Investigations on Maize in the Libyan Arab Republic

I. Effect of Plant Spacing and Nitrogen Level on Growth and Yield of Maize (*Zea mays* L.)

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ABSTRACT

In a two-year field experiment (1972, 1973), the effect of nitrogen level and plant spacing on the grain yield and its components, plant height and stover production were studied in Libya using the open-pollinated Early American variety commonly cultivated in Egypt. Addition of 52 and 104 kg N/ha significantly increased grain yield over 0 nitrogen level by 28 and 51% in 1972 and by 35 and 82% in 1973; whereas stover yield was significantly increased by 38 and 52% in 1972 and by 50 and 92% in 1973. Plant spacing significantly affected grains and stover production. At all nitrogen levels in both years, the optimum plant spacing was 35 cm in rows 70 cm apart (42857 plants/ha). However, the highest grain yield of 6.18 and 5.92 tons/ha was obtained with 104 kgN/ha and 35 cm plant spacing. On the other hand, stover production was the highest with the narrowest spacing (30 cm) and 104 kgN/ha.

Size of kernel, length, diameter and height of topmost ear, plant height and diameter of the sixth internode were significantly increased with increasing nitrogen level and plant spacing.

INTRODUCTION

Plant density is an important factor determining growth and yield of maize (*Zea mays* L.) and therefore much research has been conducted on this subject (2,3,4,5,6, 8,11,12). Few reports are available on the influence of plant population on growth and yield of maize under different levels of nitrogen fertilizer (1,7,9,10). Very rare information on cultivation of maize in Libya is available. Therefore, studies of the effect of plant spacing and nitrogen level on maize yield are necessary in this country. For this purpose a two-year experiment was conducted to determine optimum population and nitrogen level under the Libyan conditions.

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MATERIALS AND METHODS

The experiment was conducted for two years, 1972 and 1973, on the sandy loam soil of the Faculty of Agriculture farm, Tripoli. It consisted of three nitrogen levels and four plant spacings within the row in a split plot design with four replications. The nitrogen treatments were 0, 52 and 104 kgN/ha in the form of ammonium sulfate (21% N); one-half of the nitrogen amount was added 18 days after planting when the plants were thinned to one plant/hill and the second half was added 39 days after planting. The plant spacing treatments were 30, 35, 40 and 45 cm between hills and in rows 70 cm wide to give plant densities of 46428, 42857, 39285 and 35714 plants/ha.

The size of each subplot was 16.8 m^2 containing six rows 4 m long. Before sowing, the land received 250 kg of superphosphate/ha (18% P_2O_5). The open-pollinated Early American maize variety, imported from Egypt, was planted on 25 May in both years; plants were thinned to one plant/hill 18 days later. The experiment was irrigated by sprinklers every week from planting until maturity.

RESULTS AND DISCUSSION

Table 1 shows the effect of plant spacing and nitrogen level on total grain yield. There was a significant positive response of yield to nitrogen fertilization. The increase in yield with the addition of nitrogen was significant, and almost linear, amounting to an average increase of 18 kg grain/kg of N in 1972 and 21 kg of grains/kg of N in 1973. The influence of nitrogen treatments was consistent at all plant spacing in both years.

Grain yield showed a pronounced response to plant spacing at all nitrogen levels in both years. Plant spacing of 35 cm between hills consistently produced the highest grain yield. On the other hand, spacing narrower and wider than 35 cm reduced the grain yield at all levels of nitrogen in both years. Therefore, it might be concluded that the plant density of 42857 plants/ha (row spacing 70 cm, and plant spacing 35 cm) is the optimum density for grain production as revealed from the present data.

Stover yield decreased with wider plant spacing and lower plant density (Table 2). Although all spacing treatments affected stover production, only the 45 cm compared with 30 and 35 cm spacing significantly reduced stover yield in both years. However, the data suggest that the higher the plant density the higher the stover yield.

