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# Investigations on Maize in the Libyan Arab Republic

## II. Effect of Nitrogen Level and Time of Application on Growth and Yield of Maize (*Zea mays* L.)

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## ABSTRACT

The influence of nitrogen level and system of application on growth and yield of the open-pollinated Early American maize variety was investigated under the agro-climatic factors of Tripoli, Libya, over two years (1972 and 1973). Increasing nitrogen level up to 126 kgN/ha significantly increased yields of grain and stover, size of kernels, diameter and length of topmost ear. Also diameter and height of plants were significantly increased by nitrogen treatments.

Application of nitrogen in two and three equal split dressings gave higher grain and stover yields than in a single dressing. Also, size of kernels, topmost ear diameter, length and height, as well as stalk height and diameter were increased by split dressings over the single applications.

The highest grain yields of 7.33 and 6.80 tons/ha; and stover yields of 13.64 and 11.90 tons/ha were obtained in 1972 and 1973, respectively, when nitrogen was added at 126 kgN/ha in three equal split applications at 18, 33, and 45 days after planting.


## INTRODUCTION

Levels of nitrogen fertilizer, time and method of application are important factors determining growth and yield of maize. Therefore, many experiments have been conducted in different countries to determine the optimum nitrogen level and the best time and method of its application (1,2,3,4,5,6,7,8). Most reports have indicated that increased nitrogen level increased grain yield and enhanced vegetative growth (2,5,6,7). However, responses of maize growth and yield to nitrogen application depended on prevailing edaphic and climatic factors, along with methods and time of application. High nitrogen levels were more efficient when applied as split than as a single application (1,3,4,8). While studying the response of irrigated maize to time, rate, and source of nitrogen on sandy soil in Wisconsin, U.S.A., Jung *et al.* (5) showed that grain yield, plant dry matter and nitrogen uptake were greater when nitrogen was applied in the 6–8*th* week after planting than it was applied later. Moreover, it was reported that

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proper irrigation management and method of nitrogen application are important factors in controlling losses in nitrogen fertilizer.

In the Libyan Arab Republic, no significant attention was given to maize production and therefore no information is available on the optimum agricultural practices and its influence on growth and yield of maize. For this reason, the present experiments were conducted over a two-year period to determine the response of maize growth and yield to the rates and time of applied nitrogen.

## MATERIALS AND METHODS

A field trial was conducted on the sandy loam soil of the Faculty of Agriculture farm, Tripoli, Libya, in 1972 and 1973. In both years the experimental plots were set out in a split-plot design at three levels of nitrogen and three systems of application with four replicates. Nitrogen fertilizer was added in the form of ammonium sulfate (21% N) at 42, 84, and 126 kgN/ha as one single dressing 18 days after planting, two equal split dressings 18 and 33 days after planting, and three equal split dressings 18, 33, and 48 days after planting. The size of each sub-plot was 16.8 $m^2$ supplied with 250 kg of superphosphate/ha (18% $P_2O_5$) before planting. The open-pollinated Early American maize variety, commonly used in Egypt, was sown on 25 May 1972 and 1973, at a density of 40,000 plants/ha (row spacing 70 cm, plant spacing 35 cm). Three kernels were sown per hill and then thinned to one plant/hill 18 days after sowing. Sprinkler irrigation was applied weekly from planting until maturity.

## RESULTS AND DISCUSSION

Table 1 shows the effect of nitrogen levels and number of applications on total grain yield. Increasing nitrogen levels from 42 to 126 kgN/ha significantly increased grain yield whether it was applied as a single dressing or in two and three equal split dressings.

