INFLUENCE OF NITROGEN FERTILIZER ON YIELD AND ITS COMPONENTS OF BARLEY AND LUPIN OR CHICKPEA IN SOLELY OR INTERCROPPING PLANTING UNDER THE CONDITIONS OF NEWLY RECLAIMED SOIL.

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ABSTRACT:
A field trial conducted on barley, lupin and chickpea crops was practiced in sand loamy newly reclaimed soil at the experimental farm of the Faculty of Agriculture, Fayoum University, during 2006/07 and 2007/08 seasons. This work was designed to study the effect of nitrogen fertilizer rates (15, 30 and 45 kg N/fed.) on the three crops grown as sole and intercropping (barley/chickpea and barley/lupin). A split split-plot arrangement in randomized complete block design with three replications was used. The obtained results showed that, compared with the barley/chickpea pattern, monocrop chickpea had significantly improved yielding and quality traits. Whereas, intercropping had higher seed index. Fertilization with 45% N (N3) led to increases in vegetative and reproductive and consequently seed yield/fed. However, similar means of height to first branch and seed index were obtained from application of 30 kg N/fed. (N2) which produced the highest harvest index. Compared with monocrop culture, barley/lupin intercropping resulted in significant increases of lupin height traits in addition its superiority for number of branches and seed index but with inferior seed weight/plant. The heaviest weight of seeds/plant and yield/fed. were obtained from soled lupin. Nitrogen application results revealed the adequacy of N3 for lupin where it produced acceptable seed yield/fed. due to its superior number of pods and harvest index. Except seed and harvest indices all barley traits were significantly affected by intercropping in favour to soled culture. Intercropping barley produced more than half yield/fed. Compared with solid culture. Nitrogen fertilization indicated the suitability of N2 (30 kg N/fed.) for producing improved yield insignificantly different from that of N3. Under cropping patterns with N2 fertilizer dose, the second yielding combinations were barley/chickpea (12.18 ard) and then barley/lupin (11.08 ard) which represented 61 and 55% of yield of soled barley fertilized with N3. These results indicating that chickpea was of better effect than lupin on barley yielding ability and fertilization with the intermediate nitrogen dose (N2) was quite enough for intercropping. Also, with N2 barley/chickpea and barley/lupin yielded 49% chickpea together with 61% barley with LER of 1.15 as well as 46% lupin together with 55% barley with LER 1.21, respectively, compared with sole culture of each crop. These two intercropping –N2 combinations increased total production by 15% and 21% respectively.

Key words: Barley, Lupin, Chickpea, Intercropping, Nitrogen fertilizers, yield and yield components and LER.

INTRODUCTION
Research has focused primarily on the potential of C₄ cereal/legume intercrops and has demonstrated a clear yield advantage for the sole cropping of species such as maize/field bean (Willey and Osiru, 1972) sorghum/pigeon pea (Natarajan and Willey, 1980) and maize/soybean (Metwally, et al., 1988 and Abdalla, et al., 1999). However, interspecific competition that frequently occurred in the researches was due to different factors including the nitrogen aggressiveness of C₄ cereals.

Recently, C₃ cereal/legume combinations have been emphasized to gain the intercropped advantages with low competition and high efficient utilization of inputs particularly supplied nitrogen, which probably benefit in resource-limiting conditions. Chickpea and/or Lapin as grain (pulse) legumes could be contributed to the sustainability of cropping system, through intercropping with barley, via its ability to contribute nitrogen to the system via biological N₂-fixation, and reduced fossil energy consumption in plant production. It has been well documented that an important N-transfer takes place in intercropping systems of legumes with cereals (Landsberg, 1981). The cereal component oftenly competes for soil nitrogen (Caruthers, et al., 2000) and this effect encourage the legume component to fix more amount of nitrogen from the atmosphere (Hauggaard-Nielsen and Jensen, 2001). Sharma and Gupta (2002) showed that N- and P-nutrition of pearl millet was greatly improved by intercropping with legume.

Intercropped of with lupin (Gardner and Boundy, 1983 and Horst and Waschkies, 1987) and chickpea (Li, et al., 2003) with wheat had positive contribution to macronutrients uptake in wheat grains. Zhang and Li, (2003) reported that currently intercropping is attracting increasing interest in low-input crop production systems. Ghosh, et al., (2009) suggested that the specific competition for nutrients is important and can begin early in the growth of component crops.

