# RESULTS AND DISCUSSION

## A - Wheat growth :

### A.1- Number of plants per square meter :

The number of plants/$m^2$ as influenced by rates and methods of seeding in the two seasons is shown in table 3.

In the two growing seasons, each increase in the rate of seeding, was accompanied by a significant increase in the number of plants/$m^2$. Also, hand drill sowing on flat or ridges was affective to increase significantly this number in the second season. The largest number of plant/$m^2$ was recorded for hand drill sowing or flat ( Table 3).

The increase in the number of plants/$m^2$ due to the increase in the rate of seeding is rather expected. However, the increase observed in this number due to hand drilling could be attributed to uniform distribution of seeds/unit area, as well as, relatively uniform depth of sowing.

In the first season, the number of plants/$m^2$ was significantly affected by the interaction between rate and method of seeding ( Table 3-a).

It is evident that drill sowing on flat was most effective to increase plants number/$m^2$ at dense sowing. At the highest rate of seeding, a significant difference was observed amongst the two drill sowing methods in

Table (3): Number of plants/m$^2$ as influenced by rate and method of seeding in the two seasons.

| Main effects | 1975/1976 | 1976/1977 |
|---|---|---|
| Nitrogen levels | | |
| Zero | --- [1] | --- |
| 30 kg N/fad | --- | --- |
| 60 kg N/fad | --- | --- |
| 90 kg N/fad | --- | --- |
| Seeding rates : | | |
| 35 kg/fad | 205.6 a | 162.2 a |
| 52.5 kg/fad | 272.2 b | 198.4 b |
| 70.0 kg/fad | 352.3 c | 285.2 c |
| F. test | ** | ** |
| Seeding methods | | |
| Broadcastong | 235.2 a | 219.6 |
| Drilling on flat | 319.1 c | 226.8 |
| Drilling on ridges | 275.7 b | 199.4 |
| F. test | ** | N.S |

1- Not recorded because N fertilization was not yet practised.

Table (4): Plant height (cm) and number of tillers/plant as influenced by nitrogen levels, seeding rates and sowing methods in the two seasons.

| Main effects | Plant height (cm) | | | | Number of tillers/plant | | | |
|---|---|---|---|---|---|---|---|---|
| | 1975/1976 | | 1976/1977 | | 1975/1976 | | 1976/1977 | |
| | Number of days after sowing | | | | Number of days after sowing | | | |
| | 77 | 97 | 70 | 85 | 77 | 97 | 70 | 85 |
| **Nitrogen levels** | | | | | | | | |
| Zero | 52.4a | 67.4a | 50.7a | 67.3a | 2.10a | 1.55a | 2.35a | 2.42a |
| 30 kg N/fad | 60.1b | 73.6a | 65.2b | 94.0b | 2.32a | 2.69b | 2.95b | 3.36b |
| 60 kg N/fad | 66.8c | 86.5b | 66.0b | 97.6b | 2.61b | 2.88b | 3.01b | 3.69bc |
| 90 kg N/fad | 70.0c | 93.5b | 72.4c | 101.8b | 2.79b | 3.16c | 3.39b | 4.00c |
| F. test | * | * | * | ** | * | ** | * | * |
| **Seeding rates** | | | | | | | | |
| 35 kg/fad | 61.3 | 77.4a | 63.7 | 90.5 | 3.14c | 3.11b | 3.60c | 4.21b |
| 52.5 kg/fad | 62.5 | 79.9a | 62.2 | 89.0 | 2.35b | 2.40a | 2.89b | 3.10a |
| 70.0 kg/fad | 63.3 | 83.4b | 64.9 | 90.9 | 1.87a | 2.19a | 2.35a | 2.80a |
| F.test | N.S | ** | N.S | N.S | ** | ** | ** | ** |
| **Seeding methods** | | | | | | | | |
| Broadcasting | 60.5a | 78.2a | 63.2 | 88.7a | 3.32b | 3.28b | 3.21b | 3.95b |
| Drilling on flat | 63.9b | 82.2b | 63.8 | 89.6a | 2.10a | 2.21a | 2.74a | 3.03a |
| Drilling on ridges | 62.7a | 80.3a | 63.7 | 92.2b | 1.94a | 2.22a | 2.83a | 3.13a |
| F. test | * | * | N.S | ** | ** | ** | * | ** |

Addition of nitrogen was accompanied by a significant increase in plant height. In the first season, differences in plant height were most pronounced than in the second season, particularly at the second date of sampling.

Differences in the magnitude of response to N fertilization among the two seasons could be atributed to differences in the soil available N level. In the second season, the soil was of higher soil available N than in the first season ( Table 1). In wheat, several workers found N fertilization resulted in stem elongation (El-Sayed, 1973; Ibrahim and Assey, 1976; Mohamed 1976; El-Metwally, 1977 and Saleh, 1977).

In the first season, wheat plants were elongated due to doubling the rate of seeding. This was valid at 97 days after sowing, but was not observed in the second season. Similar effect was observed by Ibrahim (1972) however, Abdulgalil (1964) reported decrease in plant height of wheat due to dense sowing. Under the present study, the increase in plant height due to dense sowing could be attributed to competition between plants for light.

At the two dates of sampling in the first season and at the second date in the second season, significant differences were seen in plant height among the three methods of sowing ( Table 4). In the first season, longer plants were observed for drill sowing on flat than in the two other two methods. In the second season, drilling on ridges produced the longest plants.

The effect observed in the first season ascertained the view that wheat plants might have had compet for light when were crowded. Data in table 3 indicated the drilling on flat in the first season had the highest number of plants/m$^2$ ( Table 3). In the second season no significant differences were detected in the number of plants/m$^2$ among the three methods of sowing.

A.3- Number of tillers per plant :

The effect of N level and rate and method of seeding on the number of tillers per plant at two dates of sampling in the two seasons is shown in table 4.

In the two seasons, nitrogen fertilization increased significantly the number of tillers/plant at the two dates of sampling. The effect was most obvious at the second than at the first date of sampling. Several workers found nitrogen to increase tillering of wheat (Sandhu and Gill, 1971; Ishab and Taha, 1974; Mohamed, 1976; El-Metwally, 1977; and Saleh, 1977).

Significant reduction in the number of tillers/plant was noticed with the increase in the rate of seeding. This was valid at the two dates of sampling in the two seasons ( Table 4). At the first date of sampling, the decrease was consistent and significant with each increase in the rate of seeding. At the second date of sampling, no significant increase in the number of tillers/plant was seen when the rate of seeding was further increased from 52.5 to 70 kg/fad.

reduction in the number of tillers/plant with each increase in the rate of seeding.

A.4- <u>Leaf area per plant</u> :

Leaf area/plant as influenced by N level and rate and method of seeding at two dates of sampling in the two seasons is given in table 5.

In the two seasons, the increase in N fertilization level was accompanied by significant increases in leaf area/plant. The effect was most pronounced at 77 and 85 days after sowing in the two seasons, respectively. At this two dates of sampling, the increase in leaf area with each N increment was significant.

Addition of N was found to increase leaf area in wheat (Khalifa, 1973 and Abdulgalil, 1979). Under the present study, addition of N was effective to increase the number of tillers/plant (Table 4). This increase could contribute to the increase observed herein in leaf area/plant. The role of N towards leaf longevity cannot be denied in this respect.

A significant decrease in leaf area/plant was noticed with the increase in the rate of seeding. This was valid at the two dates of sampling, but the decrease was most obvious in the second season (Table 5).

It is rather expected, due to intense competition between plants, that dense sowing could be accompanied by a decrease in leaf area/plant.

Significant differences were observed in leaf area/plant among the three methods of sowing in favour of broadcasting (Table 5). This was true at the two dates of sampling in the two seasons.

Data in table 3 indicated that the plant stand in broadcasting was lower than in the two drilling methods. Limited competition between wheat plants in the former could account for the increase of leaf area/plant.

In the second season, the interaction between N level and rate of seeding affected significantly the leaf area/plant at 85 days after sowing ( Table 5-a).

Table (5-a): Leaf area/plant ($cm^2$), 85 days after sowing, as influenced by the interactions between nitrogen levels and seeding rates in the second season.

| Seeding rates (kg /fad) | Nitrogen levels (kg N/fad) | | | |
|---|---|---|---|---|
| | zero | 30 | 60 | 90 |
| 35 | B<br>227.6 a | C<br>387.6 b | B<br>446.8 c | C<br>532.7 d |
| 52.5 | A<br>154.5 a | A<br>238.9 b | A<br>326.1 c | B<br>434.8 d |
| 70 | A<br>153.2 a | B<br>297.8 b | A<br>278.5 b | A<br>291.8 b |

F. test : **

It is quite interesting to notice from the table that in light or moderate sown plots, each increase in N

It is obvious that without N fertilization, no significant differences could be seen in leaf area/plant due to varying the method of sowing. In the N fertilized plots, significant differences in favour of broadcasting could be observed in leaf area/plant among the three methods of seeding. This increase could be attributed to better growth by the individual plants in the broadcasted plots due to low plant number and thus limited competition among them.

A.5- Leaf area index (LAI):

Data in table 5 show the effect of N level and rate and method of sowing on the LAI at two dates of sampling in the two seasons.

The increase in N fertilization level from 30 to 90 kg N/fad was accompanied by a significant increase in LAI. This was valid at the two dates of sampling in the two seasons.

Similar increase was observed in leaf area per plant (Table 5) and in the number of tillers/plant (Table 4) and was reported by others in the literature (Khalifa, 1973 ; Saleh , 1977 and Abdulgalil, 1979).

At the second date of sampling in the two seasons, significant differences were detected in LAI among the different rates of seeding (Table 5). In the first season, LAI was increased significantly due to the increase in the rate of seeding from 35 to 70 kg/fad. In the second season, this increase did not reach the level of significance.

The present results indicate that the decrease in leaf area/plant (Table 5) as a result of the increase in the rate of seeding was compensated by the increase in the number of plants/$m^2$ (Table 3). This compensation levelled the differences in LAI at the first date of sampling in the two seasons. Late in the season, the increase in the number of plants/$m^2$ over compensated the decrease in leaf area/plant and therefore the LAI was significantly increased.

The method of sowing had significantly influenced LAI at the second date of sampling in the first season and at the two dates of sampling in the second one (Table 5 ). At the second date of sampling the effect was more pronounced among the two drilling methods. It is evident that seed drilling on flat had significantly higher LAI than drilling on ridges. No significant differences could be detected in LAI among broadcasting and drilling on flat method.

The present results indicate that drilling on flat might have had maintained uniform plant distribution and thus more light interception by leaves. This could account for the increase in LAI in the second season. In the first season, the increase in the number of plants/$m^2$ due to this method of sowing (Table 3) cannot be neglected.

In the second season, the interaction between N level and rate of seeding affected significantly the LAI at 85 days after sowing (Table 5-c).

