Effect of Plant Spacing and Nitrogen Fertilizer on Growth and Yield of Safflower in Calcareous Soil

Nawar, F.R.R
Field Crops Research Institute, Agric. Res. Center, Giza, Egypt.

ABSTRACT

Two field experiments were conducted at Nubaria Agric. Res. Station during 1998/1999 and 1999/2000 seasons to investigate the effect of three plant spacings (15, 20 and 25 cm between hills) and three nitrogen levels, i.e., 40, 60 and 80 kg N/fed. as well as their interaction on growth, yield and its components of safflower. The obtained results showed that increasing the distance between plants significantly decreased seed yield/fed. and increased stem diameter, number of branches and heads/plant, 100-seed weight, seed yield/plant. Wide spacing also decreased significantly plant height in the two seasons. All studied characters were significantly increased by increasing nitrogen levels up to 80 kg N/fed., except seed oil percentage. Maximum seed yield/fed. was obtained when spacing was 15 cm between hills and adding 80 kg N/fed.

INTRODUCTION

Egyptian government is pressing to overcome the big gap between production and consumption of oils. One of the promising oil crops to minimize gap is safflower (*Carthamus tinctorius*, L.). Two of the most important factors affecting growth and safflower yield are plant spacing and nitrogen fertilization.

With respect to plant spacing, Girase *et al.*(1980) mentioned that increasing plant densities from 55000 to 98000 and 22000 plants/ha increased plant height as well as seed and oil yields. On the other hand, number of branches and heads/plant and stem diameter markedly decreased. They also added that 100-seed weight was not affected by different plant densities. Mane *et al.*(1990) reported that increasing plant densities to give 75000 to 1200000 and 225000 plants/ha produced linear yield increases, although the values for yield components were decreased. In Egypt, Abo-Shetaia (1990) stated that increasing plant population from 70000 to 105000 plants/fed. increased plant height and seed yield/fed., while number of branches and heads/plant as well as 100-seed weight were decreased.

Concerning nitrogen fertilization, Abu-Hagaza and Metwally (1986) pointed out that adding nitrogen at the rate of 60 kg N/fed. markedly increased plant height, number of heads/plant, seed weight/plant and seed yield/fed. In India, Sachan (1986) reported that nitrogen application at a rate of 40 kg/ha produced the highest seed yield. Zaman (1988) reported that increasing nitrogen levels from 0 to 60 and 120 kg N/ha increased seed yield by 55.5% compared with the control. Katole and Meena (1988) and Mahey *et al.*(1989) reported that nitrogen application at a rate of 60 kg N/ha increased seed yield, while seed oil percentage was not affected. Recently in Egypt, Abo-Shetaia (1990) added 45, 60 and 75 kg N/fed. and found that 60 kg N/fed. gave the highest seed index, but 75 kg N/fed. gave the highest values of yield

components and seed yield/fed. Afifi (1991) demonstrated that adding nitrogen at a rate of 40 kg N/fed. significantly increased plant height, number of branches and heads per plant, seed index, seed yield/plant and seed yield/fed. However, seed oil percentage was not markedly affected. Abu-Hagaza (1991) reported that adding nitrogen at a rate of 60 or 80 kg N/fed. increased seed yield/fed. in the first and second seasons, respectively. Abo-Shetaia (1990) stated that the interaction between plant density and nitrogen levels had significant effects on number of heads/plant, weight of seeds/head, 100-seed weight and straw yield/fed.

The objective of this investigation was to determine the suitable plant spacing and nitrogen fertilization level to increase safflower productivity in calcareous soil.

MATERIALS AND METHODS

Two field experiments were conducted at Nubaria Agric. Res. Station during 1998/1999 and 1999/2000 seasons to study the effect of plant spacing and nitrogen levels as well as their interaction on growth and yield and its components of safflower cv. Giza 1.

A split plot design with five replications was performed. The main plots were devoted to three plant spacings (15, 20 and 25 cm between hills). The sub-plots were devoted to three nitrogen levels 40, 60 and 80 kg N/fed. Each sub-plot consisted of 6 ridges, 60 cm apart and 4.0 m long, occupying an area of 14.4 m^2. The physical and chemical analysis of the soil are presented in Table (1).

The preceding crop was soybean in both seasons. Safflower seeds were hand sown on November 21st and 23rd in the first and second seasons, respectively. Sowing was done on one side of the ridges and the distances between hills were 15, 20 and 25 cm. Plants were thinned to secure two plants/hill.

Nitrogen, in the form of urea (46.5% N), was added at the previously mentioned levels as side dressing in two equal portions, before the second and third irrigations. Hoeing and weed control, irrigation and the other cultural practices were normally conducted.