Specific intercrop projects have indicated the promise of barley/field bean (Martin and Snyder, 1982) and wheat/field bean (Bulson, 1991). It was suggested that the temperate C₃-cereal/legume intercrops is acknowledged for present and future agricultural potential (Ofori and Stern, 1987). At low fertility conditions, the competitive ability of the cereal is superior to the legume, so the latter forced to rely on its N-fixing ability (Danso, et al., 1987 and Ghaley, et al, 2005). Moreover, Deria, et al (2003) and Prins and Wit, (2006) showed that in low N-soil fertility conditions, a low N supply is capable of producing a great marginal of wheat. Hauggaard-Nielsen and Jensen, (2009) concluded that
pea/barley intercropping is a relevant cropping strategy that should be adopt when trying to optimize N2-fixation inputs to the cropping system. Tosti and Guiducci, (2010) Stated that in Mediterranean area, the importance of N management becomes crucial for winter cereals, as low temperatures and high autum – spring rainfall cause very low levels of available mineral N in the soil during most of the crop cycle. Thus, it is essential to search for any possible ways for changing the agriculture manner and managements including N fertilization, that should be practiced in the newly reclaimed low fertility soil in order to raise and maintain its productivity. One of the possibilities is to increase the production of C3 crops such as barley, lupin and chickpea (those of secondary importance) as a substantial crop for food and feed, through intercropping.

Therefore, the experiment reported herein was set up to provide information on the N response of barley , lupin and chickpea as sole and intercrop planting and on how these individual responses affect the total productivity under the conditions of newly reclaimed soil.

Materials and Methods :

Two field experiments were carried out during 2006/2007 and 2007/2008 winter seasons at the experimental farm of the Faculty of Agriculture, Fayoum University, in newly reclaimed soil. The major objectives of this work were to study the effect of nitrogen fertilization on the yield and yield components of barley (Hordum vulgare var. Giza 126), (Lupins terms L. Var. Giza 1) and chickpea (Cicer arietinum var. Giza 195) under sole planting of each and intercropping of barley with Lupin or chickpea as well as determine their N response and effect on the productivity. Field soil was sand – loamy in texture with 7.92 pH, ECe of 3.78 dS/m, contained 10.85% CaCo3, 0.79% organic matter and 15.89 ppm total nitrogen. The preceding cropping was fallow and sunflower in the first and second seasons, respectively. After ploughing and harrowing of the field, then ridged (60 cm a part) and divided into plots (3 x 2.4 m) with 4 ridges/plot. During the field preparation, 50 kg potassium sulphate (48 % K2O) and 150 kg/fed. single superphosphate (15.5% P2O5) were added. The tested treatments were cropping patterns (sole planting of each crop, and barley/Lupin or chickpea intercropping)and three nitrogen fertilizer doses (15 (N1), 30 (N2) and 45 (N3) kg N/fed.). A split-plot arrangement in randomized complete block design with three replications was used. The intercropping patterns of solid cultures
(l₁) 2 ridges barley : 2 ridges Lupin or chickpea, viz. 50 : 50 (l₂ and l₃) and were assigned to the main plot and the nitrogen fertilizer rates were allocated in sub-plot. Lupin and chickpea seeds were inoculated by specific rhizobium the suitable immediately before sowing.

Sowing was done on November 15 in both seasons. Barley seeds were drilled into three rows above the ridge. Chickpea and Lupin were sown on the two sides of ridges in hills 10 cm apart for the former and 25 cm for the latter, with 2 seeds/hill, Number of hills were 30 and 12 hills/ridge for chickpea and Lupin, respectively. The other agricultural practices were follow as recommendations.

At harvest time, sample of 10 guarded plants was randomly taken from each plot of each crop to determine the plant mean traits, and the grain (seed) yields were calculated on plot basis as follows:

\[
\text{Yield/ft}^2 = \text{Yield/ridge} \times \text{ridges number of crop/plot} \times \frac{4200\text{m}^2}{\text{plot area m}^2}
\]

Protein content in seeds was estimated following the procedure outlined by A.O.A.C. (1970).

The studied traits in barley were plant height (cm), number of grains/spike weight of grain (g)/spike, number of spike/m², seed index (g) and harvest index. In Lupin and chickpea, the studied traits were plant height (cm), height to first branch (cm), number of branches/plant, number of pods/plant, weight of seed (g)/plant, seed index (g) and harvest index.

For barley grain yield and seed yields of each Lupin and chickpea, land equivalent ratio (LER) values were calculated according to Willey, 1979:

\[
\text{LER} = L_{\text{barley}} + L_{\text{Legume}}
\]

Where:

\[
L_{\text{b}} = L_{\text{barley}} = \text{intercrop yield of barley / its pure stand yield.}
L_{\text{lup}} = L_{\text{lupin}} = \text{intercrop yield of Lupin / its pure stand yield.}
L_{\text{ch}} = L_{\text{chickpea}} = \text{intercrop yield of chickpea / its pure stand yield.}
\]

All the obtained data were subjected to analysis of variance, and the means were differentiated by Duncan multiple test according to Gomez and Gomez (1984).

Results and Discussion
a) Chickpea:

Soled chickpea traits surpassed those of its intercropped with barley. Whereas, seed protein content and harvest index did not show significant differences due to intercropping (Table 1) and Fig. (1). Caruthers, et al, (2000) reported that harvest indices of all component crops were seldom affected by intercropping. Whereas, Thorsted, et al (2006) showed that it reduced by intercropping in wheat. Compared with the barley chickpea intercropping, the chickpea monocrop culture had significantly improved numbers of branches and pods/plant, seed weight/plant and seed yield/fed. as well as seed protein content. However, intercropping was superior to monocropping for seed index, indicating the low contribution of this trait alone to yields of plant and unit area and this be attributed to larger seeds of intercrop chickpea than those of sole crop. In this concern, Lopez-Belledo, et al (2004) reported that seeds/pod and pods/plant were the yield components exerting the greatest direct effect on seed yield of chickpea, while the compensatory effect of the other yield components including seed index was very limited.