Table 1 Effect of plant spacing and nitrogen level on grain yield (Tons/ha)

Plant spacing (cm)	1972				1973			
	Nitrogen level (kgN/ha)							
	0	52	104	Average	0	52	104	Average
30	3.85	4.86	5.80	4.84	2.54	3.49	4.71	3.58
35	4.01	5.20	6.18	5.13	3.34	3.91	5.92	4.39
40	3.83	4.86	5.63	4.77	2.61	3.61	4.98	3.73
45	3.21	4.15	5.87	4.08	2.21	3.44	3.92	3.19
Average	3.73	4.77	5.62	—	2.68	3.61	4.88	—

LSD at 5%: for plant spacing = 0.68 tons/ha (1972); 0.70 tons/ha (1973)
for nitrogen level = 0.23 tons/ha (1972); 0.44 tons/ha (1973)

Table 2 Effect of plant spacing and nitrogen level on stover yield (Tons/ha)

Plant spacing (cm)	1972				1973			
	Nitrogen level (kgN/ha)							
	0	52	104	Average	0	52	104	Average
30	8.79	12.26	13.33	11.46	6.94	10.20	12.90	10.01
35	8.25	11.43	12.84	10.84	5.83	9.62	12.34	9.26
40	8.34	11.28	12.62	10.75	6.07	9.04	11.32	8.81
45	6.50	9.13	9.63	8.42	5.63	7.79	10.33	7.92
Average	7.97	11.03	12.11	—	6.12	9.16	11.72	—

LSD at 5%: for plant spacing 1.04 tons/ha (1972); 1.09 tons/ha (1973)
for nitrogen level 0.55 tons/ha (1972); 0.82 tons/ha (1973)
for spacing X N level = 1.64 tons/ha (1973)

Nitrogen application significantly increased stover yield in all spacing treatments in both years. Compared with 0 nitrogen level, the increments in stover production due to the addition of 52 kgN/ha were 59 kg/kgN in 1972 and 1973. Further addition of another 52 kgN/ha increased stover yield at the rate of 21 and 49 kg/kgN in 1972 and 1973, respectively. Therefore, the rate of increment tends to decrease with more nitrogen, though the decline was less pronounced in 1973 than in 1972. Also, in 1973 experiment, the interaction between plant spacing and N level was significant.

Table 3 reveals the positive effects of plant spacing and nitrogen level on size of kernels. The weight of 1,000 kernels was significantly increased with increasing nitrogen level and with wider plant spacing. The increase in kernel size was proportional to the amount of added nitrogen in 1972 and 1973; whereas it was inversely related with plant density. The improved kernel size due to nitrogen treatments could partially account for the increase in grain yield with increasing nitrogen level (Table 1). However, the increase in kernel size with wider spacing did not compensate for the reduction in grain yield due to lower plant density.

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

Plant spacing (cm)	1972				1973			
	Nitrogen level (kgN/ha)							
	0	52	104	Average	0	52	104	Average
30	234	245	255	245	234	236	256	242
35	241	255	265	254	241	263	279	261
40	249	283	329	287	243	261	331	278
45	266	306	336	303	243	284	369	299
Average	248	272	296	—	240	261	309	—

LSD at 5%: for plant spacing 17 gm (1972); 16 gm (1973)
for nitrogen level 14 gm (1972); 40 gm (1973)

Table 4 Effect of plant spacing and nitrogen level on topmost ear length (cm)

Plant spacing (cm)	1972				1973			
	Nitrogen level (kgN/ha)							
	0	52	104	Average	0	52	104	Average
30	16.8	19.4	20.2	18.8	15.6	18.4	19.3	17.8
35	18.9	21.1	20.9	20.3	16.2	20.1	21.0	19.1
40	19.7	20.6	22.1	20.8	17.9	20.4	22.1	20.1
45	20.1	22.1	23.8	22.0	18.6	21.7	23.5	21.3
Average	18.9	20.8	21.8	—	17.1	20.2	21.5	—

LSD at 5%: for plant spacing 1.5 cm (1972); 1.6 cm (1973)
for nitrogen level 1.0 cm (1972); 0.9 cm (1973)

Table 4 shows that with increasing nitrogen level the topmost ear length increased in both years. Compared with 0 nitrogen level, the 52 and 104 kgN/ha increased the topmost ear length by 1.9 and 2.9 cm in 1972 and by 3.1 and 4.4 cm in 1973. The response of ear length to nitrogen treatments was pronounced in all plant spacings. Although the number and weight of kernels per ear were not determined in this study, the increase in length of ear might result in larger number and more weight of kernels which might be positively reflected upon grain yield.