At maturity, ten guarded plants were taken at random from each experimental plot and the following measurements were recorded: plant height (cm), stem diameter (mm) in the second internode, number of branches and heads per plant, 100-seed weight (g) and seed yield/plant.

Seed yield (kg) was estimated from all plants taken from the two inner ridges in each experimental unit, then it was converted to seed yield per feddan.

Oil content in safflower seeds was determined by Soxhlet apparatus on dry weight basis as described by Sorenson (1947).

The collected data were statistically analyzed according to Snedecor and Cochran (1967).

Table 1. Mechanical and chemical analyses of the experimental soil in 1999 and 2000 seasons.

Soil properties	Season	
	1999	2000
Soil particles (%)		
Sand	50.3	51.5
Silt	21.8	22.6
Clay	27.9	25.9
Soil texture	sandy clay loam	sandy clay loam
Chemical properties		
Total N (%)	0.046	0.051
Available N (ppm)	24.30	25.60
Available P (ppm)	9.68	8.40
Available K (ppm)	415.00	413.00
pH	8.20	8.30
E.C. (mmhos/cm)	2.21	1.95
O.M. (%)	0.95	0.98
$CaCO_3$ (%)	22.90	22.50

RESULTS AND DISCUSSION

1. Effect of plant spacing

Data presented in Table (2) revealed that plant height was decreased due to plant spacing 15, 20 and 25 cm between hills in both seasons. This increment may be attributed to the competition between plants for light within the dense plant population. Also, high plant density could reduce light intensivity within plant canopy and encourage IAA synthesis and increase stem cell elongation (Abo-Shetaia, 1990). Similar results were obtained by Girase *et al.*(1980) and Mane and Narkhede (1982).

Stem diameter, number of branches and heads/plant, 100-seed weight and seed yield/plant were significantly increased by increasing plant density in the two seasons (Tables 2 and 3). This may be due to the more competition between plant root nutrients, moisture and light in dense planting. These results are in general agreement with those obtained by Girase *et al.*(1980), Kandil (1981), Mane and Markhede (1982) and Abo-Shetaia (1990).

Increasing plant spacing from 15 cm to 20 cm and 25 cm between hills decreased seed yield/fed. in the two seasons. These results are in agreement with those reported by Assey *et al.*(1990) and Mane *et al.*(1990). On the contrary, plant spacing had insignificant effect on seed oil percentage in both seasons.

Table (2): Plant height, stem diameter, number of branches/plant, number of heads/plant and 100-seed weight of safflower plant as affected by plant spacing and nitrogen fertilizer in 1998/1999 and 1999/2000 seasons.

Treatments	Plant height (cm)		Stem diameter (mm)		Number of branches/plant		Number of heads/plant		100-seed weight (g)	
	1998/ 1999	1999/ 2000	1998/ 1999	1999/ 2000	1998/ 1999	1999/ 2000	1998/ 1999	1999/ 2000	1998/ 1999	1999/ 2000
Plant spacing										
15	154.5	154.1	1.58	1.58	9.0	8.7	31.5	29.4	4.11	3.97
20	145.8	146.9	1.58	1.55	10.5	10.0	37.1	35.5	4.18	4.09
25	140.4	140.6	1.69	1.62	10.9	10.4	38.8	39.0	4.15	4.15
$L.S.D_{0.05}$	2.9	1.7	0.03	0.02	0.4	0.2	0.9	0.7	0.06	0.03
Nitrogen levels										
40	145.6	143.0	1.59	1.54	9.7	9.0	35.3	33.5	4.05	4.02
60	146.9	146.9	1.62	1.59	10.2	9.7	36.1	34.6	4.18	4.08
80	150.8	151.5	1.65	1.61	10.5	10.3	37.0	35.8	4.20	4.11
$L.S.D_{0.05}$	3.8	2.3	0.04	0.03	0.6	0.4	1.1	1.2	0.08	0.05
Interaction	NS	NS	NS	NS	1.2	0.9	2.9	3.6	NS	NS

Table 3. Seed yield/plant, seed yield/fed. and oil percentage of safflower plant as affected by plant spacing and nitrogen fertilizer in 1998/1999 and 1999/2000 seasons.

