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EFFECT OF PLANT DISTRIBUTION PATTERN AND NITROGEN FERTILIZATION ON YIELD AND PHOTOSYNTHATES PARTITIONING OF SAFFLOWER

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ABSTRACT

A field study was excuted during 2002/2003 and 2003/2004 seasons at Khattara Project Farm (newly reclaimed sandy soil), Fac. of Agric., Zagazig Univ., Egypt to test the effect of four plant distribution patterns, being P_1 (60x20 cm, 1 plant / hill, 1 side of the ridge= 35000 plant / fed.), P_2 (60 x 30 cm, 1 plant /hill, 2 sides of the ridge = 46666 plant/fed.), P_3 (60 x 20 cm, 2 plants /hill, 1 side of the ridge = 70000 plant/fed) and P_4 (60 x 30 cm, 2 plants /hill, 2 sides of the ridge = 93333 plant/fed.) as well as N fertilization levels (without N application , 40 and 80 kg N/fed.) on the yield and photosynthate partitioning respects of both Giza 1 and Demo 112 safflower cultivars.

The two safflower cultivars showed significant differences with respect most of the studied traits, where Giza 1 cv gave greater mean values respecting RPP of straw yield/plant than Demo 112 which was superior to the former cv in each of head dry weight /plant, relative photosynthetic potential (RPP) of seed yield/plant, biomass/plant, migration coefficient (MC) and the final yields/plant from straw, seed and biomass. On the other hand, no significant cultivar variance was seen regarding their Leaf area index (LAI). Such cultivar behaviour was observed in both seasons.

The four plant distribution patterns gave remarked differences among them as for all the studied respects, since the planting pattern of 60 x 20 cm, 1 plant/hill, 1 side of the ridge (35000 plant/fed.) reflected the greatest records in each of : head dry weight/plant and the final yield / plant from straw, seed and biomass as well as their relative photosynthetic potentials, when compared with the other three patterns used. On the other hand, the safflower plants established by 60 x 30 cm x two plants/hill, two sides of the ridge (93333 plant stand density/fed.) possessed greater records regarding : LAI and (MC) followed in ranking by P_3 , P_2 and P_1 of plant densities with 70000 , 46666 and 93333 thousand plant/fed., orderly. Such planting pattern behaviour was distinguished in both individual seasons.

In addition, the three N levels secured greater changes in their photosynthate partitioning parameters in both trials and over them, where the 80 kg N dose achieved the greatest averages in each of : LAI, head dry weight/plant, MC and the final yields/plant from straw, seed and biomass as well as their relative photothenthetic potentials when compared with the 40 kg N level and the check treatment.

The 3 factors tested interacted strongly as for most of the studied traits, but the best results were seen due to fertilizing imported 12 cv with 80 kg N level and by using either P_1 pattern (60 x 20 cm, 1 plant/hill, 1 side of the ridge with plant stand density of 35000 plant/fed) as for the final straw, seed, biomass and their RPP or P_4 system (60 x 20 cm, two plants/hill, two sides of the ridge = 93333 plant/fed.) respecting LAI and migration coefficient.

In brief, the safflower plants of Demo 112 cultivar proved to have a better canopy structure and can produce greater photosynthate partitioning respects and the good yields/plant when were probably established by the even distribution pattern of 35000 plant/fed. and using the 80 kg N level especially in the newly reclaimed sandy soils of poor fertility as those found in Khattara Project Farm, Zagazig location, Sharkia Governorate, Egypt.

***Key words** : fertilization , photosynthates, safflower, yield.*

1. INTRODUCTION

Safflower (*Carthamus tinctorious* L.) is considered as one of the most important oil crops in the world due to its numerous uses of both flower petals and edible oil, as well as the special advantage of its plants to grow well in barren soils. In Egypt, the Government is pressing hard to increase safflower production, especially in newly reclaimed sandy lands of little rainfall such as Toshky and North Sinai locations, to bridge the nutritious gab found between the decreased production of edible oil and the increased consumption caused by over population. So, to solve such a problem, the appropriate cultural practices should be applied such as growing the highly yielding cvs either local or introduced under modern cultural techniques such as even distributing planting patterns and suitable N fertilization levels, which could help in increasing the photosynthesis capacity of safflower plants resulting in enhancing of more metabolites inside plant organs and maximizing the consequent yield. Three of the most important factors affecting yield and dry matter partition are promising cultivars, plant density and N fertilization levels.

Many workers evaluated the safflower cultivar behaviours in most agronomic characters, of them: Khalil (1988) reported significant cultivar differences respecting leaf area (LA), LAI, dry weight (DW)/plant (at different growth stages), straw and seed yields/plant and seed yield efficiency, where the Demo 112 cultivar exceeded both Imported 63 and Giza 1 in such mentioned traits. Also, similar findings were documented by El-Wakil and Darweesh (1993) Likewise, Refaat *et al.* (1994) indicated that the Portogalian safflower cv was superior to the Egyptian, Sweiss and Romanian ones as for head weight/plant, seed weight/head and seed yield/plant.