With increasing plant spacing, length of topmost ear increased. The longest ears of 22 and 21.3 cm resulted from the 45 cm plant spacing in 1972 and 1973, respectively. The increments in ear length due to this treatment were significant compared with 30 and 35 cm spacings. Increasing ear length with wider spacing did not compensate for the reduction in grain yield associated with low plant density.

Topmost ear diameter positively responded to nitrogen treatments (Table 5). Addition of nitrogen up to 104 kgN/ha increased ear diameter at all plant spacings in both years. As an average of all plant spacings, the application of 52 and 104 kgN/ha increased ear diameter over the 0 nitrogen level by 0.3 and 0.5 cm in 1972 and by 0.3 and

Table 5 Effect of plant spacing and nitrogen level on topmost ear diameter (cm)

Plant spacing (cm)	1972				1973			
	Nitrogen level (kgN/ha)							
	0	52	104	Average	0	52	104	Average
30	3.5	3.7	3.8	3.7	3.2	3.3	3.6	3.4
35	3.6	3.8	3.9	3.8	3.4	3.6	3.9	3.6
40	3.7	4.2	4.5	4.1	3.6	4.0	4.0	3.9
45	3.8	4.1	4.5	4.1	3.4	3.9	4.4	3.9
Average	3.7	4.0	4.2	—	3.4	3.7	4.0	—

LSD at 5%: for plant spacing 0.2 cm (1972); 0.3 cm (1973)
for nitrogen level 0.2 cm (1972); 0.2 cm (1973)

0.6 cm in 1973. These increments might lead to more weight and number of kernels per ear and to an increase in total grain yield.

Plant spacing of 40 and 45 cm produced the largest ear diameter in both years. As an average of all nitrogen treatments, the increments with narrow spacing (30 cm), were 0.4 and 0.5 cm in 1972 and 1973, respectively. However, the increase in ear diameter with wide spacing, as in ear length, did not compensate for the reduction in total grain yield due to lower plant density.

Nitrogen application increased the diameter of the sixth internode at all plant spacings in both years (Table 6). Compared with 0 nitrogen level, the addition of 52 and 104 kgN/ha increased internode diameter by 0.6 and 1.0 cm in 1972 and by 0.6 and 0.9 cm in 1973. These increments were significant and therefore might account for the increase in stover yield (Table 2).

Increasing plant spacing increased the diameter of the sixth internode at all nitrogen levels in both years. The increments in internode diameter with 40 and 45 cm spacing were significant compared with 30 and 35 spacings in 1972. Whereas, in 1973, only the 45 cm spacing treatment significantly increased internode diameter.

Table 7 shows the effects of nitrogen levels and plant spacing on topmost ear height. At all plant spacings, increasing nitrogen level significantly increased topmost ear height in both years. The average percentage increments of ear height with 52 and 104 kgN/ha as compared with 0 nitrogen level were 10.0 and 12.14% in 1972; and 10.2 and 18.9% in 1973.

As plant spacing increased, the topmost ear heights were also increased at all nitrogen levels in both years. Compared with the 30 cm spacing treatment, the 35, 40 and 45 cm spacings significantly increased ear height in 1972 by 15, 20 and 24%, respectively. On the other hand, increments in ear height due to these treatments were 3.9, 7.7 and 17% in 1973, respectively.

Increasing nitrogen level increased plant height at all spacing treatments in both years (Table 8). The average percentage increase in plant height with 52 and 104 kgN/ha as compared with 0 nitrogen level were 7.9 and 18.0% in 1972; and 19 and 32% in 1973. These increments in plant height with increasing nitrogen level were significant and might account, at least in part, for the increase in stover production (Table 2).

