Influence of Sowing Dates and Combined Fertilizers (NPK) on Growth and Chemical Composition of Triticale Grains in Egyptian New Reclaimed Sandy Soils

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ABSTRACT

Two field experiments were carried out during the two successive winter seasons of 2007/2008 and 2008/2009 at the Agricultural Experiments Desert Station of the Faculty of Agriculture, Cairo University in Wadi El-Natroon, El-Beheira Governorate, Egypt. The aim of this study was to adapt triticale crop (Triticosecale Wittmack) under different environmental conditions in New Lands. To realize this goal triticale crop (c.v. Bahtim 1) was cultivated at different sowing dates (15th of November, the first of December and the 15th of December) under different combinations of N, P and K fertilizers (60, 90 and 120 kg N/fed. - 15, 30 and 60 kg P2O5/fed. - 25 and 50 kg K2O/fed.). The effect of the two factors was studied on growth and its related traits as well as on chemical composition in grains of triticale plants. In the 1st season, the sowing date 15th Dec. was superior in number of spikes/m², whereas 15th Nov. sowing date came later. However, in case of number of tillers/m², the 1st of Dec. was superior. In the 2nd season, both growth characters showed their higher values when seeds were sown at 15th of Dec. Total dry matter/m² of triticale plant varied from year to another due to sowing dates. Delaying sowing date indicated a depression in dry matter in the 1st season and the reverse was true for the 2nd season. The highest dry matter was shown by the 1st sowing date in the 1st season and by the last date in the second season. Data showed a negative relationship between delaying sowing date and grain yield in both seasons. Delaying triticale sowing from Nov.15 to Dec.15 reduced grain yield by 22.9 and 46.7 %, in the 1st and 2nd seasons, respectively. Application of 90 kg N fertilizer rate exhibited the highest improvement in growth characters i.e. number of tillers, number of spikes and dry matter content/m². This was true for both seasons. The data showed also that applying 90 kg N/fed. induced the best improvement in growth characters with the other elements of the combined fertilizer. K at 25kg/fed rate also showed the better enhancement. The highest grain yield was obtained by addition of N90P30K25 followed by N90P60K25 in the 1st season, while in the 2nd season it was by N90P60K25 and followed by N90P15K25. Moreover, no significant differences in N, protein and K percentages in triticale grains were detected among sowing dates while P concentration was slightly affected by different sowing dates. The highest P % value was shown when plants were cultivated at 15th Dec. Generally, a positive relationship was shown between the increase in P fertilizer rates and the N, P and K % in grains.

Keywords: grain yield; number of tillers/plant; dry matter/plant; grain NPK; grain protein.

INTRODUCTION

Triticale (X Triticosecale Wittmack) is a close relative of wheat resulting from pollinating durum wheat (Triticum turgidum or Triticum aestivum) with rye (Secale cereale) and using the cross in a breeding program to produce stable, self-replicating varieties. Delayed sowing reduced the growth characters as well as chemical constituents in grains of triticale and wheat plants [31,20,35,43].

Nitrogen is an important component of many important structural, genetic and metabolic compounds in plant cells. It is a major component of chlorophyll, the compound by which plants use sunlight energy to produce sugars from water and carbon dioxide (i.e. photosynthesis). It is also a major component of amino acids, the building blocks of proteins. Some proteins act as structural units in plant cells while others act as enzymes, making possible many of the biochemical reactions on which life is based. Nitrogen is a component of energy-transfer.
compounds, such as ATP (adenosine triphosphate) which allows cells to conserve and use the energy released in metabolism. Finally, nitrogen is a significant component of nucleic acids such as DNA, the genetic material that allows cells (and eventually whole plants) to grow and reproduce. Nitrogen plays the same roles (with the exception of photosynthesis) in animals too. Without nitrogen, there would be no life as we know. Phosphorus as an important nutritional element plays a part in regulating many physiological criteria in the plant which in turn affect the resulted total yield [24]. Phosphorus is implicated in carbohydrate metabolism. Although the rates of photosynthetic carbon fixation by plants may be reduced by phosphorus deficiency [29]. The presence of phosphorus in the soil encourages plant growth because the phosphorus is an essential nutrient. Practically, phosphorus is a major building block of DNA molecules [27]. Potassium also plays some important roles in plant metabolism. The role of K in photosynthesis is complex. The activation of enzymes by K and its involvement in adenosine triphosphate (ATP) production is probably more important in regulating the rate of photosynthesis than is the role of K in stomatal activity. Potassium also plays a major role in the transport of water and nutrients throughout the plant in the xylem [28]. Triticale uses more nitrogen than wheat and phosphorus must be adequate for good yields because a shortage of nitrogen will significantly reduce yield. Many research workers confirmed the effect of applying fertilizers especially NPK on growth and chemical constituents of grains of triticale. Among them are: Hassaan [13], Zende et al. [44] and Khan et al. [17].