Treatments	Seed yield/plant (g)		Seed yield/fed. (kg)		Oil percentage	
	1998/ 1999	1999/ 2000	1998/ 1999	1999/ 2000	1998/ 1999	1999/ 2000
Plant spacing						
15	31.9	32.1	963.7	1032.5	31.69	32.96
20	39.6	39.3	890.4	914.6	31.38	32.02
25	41.9	46.1	767.9	877.5	31.71	31.28
$L.S.D_{0.05}$	0.6	0.9	18.5	22.9	NS	NS
Nitrogen levels						
40	37.0	38.0	847.5	920.5	31.30	32.58
60	37.6	39.5	869.7	947.5	31.46	31.79
80	38.9	39.6	894.4	956.6	32.02	31.89
$L.S.D_{0.05}$	0.7	1.1	21.6	25.3	NS	NS
Interaction	2.6	2.3	30.8	32.9	NS	NS

2. Effect of nitrogen levels

Data presented in Tables (2 and 3) indicated that plant height, stem diameter and number of branches and heads/plant were significantly increased by increasing nitrogen levels from 40 to 60 and 80 kg N/fed. This increase might be due to the role of nitrogen on meristemic activity and cell division which, in turn, increased cell number and size. Similar results were obtained by Abu-Hagaza and El-Metwally (1986), Sachan (1986), Abo-Shetaia (1990) and Afifi (1991). Moreover, increasing nitrogen levels markedly increased 100-seed weight, seed yield/plant and seed yield/fed. This may be explained by higher dry matter accumulation that partitioned to seeds and thus resulted an increase in seed weight and seed yield/plant. On the contrary, nitrogen levels had insignificant effect on seed oil percentage in both seasons. Similar results were obtained by Singh and Singh (1980), Mahey *et al.*(1989) and Abu-Hagaza (1991).

Seed yield/fed. was affected by nitrogen levels in the two seasons. Increasing nitrogen fertilizer levels increased seed yield in the two seasons. This increase may be attributed to the role of nitrogen in increasing number of branches and heads/plant. Also, nitrogen could increase the metabolism in heads producing heads with more and heavier seeds, consequently, seed yield/fed. was increased by raising nitrogen rate from 40 to 60 and 80 kg N/fed. Similar results were reported by Katole and Meena (1986), Sachan (1986), Mahey *et al.*(1989), Abo-Shetaia (1990), Afifi (1991) and Abu-Hagaza (1991).

Table 4. Number of branches/plant, number of heads/plant, seed yield/plant and seed yield/fed of safflower plant as affected by interaction between plant spacing and nitrogen fertilizer in 1998/1999 and 1999/2000 seasons.

Plant spacing (S)	N level (kg/fed.) (N)	Number of branches/plant		Number of heads/plant		Seed yield/plant (g)		Seed yield/fed. (kg)	
		1998/ 1999	1999/ 2000	1998/ 1999	1999/ 2000	1998/ 1999	1999/ 2000	1998/ 1999	1999/ 2000
15	40	8.5	8.1	30.4	28.3	31.6	30.5	937.6	983.2
	60	9.1	8.9	31.9	29.6	31.9	32.7	953.8	1053.0
	80	9.4	9.1	32.1	30.3	32.3	33.2	1004.6	1061.4
Mean		9.0	8.7	31.5	29.4	31.9	32.1	963.7	1032.5
20	40	10.0	9.5	36.3	34.5	38.9	38.5	859.1	904.6
	60	10.5	9.7	36.9	35.2	39.1	39.6	890.7	913.8
	80	10.9	10.8	38.1	36.7	40.8	39.9	921.4	925.4
Mean		10.5	10.0	37.1	35.5	39.6	39.3	890.4	914.6
25	40	10.7	9.5	39.1	37.6	40.5	45.1	750.8	873.6
	60	10.9	10.7	39.6	38.9	41.9	46.3	764.7	875.7
	80	11.3	10.9	40.8	40.5	43.5	46.9	788.3	883.1
Mean		10.9	10.4	38.8	39.0	41.9	46.1	767.9	877.5
Interaction S x N		1.2	0.9	2.9	3.6	2.6	2.3	30.8	32.9

3. Interaction effects

Data presented in Table (4) revealed that interaction between plant spacing and nitrogen levels had significant effect on number of branches and heads/plant as well as seed yield/plant and seed yield/fed. The maximum number of branches and heads/plant was recorded by adding 80 kg N/fed. for the largest plant spacing (25 cm between hills) in the two seasons. The highest seed yield/fed. was obtained by spacing 15 cm between hills and adding nitrogen at a rate of 80 kg N/fed. in the two seasons. Similar results were reported by Abo-Shetaia (1990).

REFERENCES

Assey, A.A., A.M.M. Mohamed, A.H. Fayed, and A.S. Omama. 1990. Effect of irrigation, plant population and growth regulators on yield of safflower. Zagazig J. Agric. Res., 17 (2): 187-197.

Abo-Shetaia, A.M.A. 1990. Response of yield and yield components of safflower (*C. tinctorius*, L.) to increasing levels of nitrogen and phosphorus under two levels of plant density. Annals of Agric. Sci., Fac. of Agric., Ain Shams Univ., Egypt, 35 (1): 223-241.