Table 6 Effect of plant spacing and nitrogen level on diameter of the sixth internode (cm)

Plant spacing (cm)	1972				1973			
	Nitrogen level (kg N/ha)							
	0	52	104	Average	0	52	104	Average
30	1.7	2.3	2.7	2.2	1.6	2.3	2.5	2.1
35	1.8	2.3	2.6	2.2	1.6	2.2	2.7	2.2
40	2.1	2.9	3.1	2.7	1.8	2.5	2.7	2.3
45	2.1	2.6	3.2	2.6	2.0	2.7	2.8	2.5
Average	1.9	2.5	2.9	—	1.8	2.4	2.7	—

LSD at 5%: for plant spacing 0.3 cm (1972); 0.3 cm (1973)
for nitrogen level 0.2 cm (1972); 0.2 cm (1973)

Table 7 Effect of plant spacing and nitrogen level on topmost ear height (cm)

Plant spacing (cm)	1972				1973			
	Nitrogen level (kg N/ha)							
	0	52	104	Average	0	52	104	Average
30	124	131	143	133	120	131	139	130
35	135	153	170	153	120	138	148	135
40	148	164	169	160	129	136	154	140
45	151	168	175	165	138	154	164	152
Average	140	154	164	—	127	140	151	—

LSD at 5%: for plant spacing 12.5 cm (1972); 7.3 cm (1973)
for nitrogen level 6.5 cm (1972); 3.8 cm (1973)

Plant height significantly increased with increasing plant spacing at all nitrogen levels in both years. Compared with the 30 cm spacing the 35, 40 and 45 cm spacing treatments significantly increased plant height by 11.4, 12.1 and 15.9% in 1972; and by 4.6, 11.4 and 15.5% in 1973. However, these increments in plant height did not compensate for reduction in stover yield due to lower plant density.

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

Plant spacing (cm)	1972				1973			
	Nitrogen level (kgN/ha)							
	0	52	104	Average	0	52	104	Average
30	244	264	285	264	233	273	285	264
35	273	288	321	294	240	275	313	276
40	270	296	321	296	250	296	335	294
45	281	303	334	306	250	313	351	305
Average	267	288	315	—	243	289	321	—

LSD at 5%: for plant spacing 16.5 cm (1972); 8.6 cm (1973)
for nitrogen level 9.1 cm (1972); 8.6 cm (1973)
for spacing X N level = 17 cm (1973)

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

١ – تأثير مسافات الزراعة ومعدلات الآزوت على النمو والمحصول في الذرة الشامية .

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المستخلص

درس تأثير كل من معدلات الآزوت ومسافات الزراعة على محصول الحبوب ومكوناته ، ارتفاع النبات ، محصول العيدان لصنف الذرة الشامية مفتوح التلقيح « أمريكاني بدرى » الشائع الزراعة بجمهورية مصر العربية وذلك خلال موسمى الزراعة ١٩٧٢ ، ١٩٧٣ . وتتلخص النتائج فى النقاط الآتية :–

١ – أدت اضـــافة الآزوت بمعدلى ٥٢ ، ١٠٤ كجم / هكتار إلى زيادة معنوية في محصول الحبوب بنسبتي ٢٨ ، ٥١ ٪ في ١٩٧٢ ، ٣٥ ، ٨٢ ٪ في ١٩٧٣ ، على التــوالى بالمقارنة بعدم الاضافة . بينما زاد معنويا محصول العيدان بنسبتى ٣٨ ، ٥٢ ٪ في ١٩٧٢ ، ٥٠ ، ٩٢ ٪ في ١٩٧٣ عند اضافة هذين المعدلين .

٢ – أثرت معنويا مسافات الزراعة على محصول كل من الحبوب والعيدان في الموسمين عند جميع معدلات الآزوت وكانت أمثل مسافة للزراعة هي ٣٥ سم بين الجور ، ٧٠ سم بين الخطوط (٤٢٨٥٧ نبات / هكتار) . وقد أمكن الحصول على أعلى محصول للحبوب وهو ١٨ر٦ ، ٩٢ر٥ طن / هكتار – عند اضافة ١٠٤ كجم أزوت / هكتار والزراعة على مسافة ٣٥ سم بين الجور . بينما أمكن الحصول على أعلى محصول من العيدان مع أضيق المسافات للزراعة (٣٠ سم) عند اضافة ١٠٤ كجم أزوت / هكتار .

٣ – زاد معنويا كل من حجم الحبوب ، طول ومحيط وارتفاع الكوز الطرفي ، ارتفاع النبات ، محيط السلامية السادسة وذلك بزيادة معدلات الأزوت ومسافات الزراعة .