Table (5-c): Leaf area index (LAI), 85 days after sowing, as influenced by the interaction between nitrogen levels and seeding rates in the second season.

| Seeding rates (kg/fad) | Nitrogen levels ( kg N/fad) | | | |
|---|---|---|---|---|
| | zero | 30 | 60 | 90 |
| 35 | A<br>3.97 a | B<br>6.02 b | A<br>8.03 c | A<br>9.27 c |
| 52.5 | A<br>3.02 a | A<br>4.19 a | A<br>6.89 b | A<br>9.69 c |
| 70 | A<br>4.03 a | C<br>9.12 c | A<br>7.41 b | A<br>8.52 bc |

F. test **

It is obvious that at the lowest rate of seeding, LAI did not reach its maximum unless 90 kg N/fad was added. However, at the highest rate of seeding, LAI attained its maximum when only 30 kg N/fad were given.

The present results clearly indicate that LAI could be maximised through dense sowing with low N fertilization level. For light sowing, higher N fertilization levels should be tried. The decrease in LAI due to the increase in N level at dense sowing could be attributed to mutual shading of the upper leaves to lower ones and hence an intense competition for light.

In the second season, the interaction between N level and method of sowing affected significantly the LAI at 85 days after sowing (Table 5-d).

Table (5-d): Leaf area index (LAI), 85 days after sowing, as influenced by the interaction between nitrogen levels and methods of sowing in the second season.

| Seeding method | Nitrogen levels (kg N/fad) | | | |
| --- | --- | --- | --- | --- |
| | zero | 30 | 60 | 90 |
| Broadcasting | A<br>3.88 a | B<br>8.19 b | B<br>9.88 bc | B<br>10.50 c |
| Drilling on flat | A<br>3.61 a | A<br>5.22 ab | A<br>6.58 b | B<br>10.28 c |
| Drilling on ridges | A<br>3.53 a | A<br>5.93 b | A<br>5.87 b | A<br>6.69 b |

F. test **

It is evident that in broadcasting method, LAI continued to increase significantly up to the addition of 60 kg N/fad. In the drilling on flat method, LAI continued to increase significantly up to the addition of 90 kg N/fad. In the third method of sowing i.e. drilling on ridges, LAI failed to increase significantly beyond the addition of 30 kg N/fad.

The present results refer to differential response to N fertilization due to varying the method of sowing. It further indicate that seed drilling on ridges might have had introduced some sort of competition between plants for growth factors other than nitrogen. It is rather expected that competition for light is one of the major factors influencing growth and longevity of leaves. In drill sowing on ridges, light distribution, as well as, light intensity between plants cannot be considered uniform due to shading caused by plants in drills at high position to those in drills at low position on the ridge.

A.6- Flag leaf area :

The flag leaf area as influenced by N level and rate and method of sowing in the two seasons is shown in table 6.

The flag leaf area was significantly increased due to addition of N. The effect was most pronounced in the second season where each N increment resulted in a significant increase in flag leaf area. In the first season, no further significant increase was observed in the flag leaf area when the third N increment was given.

In the second season, the increase in rate of seeding was accompanied by a significant decrease in the flag leaf area. This was not true in the first season (Table 6).

These data indicate that the flag leaf area was adversely affected by the increase in the rate of seeding to 70 kg/fad due to high competition between wheat plants. The effect was not observed in the first season due to the interaction between rates and methods of sowing (Table 6-a).

In the second season, varying the method of sowing had significantly influenced the flag leaf area (Table 6). It is evident that the flag leaf area was decreased

Table (6): Flag leaf area ($cm^2$), number of days to heading as influenced by nitrogen levels, seeding rates and seeding methods in the two seasons.

| Main effects | Flag leaf area ($cm^2$) | | Number of days to heading | |
|---|---|---|---|---|
| | 1975/76 | 1976/77 | 1975/76 | 1976/77 |
| **Nitrogen levels** | | | | |
| Zero | 15.10a | 16.20a | 95.72 | 91.02a |
| 30 kg N/fad | 25.25b | 22.86b | 96.72 | 92.44b |
| 60 kg N/fad | 31.53c | 28.68c | 97.36 | 93.83c |
| 90 kg N/fad | 35.68c | 34.02d | 98.55 | 94.97d |
| F. test | ** | * | N.S | ** |
| **Seeding rates** | | | | |
| 35 kg/fad | 26.51 | 26.74b | 97.52b | 93.83c |
| 52.5 kg/fad | 28.50 | 25.74b | 97.27b | 92.95b |
| 70.0 kg/fad | 25.88 | 23.84a | 96.47a | 92.41aa |
| F. test | N.S | ** | ** | ** |
| **Seeding methods** | | | | |
| Boradcasting | 27.07 | 27.91b | 97.75b | 93.56b |
| Drilling on flat | 27.47 | 24.24a | 97.14b | 92.87a |
| Drilling on ridges | 26.35 | 24.17a | 96.37a | 92.77a |
| F. test | N.S | ** | ** | ** |

significantly due to drill sowing on flat or ridges. This was not observed in the first season.

Data in table 3 showed that the three methods of sowing had statistically similar numbers of plants/$m^2$ in the second season. The decrease observed herein in flag leaf area in drill sowing cannot be attributed to competition caused by crowded plants. This decrease, however, refers to better and uniform distribution in the broadcasted than in the drilled plots. In the latters competition, particularly for light, could account for the decrease of flag leaf area. The effect was not observed in the first season due to the interaction between rates and methods of sowing (Table 6-a ).

Table (6-a): Flag leaf area ($cm^2$) as influenced by the interaction between seeding rates and methods of sowing in the first season.

| Seeding methods | Seeding rates (kg/fad) | | |
|---|---|---|---|
| | 35 | 52.5 | 70 |
| | A | B | B |
| Broadcasting | 24.56 a | 30.80 b | 25.85 ab |
| | B | A | B |
| Drilling on flat | 28.52 a | 25.79 a | 28.10 a |
| | A | B | A |
| Drilling on ridges | 26.45 ab | 28.91 b | 23.69 a |

F. test **

It is evident that the flag leaf area was greatly decreased by dense sowing in drills on ridges. This was not observed when drilling was on flat or seeds were broadcasted. The present results again refer to better and uniform distribution of wheat plants in drill sowing on flat than on ridges.

A.7- Number of days to heading:

The number of days to heading as influenced by N level and rate and method of sowing in the two seasons is shown in table 6.

In the second season, the number of days to heading was significantly increased with each increment of nitrogen. This was seen in the first season but the differences did not reach the level of significance. In wheat nitrogen fertilization was reported to delay heading (El-Agamay, 1963; Rohde, 1963; Mohamed 1976 and El-Metwally,1977).

Under the present study, the number of tillers/ plant (Table 4) was significantly increased due to addition of nitrogen. Similar effect was observed in leaf area/ plant, LAI (Table 5) and flag leaf area (Table 6). All these growth improvements could account for the increase in number of days to heading.

The increase in the rate of seeding was followed by a significant decrease in the growth period to heading (Table 6). The decrease was more consistent in the second than in the first season.

The present results indicate that dense sowing reflected adverse effect on the growth of wheat plants and thus their growth period to heading. Similar effect was observed in the number of tillers/plant, leaf area/plant, LAI and flag leaf area (Tables 4,5 and 6). The decrease in the number of tillers/plant due to dense sowing could much account for the decrease observed herein in the number of days to heading.

Plants drill sown on ridges had shorter growth period to heading than those in broadcasted plots. This was valid in the two seasons (Table 6).

The present results again throw light on the adverse effect imposed on the growth of wheat plants in plots drilled on ridges. Such effect was also observed in the leaf area/plant, LAI and flag leaf area (Tables 5 and 6).

A.8- Leaf area ratio (LAR):

Leaf area ratio as influenced by N level and rate and method of sowing at one period of growth in the two seasons is shown in table 7.

In the two seasons, LAR was not significantly influenced by the rate or the method of seeding. However, addition of 90 kg N/fad resulted in a significant decrease in LAR in the first season. This was not true in the second season. This decrease could be attributed to a greater increase in the rate of dry matter input than in leaf area. This would be expected at this period of growth i.e. 77-97

Table (7): Leaf area ratio (LAR), net assimilation rate (NAR), relative growth rate (RGR) and absolute growth rate (AGR) as influenced by nitrogen levels, seeding rates and seeding methods in the two seasons.

| Main effects | LAR ($cm^2$/gm/day) | | NAR (mg/cm2/day) | | RGR (mg/gm/day | | AGR (mg/day) | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| | 1975/76 | 1976/77 | 1975/76 | 1976/77 | 1975/76 | 1976/77 | 1975/76 | 1976/77 |
| **Nitrogen levels** | | | | | | | | |
| Zero | 167b | 110 | 104.1a | 242.1 | 16.30a | 22.02 | 27.83a | 47.19a |
| 30 kg N/fad | 165b | 100 | 245.9b | 266.6 | 33.00b | 27.88 | 80.25b | 81.83b |
| 60 kg N/fad | 121b | 140 | 226.6b | 255.6 | 25.36ab | 33.16 | 75.16b | 82.11b |
| 90 kg N/fad | 112a | 100 | 254.1b | 219.5 | 24.61ab | 22.97 | 84.11b | 92.41b |
| F.test | * | N.S | * | N.S | * | N.S | * | * |
| **Seeding rates** | | | | | | | | |
| 35 kg/fad | 131 | 100 | 233.1 | 270.8 | 24.56 | 25.25 | 75.29 | 99.04c |
| 52.5 kg/fad | 141 | 110 | 201.5 | 242.3 | 25.04 | 28.79 | 64.41 | 71.89b |
| 70.0 kg/fad | 151 | 130 | 188.0 | 224.7 | 24.85 | 25.50 | 60.02 | 56.72a |
| F.test | N.S | N.S | N.S | ?N.S | N.S | N.S | N.S | ** |
| **Seeding methods** | | | | | | | | |
| Broadcasting | 120 | 100 | 275.8b | 249.9 | 28.58b | 23.47 | 88.97b | 85.54 |
| Drilling on flat | 148 | 110 | 198.0a | 248.1 | 25.37ab | 29.97 | 63.64a | 75.47 |
| Drilling on ridges | 155 | 120 | 148.8a | 239.8 | 20.50a | 26.08 | 47.10a | 66.64 |
| F.test | N.S | N.S | ** | N.S | * | N.S | ** | N.S |

1. for the period from 77-97 days after sowing.
2. for the period from 70-85 days after sowing.

days after sowing where most of the lower leaves were senescing.

In the first season, the interaction between N level and rate of seeding affected significantly the LAR in the first season (Table 7-a).

Table (7-a): Leaf area ratio ($cm^2$/gm/day) as influenced by the interaction between nitrogen levels and seeding rates in the first season.

| Seeding rates (kg/fad) | Nitrogen levels ( kg N/fad) | | | |
|---|---|---|---|---|
| | zero | 30 | 60 | 90 |
| 35 | A<br>181 b | A<br>154 b | A<br>103 a | A<br>88 a |
| 52.5 | A<br>163 b | A<br>156 b | A<br>134 ab | AB<br>113 a |
| 70 | A<br>156 ab | A<br>186 b | A<br>125 a | B<br>135 a |

F. test *

Without N fertilization, the increase in the rate of seeding was without significant influence of LAR. This was also true when 30 or 60 kg N/fad were added. However, when 90 kg/fad were given, the LAR was increased significantly due to the increase in the rate of seeding from 35 to 70 kg/fad.

The increase in LAR observed herein might indicate that dense sown plants were in need for the third N increment to increase their leaf area ratio.