This work was established to furnish knowledge and to have some understanding about some basic factors and important tools such as the use of different sowing dates and rates of fertilizer (N, P and K) to determine the optimum sowing date and proper NPK rates to obtain the highest growth and NPK concentrations of triticale under the experimental site conditions.

Materials and Methods

Soil properties and irrigation water analysis

Soil samples were taken from the surface 30 cm depth of the soil profile to determine the physical and chemical properties of the soil. In addition, samples from irrigation water source were taken for chemical analysis. The previous analyses were carried out according to the method described by Klute and Dirksen [18]. Data are shown in Tables 1 and 2.

| Table 1: Physical and chemical properties of soil experimental site in Wadi El-Natroon, Beheira Governorate, Egypt in the two growing seasons (in the surface 30 cm). |
| Sand% | 93.00 | 94.35 |
| Silt% | 4.45 | 3.48 |
| Clay% | 2.55 | 5.52 |
| Texture | Sandy | Sandy |
| Soil pH | 7.06 | 7.11 |
| EC (dS/m) | 0.80 | 0.90 |
| Organic Matter (%) | 0.20 | 0.15 |
| Total CaCO3 (%) | 2.30 | 2.20 |
| Total N (%) | 0.40 | 0.40 |
| Soluble anions concentration (meq/100g soil) | | |
| Cl- | 75.40 | 78.00 |
| SO42- | 0.30 | 0.41 |
| HCO3- | 0.30 | 0.29 |
| Soluble cations concentration (meq/100g soil) | | |
| Na+ | 43.38 | 45.00 |
| Ca++ | 17.00 | 18.50 |
| Mg++ | 15.00 | 16.00 |
| K+ | | |

| Table 2: Chemical analysis of irrigation water in the experimental site of Wadi El-Natroon, Beheira Governorate, Egypt. |
| Year | pH | EC (dS/m) | HCO3- | Cl- | SO42- | Ca++ | Mg++ | Na+ | K+ |
| 2007 | 7.54 | 4.00 | 4.5 | 32.5 | 9.25 | 4.0 | 6.0 | 35.2 | 0.54 |
| 2008 | 7.48 | 4.14 | 3.5 | 30.3 | 7.43 | 5.50 | 4.50 | 30.8 | 0.43 |

Studied factors:
1. Sowing dates: triticale crop (c.v. Bahtim 1) was sown in three different dates; i.e. 15th of November, the first of December and the 15th of December in the two experimental seasons.
2. Chemical fertilizers
   Combined doses from the different rates of NPK fertilizers were applied as follows:
   a. Nitrogen fertilizer in the rates of 60, 90 and 120 kg N/fed., in the form of ammonium nitrate (33.5% N) was added in three equal doses; at sowing, at 25 days from sowing before the first irrigation (Mohaya) in the seedling stage and at 50 days from sowing before irrigation in the tillering stage.
   b. Phosphorus fertilizer in the rates of 15, 30 and 60 kg P2O5/fed., in the form of calcium superphosphate
(15% P2O5) was added before sowing during soil preparation.
c. Potassium fertilizer in the rates of 25 and 50 kg
K2O/fed., in the form of potassium sulphate (48%
K2O) was added at 30 days from sowing. So, the
combined fertilizer treatments (kg/fed.) were as
follows:
N60+P15+K25   N90+P15+K25   N120+P15+K25
N60+P15+K50   N90+P15+K50   N120+P15+K50
N60+P30+K25   N90+P30+K25   N120+P30+K25
N60+P30+K50   N90+P30+K50   N120+P30+K50
N60+P60+K25   N90+P60+K25   N120+P60+K25
N60+P60+K50   N90+P60+K50   N120+P60+K50

Experimental design:
The applied statistical design of the experiments
was split – plot one with three replications. Sowing
dates were assigned in the main plots, whereas the
different combinations of NPK fertilizers were
distributed randomly in the sub-plots. The area of
every sub-plot was 10.5m, 3.5m in length and 3.0m
in width.

Measurements and calculations:
One vegetative sample of one square meter (1x1
m) was taken from each sub-plot at 120 days from
sowing and the following characters were measured:
1. Number of tillers/m².  2. Number of spikes/m².
3. Dry matter/m².  4. Grain yield kg/fed.
Harvesting took place at 154, 140 and 124 days
from sowing for the first, second and third sowing
date, respectively in both seasons.

