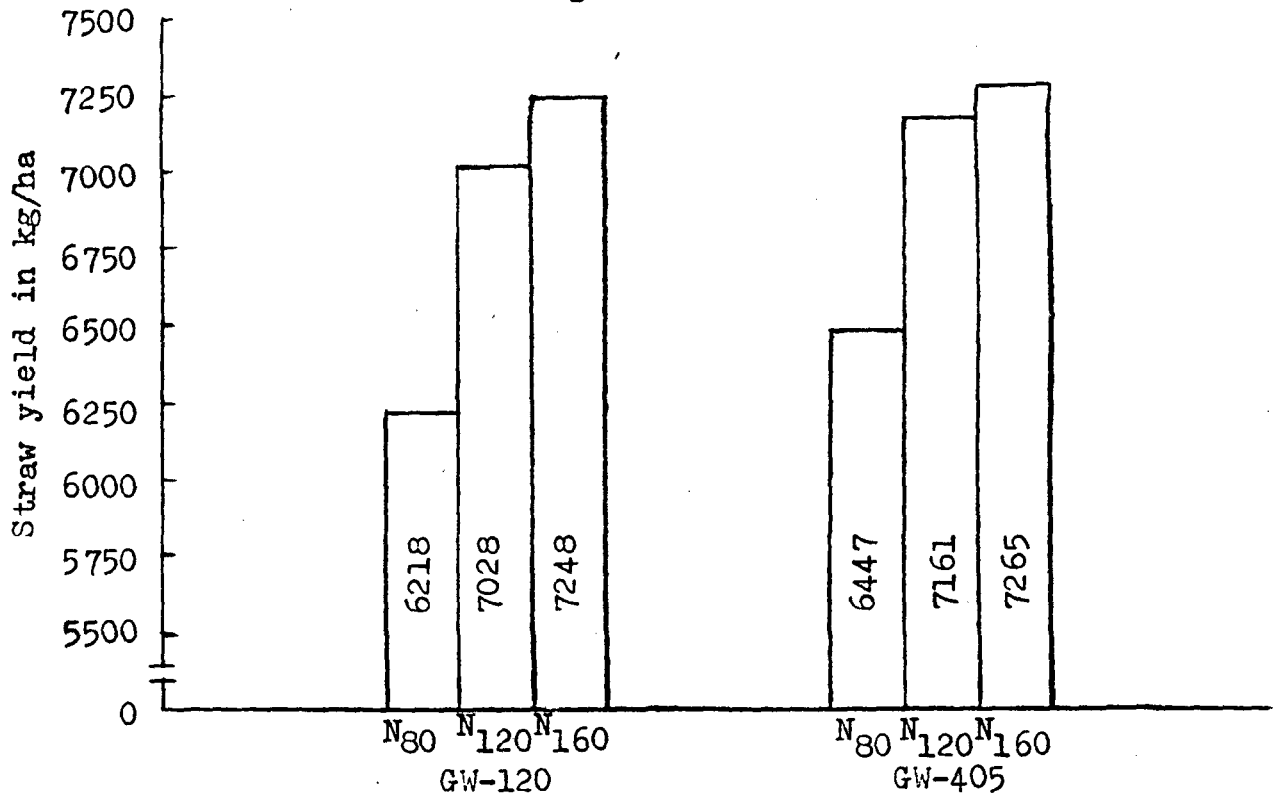
**Table 6 :** Mean straw yield in kg/ha of wheat varieties as influenced by various levels of nitrogen and phosphorus

Varieties	Phosphorus kg/ha (P)	Nitrogen kg/ha (N)			Mean
		N <sub>90</sub>	N <sub>120</sub>	N <sub>160</sub>	
GW-120 (V <sub>1</sub> )	P <sub>0</sub>	5745	6449	6688	6294
	P <sub>40</sub>	6358	7181	7431	6990
	P <sub>80</sub>	6552	7455	7625	7210
	Mean	6218	7028	7248	6831
GW-405 (V <sub>2</sub> )	P <sub>0</sub>	6115	6511	6670	6432
	P <sub>40</sub>	6500	7365	7434	7099
	P <sub>80</sub>	6726	7608	7691	7341
	Mean	6447	7161	7265	6957
Mean	P <sub>0</sub>	5930	6480	6679	6363
	P <sub>40</sub>	6429	7373	7432	7044
	P <sub>80</sub>	6639	7531	7658	7276
	Mean	6333	7095	7256	6894

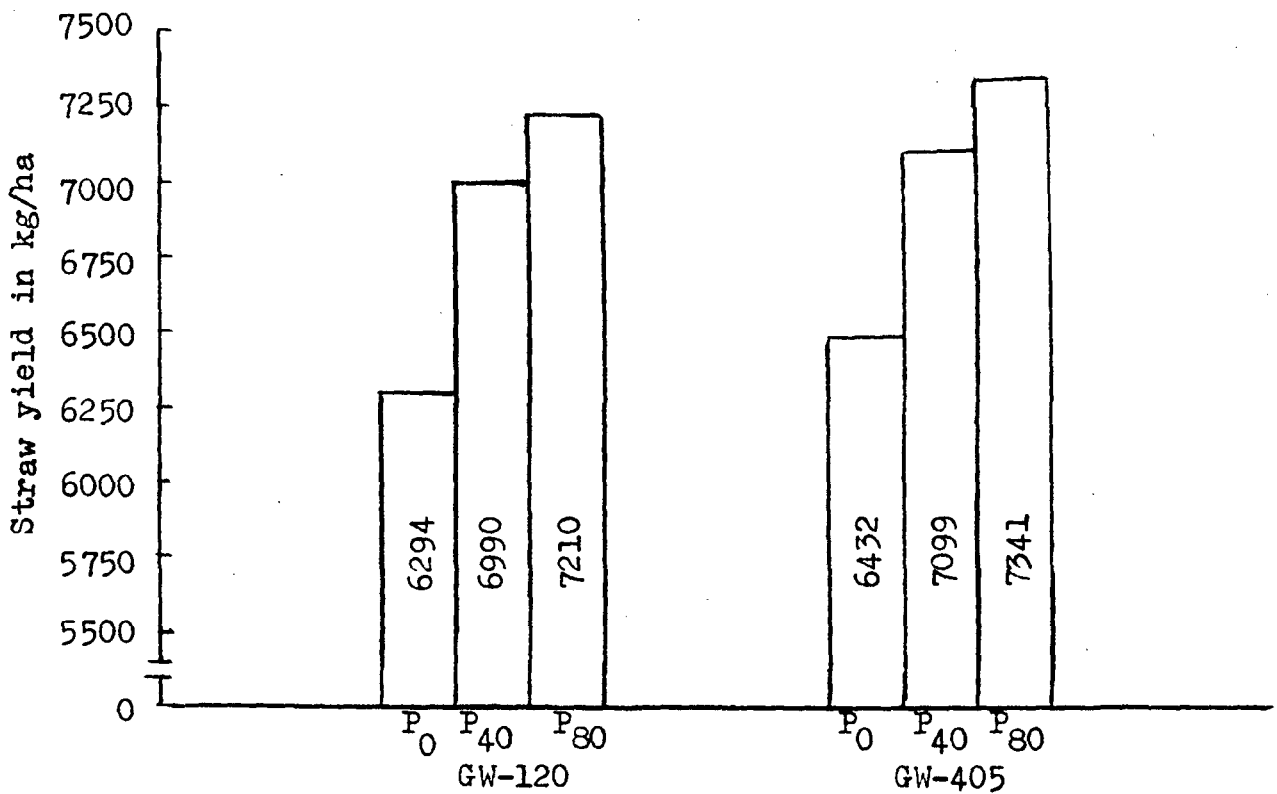
Source	S.E.M. ±	C.D. at 5%	C.V. %
V	100.03	N.S.	Main Plot
N	99.14	282.16	8.71
P	99.14	282.16	Sub Plot
V x N	140.20	N.S.	7.04
V x P	140.20	N.S.	
N x P	171.70	N.S.	
V x N x P	242.83	N.S.	

N.S. : Not significant

Figure 3



Mean straw yield in kg/ha of two wheat varieties as influenced by various levels of nitrogen.



Mean straw yield in kg/ha of two wheat varieties as influenced by various levels of phosphorus.

did not differ significantly from 120 kg N/ha. Average straw yield of 6333, 7095 and 7256 kg/ha were obtained by application of 80, 120 and 160 kg N/ha, respectively.

Various levels of phosphorus also significantly influenced the straw yield. Every increase in phosphorus level resulted in higher straw yield. Application of 80 kg  $P_2O_5$ /ha gave the highest straw yield but it was at par with 40 kg  $P_2O_5$ /ha. Both the levels of phosphorus (80 and 40 kg  $P_2O_5$ /ha) differed significantly from control (0 kg  $P_2O_5$ /ha). Mean straw yields for 0, 40 and 80 kg  $P_2O_5$ /ha were 6363, 7044 and 7276 kg/ha, respectively.

None of the interactions was found to be significant.

#### 4.3 Final plant height

The mean data on plant height in cm at harvest time as influenced by wheat varieties and different levels of nitrogen and phosphorus are presented in Table 7 and the analysis of variance is given in Appendix-I.

The results showed that differences in plant height due to varieties were not significant. However, variety GW-405 produced taller plants. The mean plant height recorded was 80.74 and 81.96 cm in GW-120 and GW-405, respectively.