A.9- Net assimilation rate (NAR);

Net assimilation rate as influenced by N level and rate and method of sowing at one period of growth in the two seasons is shown in table 7.

In the first season, NAR was significantly increased due to addition of nitrogen. The increase in N level did not reflect any significant variation in NAR. This was not observed in the second season.

The present results indicate that 30 kg N/fad was effective to increase NAR. Similar increase was observed in LAI (Table 5). The effect was pronounced in the first N than in the second season due to lower soil available N in the former than in the latter (Table 1).

In the two seasons, the rate of seeding was without significant influence of NAR, however, the method of sowing affected it significantly in the first season (Table 7). Higher NAR was recorded for broadcasting than for the two drilling methods.

Data in table 3 showed that, in the first season, broadcasting method had the lowest stand amongst the three method of sowing. Shading caused by crowded plants in drill sowing could account for the decrease in NAR. These two methods of sowing had lower LAI than broadcasting method (Table 7).

In the first season, the interaction between N level and rate of seeding affected significantly NAR (Table 7-b).

Table (7-b): Net assimilation rate (mg/cm$^2$ /day) as influenced by the interaction between nitrogen levels and seeding rates in the first season.

| Seeding rates ( kg/fad ) | Nitrogen levels (kg N/fad) | | | |
|---|---|---|---|---|
| | zero | 30 | 60 | 90 |
| 35 | A<br>98.4 a | A<br>218.5 b | B<br>275.5 bc | C<br>340.0 c |
| 52.5 | A<br>84.5 a | A<br>278.9 c | A<br>182.5 b | B<br>260.0 bc |
| 70 | A<br>129.5 a | A<br>240.4 b | A<br>220.0 b | A<br>162.3 ab |

F. test *

It is evident that without N fertilization or with the addition of 30 kg N/fad, the increase in the rate of seeding did not reflect any significant variation in NAR. At higher N levels, NAR was reduced significantly when the rate of seeding was increased from 35 to 70 kg/fad.

These data ascertained those forementioned that dense sowing caused reduction to NAR due to shading effect. The data obtained, herein, further indicate that this effect was more evident at the higher than at the lower N fertilization level.

A.10- Relative growth rate :

Relative growth rate as influenced by N level and rate and method of sowing in the two seasons is shown in table 7.

In the second season, the three factors under study did not affect significantly RGR. In the first season, both N level and method of sowing reflected significant variation in RGR.

Addition of 30 kg N/fad increased significantly RGR. The further increment of N did not reflect any significant variation in RGR.

It has been shown that 30 kg N/fad resulted in a significant increase in NAR but the further increase in N level did not affect it significantly (Table 7). Data in the same table, showed that LAR was not decreased with this N increment. The increase in RGR due to the first N increment, could be attributed to the increase of NAR.

Higher RGR was recorded for broadcasting method as compared to the other drilling methods of sowing.

Data in table 7 showed that broadcasting method had higher NAR than the other two methods of sowing. Data in the same table indicated that the three methods of sowing had almost similar LAR. Accordingly, RGR recorded for broadcasting surpassed that recorded for the other two methods of sowing due to higher NAR in the former than in the latters.

A.11- Absolute growth rate (RGR):

Absolute growth rate as influenced by N level and rate and method of sowing in the two seasons is shown in table 7.

In the two seasons, addition of nitrogen increased significantly AGR. However, the increase in N level was without significant influence on this growth attribute. Similar trend was observed in NAR and RGR (Table 7) in the first season.

According to these data, the first N increment was quite enough to increase AGR significantly. This N increment increased plant height (Table 4), number of tillers/plant (Table 4), leaf area/plant (Table 5), LAI (Table 5), flag leaf area and number of days to heading (Table 6). All these growth improvements could account for the increase in AGR observed herein in both seasons.

In the second season, each increase in the rate of seeding was followed by a significant decrease in AGR. This was observed in the first season, but the differences did not reach the level of significance (Table 7).

Since AGR is based on the dry weight input per plant during certain period of growth, it is rather expected, due to intense competition, that it decreased with the increase in the rate of seeding.

In the first season, the highest AGR was recorded for broadcasting method. Similar effect was observed in the second season but without significant differences (Table 7). Similar superiority was observed in NAR and RGR (Table 7) due to limited competition among the low number of plants/$m^2$ (Table 3) observed in this method of sowing.

Data in tables 4 and 5 indicated that plants in the broadcasting method had larger number of tiller/plant, larger leaf area/plant, higher LAI, larger flag leaf area and greater number of days to heading than in the two drilling methods of sowing.

In the second season, the interaction between N level and rate of seeding affected significantly AGR (Table 7-c).

Table (7-c): Absolute growth rate (mg/day) as influenced by the interaction between nitrogen levels and seeding rates in the second season.

| Seeding rates ( kg/fad ) | Nitrogen levels (kg N/fad) | | | |
|---|---|---|---|---|
| | zero | 30 | 60 | 90 |
| 35 | A<br>53.91 a | B<br>117.66 c | B<br>91.58 b | C<br>133.00 c |
| 52.5 | A<br>36.91 a | A<br>72.50 b | B<br>91.58 c | B<br>86.58 bc |
| 70 | A<br>50.75 a | A<br>55.33 a | A<br>63.16 a | A<br>57.66 a |

F. test **

It is seen that N fertilization failed to increase AGR at the highest rate of seeding. At the two lower rates, AGR was significantly increased by N addition. It is evident also, that at the highest N level each increase in the rate of seeding was accompanied by a significant decrease in AGR. This was not true when N fertilization was restricted.

Failure of N fertilization to increase AGR at dense sowing might indicate that competition between wheat plants was manifested for other growth factors other than N. Under such condition, shading might have had created intense competition between plants for light.

A.12- Plant top dry weight :

The effects of N level, rate and method of sowing on the plant top dry weight at two periods of growth in the two seasons are shown in table 8.

In the two seasons, the plant top dry weight continued to increase significantly up to the addition of 90 kg N/fad At the first period of growth in the first season and at the two periods of growth in the second one, a significant increase in plant top dry weight was obtained with each N increment.

These data are rather expected as all the growth attributes were significantly improved through N fertilization. Several workers observed such effect in wheat (Singh and Verma, 1965; Singh and Gupta, 1970; Singh and Anderson, 1973 and Saleh, 1977).

In the two seasons, the plant top dry weight was decreased significantly with the increase in the rate of seeding. In the second season, the decrease was most consistent and significant (Table 8). The trend observed herein was observed in all growth attributes and was attributed to competition between dense sown plants at high rates of seeding.

Table (8): Plant top dry weight (gm) as influenced by nitrogen levels, seeding rates and seeding methods in the two seasons.

| Main effects | Plant top dry weight (gm) | | | |
|---|---|---|---|---|
| | 1975/1976 | | 1976/1977 | |
| | 77 | 97 | 70 | 85 |
| <u>Nitrogen levels</u> | | | | |
| Zero | 1.22a | 1.70a | 1.73a | 2.38a |
| 30 kg N/fad. | 1.59b | 3.13b | 2.33b | 3.51b |
| 60 kg N/fad | 2.17c | 3.67bc | 2.74c | 3.97c |
| 90 kg N/fad | 2.44d | 4.09c | 3.28d | 4.66d |
| F. test | ** | * | ** | ** |
| <u>Seeding rates</u> | | | | |
| 35 kg/fad | 2.19b | 3.67b | 3.24c | 4.68c |
| 52.5 kg/fad | 1?75a | 2.96a | 2.50b | 3.57b |
| 70.0 kg/fad | 1.63a | 2.81a | 1.82a | 2.65a |
| F. test | ** | ** | ** | *** |
| <u>Seeding methods</u> | | | | |
| Broadcasting | 2.13b | 3.91b | 2.96c | 4.22c |
| Drilling on flat | 1.71a | 2.89a | 2.47b | 3.54b |
| Drilling on ridges | 1.73a | 2.64a | 2.13a | 3.13a |
| F. test | ** | ** | ** | ** |

In the two seasons, at the two dates of sampling, broadcasting method recorded higher plant top dry weight than the other two methods of sowing (Table 8). In the second season, lower plant top dry weight was recorded for drill sowing on ridges than for drill sowing on flat. This was not true in the first season where the two drilling methods had almost similar dry weights.

In the first season, broadcasting method had lower number of plants/$m^2$ (Table 3) than the other two drilling methods. The increase in dry weight therefore could be attributed to lower competition between less dense plants. In the second season, no significant differences were detected in the number of plants/$m^2$ among the different methods of sowing. The increase in plant top dry weight therefore could be attributed to better distribution of plants per unit area. This could be ascertained by the decrease in plant top dry weight when drilling was practised on ridges. In this method of sowing,plants in drills at the top of the ridge had better position for receiving light and better chance for growth than those in drills at lower position. In the present study these plants had lower leaf area (Table 5), LAI (Table 5) and flag leaf area (Table 6) than those in drills on flat. According to these data, it could be concluded that drill sowing on ridges is not recomended due to un-uniform distribution of plants in the field and thus un-equal chance of growth.

The interaction between N level and rate of seeding affected significantly the plant top dry weight at 97 and 85 days after sowing in the two seasons, respectively (Tables 8-a and 8-b).

Table (8-a): Plant top dry weight (gm), 97 days after sowing, as influenced by the interaction between nitrogen levels and seeding rates in the first season.

| Seeding rates ( kg/fad ) | Nitrogen levels (kg N/fad) | | | |
|---|---|---|---|---|
| | zero | 30 | 60 | 90 |
| 35 | A<br>1.88 a | A<br>3.26 b | B<br>4.48 c | C<br>5.05 d |
| 52.5 | A<br>1.48 a | A<br>3.12 b | A<br>3.23 b | B<br>4.02 c |
| 70 | A<br>1.76 a | A<br>3.02 b | A<br>3.28 b | A<br>3.19 b |

F. test **

Table (8-b): Plant top dry weight (gm), 85 days after sowing, as influenced by the interaction between nitrogen levels and seeding rates in the second season.

| Seeding rates ( kg/fad ) | Nitrogen levels (kg N/fad) | | | |
|---|---|---|---|---|
| | zero | 30 | 60 | 90 |
| 35 | B<br>3.02 a | C<br>4.79 b | B<br>4.80 b | C<br>6.11 c |
| 52.5 | A<br>2.14 a | B<br>3.31 b | B<br>4.11 c | B<br>4.71 c |
| 70 | A<br>1.97 a | A<br>2.44 ab | A<br>3.00 b | A<br>3.17 b |

F. test *

Though different trends were observed in the response of plant top dry weight to varying the level and rate of seeding, however, a general trend could be seen. It is evident that lower N level was required at the highest rate of seeding to increase the plant top dry weight. At the loewt rate of seeding, plant top dry weight continued to increase up to the addition of 90 kg N/fad. At the highest rate of seeding, no significant increase in plant top dry weight was obtained beyond the addition of 30 and 60 kg N/fad in the two growing seasons, respectively.

These data strengthen the view that competition was manifested at dense sowing for other factors of growth other than nitrogen. Competition for light cannot be neglected and could account for the decreased response to N fertilization at dense sowing.

The interaction between N level and method of sowing affected significantly the plant top dry weight at 97 and 85 days after sowing in the two seasons, respectively (Tables 8-c and 8-d).