Abu-Hagaza, N.M., and El.A. Metwally. 1986. Response of safflower (*C. tinctorius*, L.) to varying nitrogen levels and hill spacing. 11th Int. Conf. for Stat., Comp. Sci., Soc. and Demog. Res., 14: 159-171.

Abu-Hagaza, N.M. 1991. Response of safflower to nitrogen levels, time of application and time of harvesting. J. Agric. Mansoura Univ., 17 (1): 10-18.

Afifi, M.M. 1991. Effect of mineral fertilization and sowing dates on growth and yield of safflower plants (*C. tinctorius*, L.). M.Sc. Thesis, Fac. of Agric., Ain Shams Univ., Egypt.

Girase, P.D., A.G. Wani, and A.B. Deakar. 1980. Response of safflower varieties to plant densities and nitrogen levels. J. Maharashtra Agric. Univ., 5 (1): 53-55.

Kandil, A.A. 1981. Growth, yield and yield components of safflower as affected by planting date, population density and nitrogen fertilization. J. Agric. Mansoura Univ., 6: 604-611.

Katole, N.S. and G.P. Meena. 1986. Effect of row spacing, nitrogen and irrigation on seed yield, oil content and water requirement of safflower. Indian J. of Agronomy, 33 (3): 339-341.

Mahey, R.K., S. Baldev, and G.S. Bandhawa. 1989. Response of safflower to irrigation and nitrogen. Indian J. of Agronomy, 34 (1): 21-23.

Mane, V.S. and B.N. Narkhede. 1982. Effect of spacing and fertilizer application on yield contributory character of safflower (*C. tinctorius*, L.) variety N-62-8. Madras Agric. J., 69 (1): 97-102.

Mane, V.S., A.S. Jadhove, and A.T. Powar. 1990. Effects of fertilizers and plant densities on the growth and yield of safflower. J. Maharashtra Agricultural Universities, 15 (2): 254-256. [c.f. Soils and Fertilizers Abst., 54, 12224]

Sachan, S.S. 1986. Studies on effect of mulch, row spacing and levels of nitrogen on safflower (T65) in eroded soil under rainfed conditions. Farm Sci. J., (1-2): 78-81. [c.f. Field Crop Abst., 41, 5565]

Singh, U.B. and R.M. Singh. 1980. Effect of graded levels of moisture regimes, N. and P fertilization on seed yield, oil content and NPK uptake by safflower. Indian J. of Agronomy, 25 (1): 9-17.

Snedecor, G.W. and W.G. Cochran. 1967. Statistical Methods, sixth edition, Iowa Univ. Press, Ames., Iowa, U.S.A.

Sorenson, P.S. 1947. The Analysis of Foods. John Wiley and Sons, New York.

Zaman., A. 1988. Effect of nitrogen and phosphorus on yield attributes, seed yield and oil content of irrigated safflower in laterite soil. Annals of Arid Zone, 27 (1): 37-40. [c.f. Field Crop Abst., 43, 4393]

الملخص العربي

تأثير مسافات الزراعة والتسميد النيتروجيني على نمو ومحصول القرطم في الأراضي الجيرية

فتحي رجب رمضان نوار

قسم بحوث التكثيف المحصولى بمحطة البحوث الزراعية بالنوبارية

أجريت هذه الدراسة بمحطة البحوث الزراعية بالنوبارية خلال الموسمين ١٩٩٨/١٩٩٩ و ١٩٩٩/٢٠٠٠ لدراسة تأثير ثلاث مسافات زراعة (١٥، ٢٠، ٢٥ سم بين الجور) وثلاثة مستويات من التسميد النتروجينى (٤٠، ٦٠، ٨٠ كجم نتروجين/فدان) والتفاعل بينهم على نمو ومحصول القرطم فى الأراضى الجيرية. ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى:

١) أدت زيادة المسافة بين الجور إلى نقص المحصول معنويا وبزيادة مسافة الزراعة زاد قطر الساق وعدد الأفرع وعدد الرؤوس/نبات ووزن ١٠٠ بذرة ومحصول النبات، بينما نقص إرتفاع النبات فى الموسمين.

٢) زادت معنويا جميع الصفات المدروسة بإستثناء نسبة الزيت بالبذرة بزيادة معدلات السماد النتروجينى حتى ٨٠ كجم نتروجين/فدان.

٣) أظهرت النتائج أن أقصى محصول من البذور قد نتج عن المسافة ١٥ سم بين النباتات والتسميد بمعدل ٨٠ كجم نتروجين/فدان.