Regarding the plant distribution pattern effect, Kamel *et al.*, (1982) cited that the safflower dry weight/plant, LA and relative growth rate (RGR) recorded at different growth stages were markedly increased due to 30 cm hill spacing when compared with both 10 and 20 cm spaces. In contrast, LAI showed a significant excess in favour of the narrowest hill space of 10 cm apart. Besides, Khalil (1988) showed that safflower plant height and LAI were of greater values due to increasing plant density from 40 to 56 and 93 thousand plant/fad (Shweikh, 1988 recorded similar views in this regard). In addition, El-Hariri and Ahmed (1993) stated that the 70000 plant stand/fad exceeded both 35 and 105000 plant/fad respecting plant height, straw, seed and biological yields per plant or/fed. On the contrary, the number of branches and heads/plant, head dry weight/plant, migration coefficient (MC), seed index and relative photosynthetic potential (RPP) from straw, seed and biomass/plant were significantly decreased by raising plant density more than 35000 plant/fed. Together with, Nawar (2002) established safflower plants under 15, 20 and 25 cm between hills and cited that stem diamer, number of branches and heads/plant and seed yield/plant were markedly raised by using the widest hill spacing of 25 cm apart. But, the reverse hold true as for seed yield/fed.

Respecting N fertilization effect, Khalil (1988) mentioned that safflower dry weight/plant, LA/plant and LAI showed marked increases with 90 kg N level when compared with 30 and 60 kg/fed. Similar trend was documented by Afifi (1991). Likewise, El-Hariri and Ahmed (1993) mentioned that plant height, head dry weight/plant, seed index, straw yield/plant and its RPP were significantly increased in response to the application of 60 kg N/fad when compared with 20 and 40 kg N ones. While, the number of heads/plant, migration coefficient and RPP of both seed and biological yields/plant were statistically decreased by increasing N fertilizer level than 40 kg N/fed. Moreover, Badawi *et al.* (1996) in their study on safflower concluded that the 75 kg N level increased meaningly the number of heads/plant, seed number/head, seed index and subsequently seed yield/plant relative to 45 and 60 kg N levels and the check treatment. Whithal, Nawar (2002) working on safflower cv Giza 1 demonstrated that using 80 kg N level increased significantly stem diameter, heads/plant, seed index and seed yield either / plant or /fed when compared with both 40 and 60 kg N levels.

Accordingly, this work aimed to investigate the effect of plant distribution patterns and N fertilization levels on the yield and photosynthate partitioning respects of both Giza 1 and Demo 112 safflower cultivars grown under newly reclaimed sandy soil conditions.

2. MATERIALS AND METHODS

The present trials conducted herein were initiated during the two successive seasons of 2002/2003 and 2003/2004 at Khattara Project Farm, Fac. of Agric., Zagazig Univ., Sharkia Governorate, Egypt. The main objective of this work was to examine the effect of planting patterns and N fertilization levels on the yield and photosynthates partitioning respects of the two safflower cultivars. The soil of the trials was sandy in texture with pH of 7.5, 0.20% organic matter and having 7.50, 12.1 and 60.5 ppm available N, P and K, respectively (averages of the two seasons for the upper 25 cm of the soil).

2.1. Factors studied

2.1.1. Cultivars, V

Two safflower cultivars were used as following:

a- Giza 1, a local cultivar.
b- Demo 112 (an introduced cultivar).

The source of seeds of both cultivars was Oil Crops Section, ARC, Giza, Egypt.

2.1.2. Planting pattern, P

The planting pattern included : ridge width, hill spacing and the number of plants/hill.

The following plant distribution patterns were :

P_1 = 60 x 20 cm, 1 plant/hill, 1 side of the ridge (35.000 plant/fed).

P_2 = 60 x 30 cm, 1 plant/hill, 2 sides of the ridge (46.666 plant/fed).

P_3 = 60 x 20 cm, 2 plant/hill, 1 side of the ridge (70.000 plant/fed).

P_4 = 60 x 30 cm, 2 plants/hill, 2 sides of the ridge (93.333 plant/fed).

2.1.3. Nitrogen fertilization, N

The following N levels were used :

a- Check, without N application.
b- 40 kg N/fed.
c- 80 kg N/fed.

2.2. Layout of the field trials

The design of each experiment was split-split plot with three replicates. The two cultivars were the same as in the main plot, the four planting patterns were the same in the sub-plots and the 3 N levels were also the same in the sub-sub plots. Each sub-sub plot consisted of 6 ridges, 60 cm apart and 4 m long comprising an area of 14.4 m^2. Any of the experimental unit was surrounded by ditches of 1.2 m width to avoid the lateral movement of the irrigation water to the adjacent plots. In each experimental unit, the 2 outer ridges were left as a border, whereas the 4 inner ridges of 9.6 m^2 were used for the determination of the studied characters.