Table 1 Effect of nitrogen level and number of applications on grain yield (tons/ha)

| Number of applications | 1972 | | | | 1973 | | | |
|---|---|---|---|---|---|---|---|---|
| | Nitrogen level (kgN/ha) | | | | | | | |
| | 42 | 84 | 126 | Average | 42 | 84 | 126 | Average |
| ONE 18 days after planting | 3.61 | 4.31 | 5.58 | 4.50 | 2.96 | 3.76 | 4.26 | 3.66 |
| TWO 18 & 33 days after planting | 4.72 | 5.45 | 6.93 | 5.70 | 4.06 | 4.70 | 5.49 | 4.75 |
| THREE 18, 33 & 48 days after planting | 4.78 | 5.90 | 7.33 | 6.00 | 4.91 | 5.38 | 6.80 | 5.70 |
| Average | 4.37 | 5.22 | 6.61 | — | 3.98 | 4.61 | 5.52 | — |

LSD at 5%: for nitrogen level 0.88 tons/ha (1972); 0.63 tons/ha (1973)
for number of application 0.53 tons/ha (1972); 0.39 tons/ha (1973)

This response was consistent in both years. As an average of all application systems, the 84 and 126 kgN/ha levels, as compared with 42 kgN/ha, increased grain yield by 19.5 and 51.3% in 1972 and by 15.8 and 38.7% in 1973. At all nitrogen levels, the two and three equal split applications significantly increased grain yield in both years. However, no significant differences were observed in 1972 between the two and three applications. Compared with single application the percentage increments in grain yield with two and three equal split applications were 26.7 and 33.3% in 1972 and 29.8 and 55.7% in 1973. The percentage increment in yield due to the three split applications in 1973 was significant compared with the single and the two split applications. The average yields of 6.0 tons/ha in 1972 and 5.70 tons/ha in 1973 were obtained with the three split applications system. These data reveal that single application of nitrogen fertilizer is conclusively inferior to split applications with respect to grain yield. One might conclude that under the edaphic and agro-climatic conditions of Tripoli, maize production could be greatly improved by adding high rates of nitrogen in more than one application after planting.

Stover production was significantly increased by increasing applied nitrogen under all application systems in both years (Table 2). Nitrogen fertilizer at 84 and 126 kgN/ha as compared with 42 kgN/ha increased the average stover yield by 30.5 and 48.8% in 1972 and by 25 and 32% in 1973. No significant differences in stover yield were observed between the single application and the two and three split dressings in 1972; whereas in 1973 the single dressing treatment was significantly inferior in stover production than the two and three split applications. Compared with the single dressing, the two and three splits increased stover yield by 2.6 and 6.3% in 1972 and by 12.6 and 16.6% in 1973. It appears that the influence of split applications of nitrogen fertilizer on stover production is less pronounced than on grain yield (compare data of Tables 1 and 2). This might be explained by the fact that vegetative growth of maize plants is more enhanced by early application of nitrogen than by late applications.

Table 3 shows the relationship between size of kernels (as estimated by weight of 1,000 kernels) and levels and system of application of nitrogen fertilizer. Nitrogen

Table 2 Effect of nitrogen level and number of applications on stover yield (tons/ha)

| Number of applications | 1972 | | | | 1973 | | | |
|---|---|---|---|---|---|---|---|---|
| | Nitrogen level (kgN/ha) | | | | | | | |
| | 42 | 84 | 126 | Average | 42 | 84 | 126 | Average |
| ONE<br>18 days after planting | 8.26 | 11.14 | 12.75 | 10.72 | 7.57 | 9.15 | 9.87 | 8.86 |
| TWO<br>18 & 33 days after planting | 8.87 | 11.56 | 12.57 | 11.00 | 8.33 | 11.00 | 10.60 | 9.98 |
| THREE<br>18, 33 & 45 days after planting | 9.06 | 11.46 | 13.64 | 11.39 | 8.62 | 10.47 | 11.90 | 10.33 |
| Average | 8.73 | 11.39 | 12.99 | — | 8.17 | 10.21 | 10.79 | — |

LSD at 5%: for nitrogen level 1.50 tons/ha (1972); 1.01 tons/ha (1973)
for number of application 0.8 tons/ha (1972); 1.16 tons/ha (1973)