Table (1): Effect of intercropping systems on seed yield and yield components of chickpea (combined data over two seasons).

<table>
<thead>
<tr>
<th>Traits</th>
<th>Treatment</th>
<th>Plant height (cm)</th>
<th>Height to 1st branch (cm)</th>
<th>No. of branches/plant</th>
<th>No. of pods/plant</th>
<th>Weight of seeds/plant (g)</th>
<th>Seed Index (g)</th>
<th>Seed yield/fed. (Ardab)</th>
<th>Harvesting index</th>
<th>Protein percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid chickpea</td>
<td>(I₁)</td>
<td>57.36a</td>
<td>6.71</td>
<td>3.55a</td>
<td>32.15a</td>
<td>3.91a</td>
<td>13.14</td>
<td>3.14a</td>
<td>18.27</td>
<td>19.27</td>
</tr>
<tr>
<td>Barley : chickpea</td>
<td>2:2 (I₂)</td>
<td>56.33b</td>
<td>6.75</td>
<td>2.95b</td>
<td>25.60b</td>
<td>3.40b</td>
<td>13.59</td>
<td>1.55b</td>
<td>18.71</td>
<td>19.07</td>
</tr>
</tbody>
</table>

*Ardab = 150 Kg

Results presented in Table (2) show that, except for protein content percentage in chickpea seeds, all the other studied traits were significantly influenced by nitrogen fertilization rates. Insignificant effect of nitrogen doses on protein content may be due to that the trait was mainly dependent upon the crop N₂-fixing and/or partially on least amount of nitrogen in the rhizosphere. This result supported that previously reported by Deria et al (2003) who showed that a low in supply is capable for improving seed protein content. Lopez-belildo, et al (2004) reported that N fertilization did not appear to affect chickpea N₂-fixation. Fertilization with 45 kg N/fed. (N₃) led to increases in plant height, height to the first branch, numbers of branches and pods/plant as well as seed
weight/plant, seed index and consequently seed yield/feddan. Similar means of height to first branch and seed index were obtained from application of 30 kg N/fed. (N$_2$) which produced the highest harvest index, indicating the low response of the later trail to high N rate. Tijani-Eniola et al (2000) found that 30 kg N/ha had comparable effect with 60 kg N/ha and produced 10% increment in soybean height and 32% in seed yield. The lowest nitrogen dose (N$_1$) resulted in inferior means or all studied traits

Table (2): Effect of nitrogen levels on yield and yield components of chickpea (combined data over two seasons).

<table>
<thead>
<tr>
<th>Traits Level treatment</th>
<th>Plant height (cm)</th>
<th>Height to 1st branch (cm)</th>
<th>No. of branches/plant</th>
<th>No. of pods/plant</th>
<th>Weight of seeds/plant (g)</th>
<th>Seed Index (g)</th>
<th>Seed yield/Fed. (Ardab)</th>
<th>Harvesting index</th>
<th>Protein percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 kg nitrogen (N$_1$)</td>
<td>55.02c</td>
<td>5.44b</td>
<td>2.70c</td>
<td>22.77c</td>
<td>3.25c</td>
<td>12.90b</td>
<td>2.02c</td>
<td>15.72c</td>
<td>19.09</td>
</tr>
<tr>
<td>30 kg nitrogen (N$_2$)</td>
<td>56.80b</td>
<td>7.44a</td>
<td>3.29b</td>
<td>26.89b</td>
<td>3.52b</td>
<td>13.53a</td>
<td>2.30b</td>
<td>22.17a</td>
<td>19.23</td>
</tr>
<tr>
<td>45 kg nitrogen (N$_3$)</td>
<td>58.71a</td>
<td>7.32a</td>
<td>3.76a</td>
<td>36.97a</td>
<td>4.20a</td>
<td>13.67a</td>
<td>2.73a</td>
<td>17.60a</td>
<td>19.20</td>
</tr>
</tbody>
</table>