2.3. Cultural practices

The proceeding crop was sudan grass in both trials. The experimental fields were well prepared through 3 ploughings and levellings. Sprinkler irrigation system was followed in this study. Both phosphorus and potassium fertilizers were added fully prior to planting at the rates of 31.0 kg P_2O_5 and 50 kg K_2O /fed. in the form of calcium super phosphate (15.5% P_2O_5) and potassium sulphate (48-52% K_2O), orderly. The seeds of both Giza 1 and Demo 112 cultivars were mixed well with the recommended fungicide to control seed and seedling diseases. Seeding rate used for both cvs was 12 kg /fed. The seeds were planted by using the Afir method in hills of 20 or 30 cm apart on one or 2 sides of the ridge as per treatment. Planting was done on 8 November in both seasons. After a complete emergence, the seedlings in each hill were thinned to one or two plants/hill as per treatment tested. Nitrogen fertilizer levels of 40 or 80 kg N/fad were added in the form of urea fertilizer (46.5% N) at four equal doses after thinning and by interval of 15 days. All other practices were manually adopted on proper time and as usually applied in safflower production. At last, harvesting was done on June 15^{th} in both seasons.

2.4. Characters studied

The following photosynthate partitioning parameters (respects) were recorded on ten individual plants:

1- Leaf area index (LAI) : recorded at 120 days of age.
2- Head dry weight/plant (gm).
3- Relative photosynthetic potential of straw yield/plant (RPP_{straw}).

$$= \frac{\text{Straw yield/plant (gm)}}{\text{LAI at 120 days-old}} = \text{gm/LAI}$$

4- Relative photosynthetic potential of seed yield/plant (RPP_{seed}).

$$= \frac{\text{Seed yield/plant (gm)}}{\text{LAI at 120 days-old}} = \text{gm/LAI}$$

5- Relative photosynthetic potential of biological yield/plant (RPP_{boil}).
= RPP of both straw and seed yields/plant, gm/LAI

The $RPP_{straw,\ seed\ and\ boil}$ parameters were computed by following the procedure described by Vidovic and Pokorny (1971).

6- Migration coefficient (MC)

The migration coefficient of biomass/plant in gm was estimated using the manner outlined by McGraw (1977), as

$$MC = \frac{\text{Head dry weight (gm)/plant at harvest}}{\text{Biological yield/plant (gm), biomass}}$$

7- Straw yield/plant (gm).
8- Seed yield/plant (gm).
9- Biological yield/plant (gm), biomass output.

2.5. Statistical analysis

The collected data of individual seasons were statistically analyzed by following the split-split plot system procedure as documented by Das and Giri (1986). In addition, the combined analysis of variance was also computed for the results of the two seasons, after establishing by Barlett's homogenity test, where the error variance of the individual years was homogeneous. The significant differences among the treatment means were judged with the help of Duncan's multiple range test (Duncan, 1955). In the interaction Tables recorded on the pooled data only, capital and small letters were used to compare both row and column averages, orderly. *,** and N.S are symbols in all listed Tables to verify the significant differences among treatment means at 5 and 1 % levels of probability and insignificant differences, successively.

3. RESULTS AND DISCUSSION

3.1. Cultivar behavior

The two safflower cultivars varied markedly as for such recorded characters in Tables 1, 2 and 3, where Giza 1 cv surpassed Demo 112 in relative photosynthetic potential of straw yield/plant (RPP_{straw}). On the contrary, the latter cultivar possessed greater mean records than the former in each of : head dry weight/plant, RPP_{seed}, RPP_{boil}, migration coefficient and the final yields/plant from straw, seed and biomass. On the other hand, the difference between the two cultivars as for their LAI values did not reach the significancy level. Such cultivar behaviour was distinguished in both seasons (Tables 1, 2 and 3, orderly).

In general, the superiority of Demo 112 on its counterpart Giza 1 in these characters may be attributed inherently to the greater ability of such cv in synthesizing more assimilates that partitioned to the final economical yields of safflower plants and the consequent dry matter accumulation parameters discussed herein. Similar safflower cultivar differences were expressed by : Khalil (1988), El-Wakil and Darweesh (1993) and Refaat *et al.* (1994).

3.2. Planting pattern effect

The four planting patterns exhibited significant changes in all the studied characters recorded in Tables 1, 2 and 3 . The P_1 pattern of 35000 plant/fad gave the greatest mean values in head dry weight/plant, the final yield/plant from straw, seed and biomass as well as their RPP, followed in order by P_2 , P_3 and P_4, successively. On the other hand, the dense plant distribution pattern of 93333 plant/fed. (60 x 20 cm, 2 plants/hill and 2 sides of the ridge possessed high averages in LAI and migration coefficient. Such planting pattern trend was clearly valid in both trials and across them (Tables 1, 2 and 3, orderly).