Table (8-c): Plant top dry weight (gm), 97 days after sowing, as influenced by the interaction between nitrogen levels and methods of sowing in the first season.

| Seeding methods | Nitrogen levels (kg N/fad) | | | |
|---|---|---|---|---|
| | zero | 30 | 60 | 90 |
| Broadcasting | A<br>1.85 a | B<br>4.20 b | B<br>4.64 bc | B<br>4.95 c |
| Drilling on flat | A<br>1.58 a | A<br>2.74 b | A<br>3.48 c | A<br>3.76 c |
| Drilling on ridges | A<br>1.69 a | A<br>2.46 b | A<br>2.88 bc | A<br>3.55 c |

F. test *

Table (8-d): Plant top dry weight (gm), 85 days after sowing, as influenced by the interaction between nitrogen levels and methods of sowing in the second season.

| Seeding methods | Nitrogen levels (kg N/fed) | | | |
|---|---|---|---|---|
| | zero | 30 | 60 | 90 |
| Broadcasting | B<br>2.64 a | B<br>4.01 b | C<br>4.67 c | C<br>5.58 d |
| Drilling on flat | A<br>2.05 a | A<br>3.40 b | B<br>3.94 c | B<br>4.79 d |
| Drilling on ridges | B<br>2.44 a | A<br>3.13 b | A<br>3.31 bc | A<br>3.63 c |

F. test **

It is obvious that wheat plants in drills on ridges showed lower response to N fertilization than those in drills on flat or broadcasted. In the first season, no significant differences could be detected in plant top dry weight at the different levels among the two drilling methods (Table 8-c). In the second season, at the two higher N levels, plant in drills on flat had significantly higher top dry weight than those in drills on ridges (Table 8-d).

These data again strengthen the view that plants in drills on flat had better chance of growth than those in drills on ridges. Those in the broadcasted plots had the best chance of growth. Similar trend was observed in LAR at 85 days after sowing in the second season (Table 5-d). This effect was also observed in leaf area/plant at the same date of sampling in the first season (Table 5-b). The decrease in response was also observed in the number of tillers/plant during the same season (Table 4-a).

## B- Yield and some contributing characters :

### B.1- Plant height :

Plant height, at harvest, as influenced by N level and rate and methods of sowing in the two seasons is shown in table 9.

In the two seasons, addition of N resulted in a significant increase in plant height. In the first season, this increase was significant up to the addition of 60 kg N/fad. In the second season, no further significant increase in height was observed beyond the addition of 30 kg N/fad. Difference in the magnitude of response could be attributed to difference in the soil available N level (Table 1).

In the first season, the increase in the rate of seeding to 70 kg/fad resulted in a significant increase in plant height. This was not valid in the second season but was ascertained in the combined analysis. Similar effect was observed during the season (Table 4) and was attributed to competition between wheat plants for light.

In the two seasons, varying the method of seeding was without influence on plant height. However, the interaction between methods and rates of sowing affected it significantly in the first season (Table 9-a).

Table (9): Plant height (cm), spike length (cm) and number of spikes/plant as influenced by nitrogen levels, seeding rates and seeding rates in the two seasons.

| Main effects | Plant height (cm) | | | Spike length (cm) | | | Number of spikes/plant | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1975/76 | 76/77 | Combined | 1975/76 | 76/77 | Combined | 1975/76 | 76/77 | Combined |
| **Nitrogen levels** | | | | | | | | | |
| Zero | | | | | | | | | |
| Zero | 89.7a | 97.6a | 93.7a | 4.83a | 5.36a | 5.09a | 1.39a | 1.86a | 1.62a |
| 30 kg N/fad | 103.9b | 108.7b | 106.3b | 8.05b | 8.97b | 8.51b | 2.28b | 3.01b | 2.64b |
| 60 kg N/fad | 114.6c | 107.8b | 111.2c | 9.39c | 9.38b | 9.38c | 2.97c | 3.63c | 3.21c |
| 90 kg N/fad | 118.2c | 111.1b | 114.6c | 10.25d | 9.62b | 9.93d | 2.97c | 3.71c | 3.34c |
| F. test | ** | * | ** | ** | ** | ** | ** | * | ** |
| **Seeding rates** | | | | | | | | | |
| 35 kg/fad | 105.1a | 106.5 | 141.1a | 8.15 | 8.71c | 8.43b | 2.51b | 3.33b | 2.92b |
| 52.5 kg/fad | 106 2a | 105.8 | 141.3a | 8.19 | 8.36b | 8.28b | 2.37ab | 3.08ab | 2.72b |
| 70.0 kg/fad | 108.5b | 106.6 | 143.4b | 8.04 | 7.92a | 7.98a | 2.19a | 2.76a | 2.47a |
| F. test | ** | N.S | * | N.S | ** | ** | ** | * | ** |
| **Seeding methods** | | | | | | | | | |
| Broadcasting | 106.1 | 105.2 | 105.7 | 8.36b | 8.42 | 8.39b | 2.55b | 3.31b | 2.93c |
| Drilling on flat | 107.0 | 106.6 | 106.8 | 7.99a | 8.28 | 8.14a | 2.31a | 3.02a | 2.66b |
| Drilling on ridges | 106.7 | 107.0 | 106.9 | 8.04a | 8.28 | 8.16a | 2.21a | 2.83a | 2.52a |
| F. test | N.S | N.S | N.S | * | N.S | * | ** | ** | ** |

Table (9-a): Plant height (cm) as influenced by the interaction between seeding rates and methods of sowing in the first season.

| Seeding methods | Seeding rates (kg N/fed) | | |
|---|---|---|---|
| | 35 | 52.5 | 70 |
| Broadcasting | A<br>103.5 a | A<br>104.9 a | B<br>110.0 b |
| Drilling on flat | A<br>105.0 a | A<br>105.8 a | B<br>110.1 b |
| Drilling on ridges | A<br>106.9 a | A<br>107.9 a | A<br>105.4 a |

F. test *

It is obvious that wheat plants got taller with the increase in the rate of seeding when broadcasted or drill sown on flat. This was not true when seeds were hand drilled on ridges. At the highest rate of seeding, longer plants were seen against the first two methods of sowing i.e. broadcasting and hand drilling on flat.

The present results could be discussed on the basis of competition. Data in table 3-a showed that the highest plant number/m$^2$( 429.7) was seen when the highest rate of seeding was hand drilled on flat. At this rate of seeding, the lowest plant number was observed against broadcasting method. Intense competition for light in the first method is reasonable to explain the increase in plant height. However, low competition between plants and better chance for growth could be served to explain the increase in plant height in broadcasting method.

B.1- Number of spikes per plant :

The number of spikes/plant as influenced by N level and rate and method of sowing in the two seasons is shown in table 9.

Addition of N was accompanied by a significant increase in the number of spikes/plant. In the two seasons, no further increase in spike number was obtained beyond the addition of 60 kg N/fad. This was ascertained by the combined analysis. Several workers found the number of spikes/plant to increase due to addition of nitrogen (Sharma, 1970; El-Sayed, 1973; Abdel-Razek, 1975; Ibrahim and Assey, 1976 and El-Metwally, 1977).

According to the combined analysis, the increase in the rate of seeding from 35 or 52.5 to 70 kg/fad was accompanied by a significant decrease in the number of spikes/plant (Table 9).

Similar decrease was observed in the number of tillers/plant at two dates of sampling in the two seasons (Table 4). The decrease was attributed to competition between dense sown plants. The results obtained, herein, were also found by Das and Varma (1956), Abdulgalil (1964) and Ibrahim (1972).

The number of spikes/plant was significantly affected by the method of sowing (Table 9). In the two seasons, higher number of spikes/plant was recorded for broadcasting method than for the other two drilling methods. Data of the combined analysis showed significant differences among the two drilling methods in favour of drilling on flat.

Data in table 4 showed that broadcasting method had higher number of tillers/plant than the other two methods of sowing. The increase in the first season, was attributed to lower number of plants/$m^2$ (Table 3).

The combined analysis of the two seasons showed that the number of spikes/plant was influenced by the interaction between N level and method of sowing (Table 9-b).

Table (9-b): Number of spikes/plant as influenced by the interaction between nitrogen level, and methods of sowing. (combined analysis)

| Seeding methods | Nitrogen levels (kg N/fad) | | | |
|---|---|---|---|---|
| | zero | 30 | 60 | 90 |
| Broadcasting | A<br>1.56 a | B<br>2.86 b | C<br>3.59 c | C<br>3.71 c |
| Drilling on flat | A<br>1.60 a | A<br>2.49 b | B<br>3.26 c | B<br>3.31 c |
| Drilling on ridges | A<br>1.72 a | AB<br>2.59 b | A<br>2.78 bc | A<br>3.01 c |

F.test **

Without N fertilization, no significant differences could be detected in the number of spikes/plant among the three methods of sowing. At the two higher N levels, broadcasting method had the highest spikes number whereas drilling on ridges method had the lowest one.

These data indicate that N fertilization was more effective to increase the number of spikes/plant in broadcasting than in the other two methods of sowing. In the first method, the increase in the level of N from zero to 90 kg N/fad was accompanied by an increase of 2.15 spike/plant. In the two drilling methods these increases were 1.71 and 1.29 only. This could be attributed to better distribution of plants in broadcasting than in the other two methods of sowing.

The interaction between rates and methods of sowing affected significantly the number of spikes/plant. This was observed from the combined analysis (Table 9-c).

Table (9-c): Number of spikes/plant as influenced by the interactions between seeding rates and methods of sowing (combined analysis)

| Seeding methods | Seeding rates (kg/fad ) | | |
|---|---|---|---|
| | 35 | 52.5 | 70 |
| Broadcasting | B<br>3.10 b | B<br>3.16 b | A<br>2.52 a |
| Drilling on flat | AB<br>2.86 b | A<br>2.58 a | A<br>2.54 a |
| Drilling on ridges | A<br>2.78 b | A<br>2.43 a | A<br>2.35 a |

F. test *

It is evident that in the broadcasting method, the number of spikes/plant was not significantly decreased unless the rate of seeding was increased to 70 kg/fad. In the other two methods of sowing, the number of spikes/plant was significantly decreased when the rate of seeding was increased to 52.5 kg/fad.

The present results again strengthen the view that in broadcasting method plants were uniformly distributed than in the other two methods of sowing. The results further indicate that higher rates of seeding could be tried in broadcasting than in the two drilling methods without significant reduction in the number of spikes/plant.

B.3- Spike length :

Spike length as influenced by N level and rate and method of sowing in the two seasons is presented in table 9.

In the two seasons, addition of N resulted in a significant increase in spike length. In the first season, each N increment was accompanied by a significant increase in spike length. This is ascertained by the combined analysis. These data are in accordance with those reported by Mohamed (1976) and El-Metwally (1977).

In the second season, each increase in the rate of seeding was reflected in a significant decrease in spike length. This was not true in the first season, however, the combined analysis showed a reduction in spike length when the rate of seeding was increased to 70 kg/fad (Table 9).

The present results indicate that the competition created by dense sowing was reflected also in spike length. Data in table 4 and 9 showed that dense sowing caused reductions in both the number of tillers and spikes/plant. Similar decrease was observed in leaf area/plant and LAI (Table 5).