Dual-interaction between nitrogen doses and cropping patterns exhibited significant differences in all studied traits (Table 3). The highest seed yield/fed. (3.65 ard.) was obtained from monocrop chickpea (I$_1$) fertilized with the highest N dose (N$_3$) as a result of positive effect of superior plant height (60.70 cm) number of branches (4.27 br.) number of pods (39.4 p) seed index (13.67 g) and seed weight /plant (4.85 g). However, intercropped chickpea (I$_2$) fertilized with 30 kg N/fed. (N$_2$) showed harvest index superior to that of I$_1$N$_3$ interaction. The highest position of the first branch (8.45 cm) was obtained by I$_2$N$_3$ with insignificant difference from that of I$_1$N$_2$, indicating that the trait was less affected by intercropping and N fertilization. This I$_1$N$_2$ interaction surpassed other combinations for seed protein content, revealing again non-response of protein to high nitrogen fertilization. It was observed that, under any N fertilization rate, intercropping decreased numbers of branches and pods/ plant and resulted in inferior seed yield per both plant and feddan. Intercropped chickpea fertilized with 45 kg N/fed. (N$_3$) that ranked as the best yielding among the intercropping combinations, Fig. (2) produced seed yield/fed (1.80 ard.) reached about half (49.32%) of sole chickpea (3.65 ard.) in addition to its acceptable number of pods, seed weight/plant and seed index. These results indicating that N$_3$ was adequate for barley/chickpea intercropping.
Table (3): Effect of intercropping systems and nitrogen level interactions on yield and yield components of chickpea (combined data over two seasons).

<table>
<thead>
<tr>
<th>Traits</th>
<th>Plant height (cm)</th>
<th>Height to 1st branch (cm)</th>
<th>No. of branches/plant</th>
<th>No. of pods/Plant</th>
<th>Weight of Seeds/plant (g)</th>
<th>Seed Index (g)</th>
<th>Seed yield/Fed. (Ardab)</th>
<th>Harvesting index</th>
<th>Protein percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>I₁N₁</td>
<td>54.17d</td>
<td>5.77cd</td>
<td>2.70e</td>
<td>26.10d</td>
<td>3.12f</td>
<td>12.27b</td>
<td>2.81c</td>
<td>17.24c</td>
<td>19.19ab</td>
</tr>
<tr>
<td>I₁N₂</td>
<td>57.20b</td>
<td>8.17a</td>
<td>3.68b</td>
<td>30.95c</td>
<td>3.77b</td>
<td>13.48a</td>
<td>2.95b</td>
<td>20.11b</td>
<td>19.37a</td>
</tr>
<tr>
<td>I₁N₃</td>
<td>60.70a</td>
<td>6.18bc</td>
<td>4.27a</td>
<td>39.40a</td>
<td>4.85a</td>
<td>13.67a</td>
<td>3.65a</td>
<td>17.47c</td>
<td>19.26ab</td>
</tr>
<tr>
<td>I₂N₁</td>
<td>55.87c</td>
<td>5.10d</td>
<td>2.70e</td>
<td>19.43f</td>
<td>3.37d</td>
<td>13.53a</td>
<td>1.22f</td>
<td>14.19d</td>
<td>18.99c</td>
</tr>
<tr>
<td>I₂N₂</td>
<td>56.40bc</td>
<td>6.70b</td>
<td>2.90d</td>
<td>22.83e</td>
<td>3.27e</td>
<td>13.58a</td>
<td>1.64e</td>
<td>24.23a</td>
<td>19.08bc</td>
</tr>
<tr>
<td>I₂N₃</td>
<td>56.72bc</td>
<td>8.45a</td>
<td>3.25c</td>
<td>34.53b</td>
<td>3.55c</td>
<td>13.67a</td>
<td>1.80d</td>
<td>17.72c</td>
<td>19.14bc</td>
</tr>
</tbody>
</table>

b) Lupin:

Compared with monocrop culture (I₁), intercropping Lupin with barley (I₂) led to significant increases Lupin plant height (78.29 cm) and height to the first branch (42.13 cm) due to severe competition on light (Table 4).

Intercropped Lupin had also greatest number of branches (2.78 br.) as well as heaviest seed index (47.11 g), but with inferior seed weight/plant (5.81 g). The later trait (7.57 g/plant) and consequently the highest seed yield/fed. (4.79 ard.) was obtained from sole Lupin fig. (1). The early establishment of symbiotic N₂-fixation of legume support a high growth rate during early stages is among important features of intercropping (Hauggaard- Nielsen and Jensen, 2001), but seed yield is dependent upon the assimilates accumulation during seed filling period (Thorsted, et al., 2006). In addition to seed yield/fed., I₁ (42.94%) surpassed I₂ (42.66%) treatment for protein content. The legume component has typically suffured competition from the cereal, producing lower yields in the intercropping than sole cropping and one documented effect of adding nitrogen had been a further depression in yield because of greater competition from increased cereal growth (Ofori and Stern, 1987 and Siame, et al., 1998), in addition, Lupin had less flexible response to intercropping (Carruthers, et al., 2000). It is worth to note that seed yield/fed. of intercropped Lupin (2.22 ard.) did not reach half (46.35%) of its sole cropping (4.79ard.), indicating the preponderance of intercropping chickpea (which produced about half of its sole yield) over Lupin with barley. Hauggaard-Nietsen and Jensen, 2001) found that intercropped pea seed production was reduced to less than half compared to sole pea due to competitive interaction.
Table (4): Effect of intercropping systems on seed yield and yield components of lupin (combined data over two seasons).