It could be seen from the results recorded herein that, the better use of edaphic and above-ground environmental resources by the plants grown under the dense distribution pattern (P_4) may be completely attributed to such planting pattern excellence assembled herein as greater LAI and MC values. On the other hand, the superiority of light plant distribution pattern of 35000 plant/fad in most characters studied, being head dry weight/plant and the final yield/plant as well as their RPP might be explained by the most suitable distribution of safflower plants over the soil surface which resulted in a more effective use of light and other growth factors existed in the surrounding media which reflected their positive effect in raising the metabolites partitioned to the storage centres of safflower plants and raising the sequent yields. Analogous findings were documented by : Kamel *et al.* (1982), Khalil (1988), Shweikh (1988), El-Hariri and Ahmed (1993) and Nawar (2002).

3.3. Nitrogen fertilization effect

Significant variations between N levels were observed as for the discussed characters, the 80 kg N level secured the greatest mean values regarding LAI, head dry weight, RPP of straw, seed and biomass, MC and the final yield/plant from straw, seed and biomass followed by the 40 kg N level and the no- N fertilization treatment. This phenomenon was completely true in individual seasons and in their pooled data as well (Tables 1, 2 and 3). In poorly fertile soil like the one used in establishing these trials, the 80 kg N level was necessary in fertilization of safflower plants to increase the photosynthesis process and the consequent assimilates partitioned to the economic parts of safflower plants, which account much for increasing the final yields and the other photosynthate parameters. In other words N fertilization of safflower plants is completely required especially in newly sandy soils to enhance plant growth and to improve the transportation of more photosynthetic substances from the source to the sink during the vital synthetic processes. The effective role of N in raising safflower yield/plant and the other photosynthate respects is documented by other works, among them : Khalil (1988), Afifi (1991), El-Hariri and Ahmed (1993), Badawi *et al.* (1996) and Nawar (2002).

3.4. Interaction effect

The three factors under study interacted positively with each other with respects the dry matter partitioning parameters as follows : the V x P interactions were significantly observed in each of $RPP_{straw,\ seed\ and\ biol.}$, MC and the yield/plant from straw, seed and biomass (Table 4). The results show that Giza 1 plants under 35.000 plant/fed (P_1) gave high mean values as for RPP_{straw}. Also, the plants of Demo 112 cultivar grown under P_1 pattern (35.000 plant/fed) possessed high records

Table (1) : LAI, head dry weight/plant (gm) and relative photosynthetic potential of straw yield/plant (RPP_{straw}), gm /LAI of safflower due to various treatments during 2002/2003 and 2003/2004 seasons.

Main effects and interactions	LAI			Head dry weight/plant (gm)			RPP_{straw} (gm/LAI)		
	Season 1	Season 2	Comb.	Season 1	Season 2	Comb.	Season 1	Season 2	Comb.
Cultivar, V									
Giza 1, V_1	4.02	4.00	4.01	40.30^{a}	38.28^{a}	39.29^{a}	24.18^{b}	23.86^{b}	24.02^{b}
Demo 112, V_2	4.30	4.24	4.27	44.48^{b}	42.26^{b}	43.37^{b}	23.12^{a}	23.12^{a}	23.12^{a}
F. test	N.S	N.S	N.S	*	**	**	*	*	*
Planting pattern, P									
60x20 cm x1 plant, 1 side, P_1	2.68^{a}	2.64^{a}	2.66^{a}	46.60^{d}	43.74^{d}	45.17^{d}	33.40^{d}	33.66^{d}	33.53^{d}
60x30 cm x 1 plant, 1 side, P_2	3.36^{b}	3.32^{b}	3.34^{b}	43.44^{c}	41.44^{c}	42.44^{c}	26.96^{c}	26.20^{c}	26.58^{c}
60x20 cm x 2 plant, 1 side, P_3	4.84^{c}	4.80^{c}	4.82^{c}	40.64^{b}	39.18^{b}	39.91^{b}	19.02^{b}	19.26^{b}	19.14^{b}
60x30 cm x 2 plant, 2 side, P_4	5.76^{d}	5.72^{d}	5.74^{d}	38.88^{a}	36.72^{a}	37.80^{a}	15.22^{a}	14.84^{a}	15.03^{a}
F. test	**	**	**	*	**	**	**	**	**
N levels, kg N/fed, N :									
Check	3.36^{a}	3.28^{a}	3.32^{a}	30.21^{a}	27.73^{a}	28.97^{a}	22.55^{a}	21.83^{a}	22.19^{a}
40	4.30^{b}	4.28^{b}	4.29^{b}	47.67^{b}	44.65^{b}	46.16^{b}	23.40^{b}	23.60^{b}	23.50^{b}
80	4.82^{c}	4.80^{c}	4.81^{c}	49.29^{c}	48.43^{c}	48.86^{c}	25.00^{c}	25.04^{c}	25.02^{c}
F. test	**	**	**	**	**	**	**	**	**
Interactions									
V x P	*	N.S	N.S	N.S	*	N.S	*	N.S	N.S
V x N	*	*	*	*	*	*	N.S	*	*
P x N	*	*	*	*	N.S	*	*	*	*

P_1 = 35000 plants/fed P_2 = 70000 plants/fed P_3 = 46666 plants/fed P_4 = 93333 plants/fed

1%, 5% and NS : refer to the significance level at 1 and 5% and insignificant differences.

