Defoliation Time, Plant Density and N-Level for Sunflower as a Forage and Oil Crop

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ABSTRACT

A two years field experiment was conducted during 2006 and 2007 seasons for sunflower agronomic and economic evaluations under three N rates [30 (=N_1), 40 (=N_2) and 50 kg N/ fed (=N_3)], three plant densities [30 (P_1), 36 (P_2) and 40 (P_3)] thousand plant/ fed] and three defoliation treatments [no defoliation (D_0) and defoliation 40 days after sowing (DAS) (D_1) or 50 DAS (D_2)].

Increases N level to 50 kg/ fed increased defoliates fresh weight, head diameter and cereal units. Increasing plant density from 30 to 40 thousand/ plant fed. significantly decreased head diameter, 100-seed weight and seed yield/ fed.

The $N_3 \times P_3$ interaction produced the tallest plants, however, the product of N3 and P1 gave the highest estimates of head diameter and 100-seed weight. Responses to N-levels were linear for weights of fresh defoliates and seed/ fed. with R^2 of 0.8 and 0.9 for faddan yield and 0.4 and 0.8 for seed yield in the two successive seasons, respectively.

Correlation between seed yield/ fed with each of head diameter (0.5) and 100-seed weight (0.7) was significant. Sunflower could be used as a dual purpose crop, leaves for green fodder when plants were defoliated at 50 days after sowing with 40 kg N and 40 thousand plants/ fed plant density.

INTRODUCTION

Sunflower is a major oil seed crop in the world. Several considerations that encourage the cultivation of sunflower as a forage crop includes rapid growth and high yielding potential of fodder especially defoliates that are high in nutrional value (Seiler, 1984 and 1986, Miterav, 1989 and Hassan, 1995).

Nitrogen controls biomass production through its effects on the plant leaves number and generation (Abou Ghazala *et al.*, 2001; Khalil, 2003 and Nahad Abd Allah, 2003) as well as photosynthesis capacity (Zamski and Schaffer, 1996). The increase in N uptake, as N level increased, led to greater growth of shoot system, hence, larger photosynthates translocation into seeds (Connor and Sadras,1992). However, other researches reported that the increase in N level led to higher leaf area index (LAI), while reduction in both light intensity and assimilation rate (NAR), due to mutual shading between leaves, resulted in yield decline (Wallach, 1995). Moreover, other studies reported that sunflower height (Abou Ghazala *et al.*, 2001), seed weight/ head (EL-Tabbakh, 2000) and a single seed weight and seed yield (Khalil, 2003) were significantly affected by N fertilization level. Studies conducted by EL-Nakhlawy (1993) and EL-Tabbakh (2000), revealed significant linear increases in sunflower seed yield as N level increased. However, a field study by Khalil (2003) reported that seed yield of sunflower showed linear or quadratic response to N fertilization levels as affected by the preceding crop.

Another management decision that affects sunflower growth features is plant population density. With increase in number of plants/ m^2, there were increases in LAI and between plants mutual shading which reduced light penetration and consequently net assimilation rate. Increasing plant density increased plant height (Nahad Abd Allah, 2003), but decreased head diameter, head seed weight, 100-seed weight and seed yield (Basha, 2000, Abou Ghazala *et al.*, 2001 and Khalil, 2003).

The expansion in the use of sunflower as a forage, as well as an oil crop, could be considered and was discussed in few reports (Weiss, 1984, EL Nakhlawy, 1993 and Khalil and Nawar, 2003). Such application is of great account for Egyptian farmers in summer season, where the lack of green fodder constitute a major problem, especially for small scale farmers.

The present study was conducted to investigate sunflower response to defoliation in different times to determine the time that gives a suitable forage yield without significant reduction in seed yield under different levels of N and plant density.

MATERIALS AND METHODS:

This study was conducted at Agricultural Research Station, Faculty of Agriculture, Alexandria University, during 2006 and 2007 summer seasons for agronomic and economic evaluation of sunflower (variety Euroflor). Soil chemical properties were: pH= 8.4, organic matter (%) = 1.20, total N (%) = 0.017 and available inorganic phosphorus (ppm) = 2.7 (average of the two seasons).