Chemical constituents:
At harvest time, random samples of grains were
taken from every sub-plot, dried in an electric oven,
ground in a stainless steel mill. Digestion was done
using perchloric acid, nitric acid and sulfuric acid in
the rate of 3:1:1.
A flamephotometer was used to determine the
concentration of K in the solution. Quote results were
calculated as mg K per kg dry matter.
Phosphorus was determined by spectrophotometric
determination of phosphates. Quote results were calculated as mg P per kg dry
matter.
Total nitrogen was determined by modified
Kjeldahl method according to Cottenie et al. [5].
Quote results were calculated as mg N per kg dry
matter. Then protein was calculated by multiplying
the values of total nitrogen by 6.25 factor.

Statistical analysis:
Data were subjected to the proper statistical
analysis according to the method prescribed by
Snedecor and Cochran [39]. Means were verified
according to the Duncan's multiple range test [6].

Results and Discussion

I- Growth characters:
Effect of sowing dates:
In the 1st season (2007/2008), the sowing date
15th  Dec. was superior in number of spikes/m²
while 15th Nov. sowing date came later. However, in
case of number of tillers/m², the 1st of Dec. was
superior. In the 2nd season, both growth characters
showed its higher values when seeds were sown at
15th of Dec. as shown in  Figs. 1 and 2. The suitable
sowing date for higher number of spikes/m² was 15th
Dec. while for number of tillers/ m² it was 15th Nov.

Mahfouz  [23] in Egypt, concluded that the
highest value for plant height, number of tillers/m ,
number of spikelets/spike, spike length, number of
grains /spike, 1000-grain weight, biological and grain
yields were produced when wheat was sown on 15
November. But, the highest number of non effective
tillers/m and the highest straw yield were recorded
from sowing wheat on 30 November.

Rozbicki et al. [32] indicated that winter
Triticale cv. Presto was sown on 20 September or 10
October. Delayed sowing reduced the number of
spikes/msuperscript 2, the number of grains per spike
and 1st and 2nd order and other tillers, single-grain
weight on main shoots, 1st and 2nd order and other
tillers. Between 13 and 62 days after renewal of
growth in spring significant differences in growth
and development of plants and main stem spikes
resulted from differences in sowing date. On the
other hand, El-Sayed et al. [8] showed that the
highest values of the growth characters were
recorded for the plants grown on 5 November.
Winter Triticale cv. Duoero, Largo and M10alno were
sown on the optimum date or 14 days later. Late
sowing increased the number of short tillers with a
smaller number and weight of grains/spike. Uniform
stands of tall plants with 2 tillers gave the highest
yield [15].

Rachon [30] showed that late April sowing
reduced the number of reproductive tillers formed.
Zende et al. [43] investigated that the growth of
wheat crops (Triticum durum) cultivars (AKDW-
4146 and MACS-2846) showed significant increases
when wheat crops were sown on 15 November
compared with those sown on 1 December and 15
December.

Dry matter/m² of triticale varied from year to
year for sowing dates (Figs. 1 and 2). Delaying
sowing date indicating a depression in dry matter in
the 1st season and the reverse was true for the 2nd
season. The highest Dry matter/m² showed by the 1st
date in the 1st season and by the last date in the 2nd
season, meanwhile, the combined analyses cleared
that the highest dry matter produced by sowing seeds
in 15th Nov followed by that sown at 15th Dec.,
however, the lowest DM was by 1st Dec. sowing
Date. These differences were likely to be due to a
number of factors including tillering weather patterns
in winter months and wet months in the early
summer which may resulting in foliar diseases [4,35]
revealed that dry matter production decreased as planting was delayed from late September to late October.

LSD 0.05 for: No. of tillers/m² = 54.2, No.of spikes/m² = 34.1, Dry matter/m² = 162.3

LSD 0.05 for: No. of tillers/m² = 51.85, No.of spikes/m² = 30.24, Dry matter/m² = 159.4

**Fig. 1:** Effect of sowing date on growth characters in the 1st season.

**Effect of combined fertilizer:**
Application of fertilizer rate induced the highest improving in growth characters i.e. number of tillers, number of spikes and dry matter content/ m². This was true for both seasons (Figs. 3 and 4). This Data showed that the level of N (90 kg/fed) induced the best improvement in growth characters with the other elements of the combined fertilizer. The rate of 120 kg N seemed to be without differences in these characters) and K 25 kg/ fed rate also showed the better enhancement.