Table (2) : Relative photosynthetic potential of both seed and biological yield/plant, gm/LAI, (RPP_{seed} , RPP_{biol}) and migration coefficient (MC)of safflower due to various treatments during 2002/2003 and 2003/2004 seasons.

Main effects and interactions	RPP_{seed} , gm/LAI			RPP_{biol} , gm/LAI			Migration coefficient, MC		
	Season 1	Season 2	Comb.	Season 1	Season 2	Comb.	Season 1	Season 2	Comb.
Cultivar, V									
Giza 1, V_1	5.20 a	4.72a	4.96a	29.38a	28.58a	28.98a	0.344a	0.338a	0.341a
Demo 112, V_2	7.26 b	6.78b	7.02b	30.38b	29.90b	30.14b	0.358b	0.348b	0.353b
F. test	**	**	**	*	*	**	*	*	*
Planting pattern, P									
60x20 cm x1 plant, 1 side, P_1	10.34d	9.62d	9.98d	43.74d	43.28d	43.51d	0.331a	0.313a	0.322a
60x30 cm x 1 plant, 1 side, P_2	7.31 c	6.97c	7.14c	34.27c	33.17c	33.72c	0.343b	0.345b	0.344b
60x20 cm x 2 plant, 1 side, P_3	4.29b	3.73b	4.01b	23.31b	22.99b	23.15b	0.360c	0.350c	0.355c
60x30 cm x 2 plant, 2 side, P_4	2.98a	2.68a	2.83a	18.20a	17.52a	17.86a	0.370d	0.364d	0.367d
F. test	**	**	**	**	**	**	**	**	**
N levels, kg N/fed, N :									
Check	4.66a	4.26a	4.46a	27.21a	26.09a	26.65a	0.302a	0.300a	0.301a
40	6.53b	6.07b	6.30b	29.93b	29.67b	29.80b	0.363b	0.353b	0.358b
80	7.50c	6.92c	7.21c	32.50c	31.96c	32.23c	0.388c	0.376c	0.382c
F. test	**	**	**	**	**	**	**	**	**
Interactions									
V x P	*	*	*	*	*	*	N.S	*	**
V x N	*	*	*	*	**	*	*	N.S	N.S
P x N	*	*	*	**	*	**	*	*	*

Table (3) : Straw, seed and biological (biomass) yield/plant (gm) of safflower due to various treatments during 2002/2003 and 2003/2004 seasons.

Main effects and interactions	Straw yield/plant (gm)			Seed yield/plant (gm)			Biomass/plant (gm)		
	Season 1	Season 2	Comb.	Season 1	Season 2	Comb.	Season 1	Season 2	Comb.
Cultivar, V									
Giza 1, V_1	97.18a	94.58a	95.88a	20.42a	18.48a	19.45a	117.60a	113.06a	115.33a
Demo 112, V_2	99.42b	98.90b	99.16b	24.60b	22.38b	23.49b	124.02b	121.22b	122.65b
F. test	*	**	**	*	**	*	**	**	**
Planting pattern, P									
60x20 cm x1 plant, 1 side, P_1	112.98d	112.66d	112.82d	27.72d	25.40d	26.56d	140.70d	138.06d	139.38d
60x30 cm x 1 plant, 1 side, P_2	100.42c	96.98c	98.70c	24.56c	23.10c	23.83c	124.98c	120.08c	122.53c
60x20 cm x 2 plant, 1 side, P_3	92.06b	92.44b	92.25b	20.76b	17.84b	19.30b	112.82b	110.28b	111.55b
60x30 cm x 2 plant, 2 side, P_4	87.74a	84.88a	86.31a	17.00a	15.38a	16.19a	104.74a	100.26a	102.50a
F. test	**	**	**	**	**	**	**	**	**
N levels, kg N/fed, N :									
Check	75.96a	72.22a	74.09a	12.33a	10.89a	11.61a	88.29a	83.20a	85.70a
40	100.71b	101.21b	100.96b	23.79b	21.81b	22.80b	124.50b	123.02b	123.76b
80	118.23c	116.79c	117.51c	31.41c	28.59c	30.00c	149.64c	145.38c	147.51c
F. test	**	**	**	**	**	**	**	**	**
Interactions									
V x P	*	*	*	*	N.S	*	*	*	*
V x N	*	*	**	*	*	*	**	*	**
P x N	*	**	**	*	*	*	**	**	**

Table (4) : Straw, seed and biological yield/plant (gm) and their RPP as well as migration coefficient of safflower due to the V x P interaction (pooled data).