Spike length was significantly decreased in the two drilling methods of sowing. This was observed in the first season and in the combined analysis (Table 9).

In the first season, the number of plants/$m^2$ (table 3) was higher in the two drilling methods of sowing than in broadcasting method. This could account for the decrease in spike length observed herein in the first season. These methods of sowing had also lower number of spikes/plant (Table 9) than the broadcasting method.

The combined data of the two seasons showed that spike length was significantly influenced by the interaction between N level and rate of seeding(Table 9-d).

Table (9-d): Spike length (cm) as influenced by the interactions between nitrogen levels and seeding rates. (combined analysis)

| Seeding rates (kg/fad) | Nitrogen levels (kg N/fad) | | | |
|---|---|---|---|---|
| | zero | 30 | 60 | 90 |
| 35 | B<br>5.36 a | B<br>8.83 b | A<br>9.54 c | A<br>10.0 d |
| 52.5 | AB<br>5.08 a | B<br>8.65 b | A<br>9.36 c | A<br>10.02 d |
| 70 | A<br>4.84 a | A<br>8.05 b | A<br>9.25 c | A<br>9.78 d |

F. test **

It is evident that at the two higher N levels, no significant differences could be detected in spike length among the three rates of seeding. At the two lower N levels, dense sown plants had significantly shorter spikes than light sown ones.

These data indicate that competition between dense sown plants was overcome by the addition of 60 or 90 kg N/fad and hence the differences in spike length among the different rates of seeding did not reach the level of significance.

According to the combined analysis data, the interaction between rates and methods of sowing affected significantly spike length (Table 9-e).

Table (9-e): Spike length (cm) as influenced by the interaction between seeding rates and methods of sowing. (combined analysis)

| Seeding method | Seeding rates (kg/fad ) | | |
|---|---|---|---|
| | 35 | 52.5 | 70 |
| Broadcasting | A<br>8.50 b | B<br>8.64 b | A<br>8.03 a |
| Drilling on flat | A<br>8.50 b | A<br>8.06 a | A<br>7.85 a |
| Drilling on ridges | A<br>8.29 a | A<br>8.14 a | A<br>8.06 a |

F. test **

It is obvious that in broadcasting method, the spike length was not significantly decreased unless the rate of seeding was increased to 70 kg/fad. In the drilling method on flat, the increase in the rate of seeding to 52.5 or 70 was accompanied by a significant decrease in spike length. In the drilling method on ridges, the spike length did not respond to variation in the rate of seeding.

The present results ascertain the view that in broadcasting method, more dense sowing could be practised than in drill sowing on flat. This might indicate that competition between plants was more supervised in broadcasted than in drilled plots. Better and uniform plant distribution in the former could account for this increase.

B.4- Number of spikelets/spike :

The numbers of fertile and sterile spikelets per spike as influenced by N level and rate and method of sowing in the two seasons are shown in table 10.

Addition of N was accompanied by a significant increase in the number of fertile spikelets/spike. Data of the combined analysis showed a significant increase in the number of fertile spikelets per spike with the increase in the level of N from 30 to 90 kg N/fad. On the other hand, a consistent significant decrease was observed in the number sterile spikelets/spike with each increment of nitrogen.

In wheat, addition of nitrogen was reported to increase the number of fertile spikelets/spike (Langer and Liew, 1973; Ibrahim and Assey, 1976 and Saleh, 1977).

Table (10): Number of fertile, sterile spikelets/spike and number of grains/spike as influenced by nitrogen levels, seeding rates and seeding methods in the two seasons.

| Main effects | Fertile spikelets/spike | | | Sterile spikelets/spike | | | Number of grains/spike | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1975/76 | 1976/77 | Combined | 75/76 | 76/77 | Combined | 75/76 | 76/77 | Combined |
| **Nitrogen levels** | | | | | | | | | |
| Zero | 11.89a | 11.86a | 11.87a | 5.40c | 4.89c | 5.15d | 18.86a | 28.06a | 23.46a |
| 30 kg N/fad | 17.15b | 18.03b | 17.59b | 3.10b | 2.50b | 2.80c | 33.54b | 35.57b | 34.55b |
| 60 kg N/fad | 18.93b | 18.25b | 18.59bc | 2.13a | 2.00a | 2.06b | 42.54c | 45.50c | 44.02c |
| 90 kg N/fad | 19.99b | 18.92b | 19.46c | 1.76a | 1.64a | 1.70a | 42.72c | 43.50c | 43.11c |
| F. test | * | ** | ** | ** | ** | ** | ** | ** | ** |
| **Seeding rates** | | | | | | | | | |
| 35 kg/fad | 17.29b | 17.65c | 17.47c | 2.94a | 2.67 | 2.81a | 34.27 | 39.08 | 36.68 |
| 52.5 kg/fad | 17.18b | 16.63b | 16.90b | 3.06a | 2.74 | 2.90a | 35.15 | 38.31 | 36.73 |
| 70.0 kg/fad | 16.51a | 16.01a | 16.26a | 3.29b | 2.87 | 3.08b | 33.81 | 37.08 | 35.45 |
| F. test | ** | ** | ** | * | N.S | ** | N.S | N.S | N.S |
| **Seeding methods** | | | | | | | | | |
| Broadcastong | 17.37 | 17.25b | 17.31b | 2.96a | 2.75 | 3.81 | 36.56b | 40.91c | 38.73c |
| Drilling on flat | 16.92a | 16.52a | 16.74a | 3.10ab | 2.88 | 3.98 | 34.77b | 37.85b | 36.31b |
| Drilling on ridges | 16.64 | 16.53a | 16.58a | 3.23b | 2.66 | 3.92 | 31.90a | 35.72a | 33.81a |
| F.test | N.S | ** | * | * | N.S | N.S | ** | ** | ** |

Under the present study, addition of N increased spike length (Table 9). This could account for the increase in the number of spikelets/spike observed herein.

The increase in the rate of seeding was accompanied by a significant decrease in the number of fertile spikelets/spike. The decrease was more consistent in the second season and was reflected in the combined data of the two seasons. It is evident from the same data that the increase in the rate of seeding to 70 kg/fed caused a significant increase in the number of sterile spikelets/spike (Table 10).

The present results indicate that competition resulted from dense sowing was reflected in a significant decrease in the number of fertile spikelets and at the meantime a significant increase in the number of sterile spikelets/spike. The former was more sensitive to variations of seeding rate than the latter. Similar results were observed by Das and Varma (1956) and Djokic (1966).

Varying the method of sowing had significantly influenced both the number of fertile and sterile spikelets/spike (Table 10). In the second season, broadcasting method had higher number of spikelets/ spike than the other two drilling methods. This was also true in the combined analysis. In the first season, the former method of sowing had lower number of sterile spikelets/spike than the drilling on ridges method. However, the combined analysis did not reflect such effect (Table 10).

Data of spike length (Table 9) showed that the broadcasting method of sowing had longer spikes than the other two methods of sowing. Data obtained herein indicate that these spikes had higher number of fertile spikelets/spike than those of drill sowing. The increase in the number of fertile spikelets/spike could be attributed to better and uniform plant distribution in the broadcasting than in drilling methods of sowing.

According to the combined analysis, the interaction between N level and rate of seeding affected significantly the number of fertile spikelets/spike (Table 10-a).

Table (10-a): Number of fertile spikelets/spike as influenced by the interaction between nitrogen levels and seeding rates. (combined analysis)

| Seeding rates (kg/fad) | Nitrogen levels (kg N/fed) | | | |
|---|---|---|---|---|
| | zero | 30 | 60 | 90 |
| 35 | C<br>12.50 a | B<br>18.29 b | B<br>19.11 bc | B<br>19.99 c |
| 52.5 | B<br>11.94 a | A<br>17.30 b | B<br>18.83 c | B<br>19.56 c |
| 70 | A<br>11.18 a | A<br>17.19 b | A<br>17.84 b | A<br>18.82 c |

F. test **

It is evident that without N fertilization, each increase in the rate of seeding was accompanied by a significant decrease in the number of fertile spikelets/spike. When the level of N was increased to 60 or 90 kg N/fad, the spikelets number was not decreased unless the rate of seeding was increased to 70 kg/fad.

According to these data it could be suggested that competition between wheat plants was mainly for N when the rate of seeding was increased to 52.5 kg/fad. However, competition induced by the further increase in the rate of seeding to 70 kg/fad was mainly for light as the increase in level to 90 kg N/fad failed to counteracte the decrease in the number of fertile spikelets/spike.

B.5- Number of grains/spike :

The number of grains/spike as affected by N level and rate and method of sowing in the two seasons is shown in table 10.

A significant increase was obtained in the number of grains/spike with each increase in the level of N up to 60 kg N/fad. This was true in the two seasons and their combined analysis.

These data indicate that N fertilization increased the fertility of flowers/spikelet. Data in table 10 showed that the number of fertile spikelets/spike was not significantly increased beyond the addition of 30 kg N/fad. This was valid in the two seasons. The present results indicate that the number of grains/spike continued to increase significantly up to the highest N level i.e 90 kg N/fad. According to these data, the increase in the number of grains for spike due to the increase in the level of N from 30 to 90 kg N/fad could be attributed to an increase in the number of grains/spikelets.

Similar results were reported by Sandhu and Gill (1971), Hagras (1972), El-Sayed (1973), Abdel-Razek (1975) and Saleh (1977).

In the two seasons, the number of grains/ spike was not significantly affected by the rate of seeding (Table 10). This was also observed in the combined data of the two seasons.

Under the present study the increase in the rate of seeding to 70 kg/fad was accompanied by significant decreases in the number of spikes/plant and spike length (Table 9). Similar decrease was observed in the number of fertile spikelets/spike but the number of sterile spikelets was significantly increased (Table 10). According to these data it could be suggested that competition between dense sown plants was without any significant influence on the fertility of flower/spikelet. This competition, however, decreased the number of fertile spikelets and increased the number of sterile spikelets/spike. Since the decrease in the number of fertile spikelets/spike did not reflect any significant decrease in the number of grains/spike, it could be concluded that spikelets of dense sown plants had higher number of grains/spikelet than those of light sown ones. Again, dense sowing was reflected in an inter-spikelet rather than intra-spikelet competition.

In wheat several workers found that the increase in the rate of seeding was accompanied by a significant decrease in the number of grains/spike (Mangukia, 1953; Das and Varma, 1956 and Abdulgalil, 1964). However, others did not observe such effect (Suput, 1966).

The number of grains/spike was significantly influenced by the method of sowing (Table 10). In the first season, both the broadcasting and drilling on flat methods had higher number of grains/spike than the drilling on ridge method. In the second season, these methods had different grains number/spike in favour of the broadcasting method followed by drilling on flat one. This effect was reflected in the combined analysis of the two seasons.

It was forementioned that the broadcasted plants had longer spikes with higher number of fertile spikelets/spike than those drill sown on ridges (Tables 9 and 10 respectively). The increase, particularly in fertile spikelets/spike, could account for the increase obtained herein in the number of grains/spike.