Kozicara, et al. [19] reported that grain yield of triticale cv. Jago plant height was greatest with 100 kg N/ha. Increasing nitrogen level (90 kg N/feddan) resulted in significant increase in plant height in the first season, only [9]. Rozbicki et al. [33] described that N application at the end of tillering was recommended for triticale and low N application rates (80 kg/ha). On triticale plant, Hassaan [13] stated that increasing N-levels up to 125 kg N/fed significantly increased plant height, number of spikes/plant, spike length and number of kernels/spike. Zende et al. [43] found that the growth showed significant increases when durum wheat crop was supplied with the fertilizer level 150:75:75(kg NPK/ha). The highest dry matter/ m² was shown when plants received N120P20K25 rate while the lowest was by N120P25K25 in the 1st season but in the 2nd season the picture was different (Fig. 3 and 4). These enhancing effects resulted from the application of NPK fertilizers may be due to the role of these minerals in the physiological processes of the plant so that individually or through the synergistic effects between these elements. Ryan et al. [34] noticed that nitrogen consistently increased dry mater of barley in Morocco. Wang et al. [41] reported the beneficial effect of nitrogen in metabolic process such as protein, enzymes and hormones building inside the cereal plants. Marchener [24], Shaheen et al. [37],

**Fig. 2.** Effect of sowing date on growth characters in the 2nd season.

Lin et al. [21], Khan et al. [17] mentioned that positive responses of metabolism to P application mainly in nucleic acids formation, energy transformation. K fertilizer play important roles in enzymes activity, water adjustment in plant tissues, carbohydrate metabolism and translocation of its metabolites from source to sink [3,4,22].

2- Grain yield:
2.1. Effect of sowing dates:
Data presented in Table 3 show that delaying triticale sowing date from Nov.15 to Dec.15 reduced grain yield/ fed. by 22.9 and 46.7 %, in the 1st and 2nd seasons, respectively. The results of this study showed that grain yield of triticale decreased substantially by delaying date of sowing. It seemed that prevailing weather during the growing period may play a role for growth enhancement and acceleration of both fruit setting and grain filling which may in tern reflect on grain yield and vise versa. Planting date is one of the most important management factors involved in producing high-yielding of small- grains such as triticale [7]. Moreover, Jaskiewicz and Mazurek [15] sowed winter triticale cv. Dagro, Largo and Malno were sown in the optimum date or 14 days later. He revealed that delayed sowing significantly reduced grain yield. Kratzsch [20] reported that the grain yield of triticale decreased with delaying sowing from September to October or to November. Moreover, Rozbicki et al. [32] indicated that grain yield of winter Triticale cv. Presto sown in 20 September or 10 October averaged 6.80 and 5.28 t/ ha for the 1st and 2nd sowing date, respectively. Between 13 and 62 days after renewal of growth in spring, significant differences in growth and development of plants and main stem spikes were resulted from differences in sowing date. Schwarte et al. [35] stated that grain yield of triticale was
decreased with delaying planting after late September. Yield reductions as a result of planting in mid October compared to late September ranged from 13 to 29%. Grain yield of mid September sowing was 15% less than late September planting and early October sowings, and 13 to 15% less for mid October.

**Fig. 3**: Effect of NPK fertilizer on growth characters in the 1st season.

**Fig. 4**: Effect of NPK fertilizer on growth characters in the 2nd season.


<table>
<thead>
<tr>
<th>Sowing dates</th>
<th>Grain yield / fed. (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15th Nov.</td>
<td>898 a</td>
</tr>
<tr>
<td>1st Dec.</td>
<td>854 a</td>
</tr>
<tr>
<td>15th Dec.</td>
<td>692 b</td>
</tr>
<tr>
<td>LSD&lt;sub&gt;0.05&lt;/sub&gt;</td>
<td>46</td>
</tr>
</tbody>
</table>

2.2. Effect of combined fertilizer:

Data in Table 4 pointed out that the highest grain yield was obtained by addition of N90P30K50 followed by N90P30K25 in the 1st season, while in the 2nd one it was obtained by N90P60K25 and followed by N90P15K25. However, no obvious trend was obtained in grain yield due to increasing P fertilizer rates in both growing seasons. The increase in K fertilizer rates more than 25 kg K2O/fed. did not improve the grain yield/ fed. under the condition of this experiment in both experimental seasons. These findings were confirmed by Omran et al. [26].

Many researches dealing with application of NPK fertilizer and its effect on grain yield of cereals but their results varied according to the crop, varieties and soil type. Application of 90 kg N was applied + 38 kg P and 73 kg K/ha increased the grain yields [40]. Koziara et al. [19] reported that grain yield of triticale cv. Jago plant was greatest with 100 kg N/ha.