Planting pattern, P	RPP_{straw} (gm/LAI)		RPP_{seed} (gm/LAI)		RPP_{boil} (gm/LAI)		MC		Straw yield/plant (gm)		Seed yield/plant (gm)		Biological yield/plant (gm)	
	Cultivars, V													
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
P_1	B 34.20d	A 32.86d	A 9.49d	B 10.47d	A 43.13d	B 43.89d	A 0.319a	B 0.325a	A 110.40d	B 115.24d	A 24.48d	B 28.64d	A 134.00d	B 144.76d
P_2	B 27.18c	A 25.98c	A 6.09c	B 8.19c	A 33.23c	B 34.21c	A 0.340b	B 0.348b	A 96.60c	B 100.80c	A 21.50c	B 26.16c	A 118.00c	B 127.06c
P_3	B 19.40b	A 18.88b	A 2.64b	B 5.38b	A 22.30b	B 24.00b	A 0.345c	B 0.365c	A 91.20b	B 93.30b	A 17.40b	B 21.20b	A 109.00b	B 114.10b
P_4	B 15.30a	A 14.76a	A 1.62a	B 4.04a	A 17.26a	B 18.46a	A 0.360d	B 0.374d	A 85.32a	B 87.30a	A 14.42a	B 17.96a	A 100.32a	B 104.68a

V_1 = Giza 1 cultivar V_2 = Demo 112 cultivar

Table(5): Biomass output/plant (gm) and other characters of safflower in response to the V – N interaction. (combined data).

N levels (kg/fed.)	LAI		Head dry weight/plant (gm)		RPP_{straw} (gm/LAI)		RPP_{seed} (gm/LAI)		RPP_{biol} (gm/LAI)		Straw yield/plant (gm)		Seed yield/plant (gm)		Biomass yield/plant (gm)	
	Cultivars, V															
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_1	V_2	V_2	V_1	V_2	V_1	V_2	V_1	V_2
Check	A 3.24a	B 3.40a	A 27.35a	B 30.59a	B 22.38a	A 22.00a	A 4.00a	B 4.92a	A 26.00a	B 27.30a	A 72.15a	B 76.06a	A 10.50a	B 12.72a	A 80.00a	B 91.40a
40	A 4.15b	B 4.43b	A 44.27b	B 48.05b	B 23.86b	A 23.14b	A 5.02b	B 7.58b	A 29.00b	B 30.60b	A 98.70b	B 103.22b	A 21.40b	B 24.20b	A 119.99b	B 127.53b
80	A 4.64c	B 4.98c	A 46.25c	B 51.47c	B 25.82c	A 24.22c	A 5.86c	B 8.56c	A 31.94c	B 32.52c	A 116.82c	B 118.20c	A 26.45c	B 33.55c	A 146.00c	B 149.02c

V_1 = Giza 1 cultivar V_2 = Demo 112 cultivar

Table (6-a) : LAI, head dry weight/plant (gm), RPP_{straw}, RPP_{seed} and RPP_{boil} (gm/LAI) of safflower due to the P x N interaction (combined data).

Planting pattern, P	LAI			Head dry weight/plant (gm)			RPP_{straw} (gm/LAI)			RPP_{seed} (gm/LAI)			RPP_{biol} (gm/LAI)		
	Nitrogen fertilization levels (kg N/fad), N:														
	Check	40	80	Check	40	80	Check	40	80	Check	40	80	Check	40	80
P_1	A 1.87a	B 2.84a	C 3.27a	A 33.23d	B 50.64d	C 51.64d	A 32.50d	B 35.20d	C 34.89d	A 8.11d	B 10.35d	C 11.48d	A 37.30d	B 46.00d	C 47.23d
P_2	A 2.67b	B 3.24b	C 4.11b	A 30.20c	B 47.82c	C 49.30c	A 24.20c	B 26.60c	C 28.94c	A 4.52c	B 8.05c	C 8.85c	A 32.00c	B 33.00c	C 36.16c
P_3	A 3.97c	B 5.04c	C 5.45c	A 27.24b	B 44.50b	C 47.99b	A 17.50b	B 19.20b	C 20.72b	A 3.20b	B 3.90b	C 4.93b	A 21.10b	B 23.20b	C 25.15b
P_4	A 4.77d	B 6.04d	C 6.41d	A 25.21a	B 41.68a	C 46.51a	A 14.56a	B 15.00a	C 15.33a	A 2.01a	B 2.90a	C 3.58a	A 16.20a	B 17.00a	C 20.38a

Table (6-b) : Migration coefficient (MC) and the final safflower yield/plant from straw, seed and biomass due to the N – P interaction recorded from the combined data.

Planting pattern, P	Migration coefficient (MC)			Straw yield/plant (gm)			Seed yield /plant (gm)			biomass output /plant (gm)		
	Nitrogen fertilization levels (kg N/fad), N:											
	Check	40	80	Check	40	80	Check	40	80	Check	40	80
P_1	A 0.290a	B 0.322a	C 0.354a	A 78.00d	B 115.00d	C 145.46d	A 15.40d	B 26.85d	C 27.43d	A 102.80d	B 141.04d	C 174.30d
P_2	A 0.298b	B 0.350b	C 0.384b	A 75.00c	B 102.00c	C 119.10c	A 13.32c	B 25.75c	C 32.42c	A 90.00c	B 130.00c	C 147.59c
P_3	A 0.306c	B 0.370c	C 0.389c	A 73.10b	B 98.00b	C 105.65b	A 10.30b	B 20.78b	C 26.82b	A 80.00b	B 120.00b	C 134.65b
P_4	A 0.310d	B 0.390d	C 0.401d	A 70.26a	B 88.84a	C 99.83a	A 7.42a	B 17.82a	C 23.33a	A 70.00a	B 104.00a	C 133.50a

from RPP_{seed} , RPP_{biol} and the final yield/plant from straw, seed and biomass. On the other hand, the dense plant distribution pattern of 93333 plant/fed. gave a high value from MC when the Demo 112 cultivar was considered (Table 4).