Table 3 Effect of nitrogen level and number of applications on size of kernel (gm/1000 kernels)

| Number of applications | 1972 | | | | 1973 | | | |
|---|---|---|---|---|---|---|---|---|
| | Nitrogen level (kgN/ha) | | | | | | | |
| | 42 | 84 | 126 | Average | 42 | 84 | 126 | Average |
| ONE 18 days after planting | 229 | 240 | 253 | 241 | 210 | 241 | 254 | 235 |
| TWO 18 & 33 days after planting | 239 | 255 | 273 | 256 | 229 | 251 | 268 | 249 |
| THREE 18, 33 & 48 days after planting | 246 | 289 | 298 | 278 | 240 | 273 | 311 | 275 |
| Average | 238 | 261 | 275 | — | 226 | 255 | 278 | — |

LSD at 5%: for nitrogen level 15 gm (1972); 13 gm (1973)
for number of applications 10 gm (1972); 14 gm (1973)

application whether in single or in split dressings significantly increased size of kernels in both years. Average percentage increase in kernel size with 84 and 126 kgN/ha as compared with 42 kgN/ha reached 10 and 16% in 1972 and 13 and 23% in 1973. Split applications of nitrogen significantly improved the size of kernels at all levels. The two and three split dressings improved size of kernels over the single dressing by 6 and 15% in 1972 and by 6 and 17% in 1973. Nevertheless, these effects were less pronounced than the effect of nigrogen levels.

Nitrogen applications at higher rates increased the length of topmost ear regardless the system of application (Table 4). Ear lengths were 18.4, 20.4 and 21.6 cm in 1972;

Table 4 Effect of nitrogen level and number of applications on topmost ear length (cm)

| Number of applications | 1972 | | | | 1973 | | | |
|---|---|---|---|---|---|---|---|---|
| | Nitrogen level (kgN/ha) | | | | | | | |
| | 42 | 84 | 126 | Average | 42 | 84 | 126 | Average |
| ONE 18 days after planting | 16.8 | 19.3 | 19.4 | 18.5 | 17.7 | 17.1 | 19.1 | 18.0 |
| TWO 18 & 33 days after planting | 19.5 | 20.4 | 21.6 | 20.5 | 17.6 | 19.1 | 20.9 | 19.2 |
| THREE 18, 33 & 48 days after planting | 19.0 | 21.6 | 23.8 | 21.5 | 19.2 | 19.5 | 22.0 | 20.2 |
| Average | 18.4 | 20.4 | 21.6 | — | 18.2 | 18.6 | 20.7 | — |

LSD at 5%: for nitrogen level 2.2 cm (1972); 1.5 cm (1973)
for number of application 1.5 cm (1972); 1.3 cm (1973)

and 18.2, 18.6 and 20.7 cm in 1973 at 42, 84, and 126 kgN/ha, respectively. Compared with lower nitrogen level (42 kgN/ha), the 84 and 126 kgN/ha increased ear length by 10.9 and 17% in 1972 and by 2 and 14% in 1973.

Single application was inferior, with respect to ear length, to the two and three equal split dressings. Percentage increments in ear length due to the two and three splits over the single application were 10.8 and 16.2% in 1972; and 6.7 and 12.2% in 1973, respectively.

Since ear length positively contributed to grain yield, it appears that the improvement in ear length either by high nitrogen level or by split application may account, at least in part, for the higher grain yield revealed in Table 1.

Topmost ear diameter, as in ear length, was positively affected by nitrogen treatments in both years (Table 5). Increasing nitrogen level from 42 to 84 and 126 kgN/ha increased ear diameter by 14.7 and 20.6% in 1972 and by 12.5 and 21.9% in 1973. On the other hand, the two and three splits resulted in 8.6 and 17% increase in ear diameter in 1972, and 15.6 and 18.8% in 1973 as compared with the single dressing treatment. Only in 1973 there was a significant interaction between levels of nitrogen and number of applications.

As with ear length, these increments in ear diameter may partially account for the increments in grain yield.