<table>
<thead>
<tr>
<th>NPK Fertilizer</th>
<th>Grain yield / fed. (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N60P15K25</td>
<td>910 a</td>
</tr>
<tr>
<td>N60P15K50</td>
<td>741 bj</td>
</tr>
<tr>
<td>N60P30K25</td>
<td>711 ij</td>
</tr>
<tr>
<td>N60P30K50</td>
<td>681 j</td>
</tr>
<tr>
<td>N60P60K25</td>
<td>752 gj</td>
</tr>
<tr>
<td>N60P60K50</td>
<td>764 fi</td>
</tr>
<tr>
<td>N90P15K25</td>
<td>908 ac</td>
</tr>
<tr>
<td>N90P15K50</td>
<td>723 hj</td>
</tr>
<tr>
<td>N90P30K25</td>
<td>922 ab</td>
</tr>
</tbody>
</table>
3- Mineral Status:
Effect of sowing dates:
The results in Table 5 showed that N, P and K % in shoots responded significantly to the different sowing dates either in the 1st season or in the 2nd season. The concentration of N as well as protein % was negatively responded to the delaying of sowing date. P concentration gave the same response but K % showed its highest level when seeds sown at 15th Dec. Data also indicated that no significant differences in N as well as protein and K percentages between sowing dates while slightly affected P concentration in grains by different sowing dates. The highest P% value was shown when plant cultivated at 15th Dec. Delaying the date of sowing than 15th Nov., lowered the percentage of N, P and K in shoots of wheat plants in the 1st season but in the 2nd season, N % as well as protein showed similar response, however, P and K concentrations were reversely responded.


<table>
<thead>
<tr>
<th>Sowing Date</th>
<th>N (%)</th>
<th>P (%)</th>
<th>K (%)</th>
<th>Protein (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15th Nov.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1</td>
<td>2.01</td>
<td>0.33c</td>
<td>0.45</td>
<td>12.57</td>
</tr>
<tr>
<td>S2</td>
<td>2.12</td>
<td>0.36b</td>
<td>0.46</td>
<td>12.29</td>
</tr>
<tr>
<td>15th Dec.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1</td>
<td>1.96</td>
<td>0.34b</td>
<td>0.45</td>
<td>12.19</td>
</tr>
<tr>
<td>S2</td>
<td>1.96</td>
<td>0.38a</td>
<td>0.47</td>
<td>13.49</td>
</tr>
<tr>
<td>LSD0.05</td>
<td>NS</td>
<td>0.008</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

S1 = First season S2 = Second season

Effect of NPK fertilizer:
Generally, as shown from Figs. 5 – 8, a positive relationship was shown between the increasing in P fertilizer rates and the N, P and K %. Nevertheless, a negative relation was shown between the increase in K fertilizer and the triticale grain K %. However, the increasing of N fertilizer rates enhanced the N % but decreasing the P % of triticale plants.

Ferrise et al. [11] N treatments did not affect crop phenology, but N fertilization allowed the crops accumulating more DM and N during the vegetative period. In addition, high-N crops, because of their larger canopy, accumulated more DM and N during grain filling than low-N crops, resulting in higher grain yield and protein concentration at harvest. Angus et al. [1] Nitrogen fertilizer increased the accumulation of N by all crops at anthesis, but the magnitude of the increase depended on crop biomass which was related to the site and seasonal conditions.

Fig. 5: Effect of NPK fertilizer on N, P, and K concentration in triticale grains during 2007/2008 season.
Conclusions:

1- The 15th Dec. sowing date was superior in number of spikes/m² and number of tillers/m² of triticale plants. However, total dry matter/ m² varied from year to another due to sowing dates indicating that delaying sowing date showed a depression in dry matter in the 1st season and the reverse was true for the 2nd season. Data showed a negative relationship between delaying sowing date and grain yield in both seasons. Delaying triticale sowing from Nov.15 to Dec 15 reduced grain yield by 22.9 and 46.7 %, in the 1st and 2nd seasons, respectively.

2- Application of 90 kg N fertilizer rate exhibited the highest improvement in growth characters i.e. number of tillers, number of spikes and dry matter content/m². The data showed also that applying 90 kg N/ fed. induced the best improvement in growth characters with the other elements of the combined fertilizer. K at 25 kg/ fed rate also showed the better enhancement. The highest grain yield was obtained by addition of N90P30K50 followed by N90P30K25 in the 1st season, while in the 2nd season it was by N90P60K25 and followed by N90P15K25.

3- No significant differences in N, protein and K percentages in triticale grains were detected among sowing dates while P concentration was slightly affected by different sowing dates. The highest P % value was shown when plants were cultivated at 15th Dec. Generally, a positive relationship was shown between the increase in P fertilizer rates and the N, P and K % in grains.

References