In addition, the safflower plants of Giza 1 cv fertilized with 80 kg N level gave considerable increase in RPP_{straw}. Besides, the plants of Demo 112 cv received 80 kg N level had pronounced excess in each of : LAI, head dry weight, RPP_{seed} , RPP_{biol} and the final yield /plant from straw seed and biomass.

Moreover, the plants of the dense planting pattern of 93333 plant/fed. receiving the 80 kg N level had the best results as for LAI and MC. Likewise, the plant distribution pattern of 35000 plant/fed. fertilized with 80 kg N dose gave the best mean averages respecting : head dry weight, the final yield/plant from straw, seed and biomass and their relative photosynthetic potentials (Tables 6a and 6b). The results of the interactions recorded between the three factors tested allude to the beneficial additional effects of their treatments to exploit the available growth resources to the best which reflected strongly on improving the dry matter accumulation respects and in turn the final yields per plant.

Conclusion

It can be concluded from the findings of this paper that, applying the even distribution pattern of proper plant stand (35000 plant/fed. for the final yields/plant and their RPP or 93333 plant/fed. for LAI and MC) and using the 80 kg N level/fed. is recommended treatments for raising the partitioning and migration of more synthythates to economic yield/plant for both Giza 1 and Demo 112 cvs, being more preferable in the case of the later cultivar of greater ability to utilize the photosynthates for the better, especially in newly reclaimed sandy soil of low fertility as found in Khattara Project Farm, Zagazig, Sharkia Governorate, Egypt.

Thus, it is necessary to consider the effect of new cultural practices on photosynthate partitioning parameters and yield of high yielding safflower cultivars if the maximum advantage is to be obtained.

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تأثير نظام الزراعة والتسميد النيتروجينى على المحصول ومقاييس توظيف ناتجات التمثيل الضوئى فى القرطم

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ملخص

أقيمت هذه الدراسة خلال الموسمين ٢٠٠٢/٢٠٠٣ ، ٢٠٠٣/٢٠٠٤ بمزرعة الخطارة (أرض رملية حديثة الإستزراع) – كلية الزراعة – جامعة الزقازيق – جمهورية مصر العربية وذلك لبحث تأثير أربع نظم للزراعة وثلاث مستويات من التسميد النيتروجينى على المحصول وتوظيف (توزيع) ناتجات التمثيل الضوئى على صنفين من القرطم. كان التصميم التجريبى المستخدم هو نظام القطع الشقية من الدرجة الثانية ، حيث وزع الصنفين فى القطع الرئيسية ، ونظم الزراعة الأربعة فى القطع المنشقة الأولى ومستويات التسميد النيتروجينى الثلاث فى القطع المنشقة من الدرجة الثانية وقد وزعت هذه المعاملات فى ثلاث مكررات فى كلا الموسمين. احتوت كل قطعة تجريبية منشقة على ٦ خطوط وكان عرض الخط ٦٠ سم وطوله ٤ م وبذلك تكون مساحة هذه القطعة ١٤,٤ م٢.

عوامل الدراسة :

كانت عوامل الدراسة كما يلى :

أ- الأصناف :

١- جيزة ١ – صنف محلى – V_1

٢- ديمو ١١٢ (Demo 112) ، صنف مستورد – V_2

ب- نظم الزراعة :

تم استخدام أربع نظم للزراعة – كما يلى :

١- النظام الأول (P_1) : ٦٠ × ٢٠ سم ، نبات واحد فى الجورة ، الزراعة على جانب واحد من الخط ، وقد حقق هذا النظام كثافة نباتية ٣٥٠٠٠ نبات/فدان.

٢- النظام الثانى (P_2) : ٦٠ × ٣٠ سم ، نبات واحد فى الجورة ، الزراعة على الريشتين ، وقد أعطى هذا النظام كثافة نباتية ٤٦٦٦٦ نبات/فدان.

٣- النظام الثالث (P_3) : ٦٠ × ٢٠ سم ، نباتين فى الجورة ، الزراعة على جانب واحد من الخط، وقد نتج عن هذا النظام كثافة نباتية ٧٠٠٠٠ نبات/فدان.

٤- النظام الرابع (P_4) : ٦٠ × ٣٠ سم ، نباتين فى الجورة الواحدة ، الزراعة على جانبى الخط، وقد أعطى هذا النظام كثافة نباتية ٩٣٣٣٣ نبات/فدان.