Plant height was significantly affected by various levels of nitrogen. The highest plant height was recorded with 160 kg N/ha, but it did not differ significantly from 120 kg N/ha. Both the levels produced significantly taller

**Table 7 : Mean plant height in cm at harvest time of wheat varieties as influenced by various levels of nitrogen and phosphorus**

Varieties (V)	Phosphorus kg/ha (P)	Nitrogen kg/ha (N)			Mean
		N <sub>80</sub>	N <sub>120</sub>	N <sub>160</sub>	
GH-120 (V <sub>1</sub> )	P <sub>0</sub>	78.68	79.50	80.28	79.48
	P <sub>40</sub>	80.20	81.13	83.30	81.21
	P <sub>80</sub>	78.73	82.50	83.85	81.53
	Mean	79.20	81.04	81.98	80.74
GH-405 (V <sub>2</sub> )	P <sub>0</sub>	80.10	81.85	82.28	81.34
	P <sub>40</sub>	81.38	81.98	82.50	81.95
	P <sub>80</sub>	81.63	82.60	83.50	82.58
	Mean	81.03	82.08	82.76	81.96
Mean	P <sub>0</sub>	79.39	80.58	81.28	80.41
	P <sub>40</sub>	80.79	81.55	82.40	81.58
	P <sub>80</sub>	80.18	82.55	83.43	82.05
	Mean	80.12	81.56	82.37	81.35

Source	SEm ±	C.D. at 5%	C.V. %
V	0.86	N.S.	Main Plot
N	0.48	1.37	6.32
P	0.48	N.S.	Sub Plot
V x N	0.69	N.S.	2.89
V x P	0.69	N.S.	
N x P	0.83	N.S.	
V x N x P	1.18	N.S.	

**N.S. : Not significant**

plants than 80 kg N/ha. The mean plant height recorded due to 80, 120 and 160 kg N/ha was 80.12, 81.56 and 82.37 cm, respectively.

The data in Table 7 further indicated that the effect of phosphorus was not significant on plant height. Application of 0, 40 and 80 kg  $P_2O_5$ /ha on an average gave 80.41, 81.58 and 82.05 cm plant height, respectively.

None of the interactions was found to be significant.

#### 4.4 Total tillers per metre row length

The mean data on number of total tillers in one metre row length as influenced by varieties, levels of nitrogen and phosphorus are presented in Table 8 and the analysis of variance in Appendix-I.

The results revealed that the total tillers in one metre row length were not influenced significantly by varieties. GW-120 and GW-405 on an average produced 82.90 and 82.92 tillers in one metre row length, respectively.

Differences in total number of tillers per metre row length due to various levels on nitrogen were significant. Increasing the levels of nitrogen generally increased the number of tillers. Application of 160 kg N/ha produced the highest number of total tillers but it did not differ significantly from 120 kg N/ha. Both the levels produced significantly higher number of total tillers per metre row length as compared to 80 kg N/ha. The mean values of total tillers

**Table 8 : Mean number of total tillers per metre row length of wheat varieties as influenced by various levels of nitrogen and phosphorus**

Varieties (V)	Phosphorus kg/ha (P)	Nitrogen kg/ha (N)			Mean
		N <sub>80</sub>	N <sub>120</sub>	N <sub>160</sub>	
GW-120 (V <sub>1</sub> )	P <sub>0</sub>	70.00	83.25	83.00	78.75
	P <sub>40</sub>	79.13	87.00	83.88	84.33
	P <sub>80</sub>	80.13	87.75	89.00	85.63
	Mean	76.42	86.00	86.29	82.90
GW-405 (V <sub>2</sub> )	P <sub>0</sub>	69.50	84.88	82.50	78.96
	P <sub>40</sub>	82.50	86.88	86.00	85.13
	P <sub>80</sub>	82.63	84.25	87.13	84.67
	Mean	78.21	85.33	85.21	82.92
Mean	P <sub>0</sub>	69.75	84.06	82.75	78.85
	P <sub>40</sub>	80.81	86.94	86.44	84.73
	P <sub>80</sub>	81.38	86.00	88.06	85.15
	Mean	77.31	85.67	85.75	82.91

Source	SEm ±	C.D. at 5%	C.V. %
V	0.71	N.S.	Main Plot
N	1.21	3.45	5.10
P	1.21	3.45	Sub. Plot
V x N	1.72	N.S.	7.16
V x P	1.72	N.S.	
N x P	2.10	N.S.	
V x N x P	2.97	N.S.	

N.S. : Not significant

were 77.31, 85.67 and 85.75 with application of 80, 120 and 160 kg N/ha, respectively.

Total number of tillers per metre row length were significantly affected by various levels of phosphorus. Application of 80 kg  $P_2O_5$ /ha produced highest number of total tillers but, the same were at par with 40 kg  $P_2O_5$ /ha. Both these levels of phosphorus produced significantly more total tillers than no phosphorus application. Application of 0, 40 and 80 kg  $P_2O_5$ /ha produced 78.85, 84.73 and 85.15 total tillers per metre row length, respectively.

None of the interactions effect was found to be significant.

#### 4.5 Number of effective tillers per metre row length

The mean data on number of effective tillers per metre row length as influenced by varieties, various levels of nitrogen and phosphorus are presented in Table 9 and the analysis of variance in Appendix-I.

The data revealed that the effect of varieties in respect of effective tillers per metre row length was not significant. The varieties GW-120 and GW-405 on an average gave 78.37 and 78.11 effective tillers in one metre row length, respectively.

Effective tillers were significantly influenced by various levels of nitrogen. There was increase in number of effective tillers with increase in nitrogen. The highest number of effective tillers was obtained with 160 kg N/ha.

**Table 9 : Mean number of effective tillers per meter row length of wheat varieties as influenced by various levels of nitrogen and phosphorus**

Varieties (V)	Phosphorus kg/ha (P)	Nitrogen kg/ha (N)			Mean
		N <sub>80</sub>	N <sub>120</sub>	N <sub>160</sub>	
GW-120 (V <sub>1</sub> )	P <sub>0</sub>	64.25	77.00	77.25	72.83
	P <sub>40</sub>	75.00	82.50	82.38	79.96
	P <sub>80</sub>	75.50	84.25	87.25	82.33
	Mean	71.58	81.25	82.29	78.37
GW-405 (V <sub>2</sub> )	P <sub>0</sub>	64.63	78.15	76.38	73.25
	P <sub>40</sub>	78.00	81.88	81.38	80.42
	P <sub>80</sub>	78.88	80.25	82.88	80.67
	Mean	73.83	80.29	80.21	78.11
Mean	P <sub>0</sub>	64.44	77.88	76.81	73.04
	P <sub>40</sub>	76.50	82.19	81.88	80.19
	P <sub>80</sub>	77.19	82.25	85.06	81.50
	Mean	72.71	80.77	81.25	78.24

Source	SEm ±	C.D. at 5%	C.V. %
V	0.65	N.S.	Main Plot
N	1.12	3.18	4.94
P	1.12	3.18	Sub Plot
V x N	1.58	N.S.	6.99
V x P	1.58	N.S.	
N x P	1.94	N.S.	
V x N x P	2.74	N.S.	

**N.S. : Not significant**

Application of 120 kg and 160 kg N/ha produced significantly more number of effective tillers as compared to 80 kg N/ha but both were at par. Application of 80, 120 and 160 kg N/ha produced 72.71, 80.77 and 81.25 effective tillers, respectively.

Effective tillers were also significantly affected by different levels of phosphorus. Phosphorus tended to gave more number of effective tillers. The highest number of effective tillers were observed with 80 kg  $P_2O_5$ /ha, but it was at par with 40 kg  $P_2O_5$ /ha. Both the levels of phosphorus (40 and 80 kg/ha) gave significantly higher number of effective tillers as compared to control (0 kg  $P_2O_5$ /ha). Application of 0, 40 and 80 kg  $P_2O_5$ /ha gave 73.04, 80.19 and 81.50 effective tillers in one metre row length, respectively.

No significant differences were observed in respect of effective tillers due to various interactions.

#### 4.6 Length of earhead

The mean data on length of earhead in cm of wheat varieties as influenced by various levels of nitrogen and phosphorus are presented in Table 10 and the analysis of variance in Appendix-I.

As regards the length of earheads, both the varieties did not differ significantly with each other. The mean values were 8.36 and 8.50 cm for GW-120 and GW-405, respectively.

**Table 10 : Mean length of earhead in cm of wheat varieties as influenced by various levels of nitrogen and phosphorus**

Varieties (V)	Phosphorus kg/ha (P)	Nitrogen kg/ha (N)			Mean
		N <sub>80</sub>	N <sub>120</sub>	N <sub>160</sub>	
GW-120 (V <sub>1</sub> )	P <sub>0</sub>	8.07	8.28	8.39	8.25
	P <sub>40</sub>	8.27	8.49	8.48	8.41
	P <sub>80</sub>	8.29	8.35	8.67	8.44
	Mean	8.21	8.37	8.51	8.36
GW-405 (V <sub>2</sub> )	P <sub>0</sub>	8.17	8.39	8.43	8.33
	P <sub>40</sub>	8.39	8.65	8.65	8.56
	P <sub>80</sub>	8.44	8.66	8.72	8.60
	Mean	8.33	8.56	8.60	8.50
Mean	P <sub>0</sub>	8.12	8.34	8.41	8.29
	P <sub>40</sub>	8.33	8.57	8.56	8.49
	P <sub>80</sub>	8.37	8.50	8.69	8.52
	Mean	8.27	8.47	8.55	8.43

Source	SEM	C.D. at 5%	C.V. %
V	0.05	N.S.	Main Plot
N	0.08	N.S.	3.62
P	0.08	N.S.	Sub Plot
V x N	0.12	N.S.	4.85
V x P	0.12	N.S.	
N x P	0.14	N.S.	
V x N x P	1.21	N.S.	

N.S. : Not significant

Earhead length did not differ significantly due to various levels of nitrogen. However, nitrogen resulted in marginal increase in length of earhead. The mean earhead length of 8.27, 8.47 and 8.55 cm were recorded with 80, 120 and 160 kg N/ha, respectively.

The data further showed that effect of phosphorus was not found significant with regard to earhead length. However, phosphorus has positive effect on length of earhead to some extent. On an average 8.29, 8.49 and 8.52 cm length of earhead was noted with 0, 40 and 80 kg  $P_2O_5$ /ha, respectively.

The results revealed that none of the interactions was observed to be significant in respect of length of earhead.

#### 4.7 Number of spikelets per earhead

The average number of spikelets per earhead of wheat varieties as influenced by various levels of nitrogen and phosphorus are presented in Table 11 and the analysis of variance in Appendix-II.

The data indicated the number of spikelets did not differ significantly due to varieties. On an average, GW-120 and GW-405 gave 14.23 and 14.17 spikelets per earhead, respectively.

Effect of various levels of nitrogen was not significant with respect to number of spikelets per earhead. Application of 80, 120 and 160 kg N/ha produced 14.03, 14.27 and 14.31 spikelets per earhead, respectively.