<table>
<thead>
<tr>
<th>Level treatment</th>
<th>Traits</th>
<th>Plant height (cm)</th>
<th>Height to 1st branch (cm)</th>
<th>No. of branches/plant</th>
<th>No. of pods/Plant</th>
<th>Weight of seeds/plant (g)</th>
<th>Seed Index (g)</th>
<th>Seed yield/Fed. (Ardab)</th>
<th>Harvesting Index</th>
<th>Protein percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid lupin</td>
<td></td>
<td>74.30b</td>
<td>40.88b</td>
<td>2.70b</td>
<td>4.75</td>
<td>7.57b</td>
<td>45.36b</td>
<td>4.79a</td>
<td>24.16b</td>
<td>42.94a</td>
</tr>
<tr>
<td>Barley : lupin</td>
<td></td>
<td>78.29a</td>
<td>42.13a</td>
<td>2.78a</td>
<td>4.64</td>
<td>5.81a</td>
<td>47.11a</td>
<td>2.22b</td>
<td>28.31a</td>
<td>42.66b</td>
</tr>
</tbody>
</table>

As shown in Table (5), all the studied Lupin traits, except seed protein content, were significantly affected by nitrogen fertilization rates. Application of 45 kg N/fed ($N_3$) gave the highest means of all traits except number of branches/plant, seed weight/plant and seed index. These three exception traits were superior when 30 kg N/fed ($N_2$) was applied. As shown above in chickpea, the protein content of Lupin seeds did not affect by increasing nitrogen dose due to its independence open $N_2$-fixing and/or low N application (Deria, et al, 2003 and Lopez- Bellido et al, 2004). These results revealed the adequacy of $N_3$ fertilization for Lupin, where it produced acceptable seed yield (4.06 ard./fed) due to its superior number of pods and harvest index, with improved quality (42.95% protein). Ghaley, et al, (2005) reported that $N_2$-fixing ability enabled legume to grow well with the help of N dose.

Table(5): Effect of nitrogen levels on seed yield and yield components of lupin (combined data over two seasons).
Interaction between cropping patterns and nitrogen fertilizer rates showed significant differences among different combinations for all studied traits (Table 6). Sole lupin (I₁) when fertilized with 45 kg N/fed (N₃) was superior for number of pods/plant (5.77 p) and seed yield/fed (5.88 ard.) Fig. (2) with highest protein content (43.30%) indicating the importance of pods number as effective contributor to seed yield. However, sole Lupin fertilized with 30 kg N/fed (N₂) resulted in the heaviest weight of seeds/plant (9.16 g). Barley/ Lupin intercropping fertilized with N₂ was superior for number of branches/plant and seed index. The tallest plants with highest position of the first branch and largest harvest index were obtained from intercropped Lupin fertilized with the highest N dose (I₂N₃). The data showed that I₂N₂ produced seed yield/fed (2.71 ard.) lesser than half (46.09%) of that of I₁N₃ combination (5.88 ard), revealing that Lupin was greatly negatively influenced by intercropping with barley, compared to chickpea under the same N dose.
Fig. 2. Average seed yield/Fed (ardab) of barley, lupin and chickpea as affected by different treatments (intercropping and nitrogen levels interactions) over two seasons

Table (6): Effect of intercropping systems and nitrogen level interactions on yield and yield components of lupin (combined data over two seasons).

<table>
<thead>
<tr>
<th>Traits Level Treatment</th>
<th>Plant height (cm)</th>
<th>Height to 1st branch (cm)</th>
<th>No. of branches/plant</th>
<th>No. of pods/Plant</th>
<th>Weight of seeds/plant (g)</th>
<th>Seed index (g)</th>
<th>Seed yield/Fed. (Ardab)</th>
<th>Harvesting Index</th>
<th>Protein percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>I₁N₁</td>
<td>68.07d</td>
<td>40.67b</td>
<td>2.57cd</td>
<td>3.90e</td>
<td>5.12e</td>
<td>46.75b</td>
<td>3.61c</td>
<td>22.30d</td>
<td>42.87ab</td>
</tr>
<tr>
<td>I₁N₂</td>
<td>73.77c</td>
<td>40.6b</td>
<td>2.82b</td>
<td>4.57c</td>
<td>9.16a</td>
<td>44.10d</td>
<td>4.89b</td>
<td>23.52d</td>
<td>46.24b</td>
</tr>
<tr>
<td>I₂N₁</td>
<td>81.07b</td>
<td>41.37b</td>
<td>2.7bc</td>
<td>5.77a</td>
<td>8.43b</td>
<td>45.23c</td>
<td>5.88a</td>
<td>26.66c</td>
<td>43.30a</td>
</tr>
<tr>
<td>I₂N₂</td>
<td>72.92c</td>
<td>41.27b</td>
<td>2.4d</td>
<td>4.5cd</td>
<td>4.89e</td>
<td>42.27e</td>
<td>1.72f</td>
<td>27.21b</td>
<td>42.9ab</td>
</tr>
<tr>
<td>I₃N₁</td>
<td>76.03c</td>
<td>39.8b</td>
<td>3.3a</td>
<td>4.33d</td>
<td>6.45c</td>
<td>52.97a</td>
<td>2.71d</td>
<td>25.87c</td>
<td>42.47b</td>
</tr>
<tr>
<td>I₃N₂</td>
<td>85.93a</td>
<td>45.33a</td>
<td>2.63bc</td>
<td>5.10b</td>
<td>6.10d</td>
<td>46.08bc</td>
<td>2.24e</td>
<td>31.86a</td>
<td>42.60b</td>
</tr>
</tbody>
</table>