Table (11): Thousand grain weight, Grain weight/spike and grain yield/plant as influenced by nitrogen levels, seeding rates and seeding methods in the two seasons.

| Main effect | 1000 grain weight(gm) | | | Grain weight/spike(gm) | | | Grain yield/plant(gm) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1975/76 | 1976/77 | Combined | 1975/76 | 1976/77 | Combined | 75/76 | 1976/77 | Combined |
| **Nitrogen levels** | | | | | | | | | |
| Zero | 46.32 | 51.44b | 48.88b | 0.84a | 1.43a | 1.14a | 1.20a | 2.64a | 1.92a |
| 30 kg N/fad | 46.97 | 48.77a | 47.87b | 1.46b | 1.73b | 1.60b | 3.66b | 5.24b | 4.44b |
| 60 kg N/fad | 46.51 | 48.38a | 47.45ab | 2.02c | 2.20c | 2.11c | 5.63c | 8.08c | 6.85c |
| 90 kg N/fad | 44.60 | 47.31a | 45.95a | 1.91c | 2.05c | 1.98c | 5.62c | 7.73c | 6.67c |
| F. test | N.S | * | * | ** | ** | ** | ** | ** | ** |
| **Seeding rates** | | | | | | | | | |
| 35 kg/fad | 46.44 | 49.45 | 47.95b | 1.58 | 1.92b | 1.75b | 4.26b | 6.64b | 4.45b |
| 52.5 kg/fad | 46.02 | 49.92 | 47.97b | 1.58 | 1.89b | 1.74b | 4.17b | 6.07b | 5.12b |
| 70.0 kg/fad | 45.83 | 47.55 | 46.69a | 1.52 | 1.75a | 1.63a | 3.66a | 5.05a | 4.35a |
| F. test | N.S | N.S | * | N.S | ** | ** | * | ** | ** |
| **Seeding methods** | | | | | | | | | |
| Broadcasting | 45.75 | 48.93 | 47.34 | 1.64 | 2.00c | 1.82c | 4.66b | 6.92c | 5.79c |
| Drilling on flat | 45.84 | 48.80 | 47.32 | 1.55 | 1.83b | 1.69b | 3.86a | 5.77b | 4.81b |
| Drilling on ridges | 46.71 | 49.19 | 47.95 | 1.49 | 1.73a | 1.61a | 3.56a | 5.07a | 4.31a |
| F. test | N.S | N.S | N.S | N.S | ** | ** | ** | ** | ** |

El-Metwally (1977) got increases in 1000 grain weight due to N fertilization. On the other hand, Djokic (1966), Gomaa *et al.* (1977), Khalil *et al.* (1977) and Saleh (1977) observed decreases in this yield component due to the increase in the level of N fertilization.

In the two seasons, varying the rate or the method of seeding did not reflect any significant variation in 1000 grain weight. However, the combined analysis showed that the increase in the rate of seeding to 70 kg/fad was accompanied by a significant decrease in 1000 grain weight (Table 11).

It was mentioned that the increase in the rate of seeding to 70 kg/fad was accompanied by a significant decrease in the number of fertile spikelets/spike. This decrease did not reflect any significant decrease in the number of grains/spike (Table 10). Data obtained herein, showed that the 1000-grain weight was decresed due to the increase in the rate of seeding to 70 kg/fad. According to these data it could be suggested that dense sowing might have had created inter-and intra-spikelete competition which reduced single grain weight rather than grain number spike.

According to the combined analysis, the interaction between N level and rate of seeding affected significantly the 1000-grain weight (Table 11-a).

Table (11-a): 1000-grain weight (gm) as influenced by the interaction between nitrogen levels and seeding rates (combined analysis)

| Seeding rates ( kg/fad ) | Nitrogen levels (kg N/fad) | | | |
|---|---|---|---|---|
| | zero | 30 | 60 | 90 |
| 35 | A<br>48.64 ab | B<br>49.0 b | A<br>47.55 ab | B<br>46.60 a |
| 52.5 | A<br>48.64 a | B<br>48.85 a | A<br>46.87 a | B<br>47.53 a |
| 70 | A<br>49.36 c | A<br>45.75 ab | A<br>47.92 bc | A<br>43.73 a |

F. test *

It is evident that at the two lower rates of seeding, the increase in N level from 0 to 90 kg N/fad did not reflect a significant variation in the 1000-grain weight. At the heighest rate of seeding, however, this increase in N level was accompanied by a significant decrease in 1000-grain weight.

These data indicate that at dense sowing i.e 70 kg seed/fad , N fertilization failed to counteracte the reduction effect caused by competition between plants. Similar effect was observed in the number of fertile spikelets/ spike (Table 10-a). Data in the present table further indicate that without N fertilization, no significant differences were detected in the 1000-grain weight among the different rates of seeding. When 30 or 90 kg N/fad were added, 1000-grain weight was decreased due to dense sowing.

These data are quite interesting and throw light on the nature of competition between wheat plants for growth factors. Reduction in 1000 grain weight caused by dense sowing when 30 kg N/fad were added, could be attributed to competition for nitrogen. When the level of N was increased to 60 kg N/fad , this reduction was not observed. This effect indicates that this N increment reduced the competition among dense sown plants for nitrogen. When the third N increment was given, some sort of imbalance might have been induced between the different yield components. Therefore, competition between wheat plants, on one hand, and their yield components, on the other, was manifested for other factors of growth other than nitrogen. During grain filling, competition for light cannot be neglected.

B.7 - Grain weight per spike :

Grain weight/spike as influenced by N level and rate and method of sowing in the two seasons is shown in table 11.

In the two seasons, the grain weight/spike continued to increase significantly up to the addition of 60 kg N/fad. This was valid in the combined analysis.

Similar trend was observed in the number of grains/ spike. The number of fertile spikelets/spike was significantly increased up to the addition of 90 kg N/fad (Table 10). Though the 1000-grain weight was significantly decreased due to addition of N (Table 11), the increase in the number of grains counteracted this decrease. Similar results were reported by Sandhu and Gill (1971), Hagras (1972) and Ibrahim and Assey (1976).

The grain weight/spike was significantly reduced due to the increase in the rate of seeding to 70 kg/fad. This was observed in the second season and was reflected in the combined analysis (Table 11). This reduction could be attributed to the reduction in 1000 grain weight since the increase in the rate of seeding did not reduce significantly the number of grains/spike (Table 10).

In the second season, the broadcasting method of sowing recorded the highest grain weight/spike followed by the drilling on flat and the lowest weight was recorded by the drilling on ridges method. This effect was not observed in the first season, but was reflected in the combined analysis (Table 11).

Under the present study, this trend was observed in the number of spikes/plant and in the number of grains / spike (Table 10). Since the increase in the number of spikes/plant did not yield any significant decrease in the number of grains/spike, it could be suggested that broadcasted plants had better chance of growth than drilled ones. This better chance of growth could be due to a uniform distribution of plants/unit area and thereby a better distribution of light on wheat foliage. This could be acertained by the increase in LAI (Table 5), as well as, in flag leaf area and growth period to heading (Table 6).

B.8- Grain yield per plant :

The grain yield/plant as influenced by N level and rate and method of sowing in the two seasons is presented in table 11.

In the two growing seasons, the first two N increments yielded significant increases in the grain yield/plant. No significant increase was obtained beyond the addition of 60 kg/fad.

The increase in grain yield/plant could be attributed to similar increases in the number of spikes/plant (Table 9) and grain weight/spike (Table 11).

The grain yield/plant was significantly decreased when the rate of seeding was increased to 70 kg/fad. This was true in the two seasons (Table 11).

Under the present study, both the number of spikes/plant and grain weight/spike were decreased due to the increase in the rate of seeding to 70 kg/fad (Tables 9 and 11, respectively). These decreases were attributed to intense competition between dense sown plants for growth factors. In the literature, several workers found the grain/plant to decrease due to competition caused by the increase in the rate of seeding (Das and Varma, 1956 ; Kamel, 1959 and Abdulgalil, 1964).

In the two seasons, the method of sowing affected significantly the grain yield/plant (Table 11). It is evident that the broadcasting method had significantly higher grain yield/plant than the other two methods of sowing. In the second season, significant differences could be detected in grain yield/plant among the two drilling methods in favour of drilling on flat. This was ascertained by the combined analysis.

The trend observed herein, was also noticed in the number of spikes/plant and grain weight/spike (Tables 9 and 11, respectively). This trend reflects the favourable and better chance of growth in broadcasted plots, followed by drilled on flat plots.

The interaction between N level and method of sowing affected significantly the grain yield/ plant. This was observed in the combined analysis of both seasons (Table 11-b).

Table (11-b): Grain yield/plant (gm) as influenced by the interaction between nitrogen levels and methods of sowing. (combined analysis)

| Seeding methods | Nitrogen levels (kg N/fed) | | | |
|---|---|---|---|---|
| | zero | 30 | 60 | 90 |
| | A | B | C | C |
| Broadcasting | 2.01 a | 5.10 b | 8.10 c | 7.94 c |
| | A | A | B | B |
| Drilling on flat | 1.89 a | 4.19 b | 6.69 c | 6.47 c |
| | A | A | A | A |
| Drilling on ridges | 1.88 a | 4.04 b | 5.76 c | 5.60 c |

F. test **

It is evident that without N fertilization, no significant differences could be detected in the grain yield/plant among the three methods of sowing. When the first N increment was given, the broadcasting method showed superiority to the other methods of sowing in grain yield/plant. When the second and third N increments were added, broadcasting method was still superior but significant differences were observed among the two drilling methods in favour of drilling on flat.

Data obtained herein, indicate a differential response to N fertilization among the three methods of sowing. The data further indicate that broadcasted plants were more responsive to N fertilization than those in drills. At higher N levels, wheat plants in drills on flat were more responsive to N than those on ridges. These data strengthen the view that broadcasted plants had better chance of growth than those in drills. Furthermore, plants in drills on flat had better chance of growth than those in drills on ridges. Similar results were observed in the number of spikes/plant (Table 9-a) and could account for the increase observed herein in grain yield/plant.

B.9 - <u>Total yield per faddan</u> :

the total yield/fad as influenced by N level and rate and method of sowing in the two seasons is given in table 12.

In the two seasons, addition of N increased significantly the total yield/fad as compared to the control. In

Table (12): Total, straw and grain yield as influenced by nitrogen levels, seeding rates and seeding methods in the two seasons.

| Main effect | Total yield (t fad) | | | Straw yield (t.fad) | | | Grain yield (Ardab/fad.) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1975/76 | 1976/77 | Combined | 1975/76 | 1976/77 | Combined | 1975/76 | 1976/77 | Combined |
| **Nitrogen levels** | | | | | | | | | |
| Zero | 3.62a | 5.58 a | 4.61a | 2.77a | 4.09a | 3.43a | 6.75a | 11.03a | 8.89a |
| 30 kg N/fad | 6.17b | 7.63bb | 6.90b | 4.69b | 5.40b | 5.05b | 12.62b | 14.55b | 13.58b |
| 60 kg N/fad | 7.72c | 8.01 b | 7.87c | 5.35b | 5.66b | 5.51b | 17.32c | 15.32b | 16.32c |
| 90 kg N/fad | 8.94d | 8.22 b | 8.59d | 6.26c | 6.06b | 6.16c | 17.83c | 14.48b | 16.15c |
| F. test | ** | * | ** | ** | * | ** | ** | * | ** |
| **Seeding rates** | | | | | | | | | |
| 35 kg./fad | 6.51 | 7.43 | 6.98 | 4.64 | 5.37 | 5.00 | 13.85 | 14.09 | 13.97 |
| 52.5 kg./fad | 6.61 | 7.26 | 6.94 | 4.83 | 5.22 | 5.02 | 13.44 | 13.67 | 13.56 |
| 70.0 kg./fad | 6.72 | 7.38 | 7.05 | 4.83 | 5.33 | 5.08 | 13.58 | 13.77 | 13.68 |
| F. test | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S | N.S |
| **Seeding methods** | | | | | | | | | |
| Broadcasting | 7.02c | 7.66b | 7.35b | 5.10c | 5.55b | 5.33 | 14.07b | 14.64b | 14.35b |
| Drilling on flat | 6.40b | 7.26a | 6.83a | 4.73b | 5.18a | 4.96 | 13.30a | 13.73a | 13.51a |
| Drilling on ridges | 6.19a | 7.15a | 6.79a | 4.47a | 5.18a | 4.83 | 13.51a | 13.16a | 13.34a |
| F. test | ** | ** | ** | ** | * | N.S | * | ** | ** |

the second season, each increment of N yielded significant increase in the total yield. This was also valid in the combined analysis.