Table 11 : Mean number of spikelets per earhead of wheat varieties as influenced by various levels of nitrogen and phosphorus

Varieties (V)	Phosphorus kg/ha (P)	Nitrogen kg/ha (N)			Mean
		N <sub>80</sub>	N <sub>120</sub>	N <sub>160</sub>	
GW-120 (V <sub>1</sub> )	P <sub>0</sub>	13.90	14.00	14.05	13.98
	P <sub>40</sub>	14.15	14.40	14.40	14.32
	P <sub>80</sub>	14.20	14.50	14.50	14.40
	Mean	14.08	14.30	14.32	14.23
GW-405 (V <sub>2</sub> )	P <sub>0</sub>	13.80	14.00	14.10	13.97
	P <sub>40</sub>	14.00	14.30	14.40	14.23
	P <sub>80</sub>	14.10	14.40	14.40	14.30
	Mean	13.97	14.23	14.30	14.17
Mean	P <sub>0</sub>	13.85	14.00	14.08	13.98
	P <sub>40</sub>	14.08	14.35	14.40	14.28
	P <sub>80</sub>	14.15	14.45	14.45	14.35
	Mean	14.03	14.27	14.31	14.20

Source	SEM ±	C.D. at 5%	C.V. %
V	0.08	N.S.	Main Plot
N	0.13	N.S.	3.18
P	0.13	N.S.	Sub Plot
V x N	0.18	N.S.	4.50
V x P	0.18	N.S.	
N x P	0.23	N.S.	
V x N x P	0.32	N.S.	

N.S. : Not significant

Number of spikelets per earhead was not significantly influenced by different levels of phosphorus. On an average 13.98, 14.28 and 14.35 spikelets per earhead were observed with the levels of 0, 40 and 80 kg  $P_2O_5$ /ha, respectively.

None of the two or three factors interactions was found to be significant.

#### 4.8 Number of grains per earhead

Mean number of grains per earhead of wheat varieties as influenced by varying levels of nitrogen and phosphorus are presented in Table 12 and the analysis of variance in Appendix-II.

It was evident from the data that varieties did not differ significantly in respect to number of grains per earhead. However, marginal difference in number of grains per earhead was observed. The grain count per earhead was 41.87 and 40.97 for variety GW-120 and GW-405, respectively.

Mean number of grains was significantly affected by various levels of nitrogen. Increase in nitrogen level resulted in increased number of grains per earhead. Application of 160 kg N/ha produced highest number of grains per earhead which was at par with that of 120 kg N/ha but both were significantly superior over 80 kg N/ha in this respect. On an average 80, 120 and 160 kg N/ha produced 39.82, 41.79 and 42.65 grains per earhead, respectively.

Table 12 : Mean number of grains per ear head of wheat varieties as influenced by various levels of nitrogen and phosphorus

Varieties (V)	Phosphorus kg/ha (P)	Nitrogen kg/ha (N)			Mean
		N <sub>80</sub>	N <sub>120</sub>	N <sub>160</sub>	
GW-120 (V <sub>1</sub> )	P <sub>0</sub>	39.65	41.20	42.35	41.07
	P <sub>40</sub>	40.20	42.50	43.25	41.98
	P <sub>80</sub>	41.05	43.25	43.40	42.57
	Mean	40.30	42.32	43.00	41.87
GW-405 (V <sub>2</sub> )	P <sub>0</sub>	38.25	40.30	41.15	39.90
	P <sub>40</sub>	39.65	41.50	42.50	41.22
	P <sub>80</sub>	41.10	42.00	43.25	41.78
	Mean	39.33	41.27	42.30	40.97
Mean	P <sub>0</sub>	38.95	40.75	41.75	40.48
	P <sub>40</sub>	39.93	42.00	42.88	41.60
	P <sub>80</sub>	40.58	42.63	43.33	42.18
	Mean	39.82	41.79	42.65	41.42

Source	SEm ±	C.D. at 5%	C.V. %
V	0.23	N.S.	Main Plot
N	0.35	0.99	3.27
P	0.35	0.99	Sub Plot
V x N	0.49	N.S.	4.01
V x P	0.49	N.S.	
N x P	0.60	N.S.	
V x N x P	0.85	N.S.	

N.S. : Not significant

Application of various levels of phosphorus had a significant effect on number of grains per earhead. Increasing levels of phosphorus generally resulted in increasing the number of grain per earhead. Application of 80 kg  $P_2O_5$ /ha gave the highest number of grains per earhead, but it was at par with 40 kg  $P_2O_5$ /ha. Both the levels of phosphorus gave significantly higher number of grains per earhead than control (0 kg  $P_2O_5$ /ha). Application of 0, 40 and 80 kg  $P_2O_5$ /ha on an average gave 40.48, 41.60 and 42.18 grains per earhead, respectively.

None of the interactions was found to be significant.

#### 4.9 Grain weight per earhead

The data on grain weight per head as influenced by various levels of nitrogen and phosphorus are presented in Table 13 and the analysis of variance in Appendix-II.

The data indicated that grain weight per earhead was significantly affected by varieties. Variety GW-405 gave significantly higher grain weight per earhead than GW-120. On an average variety GW-120 and GW-405 gave 1.71 and 1.84 g grain weight per earhead, respectively.

Effect of various levels of nitrogen was significant in respect of grain weight per earhead. Increase in nitrogen application resulted in increase in grain weight per earhead. Each level of nitrogen differed significantly with each other in respect of grain weight per earhead. Application of 160 kg N/ha showed highest grain weight per earhead followed by

Table 13 : Mean grain weight per earhead in gram of wheat varieties as influenced by various levels of nitrogen and phosphorus

Varieties (V)	Phosphorus kg/ha (P)	Nitrogen kg/ha (N)			Mean
		N <sub>80</sub>	N <sub>120</sub>	N <sub>160</sub>	
GW-210 (V <sub>1</sub> )	P <sub>0</sub>	1.50	1.61	1.61	1.57
	P <sub>40</sub>	1.58	1.75	1.93	1.75
	P <sub>80</sub>	1.60	1.84	1.98	1.81
	Mean	1.56	1.73	1.84	1.71
GW-405 (V <sub>2</sub> )	P <sub>0</sub>	1.66	1.83	1.80	1.76
	P <sub>40</sub>	1.61	1.90	2.05	1.85
	P <sub>80</sub>	1.72	1.90	2.10	1.91
	Mean	1.66	1.88	1.98	1.84
Mean	P <sub>0</sub>	1.58	1.72	1.71	1.67
	P <sub>40</sub>	1.59	1.82	1.99	1.80
	P <sub>80</sub>	1.66	1.87	2.04	1.86
	Mean	1.61	1.81	1.91	1.78

Source	SEM ±	C.D. at 5%	C.V. %
V	0.008	0.036	Main Plot
N	0.023	0.065	2.70
P	0.023	0.065	Sub Plot
V x N	0.032	N.S.	6.31
V x P	0.032	N.S.	
N x P	0.04	0.113	
V x N x P	0.06	N.S.	

N.S. : Not significant

120 kg N/ha. On an average 1.61, 1.81 and 1.91 g grain weight per earhead was recorded with the application of 80, 120 and 160 kg N/ha, respectively.

Various levels of phosphorus differed significantly in respect of grain weight per earhead. Every increase in phosphorus level resulted in an increase in grain weight per earhead. Application of 80 kg  $P_2O_5$ /ha gave highest grain weight per earhead (1.86 g) but it was at par with 40 kg  $P_2O_5$ /ha (1.80 g). However, both the levels of phosphorus gave significantly higher grain weight per earhead than control (0 kg  $P_2O_5$ /ha). Mean grain weights per earhead for 0, 40 and 80 kg  $P_2O_5$ /ha were 1.67, 1.80 and 1.86 g, respectively.

Except interaction between N and P, none of the other interactions was found to be significant. The treatment combination  $N_{160}P_{80}$  gave the highest grain weight per earhead (2.04 g) (Table 13). However, it was at par with treatment combination  $N_{160}P_{40}$  (1.99 g). But both were significantly superior to rest of the treatment combinations.

#### 4.10 Test weight (weight of 1000 grains)

The mean data on 1000 grain weight (g) as influenced by wheat varieties and different levels of nitrogen and phosphorus are presented in Table 14 and the analysis of variance in Appendix-II.

The data revealed that test weight was significantly affected by varieties. Variety GW-405 gave significantly

**Table 14 : Mean test weight (1000 grain) in gram of wheat varieties as influenced by various levels of nitrogen and phosphorus**

Varieties (V)	Phosphorus kg/ha (P)	Nitrogen kg/ha (N)			Mean
		N <sub>80</sub>	N <sub>120</sub>	N <sub>160</sub>	
GW-120 (V <sub>1</sub> )	P <sub>0</sub>	34.20	35.00	35.60	34.93
	P <sub>40</sub>	35.00	36.53	37.00	36.18
	P <sub>80</sub>	36.10	37.15	37.80	37.02
	Mean	35.10	36.23	36.80	36.04
GW-405 (V <sub>2</sub> )	P <sub>0</sub>	36.70	37.85	39.05	37.87
	P <sub>40</sub>	37.53	39.70	41.00	39.41
	P <sub>80</sub>	37.80	39.85	41.50	39.72
	Mean	37.34	39.13	40.52	39.00
Mean	P <sub>0</sub>	35.45	36.43	37.33	36.40
	P <sub>40</sub>	36.26	38.11	39.00	37.79
	P <sub>80</sub>	36.95	38.50	39.65	38.37
	Mean	36.22	37.68	38.66	37.52

Source	SEM ±	C.D. at 5%	C.V. %
V	0.18	0.83	Main plot
N	0.24	0.67	2.94
P	0.24	0.67	Sub plot
V x N	0.33	N.S.	3.08
V x P	0.33	N.S.	
N x P	0.41	N.S.	
V x N x P	0.58	N.S.	

N.S. : Not significant

higher test weight as compared to GW-120. Test weight of 39.00 and 36.04 were noted with GW-405 and GW-120, respectively.