C) Barley:

Data listed in Table (7) show that cropping patterns significantly affected all barley traits except seed and harvest indices. The two exception traits may be attributed to decreased assimilates accumulation during grain filling (Weiner, 2004 and Thorsted et al, 2006). Grain yield of the intercropped barley either with chickpea (10.38) or lupin (10.68 ard) was more than half (55% and 57%, respectively) of that of monoculture barley (18.78 ard), indicating that barley yield was affected by intercropping but with different magnitude owing to chickpea or Lupin fig. (1). In addition to grain yield, the effect of the two legumes was significantly different on grain weight/barley plant, where Lupin effect was better than that of chickpea. Intercropping winter wheat and clover resulted in wheat grain yield decrease of 10-25 % compared with sole wheat crop. The yield reduction was likely caused by interspecific competition for light during vegetative growth and for soil water deficit during grain filling (Thorsted, et al, 2006). However, Hauggaard-Nielsen and Jensen, (2001) reported that barley was stronger competitor in the intercrop and, as a result, its intercropped grain yield was similar to its sole cropping. The two tested legumes showed insignificant differences for barley plant height, number of grains/spike, number of spikes/m².

Table(7): Effect of intercropping systems on yield components of barley (combined data over two seasons).

<table>
<thead>
<tr>
<th>Traits Treatments</th>
<th>Plant height (cm)</th>
<th>No. of grains/spike</th>
<th>Weight of grains/spike</th>
<th>No. of spikes/m²</th>
<th>Seed Index (g)</th>
<th>grain Yield/Fad. (ardab)</th>
<th>Harvesting Index</th>
</tr>
</thead>
</table>


Nitrogen fertilizer rates had significant effect on all barley traits without exception (Table 8). The highest dose (N\textsubscript{3}) increased plant height (98.98 cm) and number of grains/spike (57.53 g). As previously reported, barley is much more competitive for soil mineral N than pea (Jensen, 1996) most likely as a consequence of the foster and deeper root growth of barley (Bellestas, et al, 2003) in addition to that high level of N application increased barley growth at early stage (Torsted, et al, 2006). The highest values of grain weight/plant (3.29 g), number of spickes/m\textsuperscript{2} (265.67 sp.) were showed with N\textsubscript{3} fertilization, while seed index (5.77 g) and grain yield /fed (13.96 ard) were produced by application of the intermediate N dose (N\textsubscript{2}) similar to that of N\textsubscript{3} (5.73 g) and (13.85 ard) for the respective two traits, reflecting the importance of spike number/m\textsuperscript{2} and seed index as effectual yield components, and affirmed that N\textsubscript{2} dose was enough for barley fertilization to produce improved yield. It interesting to note that intercropped barley responded to nitrogen fertilization at the both rate of N\textsubscript{2} and N\textsubscript{3} without significant differences, due to the positive effect of legume on barley productivity in such newly reclaimed soil, and from economic point of view the N\textsubscript{2} dose is preferable.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant height (cm)</th>
<th>No. of grains/spike</th>
<th>Weight of grains/spike</th>
<th>No. of spicas/m\textsuperscript{2}</th>
<th>Seed Index (g)</th>
<th>grain Yield /Fad. (ardab)</th>
<th>Harvesting Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 kg nitrogen (N\textsubscript{1})</td>
<td>95.14b</td>
<td>46.92c</td>
<td>3.01b</td>
<td>240.11b</td>
<td>5.59b</td>
<td>12.04b</td>
<td>24.13c</td>
</tr>
<tr>
<td>30 kg nitrogen (N\textsubscript{2})</td>
<td>95.90b</td>
<td>54.50b</td>
<td>3.25a</td>
<td>264.56a</td>
<td>5.77a</td>
<td>13.96a</td>
<td>27.98a</td>
</tr>
<tr>
<td>45 kg nitrogen (N\textsubscript{3})</td>
<td>98.98a</td>
<td>57.53a</td>
<td>3.29a</td>
<td>265.67a</td>
<td>5.73a</td>
<td>13.85a</td>
<td>27.10a</td>
</tr>
</tbody>
</table>

Dual-interaction results, i.e., sole barley (I\textsubscript{1}) with N, barley / Lupin (I\textsubscript{2}) with N, and barley/chickpea with N, are presented in Table (9). Soled barley (I\textsubscript{1}) plants were the tallest when fertilized with 30 (N\textsubscript{2}) or 45 (N\textsubscript{3}) kg N/fed. The later combination (I\textsubscript{1}N\textsubscript{3}) had greatest number of spikes/m\textsuperscript{2} (280.67 sp.), seed index (5.80g),
grain yield/fed (20.05 ard.) and comparable plant height with that of I1N2 interaction.