ج- التسميد النيتروجينى :

كانت مستويات التسميد النيتروجينى المستخدمة كما يلى :

١- بدون إضافة (كنترول) = N_0

٢- ٤٠ كجم ن/فدان = N_1

٣- ٨٠ كجم ن/فدان = N_2

أظهرت النتائج وجود اختلافات معنوية صنفية فى معظم الصفات تحت الدراسة ، حيث كان الصنف المحلى جيزة ١ متفوقا على الصنف ديمو ١١٢ (Demo 112) فى الإمكانية التمثيلية الضوئية لمحصول القش/نبات. بينما فاق الصنف الأخير V_2 الصنف الأول V_1 فى كل من :

الوزن الجاف للرؤوس / نبات ، الإمكانية التمثيلية الضوئية لمحصولى البذور والكتله البيولوجية البيوماسى / نبات ، معامل الهجرة وأخيراً المحصول النهائى للنبات من القش ، البذور والكتله البيولوجية. فى نفس الوقت، كشفت النتائج عدم وجود اختلافات صنفية معنوية فى دليل مساحة الأوراق. وقد ظهر هذا السلوك الصنفى فى كلا الموسمين وفى التحليل المشترك لهما، على التوالى.

كشفت النتائج أيضاً ، وجود اختلافات معنوية بين نظم الزراعة الأربع فى جميع الصفات تحت الدراسة ، حيث نتج عن تطبيق نظام الزراعة الأول (P_1) أعلى القيم معنوياً فى كل من : الوزن الجاف للنورات / نبات والمحصول النهائى للنبات من القش ، البذور والبيولوجى وأيضا الإمكانية التمثيلية الضوئية لهذه الصفات المحصولية الثلاث وذلك بالمقارنة بالنظام الثانى P_2 ، الثالث P_3 والنظام الرابع P_4 على التوالى. وفوق ذلك ، فقد تفوق معنوياً النظام الرابع P_4 عن النظام الثالث P_3 ، الثانى P_2 والأول P_1 فى كل من : دليل مساحة الأوراق ومعامل الهجرة. وقد ظهرت هذه الاختلافات بين نظم الزراعة الأربع فى كلا موسمى الزراعة وفى التحليل التجميعى لهما على الترتيب.

بالمثل ، أظهرت النتائج عن وجود تأثيرات معنوية بين مستويات التسميد النيتروجيني الثلاث في جميع صفات المحصول الفردى وناتجات التمثيل الضوئى فى كلا الموسمين وفى التحليل التجميعى لهما على الترتيب ، حيث أعطى المستوى ٨٠ كجم ن/فدان أعلى القيم جوهرياً في كل من : دليل مساحة الأوراق ، الوزن الجاف للنورات/نبات ، معامل الهجرة والمحصول النهائى للنبات من القش ، البذور والبيوماسى وأيضاً الإمكانية التمثيلية الضوئية لهذه الصفات المحصولية الثلاث وذلك بالمقارنة بالمستوى ٤٠ كجم ن/فان ومعاملة الكنترول غير المسمدة ، على التوالي.

أوضحت النتائج أيضاً ، وجود تداخل فعل معنوى بين أى زوج من أ زواج المعاملات الدراسية بخصوص الصفات الخاصة بالمحصول وقياسات توظيف المادة الجافة فى القرطم ، وقد كانت أفضل النتائج فى صالح الصنف ديمو ١١٢ (Demo 112)وعند زراعة نباتاته تحت كثافة نباتية إما ٣٥٠٠٠ نبات/فدان (P_1) مع إضافة ٨٠ كجم ن/فدان وذلك فيما يتعلق بمحصول القش ، البذور والمحصول البيولوجي والإمكانية التمثيلية الضوئية لهذه الصفات المحصولية أو تحت كثافة نباتية ٩٣٣٣٣ نبات/فدان مع نفس المعدل العالى من السماد النيتروجينى وذلك فيما يتعلق بدليل مساحة الأوراق ومعامل الهجرة فقط.

وباختصار ، أظهرت نتائج هذا البحث أن الصنف المستورد Demo 112 ذات كفاءة تمثيلية عالية وذات قدرة فائقة فى زيادة توزيع المادة الجافة والمحصول النهائى وذلك بزراعته تحت نظام الزراعة ٦٠ × ٢٠ سم ، ١ نبات/جورة وعلى جانب واحد من الخط (٣٥٠٠٠ نبات/فدان) مع إضافة المعدل العالى ٨٠ كجم ن/فدان وذلك تحت ظروف الأراضى الرملية حديثة الاستزراع مثل أراضى مشروع الخطارة التابع لكلية الزراعة – جامعة الزقازيق – محافظة الشرقية ، جمهورية مصر العربية.

وأخيراً ، يمكن الأخذ فى الاعتبار أى عملية زراعية حديثة تؤثر إيجابياً على مقاييس توظيف المادة الجافة والمحصول النهائى لأصناف القرطم عالية الإنتاج تحت ظروف الأراضى الرملية الفقيرة حديثة الاستزراع والموجودة فى أى موقع فى الأراضى المصرية.