Nitrogen as urea fertilizer (46.5 % N), was applied at 3 levels (30 = N_1, 40 = N_2 and 50 = N_3 kg/ fed.). Nitrogen was added in two equal splits (at first and second irrigations, respectively). Plant population densities were 30000 (=P_1), 36000 (=P_2) and 40000 (=P_3) plants/ fed. Defoliation treatments were: no defoliation (=D_0) and defoliation 40 (=D_1) and 60 (=D_2) days after sowing (DAS), respectively, starting from the eighth node and upwards. Defoliated leaves were weighed and transformed to tons/ fed. green forage. Seeds were sown on May 10 and 15 during the two successive seasons, in hills. Hill spacing of 0.20 m (with 1 plant/ hill) was used in case of P_1, then adjusted to 0.30 m (2 plants/ hill) and 0.50 m (3 plants/ hill) to P_2 and P_3 densities, respectively. All other agriculture practices were uniformly applied according to recommendations.

A split split plot design with 3 replicates was used in both seasons Nitrogen, densities and defoliation procedure were allocated to the main, sub and sub sub plots, respectively. Plot area was 21.00 sq. meter with 6 ridges, each 0.3 m wide and 5.00 long.

At harvest, the average of a sample of 10 plants (taken at random from each sub subplot) was used to determine plant height (cm), head diameter (cm), head seed weight (g) and 100-seed weight (g). The four inner ridges were harvested to evaluate straw and seed yields in addition to cereal units (CU_s, as economic measurement). Cereal units were proposed by Brockhaus (1962) to represent the agronomic gain from the main and/ or the secondary products where 100 kg of seed or straw yield equals 1.5 or 0.15 cereal units, respectively. Data were statistically analyzed according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION:

Analysis of variance for the two seasons (Table 1) indicated that nitrogen levels caused significant variations in weight of fresh defoliates, plant height, head diameter, 100-seed weight, seed yield and cereal units/ fed. in both seasons. The response of plant height, head diameter, 100-seed weight and seed yield/ fed. to plant population was significant during 2006 and 2007 seasons. The two factor interaction (N×P) exhibited significant effects on plant height, head diameter and seed yield/ fed. in both seasons. In addition, data showed that variations in weight of fresh defoliated leaves, 100-seed weight and seed yield/ fed reached the 5% level of significance in the two seasons, as affected by time of defoliation. Furthermore, the 3-factor interaction was significant for 100-seed weight and seed yield/ fed. in both seasons.

Means for the studied characters are presented in Table (2). Yield of fresh defoliates (ton/fed) significantly increased as nitrogen fertilizer increased, over the two seasons. It was, as an average of both seasons, 0.28 for N3 and 0.08 t/ fed for N_2 greater than the yield obtained from N_1 (0.88 t/ fed). These findings indicated that increased yield of fresh defoliates under the highest N level, without deleterious effect on seed yield, may suggest the application of this practice by small farmers who can not afford to grow sole forage crops.

Data showed that plant height was proportionally related to the increasing rates of nitrogen. Application of 40 kg N/ fed. caused considerable increase over the 30 kg level. Increases in plant height were 15.59 cm for N_2 and 27.92 cm for N_3, compared to N_1 level, as an average of the two seasons. Increases in N uptake (due to increases in N level) led to greater vegetative growth (in respect with increases in cell division and number) and consequently taller sunflower plants (Khalil, 2003). These results were in line with Zeiton (1992) and EL-Nakhlawy (1993), but disagreed with Nawar (1994) and EL-Tabbakh (2000) who found that plant height was insignificantly affected by N levels.

Higher and medium nitrogen levels were similar in their effects on head diameter and 100-seed weight during the two seasons, and proved superior to the lower N level. This finding may be due to the increase in leaf N content leading to increases in leaf photosynthetic area and capacity, and in turn, to greater assimilates partitioning to heads and seeds. Averaged over the two seasons, increases in head diameter for N_2 and N_3 over N_1 were 1.23 and 1.33 cm, respectively, however the corresponding values for 100-seed weight were 1.10 and 1.27 g. Similar trends were obtained for those characters by EL-Nakhlawy (1993) and Geweifel *et al.* (1997).