Table (9): Effect of intercropping systems and nitrogen levels interactions on seed yield and seed yield components of barley (combined data for two seasons).

<table>
<thead>
<tr>
<th>Traits</th>
<th>Treatments</th>
<th>Plant height (cm)</th>
<th>No. of grains/spike</th>
<th>Weight of grains/spike</th>
<th>No. of spikes/m²</th>
<th>Seed Index (g)</th>
<th>grain Yield/Fad. (ardab)</th>
<th>Harvesting Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I1N1</td>
<td>91.47f</td>
<td>49.42e</td>
<td>3.02de</td>
<td>242.33e</td>
<td>5.78a</td>
<td>17.68b</td>
<td>24.29e</td>
</tr>
<tr>
<td></td>
<td>I1N2</td>
<td>100.13a</td>
<td>55.17c</td>
<td>3.43b</td>
<td>252.67d</td>
<td>5.65b</td>
<td>18.61b</td>
<td>26.13d</td>
</tr>
<tr>
<td></td>
<td>I1N3</td>
<td>99.7a</td>
<td>57.75b</td>
<td>3.10d</td>
<td>280.67a</td>
<td>5.8a</td>
<td>20.05a</td>
<td>26.95bc</td>
</tr>
<tr>
<td></td>
<td>I2N1</td>
<td>95.52c</td>
<td>41.33f</td>
<td>3.04de</td>
<td>236.33f</td>
<td>5.47d</td>
<td>9.44e</td>
<td>26.27cd</td>
</tr>
<tr>
<td></td>
<td>I2N2</td>
<td>94.38d</td>
<td>54.83c</td>
<td>3.09b</td>
<td>275.67b</td>
<td>5.85a</td>
<td>12.18c</td>
<td>28.96a</td>
</tr>
<tr>
<td></td>
<td>I2N3</td>
<td>99.03ab</td>
<td>60.33a</td>
<td>3.53a</td>
<td>253.00d</td>
<td>5.62bc</td>
<td>10.43d</td>
<td>26.71cd</td>
</tr>
<tr>
<td></td>
<td>I3N1</td>
<td>98.43cb</td>
<td>50.00e</td>
<td>2.96e</td>
<td>241.67e</td>
<td>5.52cd</td>
<td>8.99f</td>
<td>21.84f</td>
</tr>
<tr>
<td></td>
<td>I3N2</td>
<td>93.18e</td>
<td>53.5d</td>
<td>3.23c</td>
<td>265.33c</td>
<td>5.82a</td>
<td>11.08d</td>
<td>28.85a</td>
</tr>
<tr>
<td></td>
<td>I3N3</td>
<td>98.2b</td>
<td>54.50c</td>
<td>3.24c</td>
<td>263.33c</td>
<td>5.77a</td>
<td>11.06d</td>
<td>27.65b</td>
</tr>
</tbody>
</table>

Barley/Lupin (I2) fertilized with 30 kg N/fed (I2N2 combination) showed the highest values of seed index (5.85 g) and harvest index (28.96) similar to those exhibited by barley / chickpea (I3) fertilized with the same N dose (I3N2) indicating similar effect of both legumes on the two traits. Barley / Lupin (I2) fertilized with N3 (I2N3 combination) had plant height insignificantly different from the tallest one (produced by I1N2), in addition the greatest number of grain/spike (60.33g) and heaviest weight of grain /spike (3.53 g). It is obvious that barley traits in intercropping with chickpea were inferior to those when intercropped with Lupin, except seed and harvest indices produced by I3N2 which were insignificantly different from those of I2N2, and seed index given by I3N3 that was of comparable value to that of I2N2. It is worth to note that, under cropping patterns with N2 fertilizer the second yielding combinations were barley/chickpea (12.18 ard) and then barley/lupin (11.08 ard) which represented 61% and 55% of yield of soled barley fertilized with N3. These results indicating that chickpea was of better effect than lupin on barley yielding ability and fertilization with nitrogen dose (N2) was quite enough for intercropping.

D) Land equivalent ratio (LER):

Based LERs calculated for the three tested crops Fig. (3) it was observed that lupin in all intercropping x N combinations, except with N3, was greater competitive than chickpea, revealing
different response of the two legumes to intercropping with barley. Both legume crops had higher LER values than those of barley under any N level, reflecting their stronger competitive than barley. This may be attributed to their N$_2$-fixing ability as well as to the response of barley to nitrogen application up to only N$_2$. Consequently, the legume crops seemed to be dominant while barley appeared to be dominated. Tosti and Guiducce (2010) reported that legume tended to be dominant and exerted a high competitive effect towards wheat which was not capable of a suitable competitive response. The total LERs were ranged from 0.94 for barley/chickpea with N$_1$ and barley/Lupin with N$_3$ to 1.21 for barley/Lupin with N$_2$. The later combination is preferable where it caused 21% increase in production/ unit area during one season of intercropping, followed by that of barley/chickpea with N$_2$ that caused 15% increase in production.