Test weight was significantly influenced by various levels of nitrogen. Every increase in nitrogen level resulted in an increase in test weight. The highest test weight (38.66 g) was recorded with 160 kg N/ha. Test weight of 36.22, 37.68 and 38.66 g was obtained with application of 80, 120 and 160 kg N/ha, respectively.

Differences in test weight due to various levels of phosphorus were significant. The highest test weight was recorded when 80 kg  $P_2O_5$ /ha was applied, but it did not differ significantly from 40 kg  $P_2O_5$ /ha. Both these levels of phosphorus gave significantly higher test weight than control (0 kg  $P_2O_5$ /ha). Application of 0, 40 and 80 kg  $P_2O_5$ /ha gave 36.40, 37.79 and 38.37 g test weight, respectively.

None of the two or three factors interactions was found to be significant.

#### 4.11 Protein content of grain

Data on mean protein content of grain as influenced by varieties and different levels of nitrogen and phosphorus are presented in Table 15 and the analysis of variance is furnished in Appendix-II. The data are also depicted in Figure 4.

Differences in protein content due to varieties were significant. Variety GW-405 was found richer in protein

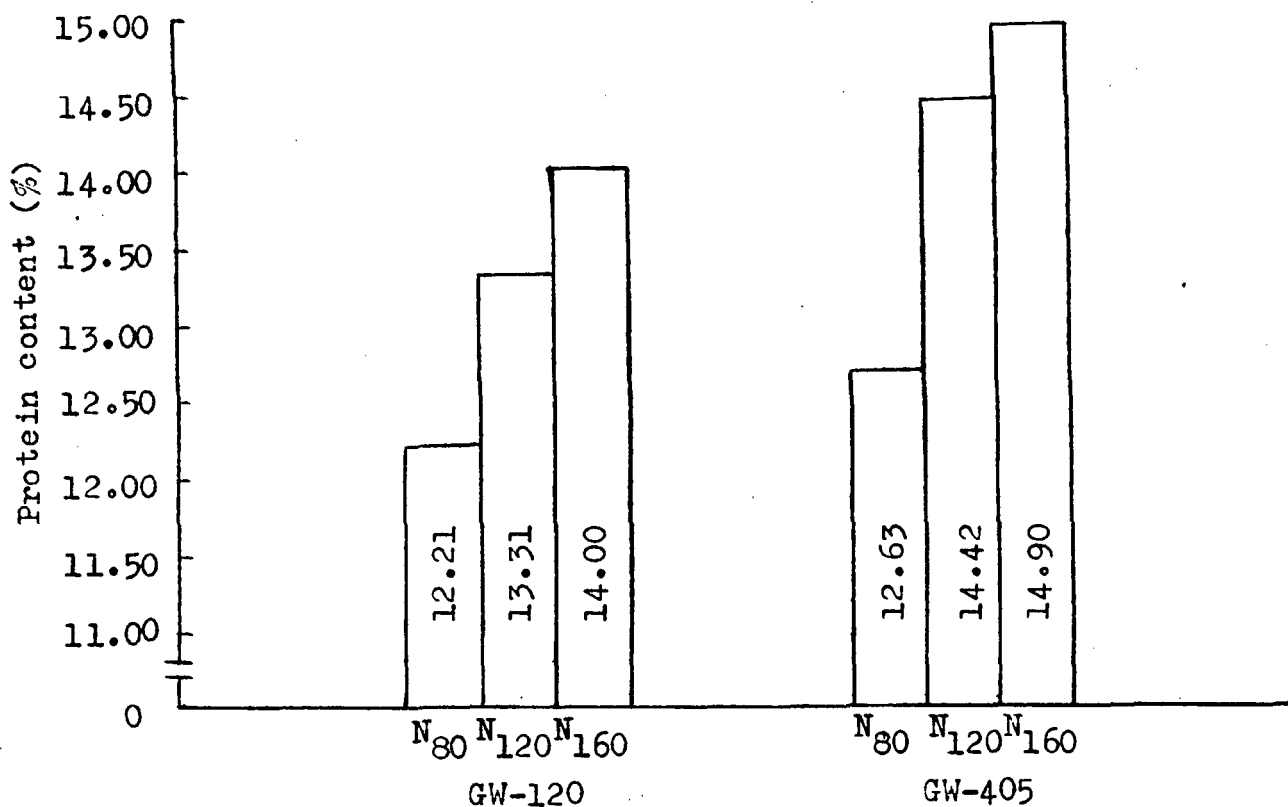
Table 15 : Mean protein content of wheat grain in percentage of wheat varieties as influenced by various levels of nitrogen and phosphorus

Varieties (V)	Phosphorus kg/ha (P)	Nitrogen kg/ha (N)			Mean
		N <sub>80</sub>	N <sub>120</sub>	N <sub>160</sub>	
GW-120 (V <sub>1</sub> )	P <sub>0</sub>	11.88	12.34	13.56	12.59
	P <sub>40</sub>	12.25	13.60	14.00	13.28
	P <sub>80</sub>	12.50	14.00	14.44	13.65
	Mean	12.21	13.31	14.00	13.17
GW-405 (V <sub>2</sub> )	P <sub>0</sub>	12.06	13.50	14.19	13.25
	P <sub>40</sub>	12.88	14.44	14.94	14.09
	P <sub>80</sub>	12.95	15.31	15.56	14.61
	Mean	12.63	14.42	14.90	13.98
Mean	P <sub>0</sub>	11.97	12.92	13.88	12.92
	P <sub>40</sub>	12.57	14.02	14.47	13.69
	P <sub>80</sub>	12.73	14.66	15.00	14.13
	Mean	12.42	13.87	14.45	13.58

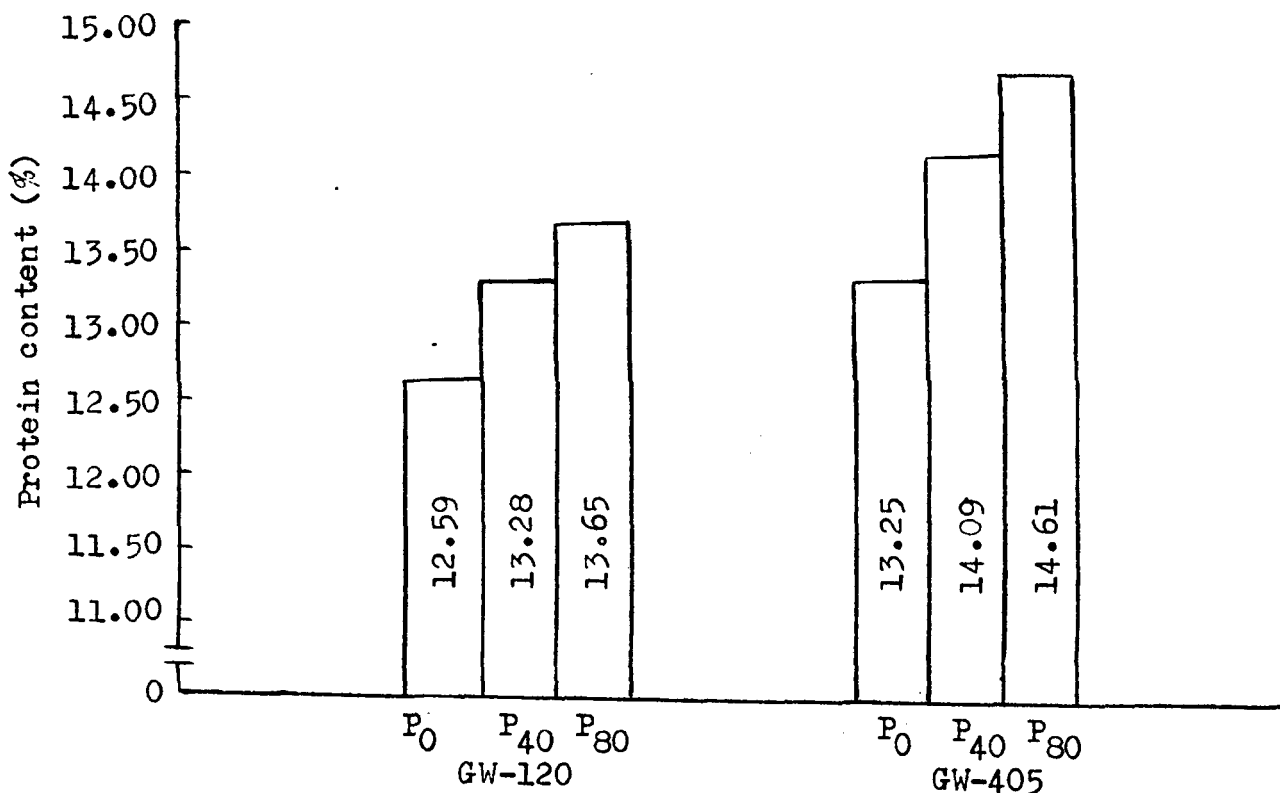
Source	SEm ±	C.D. at 5%	C.V. %
V	0.14	0.60	Main plot
N	0.11	0.31	5.94
P	0.11	0.31	Sub plot
V x N	0.15	N.S.	3.90
V x P	0.15	N.S.	
N x P	0.19	N.S.	
V x N x P	0.27	N.S.	

N.S. : Not significant

Figure 4



Mean protein content of two wheat varieties as influenced by various levels of nitrogen.



Mean protein content of two wheat varieties as influenced by various levels of phosphorus.

content than GW-120. Protein content found in GW-120 and GW-405 was 13.17 and 13.98 per cent, respectively.

Protein content was significantly affected by various levels of nitrogen. The highest protein content was recorded with the application of 160 kg N/ha, followed by 120 kg N/ha and 80 kg N/ha. All the levels of nitrogen differed significantly with each other. Application of 80, 120 and 160 kg N/ha gave 12.42, 13.87 and 14.45 per cent protein content, respectively.

Protein content was significantly affected due to various levels of phosphorus. The highest protein content was recorded with 80 kg  $P_2O_5$ /ha. All the three levels differed significantly with each other. Application of 0, 40 and 80 kg  $P_2O_5$ /ha on an average produced 12.92, 13.69 and 14.13 per cent protein content, respectively.

The results revealed that none of the interactions was observed to be significant.

#### 4.12 Economics

Average yield of grain and straw, gross realization, cost of cultivation, net profit and CBR for various treatments has been worked out and presented in Table 16.