Table 6 summarizes the effects of nitrogen levels and number of applications on topmost ear height in 1972 and 1973. In both years, nitrogen treatments increased the height of the topmost ear whether added as a single or as split dressings. The 84 and 126 kgN/ha significantly increased ear height over the 42 kgN/ha by 10 and 18% in 1972 and by 15.5 and 21% in 1973. Compared with single application, the two and three split applications resulted in average increments in ear height of 10–14% and 16.2–17.7% in 1972 and 1973, respectively. However, the interaction between nitrogen levels and number of applications was significant only in 1973 experiment.

Increasing nitrogen levels from 42 to 84 kgN/ha significantly increased the diameter

Table 5 Effect of nitrogen level and number of applications on topmost ear diameter (cm)

| Number of applications | 1972 | | | | 1973 | | | |
|---|---|---|---|---|---|---|---|---|
| | Nitrogen level (kgN/ha) | | | | | | | |
| | 42 | 84 | 126 | Average | 42 | 84 | 126 | Average |
| ONE<br>18 days after planting | 3.1 | 3.7 | 3.8 | 3.5 | 2.6 | 3.2 | 3.7 | 3.2 |
| TWO<br>18 & 33 days after planting | 3.4 | 4.0 | 4.0 | 3.8 | 3.6 | 3.5 | 4.0 | 3.7 |
| THREE<br>18, 33 & 48 days after planting | 3.7 | 4.1 | 4.5 | 4.1 | 3.3 | 4.0 | 4.1 | 3.8 |
| Average | 3.4 | 3.9 | 4.1 | — | 3.2 | 3.6 | 3.9 | — |

LSD at 5%: for nitrogen level 0.3 cm (1972); 0.2 cm (1973)
for number of applications 0.3 cm (1972); 0.3 cm (1973)
for level X number of applications = 0.3 cm (1973)

Table 6 Effect of nitrogen level and number of applications on topmost ear height (cm)

| Number of applications | 1972 | | | | 1973 | | | |
|---|---|---|---|---|---|---|---|---|
| | Nitrogen level (kgN/ha) | | | | | | | |
| | 42 | 84 | 126 | Average | 42 | 84 | 126 | Average |
| ONE 18 days after planting | 125 | 135 | 149 | 136 | 119 | 135 | 135 | 130 |
| TWO 18 & 33 days after planting | 135 | 155 | 161 | 150 | 129 | 158 | 166 | 151 |
| THREE 18, 33 & 48 days after planting | 145 | 153 | 168 | 155 | 139 | 155 | 166 | 153 |
| Average | 135 | 148 | 159 | — | 129 | 149 | 156 | — |

LSD at 5%: for nitrogen level 8.3 cm (1972); 3.2 cm (1973)
for number of applications 5.1 cm (1972); 5.2 cm (1973)
for level X number of applications 5.6 cm (1973)

of the sixth internode in both years (Table 7). On the other hand, the increase in nitrogen levels from 84 to 126 kgN/ha did not significantly affect internode diameter. The average increments in the sixth internode diameter due to increases in nitrogen levels up to 84 and 126 kgN/ha over the 42 kgN/ha were 11.1 and 14.8% in 1972, and 20 and 24% in 1973. Both the two and three split applications significantly increased the sixth internode diameter over the single dressing treatment by 7.1 and 10.7%, and by 7.4% in 1972 and 1973, respectively; these positive effects might be reflected upon the stover production (Table 2).