The increase in total yield/fad due to addition of N is rather expected as the plant top dry weight (Table 8) was significantly increased.

The increase in the rate of seeding did not reflect any significant variation in the total yield/fad. This was true in the two seasons and their combined analysis (Table 12).

The present results indicate that the decrease in plant top dry weight (Table 8) or in the number of tillers/plant (Table 4) caused by the increase in the rate of seeding was compensated by the increase in the number of plants/$m^2$ (Table 3). Similar results were reported by Abdulgalil (1964).

In the two seasons, broadcasting method had significantly higher total yield/fad. than the other two drilling methods of sowing. In the first season, drilling on flat yielded higher total yield than drilling on ridges, however, the combined analysis did not show such effect (Table 12).

Similar results were observed in the number of tillers/plant (Table 4), and plant top dry weight (Table 8) at two dates of sampling during the two seasons. The present results clearly indicate that the favourable chance of growth observed on individual plant basis in broadcasting method was reflected in the total yield per fad.

According to the combined analysis, the interaction between N level and method of sowing affected significantly the total yield/fad (Table 12-a).

Table (12-a): Total yield (ton/fad ) as influenced by the interaction between nitrogen levels and methods of sowing (combined analysis)

| Seeding methods | Nitrogen levels (kg N/fed) | | | |
|---|---|---|---|---|
| | zero | 30 | 60 | 90 |
| Broadcasting | A<br>4.65 a | B<br>7.36 b | B<br>8.33 c | B<br>9.07 d |
| Drilling on flat | A<br>4.62 a | A<br>6.62 b | A<br>7.66 c | A<br>8.43 d |
| Drilling on ridges | A<br>4.56 a | A<br>6.73 b | A<br>7.61 c | A<br>8.27 d |

F. test *

It is seen that without N fertilization, the three methods had statistically similar total yields/fad. When N was added, broadcasting method yielded significantly higher total yield/fad than the other two methods of sowing.

The presents results strengthen the view that broad-casted plants could make better use of added nitrogen than those in drills.

B. 10- <u>Straw yield per faddan</u> :

The straw yield/fad. as influenced by N level and rate and method of sowing in the two seasons, is shown in table 12.

In the two seasons, addition of N resulted in a significant increase in the straw yield/fad. In the first season, the increase in N level to 90 kg N/fad increased the straw yield. In the second season, no further significant increase in straw yield was obtained beyond the addition of 30 kg N/fad. However, the combined analysis reflected the trend observed in the first season where the straw yield continued to increase significantly up to the addition of 90 kg N/fad.

In wheat, several workers get increases in the straw yield due to addition of nitrogen (Ibrahim and Assey, 1976 and El-Metwally, 1977). Under the present study, the total yield/fad (Table 12) showed greater response to N fertilization than straw yield. In the former, each N increment was followed by a significant increase. The increase in straw yield could be attributed to the increase in plant height (Table 9) and number of tillers/plant (Table 4) obtained due to addition of nitrogen.

The straw yield was not significantly influenced by the rate of seeding. This was true in the two seasons and their combined analysis (Table 12).

Similar results were seen in the total yield/fad (Table 11) and were attributed to compensation by the higher plant number at dense sowing to decrease in tillering and plant top dry weight.

In the two seasons, broadcasting method recorded significantly higher straw yield than the other two methods of sowing (Table 12). In the first season, significant difference in straw yield was seen among the two drilling methods in favour of drilling on flat. This was not observed in the second season. According to the combined analysis, all these differences proved to be insignificant.

B.11- Grain yield per faddan :

The grain yield/fad as influenced by N level, rate and method of sowing in the two seasons is given in table 12.

In the two seasons, differential response to N fertilization was observed by grain yield/fad. In the first season, the grain yield continued to increase significantly up to addition of 60 kg N/fad. In the second season, the grain yield failed to increase significantly beyond the addition of 30 kg N/fad. The greater response observed in the first season was also observed in the combined analysis.

Under the present study, the total yield/fad continued to increase significantly up to the addition of 90 kg N/fad. Similar response was observed in the straw yield but to a lower extent (Table 12). These data clearly indicate that 60 kg N/fad were quite enough to increase the grain yield whereas 90 kg N/fad were required to maximize the total yield/fad.

In the present study, the two main grain yield components i.e number of spikes/plant (Table 9) and grain weight/spike (Table 11) were significantly increased due to the increase in level of nitrogen up to 60 kg N/fad.

Differences in the magnitude of response to N fertilization among the two seasons, could be attributed to differences in soil fertility levels particularly of nitrogen (Table 1).

In the literature, increases in grain yield were reported by the authors due to N fertilization (Singh and Verma, 1965; Singh and Govil, 1968; Misra and Singh, 1971; Mohamed, 1976; Ibrahim and Assey, 1976 and El-Metwally,1977 and Saleh, 1977).

In the two seasons, the rate of seeding was without significant influence on the grain yield/fad. Similar results were observed in total and straw yields/fad (Table 12).

In the two seasons, broadcasting method recorded significantly higher grain yield/fad than the other two drilling methods (Table 12). The two drilling methods had almost similar grain yields. These data were ascertained by the combined analysis of the two seasons.

The increase of grain yield/fad in broadcasting method could be attributed to similar increases in the number of spikes/plant and grain weight/spike (Tables 9 and 11, in the same order). In this method of sowing, all the growth attributes of wheat were improved (Tables 4 to 7).

B.12- Grain protein content :

The grain protein content as influenced by N level, rate and method of sowing in the two seasons is given in table 13.

In the two seasons, each N increment resulted in a significant increase in the grain protein content. This was ascertained by the combined analysis.

The present results indicate that the increase in grain yield did not reflect any dilution effect to the content of protein in grain. These data are in accordance with those reported by others (Singh and Gupta, 1969 ; Jaisinghani *et al*, 1970; Youssef *et al*, 1971, Misra and Singh, 1971 and Saleh, 1977).

The grain protein was significantly influenced by the rate of seeding. This was true in the two seasons and their combined analysis (Table 13). It is evident that the grain protein was increased due to the increase in the rate of seeding to 52.5 kg/fad. but it thereafter decreased with the further increase in the rate of seeding.

These data indicate that moderate sown plants were able to translocate nitrogen to their grain than light sown ones. The decrease in grain protein due to the further increase in the rate of seeding could be attributed to intense competition between dense sown plants for nitrogen. Under the present study, the grain yield/fad was not

Table (13): Protein content (%) as influenced by nitrogen levels, seeding rates and seeding methods in the two seasons.

| Main effects | Protein content % | | |
|---|---|---|---|
| | 1975/1976 | 1976/1977 | Combined |
| Nitrogen levels | | | |
| Zero | 9.18 a | 8.69 a | 8.94 a |
| 30 kg N/fad | 9.93 b | 9.51 b | 9.72 b |
| 60 kg N/fad | 10.90 c | 10.30 c | 10.60 c |
| 90 kg N/fad | 11.87 d | 11.16 d | 11.52 d |
| F. test | ** | ** | ** |
| Seeding rates | | | |
| 35 kg/fad | 10.31 a | 9.93 b | 10;12 a |
| 52.5 kg/fad | 10.80 b | 10.16 c | 10.48 b |
| 70.0 kg/fad | 10.30 a | 9.66 a | 9.98 a |
| F. test | ** | ** | ** |
| Seeding methods | | | |
| Broadcasting | 10.17 a | 9.78 a | 9.97 a |
| Drilling on flat | 10.54 b | 9.92 b | 10.23 b |
| Drilling on ridges | 10.70 b | 10.06 c | 10.38 c |
| F. test | ** | ** | ** |

significantly influenced by the rate of seeding (Table 12). The increase obtained herein in grain protein due to the use of 52.5 kg seed/fad makes this rate advantageous to other two rates of seeding.

In the two seasons, broadcasting method had significantly lower grain protein content than the other two methods of sowing. According to the combined analysis, it is evident from table 13 that drilling on ridges method had higher protein content than drilling on flat one.

The trend of protein content followed almost opposite pattern to the trend of grain yield/fad. Data in table 12 showed that broadcasting method recorded higher grain yield than the other two methods of sowing. These results indicate that dilution in protein content caused by the increase in grain yield could account for the decrease in grain protein in broadcasting method.

## Summary

This investigation was conducted at the Agricultural Research Station at Gimmieza during two successive seasons (1975/1976 and 1976/1977). The study aimed to find out the response of a semi-dwarf wheat cultivar (Chenab 70) to three levels of nitrogen (30, 60 and 90 kg N/fad), three rates of seeding (35,52.5 and 70 kg/fad) and three methods of sowing (broadcasting, hand drilling on flat and hand drilling on ridges).

A split split plot design of four replications was tried where N levels, rates of seeding and methods of sowing were allocated at random in the main, sub and sub sub plots, respectively. A main plot was devoted where nitrogen fertilization was restricted. The response of wheat to the three factors under study was traced on grown of two samples taken at 77 and 97 and at 70 and 85 days after sowing in the two seasons, respectively, as well as, on yield and some of its contributing characters at harvest.

The number of plants/$m^2$ was recorded 23 days after sowing. Data recorded on growth of wheat at the two fore-mentioned dates of sampling included: plant height, number of tillers/plant, leaf area/plant, LAI, LAR, NAR, RGR, AGR. At the second date of sampling flag leaf area was recorded. The number of days to 75 % heading was also recorded. Data recorded of harvest included : plant height, number of spikes/plant, spike length, number of fertile and sterile spikelets/spike, number of grains/spike, 1000 grain weight, grain weight/spike, grain yield/plant, total yield/fad,

straw yield/fad, grain yield/fad and grain protein content.

The results obtained from this study could be summarized under two main headings as follows :

A. Growth of wheat :

A.1. Effect of nitrogen :

A.1.1- Plant height responded to N fertilization at the two dates of sampling, but the response decreased with the advance of growth. In the first season, plant height continued to increase significantly up to addition of 60 kg N/fad. whereas it responded to 30 kg N/fad only in the second season.

A.1.2- Number of tillers/plant responded to N fertilization with increased response with the advance of growth. In the first season, tiller number/plant continued to increase significantly up to addition of 90 kg N/fad whereas it responded to only 60 kg N/fad in the second season.