Table 16 : Mean grain and straw yield in kg/ha of wheat, gross realization, cost of cultivation, net profit and CBR as influenced by various treatment combinations

Treatment effects	Grain yield kg/ha	Straw yield kg/ha	Gross realization Rs/ha	Total cost of cultivation Rs/ha	Net profit Rs./ha	CBR
V <sub>1</sub> N <sub>80</sub> P <sub>0</sub>	4000	5745	9862	5346	4516	1 : 1.84
V <sub>1</sub> N <sub>80</sub> P <sub>40</sub>	4269	6358	10559	5653	4906	1 : 1.87
V <sub>1</sub> N <sub>80</sub> P <sub>80</sub>	4313	6552	10687	5960	4727	1 : 1.79
V <sub>1</sub> N <sub>120</sub> P <sub>0</sub>	4302	6449	10647	5570	5077	1 : 1.91
V <sub>1</sub> N <sub>120</sub> P <sub>40</sub>	4632	7181	11499	5878	5621	1 : 1.96
V <sub>1</sub> N <sub>120</sub> P <sub>80</sub>	4688	7455	11666	6185	5481	1 : 1.89
V <sub>1</sub> N <sub>160</sub> P <sub>0</sub>	4316	6688	10724	5796	4918	1 : 1.85
V <sub>1</sub> N <sub>160</sub> P <sub>40</sub>	4646	7431	11569	6103	5466	1 : 1.90
V <sub>1</sub> N <sub>160</sub> P <sub>80</sub>	4733	7625	11793	6411	5382	1 : 1.84
V <sub>2</sub> N <sub>80</sub> P <sub>0</sub>	4104	6115	10151	5346	4805	1 : 1.90
V <sub>2</sub> N <sub>80</sub> P <sub>40</sub>	4276	6500	10596	5653	4943	1 : 1.87
V <sub>2</sub> N <sub>80</sub> P <sub>80</sub>	4340	6725	10774	5960	4814	1 : 1.81
V <sub>2</sub> N <sub>120</sub> P <sub>0</sub>	4285	6511	10618	5570	5048	1 : 1.91
V <sub>2</sub> N <sub>120</sub> P <sub>40</sub>	4663	7365	11597	5878	5719	1 : 1.97
V <sub>2</sub> N <sub>120</sub> P <sub>80</sub>	4755	7608	11840	6185	5655	1 : 1.91
V <sub>2</sub> N <sub>160</sub> P <sub>0</sub>	4305	6670	10687	5796	4891	1 : 1.84
V <sub>2</sub> N <sub>160</sub> P <sub>40</sub>	4688	7434	11663	6103	5560	1 : 1.91
V <sub>2</sub> N <sub>160</sub> P <sub>80</sub>	4809	7691	11974	6411	5563	1 : 1.87

The data pertaining to average net realization derived from the main effect presented in Table 17 indicated that variety GW-405 gave higher net profit (Rs.5222/ha) than GW-120 (Rs.5114/ha).

Among the various levels of nitrogen 120 kg N/ha gave the maximum net profit (Rs.5434), followed by 160 kg N/ha (Rs.5297) and 80 kg N/ha (Rs.4785).

With respect to phosphorus, application of 40 kg  $P_2O_5$ /ha gave the highest net profit of Rs.5369, while 80 kg  $P_2O_5$ /ha gave Rs.5270 and 0 kg  $P_2O_5$ /ha gave Rs.4876.

Considering the various treatment combinations, variety GW-405 with 120 kg N/ha + 40 kg  $P_2O_5$ /ha ( $V_2N_{120}P_{40}$ ) gave maximum net profit of Rs.5719, while, minimum net profit of Rs.4516 was obtained with variety GW-120 with 80 kg N/ha without phosphorus application ( $V_1N_{120}P_0$ ).

#### Cost Benefit Ratio (CBR)

Application of 120 kg N/ha + 40 kg  $P_2O_5$ /ha to variety GW-405 gave the highest CBR (1 : 1.97) with maximum net profit. Minimum CBR (1 : 1.79) was attained by application of 80 kg N/ha + 80 kg  $P_2O_5$ /ha to variety GW-120.

Table 17 : Net realization in Rs/ha of wheat as influenced by different treatments

Treatment	Net realization Rs/ha
V <sub>1</sub> GW-120	5114
V <sub>2</sub> GW-405	5222
N <sub>80</sub> 80 kg Nitrogen/ha	4785
N <sub>120</sub> 120 kg nitrogen/ha	5434
N <sub>160</sub> 160 kg nitrogen/ha	5297
P <sub>0</sub> 0 kg phosphorus/ha	4876
P <sub>40</sub> 40 kg phosphorus/ha	5369
P <sub>80</sub> 80 kg phosphorus/ha	5270

Cost

Sr. No.	Source	Amount in Rs.
1.	Cost of fertilizers	
(i)	Cost of N from urea	5.32/kg N
(ii)	Cost of P <sub>2</sub> O <sub>5</sub> from single super phosphorus	7.25/kg P <sub>2</sub> O <sub>5</sub>
2.	Cost of cultivate with tractor	45.00/hr
3.	Cost of seeds	3.00/kg
4.	Cost of labour	11.00/day
5.	Cost of irrigation	12.00/hr
6.	Cost of Aldrin	125.00/lit
7.	Cost of Ceresan	18.00/kg
8.	Interest %	12%
	<u>Selling price</u>	
1.	Grain (i) GW-120	225.00/q
	(ii) GW-405	225.00/q
2.	Straw	15.00/q

## **DISCUSSION**

## CHAPTER - 5

### DISCUSSION OF RESULTS

An experiment was conducted in rabi season of the year 1985-86 to study the performance of two late sown dwarf wheat varieties viz., GW-120 and GW-405 under different levels of nitrogen and phosphorus on loamy sand of Anand.

The results of the study presented in the preceding chapter are discussed in this chapter.

#### 5.1 Grain yield

The results reported in Table 5 indicated that the effects of varieties were found not significant. GW-120 and GW-405 gave on an average 4433 and 4469 kg/ha grain yield, respectively. The difference in grain yield due to varieties was not significant. This seems to be due to similar genetic set up due to common female parent utilized in the evolution of both the varieties. The non significant differences were observed in main yield affecting characters like mean number of effective tillers per metre row length, length of earhead, mean number of spikelets per earhead and mean number of grains per earhead. This leads to about equal response of both the varieties in grain yield. The results were in close concurrence with those reported by Agarwal et al. (1972); Singh and Singh (1973); Garg and Saraswat (1974); Shekhawat and Singh (1976); Bhardwaj (1977) and Singh et al. (1984).

It is observed from the data exhibited in Table 5 that 120 kg N/ha significantly increased grain yield as compared to 80 kg N/ha but it was at par with 160 kg N/ha. The three levels of nitrogen viz., 80, 120 and 160 kg/ha produced mean grain yield of 4217, 4554 and 4583 kg/ha, respectively. The increase in grain yield due to 120 and 160 kg N/ha was 7.99 and 8.68 per cent over that of 80 kg N/ha. Higher grain yields due to higher dose of nitrogen can be attributed to its heavier grains (Table 14), higher grain weight per earhead (Table 13), more number of grains per earhead (Table 12) and more number of effective tillers per metre row length (Table 9). The probable reason for such a marked response due to the addition of nitrogen might be that the soil of the experiment plot was deficient in this element (Table 1) which with applied nitrogen tended to put more vegetative growth, better root development and resulted in efficient photosynthesis and ultimately produced more grain yield. The increase in yield due to nitrogen beyond 120 kg N/ha showed a shouldering or levelling off effect and hence 120 kg N/ha appeared to be the optimum. The results were in agreement with those reported by Dubey and Lal (1971), Mathur *et al.* (1971); Sandhu and Gill (1972); Sharma *et al.* (1972); Shekhawat and Shekhawat (1973), Singh and Singh (1975 c), Bhardwaj (1977), Malik (1981), Singh and Agarwal (1982), Kapur *et al.* (1985) and Kumar (1985).

The data presented in Table 5 further showed that phosphorus application had significant effect on grain yield. Mean grain yield obtained was 4219, 4529 and 4606 kg/ha with 0, 40 and 80 kg  $P_2O_5$ /ha, respectively. The increase in grain yield due to 40 and 80 kg  $P_2O_5$ /ha was 7.35 and 9.17 per cent over that of no phosphorus application. The effect of 80 and 40 kg  $P_2O_5$ /ha in respect of grain yield production was at par. Higher grain yield with phosphorus application could be ascribed due to heavier grains (Table 14), higher grain weight per earhead (Table 13), more number of grains per earhead (Table 12) and more number of effective tillers per metre row length (Table 9). The probable reason for such a marked response might be due to the fact that application of phosphorus might have enhanced the root growth extensively. Also it is the important constituent of co-enzymes which are important for photosynthesis and protein synthesis. This might have increased number of tillers, number of grains per earhead, grain weight per earhead and test weight and ultimately the grain yield upto an optimal limit. In the present experiment the increase in yield due to phosphorus beyond 40 kg  $P_2O_5$ /ha showed a shouldering or levelling off effect and hence 40 kg  $P_2O_5$ /ha seemed to be the optimum. The results are in conformity with those noted by Sharma et al. (1971), Sinha et al. (1973), Sinha and Rai (1976), Varshney (1976), Singh et al. (1980), Vyas et al. (1980), Prasad et al. (1981), Yadav and Verma (1983), Parauha (1984) and Rana et al. (1985).

None of the interactions was found to be significant.

## 5.2 Straw yield

The data presented in Table 6 indicated that straw yield was not significantly affected by varieties. Variety GW-120 and GW-405 on an average produced 6831 and 6957 kg/ha straw yield, respectively. Both the varieties were at par in respect of straw yield due to same genetic set up and adaptability to the similar climatic conditions of locality. Plant height (Table 7) and total number of tillers per metre row length (Table 8) of these varieties were non significant. These two are the main plant characteristics which governs the vegetative growth (straw yield). This might have resulted in non significant differences between two varieties in straw yield. Similar results were obtained by Shekhawat and Singh (1976), Singh and Agarwal (1976), Bhadrwaj (1977) and Singh et al. (1984).