In sum, the above mentioned results revealed that 30 kg N/fed. (N$_2$) is considered as adequate for producing improved barley yield under the conditions of the experimented newly reclaimed soil. Also with N$_2$ barley/chickpea and barley/Lupin yielded 49% chickpea together with 61% barley with LER of 1.15 as well as 46% Lupin together with 55% barley with LER 1.21, respectively, compared with sole culture of each crop. These two intercropping-N$_2$ combinations increased the total production by 15% and 21%, respectively.

![Graph showing Land Equivalent Ratio (LER) against nitrogen levels](image)
Fig. 3. Land equivalent ratio (LER) in barley–chickpea and barley–lupin intercropping system

REFERENCES:


Prins, U. and J. de Wit (2006). Intercropping cereals and grain legumes: farmers perspective. In: Bo Andreasen, C.,
Elsgaard, L., Sondergaard Sorensen, L. (Eds.), Organic Farming and European Rural Development. Proceedings of European
الملخص العربي
تأثير التسميد النتروجيني على المحصول ومكوناتة للزراعة المنفردة أو المحملة للشعر
والترمس والحص في الأراضي حديثة الاستصلاح

أكرم علي مجاور
قسم المحاصيل - كلية الزراعة - جامعة القيومن

أجريت تجارب حقلية على محاصل الشعير والترمس والمحمل في أرض مستصلحة حديثاً 
بمزرعة كلية الزراعة - جامعة القيومن، خلال دورة تأثير التسميد النتروجيني مع معدلات (0، 20، 
40، 60، 80 كجم نتروجين/فدان) على نمو هذه المحاصيل المنفردة أو عند تحمل الشعير مع الترمس أو الشعير مع المحمل بنظام التحمل (0.2: 0.2) في تصميم الفئات المنهجية مرة واحدة 
وزعفت المقابلات عشوائياً في ثلاث مكررات. واحصلت الزراعة المنفردة والمحملة القطب الرئيسية ومعدلات 
التسميد النتروجيني القطع المنهجية الأولى. واظهرت النتائج ما يلي:

- عند مقارنة الزراعة المنفردة بالمحملة للشعر كانت صفات المحصول والجودة ممنوعة وأظهر 
التسميد قيم عالية لكل البنية.
- ادى التسميد بمدخل 40 كجم نتروجين/فدان زيادة وتحسين في النمو ذات زيادة المحصول، بينما لوحظ نفس 
التأثير من الجرعة التالية 30 كجم نتروجين/فدان على ارتفاع أول فرع ثمداً ودليل البذرة واعطى أعلى 
دليل حصص.
- أعطت الزراعة المحملة للشعر مع الترمس زيادة في صفات الطول بالإضافة لعدد الأوراق ودليل البذرة ونتج 
على وزن بذور النباتات ومحصول الفدان من الزراعة المنفردة للترمس.
- أظهر اضافية معدلات نتروجين توقع المعدل الثالث 45 كجم نتروجين/فدان في زراعة الترمس باتجاه 
محصول مناسب للفدان مع توق على الأوراق ودليل المحاصد وحماه دللي الحصاد توقعات الزراعة 
المنفردة معيناً لكل صفات الشعير فاعلية الشعير المحمل أكثر من 50% من محصول الفدان مقارن 
بزراعة الزراعة المنفردة.
- أظهر المعدل الثاني (30 كجم نتروجين/فدان) تقسيم في الانتاجية بدون اختلاف معنوي مع المعدل الثالث
(45 كجم نتروجين/فدان).
- اضطر أن التحميل باستخدام 30 كجم نتروجين/فدان أعطى الشعير المحمل من المحصم 12.18 أردب 
للفدان، والشعر المحمل على الترمس 11.42 أردب 171% 55% مقابر بالزراعة المنفردة للجرعة 
الثالثة 45 كجم نتروجين/فدان.

وأيضاً تشير النتائج إلى أن تأثير الحمض أفضل من تأثير الترمس على الشعر مع اضافة الجرعة 
المتوسطة من الترمس 40 كجم نتروجين/لفدان، وفي النهاية ينصح من النتائج السابقة أن الجرعة المتوسطة 
للتسميد النتروجيني هو مفيدة تحت طرور الأراضي المستصلحة حديثاً. أيضاً المعدل 40 كجم 
نتروجين/فدان أعطى الشعير مع المحمل مع الترمس 44% محص متأثراً 15% و 48% ترمس مع معاً 11% 
شبع مكافأة ارضية 31% مقابر بالزراعة المنفردة لكل منهم. وهذا يعني أن 
التحمل مع الجرعة الثانية أدى لزيادة الانتاجية بنسبة 15% و 12% ترجيحًا.