A.1.3- The response of leaf area/plant and LAI to N fertilization was decreased with the advance of growth in the first season but it was increased in the second season up to the addition of 90 kg N/fad.

A.1.4- Flag leaf area responded to 60 and 90 kg/fad in the two seasons, respectively.

A.1.5- In the second season, number of days to 75 % heading was increased significantly with the increase in N level to 90 kg N/fad.

A.1.6- In the first season, LAR was decreased due to the addition of 90 kg N/fad. During the same season, NAR was significantly increased as compared to control due to addition of nitrogen.

A.1.7- In the first season, RGR was significantly increased when the first N increment was given but it thereafter decreased.

A.I.8- In the two seasons, addition of 30 kg N/fad. was effective to increase AGR but the further N increments failed to add any significant increase.

A.1.9- In the first season, the response of plant top dry weight to the increase in N level was decreased with the advance of growth. In the second season, a linear increase was observed with the increase in N level at the two dates of sampling.

A.2. Effect of seedling rate :

A.2.1- In the two seasons, each increase in the rate of seeding was accompanied by a significant increase in the number of plants/$m^2$.

A.2.2- At the second date of sampling in the first season, the increase in the rate of seeding to 70 kg/fad. was accompanied by a significant increase in plant height.

A.2.3- In the two seasons, the number of tillers/plant was significantly decreased with the increase in the rate of seeding. The effect was more pronounced in the first than in the second season.

A.2.4- In the seasons, the leaf area/plant was significantly decreased with the increase in the rate of seeding. This was not observed in LAI at the first date of sampling but it was increased at the second date of sampling in the first season due to doubling the rate of seedings.

A.2.5- In the second season, flag leaf area was significantly reduced when the rate of seeding was increased to 70 kg/fad.

A.2.6- In the two seasons, the number of days to 75 % heading was decreased due to the increase in the rate of seeding. The decrease was consistent in the second season.

A.2.7- Both LAR and NAR were not influenced by the increase in the rate of seeding. This was also observed in RGR but AGR was significantly decreased in the second season.

A.2.8- In the first season, the increase in the rate of seeding to 52.5 or 70 kg/fad. resulted in a significant decrease in the plant top dry weight. In the second season, the decrease was consistent with each increase in the rate of seeding.

A.3. Effect of seeding method :

A.3.1- In the first season, the lowest number of plants/$m^2$ was recorded for broadcasting whereas drilling on flat had the highest one.

A.3.2- In the first season, drilling on flat had longer plants than the other two methods of sowing which had almost similar plant heights. In the second season, drilling on ridges had longer plants at the second date of sampling than the other two methods of sowing.

A.3.3- In the two seasons, broadcasted plants produced larger number of tillers than drilled ones at the two dates of sampling.

A.3.4- In the two seasons, broadcasted plants had larger leaf area/plant than drilled ones at the two dates of sampling.

A.3.5- In the second season, higher LAI was recorded in the broadcasted than in the drilled on ridges plots.

A.3.6- In the second season, highen flag leaf area was recorded for broadcasting than for the other two methods of sowing which had almost similar averages.

A.3.7- In the two seasons, heading was delayed in the broadcasted than in drilled plots.

A.3.8- LAR was not influenced by varying the method of sowing, however, higher NAR was recorded for the broadcasted plants than for drilled ones in the first season.

A.3.9- In the first season, higher RGR and AGR were recorded for the broadcasted plants than those drilled either on flat or ridges, respectively .

A.3.10- In the two seasons, broadcasted plants were significantly heavier than drilled ones. In the second season, significant differences were observed among drilled plants in favour of those drilled on flat.

A.4. Interaction effect :

A.4.1- Nitrogen level X seeding rate :

a - In the second season, at 85 days after sowing; leaf area/plant failed to increase significantly beyond addition of 30 kg N/fad in dense sown plots, but continued to increase significantly up to addition of 90 kg N/fad in lighter sown ones.

b - In the second season, at 85 days after sowing, similar LAI were recorded in light and dense sown plots when 90 kg N/fad were added to the former and only 30 kg N/fad were added to the latter.

c - In the first season, at the highest N level, the increase in the rate of seeding from 30 to 70 kg/fad resulted in a significant increase in LAR. This was not true at the two lower levels of nitrogen.

d - In the first season, at 60 or 90 kg N/fad, the increase in the rate of seeding was followed by a significant decrease in NAR. This was not true at the two lower N levels.

e - In the second season, nitrogen fertilization failed to increase AGR in dense sown plots. At the two lower rates of seeding, AGR was significantly increased by N fertilization.

f - In the two seasons, in light sown plots, the plant top dry weight continued to increase significantly with the increase in N level. At the two highest rates of seeding, plant top dry weight failed to increase significantly beyond the addition of 30 and 60 kg N/fad in the two seasons, respectively.

A.4.2- Nitrogen level X seeding method :

a - In the first season, at 77 days after sowing, the number of tillers/plant was significantly increased by N fertilization in broadcasted plots up to addition of 90 kg N/fad. In the other two methods of sowing, lower response was observed to the increase in the level of nitrogen.

b - In the first season, at 97 days after sowing, N fertilization was effective to increase the leaf area/plant in the broadcasted plots to a greater extent than in the drilled ones.

c - In the second season, at 85 days after sowing, the three methods of seeding had almost similar LAI when N fertilization was restricted. In the fertilized plots, broadcasting method had higher LAI than drilling ones.

d - In the two seasons at the second date of sampling, lower response to N fertilization was shown by the plant top dry weight in drilling on ridges method than in the other two methods of seeding.

A.4.3- Seeding rate X seeding method :

a - In the first season, at the highest rate of seeding, drill sowing on flat had the highest number of plants/$m^2$ than in the other two methods of seeding.

b - In the first season at the first date of sampling, the decrease in the number of tillers/plant due to the increase in the rate of seeding was more consistent in broadcasting than in the other two drilling methods.

B - Wheat yield and some contributing characters :

B.1. Effect of nitrogen :

B.1.1- Plant height continued to increase significantly up to addition of 60 and 30 kg N/fad in the two seasons, respectively.

B.1.2- In the two seasons, the number of spikes/plant continued to increase up to addition of 60 kg N/fad.

B.1.3- In the two seasons, spike length was linearly increased up to the highest N level i.e 90 kg N/fad.

B.1.4- According to the combined analysis, the number of fertile spikelets was increased and at the meantime the number of sterile spikelets was decreased with the increase in the level of N to 90 kg N/fad. The decrease was more consistent than the increase.

B.1.5- In the two seasons, a significant increase in the number of grains/spike was obtained with the first two increments of nitrogen.

B.1.6- In the second season, addition of N was accompanied by a significant decrease in 1000 grain weight. This was true in the combined analysis when the level of N was increased to 90 kg N/fad.

B.1.7- In the two seasons, both the grain weight/spike and grain yield/plant were linearly increased up to the addition of 60 kg N/fad.

B.1.8- According to the combined analysis, a significant increase in the total yield/fad was obtained with each increment of nitrogen. In the straw yield this increase was less pronounced.

B.1.9- According to the combined analysis, a linear increase was observed in the grain yield/fad with the first two N increments.

B.1.10- In the two seasons, a linear increase was obtained in the protein content with each increase in the level of nitrogen.

B.2. Effect of seeding rate :

B.2.1- In the first season, the plant height was significantly increased when the rate of seeding was increased to 70 kg /fad.

B.2.2- According to the combined analysis, both the spike length and number of spikes/plant were significantly decreased as the rate of seeding was increased to 70 kg /fad.

B.2.3- According to the combined analysis, a consistent significant decrease was observed in the number of fertile spikelets/spike with the increase in the rate of seeding. On the other hand, the number of sterile spikelets was significantly increased when the rate of seeding was increased to 70 kg /fad.

B.2.4- The number of grains/spike was not significantly influenced by the increase in the rate of seeding, however, the 1000 grain was significantly decreased as was observed from the combined analysis.

B.2.5- According to the combined analysis, both the grain weight/spike and grain yield/plant were significantly decreased with the increase in the rate of seeding to 70 kg /fad.

B.2.6- In the two seasons, the increase in the rate of seeding was without significant influence on the total, straw and grain yields/fad.

B.2.7- According to the combined analysis, the grain protein content was significantly increased with the increase in the rate of seeding to 52.5 kg / fad but it thereafter decreased when the rate of seeding was increased.

B.3. Effect of seeding method :

B.3.1- In the two seasons, varying the method of seeding did not reflect any significant variation in plant height.

B.3.2- According to the combined analysis, broadcasted plants had larger number of spikes/plant than drilled ones. Those drilled on flat had larger numbers than those drilled on ridges.

B.3.3- According to the combined analysis, broadcasted plants produced longer spikes with greater number of fertile spikelets than those produced by drilled ones. No significant differences were detected in the number of sterile spikelets/spike, though the drilled plants had larger numbers in the first season.

B.3.4- According to the combined analysis, broadcasted plants had greater number of grains/spike than drilled ones. Plants drilled on flat had greater numbers than those drilled on ridges.

B.3.5- In the two seasons, 1000 grain weight was not incluenced by the method of sowing, however, the combined analysis of the two seasons, showed that broadcasted plants had significantly heavier grain weights either per spike or per plant than drilled ones. Also drilled plants on flat had heavier weight than drilled ones on ridges.

B.3.6- According to the combined analysis, broadcasted plants produced significantly greater total and grain yields/fad than drilled ones. This was not true in the straw yield where differences did not reach the level of significance.

B.3.7- According to the combined analysis, the highest grain protein content was recorded for the drilling on ridges method followed by drilling on flat. The lowest content was recorded for broadcasting method.

B.A. Interaction effect :

B.4.1. Nitrogen level X seeding rate :

a - At the two lower N levels, the increase in the rate of seeding reflected significant decreases in spike length. This was not observed at the two higher N levels.

b - Without N fertilization, each increase in the rate of seeding was accompanied by a significant decrease in the number of fertile spikelets/spike. At the highest N levels, this was not true unless the rate of seeding was increased to 70 kg/fad.

c - At the highest rate of seeding, the increase in N level from 0 to 90 kg N/fad resulted in a significant decrease in 1000 grain weight. This was not true at the two lower rates of seeding.

B.4.2. Nitrogen level X seeding method :

a - At the two higher N levels, broadcasted plants had higher numbers of spikes/plant than drilled ones. Without N fertilization, no significant differences were detected.

b - Without N fertilization, the three methods of sowing had almost similar grain yields/plant. At the two higher N levels, broadcasting method recorded the highest grain yield followed by drilling on flat and the lowest yield was recorded by drilling on ridges method.

c - With the addition of nitrogen, broadcasting method had higher total yield/fad than the two drilling methods. When N fertilization was restricted, the three method had almost similar yields.

B.4.3. Seeding rate X seeding method :

a - In the first season, plants got taller with the increase in the rate of seeding in the broadcasting or drilling on flat method. This was not true in plots drilled on ridges.

b - In the broadcasted plots, the number of spikes/plant, as well as, spike length were not significantly decreased unless the rate of seeding was increased to 70 kg/fad. In the two drilling methods both characters were decreased with any increase in the rate of seeding.