The differences in straw yield due to levels of nitrogen were significant (Table 6). The three levels of nitrogen viz., 80, 120 and 160 kg/ha on an average gave 6333, 7095 and 7256 kg/ha straw yield, respectively. Application of 160 kg N/ha did not differ significantly from 120 kg N/ha in this respect. The increase in straw yield due to 120 and 160 kg N/ha was to the tune of 12.03 and 14.57 per cent over that of 80 kg N/ha. The higher straw yield

under higher dose of nitrogen is attributed to more number of total tillers per metre row length (Table 8) and taller plants (Table 7). These ultimately resulted in more vegetative growth and higher straw yield. The increase in straw yield due to nitrogen beyond 120 kg N/ha showed a shouldering or levelling off effect and hence 120 kg N/ha seemed to be the optimum. The results are closely related with those reported by Singh and Shrivastva (1971), Khan et al. (1977), Agarwal and Moolani (1978), Agarwal and Yadav (1978), Patil and Khuspe (1978), Dhiman et al. (1982), Patel et al. (1982), Singh and Agarwal (1982) and Singh et al. (1983).

The mean data on straw yield presented in Table 6 revealed that the straw yield was significantly influenced due to phosphorus levels. The straw yields of 6363, 7044 and 7236 kg/ha were obtained by 0, 40, and 80 kg  $P_2O_5$ /ha, respectively. Effect of 80 kg  $P_2O_5$ /ha was found at par with 40 kg  $P_2O_5$ /ha in respect of straw yield. The increase in straw yield due to 40 and 80 kg  $P_2O_5$ /ha was 10.70 and 13.72 per cent over no phosphorus. Phosphorus is essential for cell division and growth which might have increased total number of tillers per metre row length (Table 8) and plant height to some extent (Table 7). This might have resulted in significant differences in plant height and total tillers per metre row length. The increase in straw yield due to

phosphorus beyond 40 kg  $P_2O_5$ /ha showed a shouldering or levelling off effect and hence 40 kg  $P_2O_5$ /ha appeared to be the optimum. The results were in conformity with those obtained by earlier workers viz., Singh et al. (1983), Yadav and Verma (1983) and Sinha and Rai (1984).

None of the interactions was found to be significant.

### 5.3 Final plant height

The varieties GW-120 and GW-405 did not differ significantly in their height (Table 7). GW-120 and GW-405 on an average gave plant height of 80.74 and 81.96 cm, respectively. The non significant differences in the plant height seemed to be due to same genetical characters because both varieties are double gene dwarf varieties. The results are in agreement with those reported by Sewaram et al. (1973).

Fertilisation of N at the rate of 80, 120 and 160 kg/ha to the crop caused a significant variation in the final plant height (Table 7). The higher two doses of nitrogen significantly increased the plant height over the lower dose. All the three rates of nitrogen viz., 80, 120 and 160 kg/ha had average plant height of 80.12, 81.56 and 82.37 cm, respectively. The increase in the plant height due to 120 and 160 kg N/ha was 1.8 and 2.8 per cent over that of 80 kg N/ha. The increase in the plant growth in term of plant height due to N application is expected because the soil of the

experiment plot was deficient in nitrogen. The basic fact that the nitrogen helps in cell division and cell elongation which might have ultimately increased the plant height. The results were in agreement with the findings of Sandhu and Gill (1971), Singh and Anderson (1975) and Halikatti (1983).

Data on the plant height (Table 7) showed that differences due to different rates of phosphorus were not significant. All the three rates of phosphorus viz., 0, 40 and 80 kg  $P_2O_5$ /ha had average plant height of 80.41, 81.58 and 82.05 cm, respectively. Thus phosphorus did not show improvement in height. Similar results were obtained by Patel (1985).

None of the interactions was found to be significant.

#### 5.4 Total tillers per metre row length

The mean data on number of total tillers per metre row length are presented in Table 8. It indicated that the difference in total tillers per metre row length due to varieties was not significant. GW-120 and GW-405 gave on an average 82.90 and 82.92 tillers per metre row length, respectively. Both the varieties were at par in respect of this character. This might be due to same genetic set up and adaptability to the same climatic conditions of locality. Similar results were obtained by Sewaram *et al.* (1973), Sewaram *et al.* (1975), Patel (1976a) and Sandhu (1982).

The data presented in Table 8 showed that there was significant increase in total tillers per metre row length with increase in nitrogen levels. The highest number of total tillers was recorded in the plots under the treatment of 160 kg N/ha but it was at par with 120 kg N/ha in this respect. Mean number of total tillers were 77.31, 85.67 and 85.75 by application of 80, 120 and 160 kg N/ha, respectively. The increase in total tillers due to 120 and 160 kg N/ha was 10.8 and 10.9 per cent over that of 80 kg N/ha. Application of nitrogen added to the vegetative vigour of the plant. This might have resulted in sprouting the newer tillers. The results were in agreement with those reported by Singh and Anderson (1975), Dhingra et al. (1979) and Gill and Singh (1980).

It is seen from the data presented in Table 8 that total tillers per metre row length were significantly affected due to phosphorus levels. Average total tillers per metre row length were 78.85, 84.73 and 85.15 under the treatment of 0, 40 and 80 kg  $P_2O_5$ /ha, respectively. The soil of the experimental plot was medium in phosphorus content (Table 1) which has responded to the lower level of 40 kg  $P_2O_5$ /ha and then after there was no advantage with higher level. Thus both the higher levels of phosphorus (40 and 80 kg  $P_2O_5$ /ha) did not differ significantly with each other in this respect. The increase in total tillers due to 40 and 80 kg  $P_2O_5$ /ha was 7.46 and 10.80 per cent over that of no phosphorus.

The results were in conformity with those obtained <sup>by</sup> earlier workers viz. Patel et al (1971), Tiwari and Singh (1969) and Amin (1983).

None of the interactions was found to be significant.

#### 5.5 Number of effective tillers per metre row length

The results reported in Table 9 indicated that the effects of varieties were found not significant. GW-120 and GW-405 gave on an average 78.37 and 78.11 effective tillers per metre row length, respectively. Both the varieties were at par in this respect due to same genetic set up. The results were in agreement with those reported by Sewaram et al.(1973), Sewaram et al. (1975), Patel (1976a), Sadhu (1982), Singh et al.(1985), Singh and Dixit (1985) and Naidu et al.(1986).

On examination of results (Table 9), it was found that levels of nitrogen had significant effect on effective tillers per metre row length. The treatment 160 kg N/ha produced the highest number of effective tillers per metre row length which was at par with 120 kg N/ha but significantly superior to 80 kg N/ha. Effective tillers per metre row length were 72.72, 80.77 and 81.25 by the application of 80, 120 and 160 kg N/ha, respectively. The increase in number of effective tillers per metre row length due to 120 and 160 kg N/ha was 11.09 and 11.75 per cent over that of 80 kg N/ha. The probable reason for higher number of effective

tillers under higher doses of nitrogen might be increased uptake of nitrogen throughout the growth period. Nitrogen being basic element for grain protein might have resulted in fruit-ful tillers. The results were in close concurrence with those reported by Bathkal and Patil (1970), Singh and Anderson (1975), Dhingra et al. (1979), Borse and Mahajan (1980), Gill and Singh (1980), Malik (1981) and Sadhu (1982).

Significant differences in number of effective tillers per metre row length were observed due to levels of phosphorus (Table 9). Number of effective tillers were 73.04, 80.19 and 81.50 under the treatments of 0, 40 and 80 kg  $P_2O_5$ /ha, respectively. Effect of 40 and 80 kg  $P_2O_5$ /ha did not differ significantly in this respect. The increase in number of effective tillers per metre row length due to 40 and 80 kg  $P_2O_5$ /ha was 9.79 and 11.58 per cent over that of no phosphorus application. The higher number of effective tillers under higher doses of phosphorus were observed due to increase in uptake of phosphorus throughout growth period. It plays an important role in enzymatic reaction and metabolism hence promotes the heading. The results are in close agreement with those reported by Tivari and Singh (1969), Patel et al. (1971), Prasad et al. (1981), Amin (1983) and Parauha (1984).

None of the interactions was found to be significant.

#### 5.6 Length of earhead

The data presented in Table 10 indicated that length of earhead was not significantly affected by the

varieties. Variety GW-120 and GW-405 gave on an average 8.36, and 8.50 cm length of earhead, respectively. The differences in length of earhead due to varieties were not significant. This could be ascribed to their same genetic set up and it is a hereditary character which is difficult to alter. Similar results were obtained by Patel (1976), Singh and Agarwal (1976), Sadhu (1982) and Singh et al. (1985).

The mean data on length of earhead presented in Table 10 revealed that the length of earhead was not significantly affected due to nitrogen levels. The length of earhead was 8.27, 8.47 and 8.55 cm with 80, 120 and 160 kg N/ha, respectively. The difference in length of earhead due to various levels of nitrogen was not significant. The probable reason is it being genetical character which might be not affected much by nitrogen. The results were in agreement with the finding of Gill and Singh (1980).

On examination of results (Table 10) it was found that levels of phosphorus had not significant effect on length of earhead. All three rates of phosphorus viz., 0, 40, and 80 kg  $P_2O_5$ /ha had average earhead length of 8.29, 8.49 and 8.52 cm, respectively. This showed no marked effect of phosphorus on earhead length. Similar results were obtained by Samui et al. (1975), Reddy and Bhardwaj (1984) and Patel (1985).

None of the interactions was found to be significant.

### 5.7 Number of spikelets per earhead

The results reported in Table 11 indicated that the number of spikelets per earhead was not significantly affected by the varieties. GW-120 and GW-405 gave on an average 14.23 and 14.17 spikelets per earhead, respectively. Both the varieties were at par in respect of number of spikelets per earhead due to same genetic set up and adaptability to the similar climatic conditions of locality. The results were in agreement with those reported by Patel (1976 a).

The mean data on number of spikelets per earhead presented in Table 11 revealed that the number of spikelets was not significantly affected by the various levels of nitrogen. However, nitrogen tended to increase number of spikelets per earhead. The number of spikelets per earhead were 14.03, 14.27 and 14.31 with 80, 120 and 160 kg N/ha, respectively. Similar results were obtained by Halikatti (1983).