Table 7 Effect of nitrogen level and number of applications on diameter of the sixth internode (cm)

| Number of applications | 1972 | | | | 1973 | | | |
|---|---|---|---|---|---|---|---|---|
| | Nitrogen level (kgN/ha) | | | | | | | |
| | 42 | 84 | 126 | Average | 42 | 84 | 126 | Average |
| ONE 18 days after planting | 2.6 | 2.9 | 2.8 | 2.8 | 2.4 | 2.8 | 2.9 | 2.7 |
| TWO 18 and 33 days after planting | 2.7 | 3.1 | 3.2 | 3.0 | 2.5 | 3.1 | 3.2 | 2.9 |
| THREE 18, 33 & 48 days after planting | 2.7 | 3.1 | 3.4 | 3.1 | 2.6 | 3.0 | 3.2 | 2.9 |
| Average | 2.7 | 3.0 | 3.1 | — | 2.5 | 3.0 | 3.1 | — |

LSD at 5% for nitrogen level 0.2 cm (1972); 0.3 cm (1973)
for number of applications 0.2 cm (1972); 0.2 cm (1973)

Table 8 Effect of nitrogen level and number of applications on plant height (cm)

| Number of applications | 1972 | | | | 1973 | | | |
|---|---|---|---|---|---|---|---|---|
| | Nitrogen level (kgN/ha) | | | | | | | |
| | 42 | 84 | 126 | Average | 42 | 84 | 126 | Average |
| ONE 18 days after planting | 206 | 289 | 293 | 263 | 241 | 288 | 285 | 271 |
| TWO 18 and 33 days after planting | 280 | 305 | 321 | 302 | 266 | 293 | 308 | 289 |
| THREE 18, 33 & 48 days after planting | 291 | 321 | 332 | 315 | 275 | 316 | 323 | 305 |
| Average | 259 | 305 | 315 | — | 261 | 299 | 305 | — |

LSD at 5% for nitrogen level 8.7 cm (1972); 14.8 cm (1973)
for number of applications 7.5 cm (1972); 8.3 cm (1973)

Data in Table 8 indicate the positive effects of increasing nitrogen levels on plant height at all systems of application. Compared with 42 kgN/ha, the addition of 84 and 126 kgN/ha increased plant height by 18 and 22% in 1972, and by 15 and 17% in 1973. Applying nitrogen in two and three equal split dressings significantly increased plant height over the single application treatment by 15 and 20% and by 7 and 13% in 1972 and 1973, respectively; these increments in plant height must account, at least in part, for the increase in stover yield, as indicated by data in Table 2.

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# دراسات على محصول الذرة الشامية (السبول) في الجمهورية العربية الليبية

## ٢ – تأثير معدلات الأزوت ومواعيد الاضافة على النمو والمحصول في الذرة الشامية

م. ع. الشرقاوي – خ. الصغير – ف. ع. سرور – م. أ. يوسف

## المستخلص

درس تأثير كل من معـــدلات الأزوت ومواعيد الاضافة على النمو والمحصول فى صنف الذرة الشامية « أمريكاني بدري » مفتوح التلقيح تحت الظروف البيئية لطرابلس بالجمهورية العربية الليبية في موسمي الزراعة ١٩٧٢، ١٩٧٣ . ويمكن تلخيص النتائج في الاني :

١ – أدت معدلات الأزوت حتى ١٢٦ كجم/هكتار إلى زيادة معنوية في محصول الحبوب والعيـدان ، حجم الحبوب ، محيط وطول الكوز الطرفي ، محيط وارتفـاع النباتات .

٢ – أعطت اضافة الأزوت على دفعتين أو ثلاث دفعـــات متساوية محصولاً أعلى من الحبوب والعيدان بالمقارنة بالاضافة دفعـة واحدة . كما زاد حجم الحبوب ، محيط وطول وارتفاع ومحيط النبات عند اضافة الأزوت على دفعات متساوية بدلاً من دفعة واحدة .

٣ – أمكن الحصول على أعلى محصول للحبوب وهو ٧,٣٣ ، ٦,٨٠ طن/ هكتار وأعلى محصول للعيدان وهو ١٣,٦٤ ، ١١,٩٠ طن/ هكتار في موسمي ١٩٧٢ ، ١٩٧٣ على التوالي عند اضافة الأزوت بمعدل ١٢٦ كجم/ هكتار مقسمة إلى ثلاث دفعات متساوية بعد ١٨ ، ٣٣ ، ٤٥ يوماً من الزراعة .