Data on number of spikelets per earhead (Table 11) showed that differences due to different rates of phosphorus were not significant. All the three levels of phosphorus viz., 0, 40 and 80 kg  $P_2O_5$ /ha had on an average 13.98, 14.28 and 14.35 spikelets per earhead, respectively. Thus phosphorus tended to increase number of spikelets per earhead to some extent. Similar results were obtained by Reddy and Bhardwaj (1984).

None of the interactions was found to be significant.

### 5.8 Number of grains per earhead

The differences in average number of grains per earhead due to varieties were not significant (Table 12). The reason for obtaining statistically equal number of grains per earhead of the two varieties under test may be that they might be having similar genetical nature and the same climatic conditions of the place. Similar results were reported by Sharma and Singh (1971) in case of Sonalika and Chhoti lerna. Singh and Agarwal (1976) also found the same results for Kalyansona and Sonalika at Narsan.

The mean number of grains per earhead was influenced significantly by various levels of nitrogen. Mean number of grains per earhead was 39.82, 41.79 and 42.65 under the treatments 80, 120 and 160 kg N/ha, respectively. The effects of two higher levels of nitrogen did not differ significantly with each other. The probable reason for more number of grains per earhead under higher levels of nitrogen might be due to higher availability and uptake of nitrogen by the crop at grain filling stage. Moreover nitrogen helps in seed formation. The results are in agreement with those reported by Gupta and Singh (1971), Singh and Anderson (1975), Borse and Mahajan (1980), Malik (1981), Halikatti (1983) and Singh (1986).

The data on mean number of grains per earhead showed significant differences due to various levels of phosphorus.

The three levels viz., 0, 40 and 80 kg  $P_2O_5$ /ha produced 40.48, 41.60 and 42.18 grains per earhead, respectively. Effects of 80 and 40 kg  $P_2O_5$ /ha were at par in respect of number of grains per earhead. These findings are supported by Tiwari and Singh (1969); Amin (1983) and Parauha (1984).

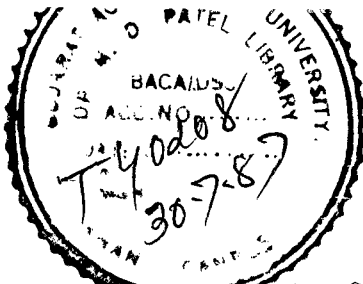
None of the interactions was found to be significant.

### 5.9 Grain weight per earhead

The data on grain weight per earhead as influenced by varieties, levels of nitrogen and phosphorus are presented in Table 13.

Both the varieties significantly affected the grain weight per earhead. Variety GW-405 produced significantly higher (1.84 g) grain weight as compared to the grain weight per earhead of variety GW-120 (1.71 g). The higher grain weight per earhead under GW-405 is attributed to higher test weight and compact filling of the spike of the variety. The results are similar to those obtained by Sharma and Singh (1971) and Sharma et al. (1972).

Perusal of results of the effect of nitrogen on mean grain weight per earhead indicated significant differences. Three levels of nitrogen i.e. 80, 120 and 160 kg N/ha gave an average grain weight of 1.61, 1.81 and 1.91 g per earhead, respectively. Application of nitrogen at each level significantly improved the grain weight per earhead. The increase in grain weight per earhead due to 120 and 160 kg N/ha was



12.42 and 18.63 per cent over that of 80 kg N/ha. This could be attributed to role of nitrogen to form plumpy and bold grains. These findings are in conformity with those obtained by Singh and Singh (1975 a) and Gill and Singh (1980).

Various levels of phosphorus exhibited significant effect on grain weight per earhead. Application of 40 and 80 kg  $P_2O_5$ /ha did not differ significantly in respect of grain weight per earhead. Application of 80 kg  $P_2O_5$ /ha produced 3.33 and 11.37 per cent more grain weight per earhead over 40 and 0 kg  $P_2O_5$ /ha, respectively. This may be due to the balanced utilization of nitrogen and phosphorus. Moreover, phosphorus might have stimulated the development of the grains. These results are supported by Prasad *et al.* (1981).

The interaction effects of nitrogen x phosphorus was found significant. Treatment combination  $N_{160}P_{80}$  produced significantly more grain weight per earhead than the remaining NP combinations followed by  $N_{160}P_{40}$  and both were significantly different from each other.

#### 5.10 Test weight (1000 grains weight)

The results of test weight as influenced by varieties, levels of nitrogen and phosphorus are presented in Table 14.

The differences in test weight due to varieties were significant. Variety GW-405 and GW-120 recorded 39.00, and 36.04 g test weight, respectively. Thus variety GW-405

had 8.21 per cent more test weight than GW-120. The higher test weight of GW-405 may be attributed to its larger size which is an inherent characteristic of the variety. These results are in agreement with those reported by Gupta and Singh (1971), Khanpara (1974), Patel (1976a), Amin (1983), Singh et al. (1985), Singh and Dixit (1985), Naidu et al. (1986).

Various levels of nitrogen significantly influenced the test weight of the seeds. The mean test weight values were 36.22, 37.68 and 38.66 g with 80, 120 and 160 kg N/ha, respectively. Application of each additional level of nitrogen significantly increased the test weight. This has also favoured the increase in grain yield. The probable reason for the increase in test weight due to higher levels of nitrogen is attributed to the formation of bold sized seeds. These findings are in conformity with those obtained by Bhatkal and Patil (1970), Misra and Singh (1971a), Gill and Singh (1980), and Halikatti (1983).

The significant differences in test weight were observed due to various levels of phosphorus. The mean test weight values of 36.40, 37.79 and 38.37 g were recorded with 0, 40 and 80 kg  $P_2O_5$ /ha, respectively. The latter two levels were at par in respect of their test weight values. Application of 80 kg  $P_2O_5$ /ha gave 1.53 and 5.4 per cent more test weight as compared to those due to 40 and 0 kg  $P_2O_5$ /ha, respectively. This may be due to favourable inducement of

seed development at higher rate of phosphorus. Similar results were reported by Patel et al. (1971); Samui et al. (1975); Sharma et al. (1977); Prasad et al. (1981) and Reddy and Bhardwaj (1984).

All the interaction effects were not significant.

#### 5.11 Protein content of grains

The results of the protein content of wheat grains as affected by varieties, levels of nitrogen and phosphorus are exhibited in Table 15.

The differences in protein content of grains due to varieties were observed to be significant. Mean protein content recorded with GW-120 was 13.17 per cent while with GW-405 it was 13.98 per cent. This showed that GW-405 contained 6.15 per cent more protein over that of GW-120. This variation may be due to the inherent capacity of the varieties as well as the nitrogen use efficiency of the varieties. Similar findings have been obtained by Patel (1976<sub>a</sub>), Amin (1983) and Patel (1984).

The results further showed significant effect of different levels of nitrogen on protein content. Application of nitrogen at 80, 120 and 160 kg N/ha gave an average protein content of 12.42, 13.87 and 14.45 per cent, respectively. Each additional level of nitrogen significantly improved the protein content of grain. Thus 160 kg N/ha registered 4.18 and

16.34 per cent more protein over those due to 120 and 80 kg N/ha, respectively. The higher protein content is attributed to higher uptake of nitrogen from the soil. These results are in agreement with those reported by Dutta and Seth (1970), Misra and Singh (1971 a), Subbaih and Morachan (1974), Koshenyakava (1976), Pal and Sharma (1977), Sadhu (1982), Amin (1983) and Patel (1985).

From the Table 15 it appears that the increase in rate of phosphorus has significantly increased the protein content of the grains. Phosphorus application at 0, 40 and 80 kg  $P_2O_5$ /ha gave the mean protein content as 12.92, 13.69 and 14.13 per cent, respectively. The highest rate of phosphorus i.e. 80 kg  $P_2O_5$ /ha noted 3.21 and 9.3 per cent more protein content over those due to 40 and 0 kg  $P_2O_5$ /ha, respectively. The increase in protein content with increase in P levels may be due to more protein synthesis in the presence of phosphorus and formation of some stable phospho-protein compounds. These results are in conformity with those obtained by Ahmed and Khan (1977), Amin (1983), Yadav and Verma (1983) and Patel (1985).

Effect of all the interactions were not significant with respect to protein content of grain.

### 5.12 Monetary return (Economics)

The data on gross realization, cost of cultivation, net realization and CBR are presented in Table 16 and 17.

Perusal of economics indicated about equal response of both the varieties, but the difference was marginal in respect of net profit. Average net realization of GW-405 was more (Rs.5222/ha) than the GW-120 (Rs.5114/ha).

The differences in cost of cultivation between  $N_{80}$ ,  $N_{120}$  and  $N_{160}$  were appreciable. The significant increase in yield due to increase in nitrogen was observed upto 120 kg N/ha. The mean values of net realization for  $N_{80}$ ,  $N_{120}$  and  $N_{160}$  were Rs.4785, 5434 and 5297 $\frac{1}{2}$  respectively. The low realization with 160 kg N/ha was due to increasing cost of nitrogen with increasing rate of nitrogen. The  $N_{120}$  gave 13.56 and 2.59 per cent higher net realization than  $N_{80}$  and  $N_{160}$ , respectively. Thus, there was a clear indication of law of diminishing return with increasing rate of nitrogen.

The per hectare net realization values for  $P_0$ ,  $P_{40}$  and  $P_{80}$  were Rs.4876, 5369 and 5270, respectively. This showed that 40 kg  $P_2O_5$ /ha gave 10.11 and 1.88 per cent more remuneration as compared to 0 kg  $P_2O_5$  and 80 kg  $P_2O_5$ /ha, respectively. Higher net realization from the treatment 40 kg  $P_2O_5$ /ha was observed then after increasing rate did not produce more remuneration due to law of diminishing return.

The overall data showed that the treatment combination  $V_2N_{120}P_{40}$  which involved the variety GW-405, 120 kg N/ha and 40 kg  $P_2O_5$ /ha ranked first in respect of net realization, which amounted to Rs.5719 per hectare.

#### OBR

The figures of cost benefit ratios showed that the both the varieties slightly differed in respect of their ratios with the high yielding fertilizer treatment combination i.e. 120 kg N/ha + 40 kg  $P_2O_5$ /ha. Thus the highest cost benefit ratio (1 : 1.97) is obtained under GW-405 followed by GW-120 (1 : 1.96) with this fertilizer treatment.

#### 5.13 Practical application

Practical recommendations arising from this investigation for middle Gujarat agro-climatic conditions are :

1. From yield and economic point of view, both the varieties are recommended depending upon the availability and cost of the seeds.
2. Application of 120 kg N/ha found optimum and economical dose, hence it is recommended.
3. In case of phosphorus 40 kg  $P_2O_5$ /ha, observed optimum and economic level, thus it is recommended.

#### 5.14 Future line of work

The following suggestions are made for future line of work on the basis of results obtained in this investigation.

1. Varieties GW-120 and GW-405 should be tested for other agronomic requirements like seed rate, sowing time, spacing, method of sowing and irrigation for different agro-climatic zones.
2. Phosphorus and zinc requirement should be investigated based on soil test values.
3. Other micronutrients requirement may be tested for high yielding dwarf varieties of wheat.
4. Method, time of application and source of minor and major nutrient elements need to be investigated.

**SUMMARY  
AND  
CONCLUSION**

## CHAPTER - 6.

### SUMMARY AND CONCLUSION

In irrigated areas, wheat is taken after monsoon crop in the intensive cropping system. There was, therefore, a need for late sown varieties to grow in such regions. The release of the two new high yielding late sown varieties showed a promise for this purpose but the information on fertilizer requirement of these varieties was lacking for the middle Gujarat Agro-climatic Zone of the State. To evaluate the performance of wheat varieties, 'GW-120' and 'GW-405' and find out optimum and economic dose of nitrogen and phosphorus of both these varieties an experiment was conducted at the College Agronomy Farm, B.A. College of Agriculture, Gujarat Agricultural University, Anand Campus during rabi season of the year 1985-86.

Totally 18 treatment combinations comprising of two varieties viz., (i) GW-120 and (ii) GW-405; three levels of nitrogen viz., 80, 120 and 160 kg N/ha and three levels of phosphorus viz., 0, 40 and 80 kg  $P_2O_5$ /ha were laid out in a split plot design with four replications.

The results of the performance of two varieties in terms of yield and quality of grain protein as affected by different levels of nitrogen and phosphorus are summarised as under.

### 6.1 Varietal performance

Experimental findings indicated that both the wheat varieties viz., GW-120 and GW-405 performed statistically at par producing the grain yield of 4433 and 4469 kg/ha, respectively. Similar trend was also observed in case of straw yield. Variety GW-120 gave the straw yield of 6831 kg/ha while GW-405 gave 6957 kg/ha. The net profit of Rs.5112 and 5222 per hectare was realised with the variety GW-120 and GW-405, respectively. The marginal increase in net profit with GW-405 is related to slightly more grain and straw yield over GW-120.

Among different yield attributes, only grain weight per earhead and test weight (1000-grains) were affected significantly due to varieties. GW-405 had higher grain weight per earhead as well as test weight (1000 grains) as compared to GW-120. The remaining yield attributing characters under study were not influenced significantly due to varieties.

Protein content of grain was significantly higher in GW-405 (13.98 %) than GW-120 (13.17 %).

### 6.2 Effect of nitrogen

Application of nitrogen at 160 kg/ha gave the maximum grain (4583 kg/ha) yield, which was at par with the yield (4554 kg/ha) obtained under 120 kg N/ha. Application of nitrogen at 80 kg/ha produced significantly the lowest grain yield (4217 kg/ha).

In case of straw yield, the linear response of nitrogen was noted upto 120 kg N/ha. Maximum straw (7256 kg/ha) yield recorded under 160 kg N/ha was at par with the straw yield (7095 kg/ha) obtained with an application of 120 kg N/ha. Application of 80 kg N/ha gave the lowest straw yield (6333 kg/ha). Maximum net profit of 5434 Rs/ha was realised with application of 120 kg N/ha. Application of 80 and 160 kg N/ha gave lower net profit of Rs.4785 and 5297 Rs/ha over 120 kg N/ha.

Application of higher levels of nitrogen i.e. 120 and 160 kg N/ha significantly improved the number of total tillers/metre row length, number of effective tillers/metre row length, plant height, number of grains per earhead, grain weight per earhead and test weight as compared to 80 kg N/ha. The effect of the former two levels of nitrogen on these parameters did not differ significantly. The length of earhead and number of spikelets per earhead were not influenced significantly due to the levels of nitrogen.

An increase in rates of nitrogen significantly improved the protein content of grain. The protein content was 12.42, 13.87 and 14.45 per cent with 80, 120 and 160 kg N/ha, respectively.

### 6.3 Effect of phosphorus

Phosphorus application helped to increase the grain yield of wheat. Maximum grain (4606 kg/ha) yield was obtained

with 80 kg  $P_2O_5$ /ha, which was at par with the yield (4529 kg/ha) produced with 40 kg  $P_2O_5$ /ha. The lowest grain yield of 4219 kg/ha was obtained when no phosphorus was applied.

Similar trend as in grain yield was observed for straw yield also. Application of 80 kg  $P_2O_5$ /ha yielded (7276 kg/ha) significantly higher straw yield as compared to no phosphorus (6363 kg/ha) but the former was at par with 40 kg  $P_2O_5$ /ha (7044 kg/ha) in respect of straw yield.

The highest net profit (5369 Rs/ha) was achieved with application of 40 kg  $P_2O_5$ /ha, which was 1.88 and 10.11 per cent more than 80 kg  $P_2O_5$ /ha and no phosphorus, respectively.

The yield attributes like number of total tillers/metre row length, number of effective tillers/metre row length, number of grains/earhead, grain weight/earhead, and test weight were significantly improved with phosphorus application over no phosphorus application. Both the levels of phosphorus viz., 40 and 80 kg  $P_2O_5$ /ha exhibited similar effect on these parameters. Significant response of phosphorus application was not observed on length of earhead, plant height and number of spikelets/earhead.

An increase in rate of phosphorus significantly increased the protein content of grain. The protein content was 12.92, 13.69 and 14.13 per cent with the levels of 0, 40 and 80 kg  $P_2O_5$ /ha, respectively.

#### 6.4 Effect of interactions

None of the interactions except nitrogen x phosphorus with regard to grain weight/earhead was significant. The treatment combination 160 kg N/ha + 80 kg  $P_2O_5$ /ha was found superior, followed by 160 kg N/ha + 40 kg  $P_2O_5$ /ha.

#### 6.5 Economics

Both the varieties performed just similar in respect of grain and straw yield, hence the marginal difference was observed in net profit. GW-405 gave maximum net profit of 5222 Rs/ha, while GW-120 gave 5114 Rs/ha.

Among three levels of nitrogen 120 kg N/ha realised the maximum net profit of 5434 Rs/ha which was 13.56 and 2.59 per cent higher over 80 and 160 kg N/ha, respectively. Similar trend was also observed in case of phosphorus application. The highest level of phosphorus and the control treatment did not help to improve the net profit but 40 kg  $P_2O_5$ /ha gave maximum net profit of 5369 Rs/ha. The treatment combination  $V_2N_{120}P_{40}$  (GW-405, 120 kg N/ha + 40 kg  $P_2O_5$ /ha) realised maximum net profit of 5719 Rs/ha, followed by 5655 Rs/ha due to the same variety with 120 kg N/ha + 80 kg  $P_2O_5$ /ha.

The highest CER value (1 : 1.97) was obtained with application of 120 kg N/ha + 40 kg  $P_2O_5$ /ha to variety GW-405, immediately followed by GW-120 variety at the same combination of NP (1 : 1.96).

## 6.6 Conclusion

From the results of grain and straw yield as well as the economics, it can be concluded that both the dwarf wheat varieties were suitable for late sown conditions in the middle Gujarat agro-climatic zone. These varieties should be fertilized with 120 kg N/ha + 40 kg P<sub>2</sub>O<sub>5</sub>/ha for securing maximum net profit.

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\* Original not referred.

APPENDIX - I

Analysis of variance for various characters

Sources	d.f.	Mean square values						
		Grain yield (kg/ha) 10 <sup>3</sup>	Straw yield (kg/ha) 10 <sup>3</sup>	Final plant height on	Total tillers per row length	Effective tillers per metre row length	Length of ear head	
Replication	3	12.48	24.72	8.87	25.60	32.15	0.07	
Variety (V)	1	23.76	286.15	26.65	0.004	1.25	0.32	
Error (A)	3	171.24	360.25	26.43	17.90	14.92	0.09	
Nitrogen (N)	2	992.51*	5840.68*	31.18*	563.96*	552.77*	0.51	
Phosphorus (P)	2	1009.67*	5409.54*	17.06	297.10*	497.32*	0.38	
N x P	4	22.05	78.22	1.97	61.58	51.43	0.02	
V x N	2	0.53	67.09	1.81	14.48	30.34	0.02	
V x P	2	22.05	78.22	1.97	61.58	51.43	0.02	
V x N x P	4	5.37	20.43	2.06	9.04	10.54	0.01	
Error (B)	48	101.30	235.87	5.53	35.27	29.99	0.17	
Total	71							

\* : Indicates significant at 5 per cent level.

APPENDIX - II

Analysis of variance for various characters

Sources	d.f.	Mean square values				
		Number of spikelets per earhead	Number of grains per earhead	Grain weight per earhead	Test weight, g	Protein content of grain, %
Replication	3	0.50	3.67	0.002	0.59	0.08
Variety (V)	1	0.08	14.76	0.31*	157.24*	11.71*
Error (A)	3	0.20	1.83	0.002	1.21	0.65
Nitrogen (N)	2	0.56	50.66*	0.56*	36.11*	26.17*
Phosphorus (P)	2	0.95	17.76*	0.22*	24.54*	8.92*
N x P	4	0.01	0.08	0.05*	0.61	0.52
V x N	2	0.02	0.20	0.003	3.27	0.74
V x P	2	0.01	0.08	0.05	0.61	0.52
V x N x P	4	0.004	0.34	0.004	0.14	0.10
Error (B)	48	0.41	2.68	0.01	1.34	0.28
Total	71					

\* : Significant at 5 per cent level