Increasing nitrogen levels from 30 to 40 kgN/ fed., in the two seasons, resulted in significant increases in seed yield and cereal units/ fed. However, further increase in nitrogen application to 50 kgN/ fad. led to insignificant increase for such traits, compared to 40 kgN/ fad. in both seasons. Responses of sunflower seed yield to N_2 and N_3 levels were, respectively, 149.4 and 174.63 kg/ fad, as and average of the two seasons, greater compared to N_1 level. Meanwhile, corresponding values for cereal units were 2.26 and 2.68 greater. EL Nakhlawy (1993) and Nawar (1994) found that increasing nitrogen application level increased seed yield of sunflower. Increases in 100-seed weight and seed weight per head might be the reason for seed yield increases.

On the other hand, the negative effect of N_1 on cereal units may be attributed to poor N uptake and weak plant growth that was associated with reductions in assimilates partitioning to head seeds leading to reductions in seed weight and seed yield/ fed. Partitioning of defoliated fresh weight and seed yield/ fed into linear and quadratic responses (Table 1) indicated that both traits responded linearly to increasing N level in both seasons. Linear regression of each of weight of defoliated leaves and seed yield/ fed on nitrogen levels were as follows:

I. For defoliated leaves:

$\hat{Y} = 0.0527 + 0.0195\,X$ ($R^2 = 0.799$) in the first season

$\hat{Y} = 0.437 + 0.0135\,X$ ($R^2 = 0.899$) in the second season

Equations indicated progressive increases in leaves fresh weight by 0.0195 and 0.0135 (tan/ fad) in the two seasons, respectively for each unit (1 kg) increase in nitrogen amount within the range from 30 to 50 (kg/ fed.).

Furthermore, from these equations as an average of both season, 84.9% of the total variation in such trait can be accounted for by a linear function between leaves fresh weight and nitrogen levels.

II. For seed yield/ fed.:

$\hat{Y} = 626.77 + 7.80 X$ ($R^2 = 0.89$) in 2006 season

$\hat{Y} = 563.43 + 9.66 X$ ($R^2 = 0.83$) in 2007 season

Equations indicated that when seed yield was regressed on nitrogen levels, similar increases in yield (7.8 kg in 2006 and 9.66 kg/ fed in 2007 season) were obtained from each increase in N by (1 kg/ fed.). Coefficient of determination (R^2), as an average of the two seasons, showed that about 86% of changes in seed yield/ fed were attributable to changes in N level.

Data concluded that the effect of nitrogen levels on yield of clipped leaves was linear showing that the effect of higher N doses on increasing the yield of fresh leaves needs more investigation. In addition, is suggested that application of nitrogen fertilizer at higher doses than those applied in this study should be tried in order to determine the optimum level of nitrogen needed for sunflower. These results confirmed with EL-Tabbakh (2000) who concluded that sunflower seed yield/ ha linearly responded to nitrogen levels from 70 to 140 (kg/ ha) in one season of study.

Data in Table (2) also indicated that increase in plant population from 30,000 to 36,000 plants/ fed were associated with insignificant increase in plant height, whereas, further increase to 40,000 plants/ fed caused significant increase in plant height over the two seasons. These results may be due to increasing sunflower plant to plant competition for light as plant density increased. These results confirmed those reported by Eschie *et al.* (1996) and Sharief (1998) who reported that sunflower plants grew taller as plant density increased.

Increases in plant density were associated with decreasing values of head diameter, seed yield/ head and 100-seed weight over the two seasons. These results may be attributed to the increase in competition between sunflower plants and higher shading at higher plant densities and were in agreement with Eschie *et al.* (1996) and Geweifel *et al.* (1997). Despite decline in sunflower yield attributes (head diameter and 100-seed weight), there was increases in seed yield/ fed. Schneiter (1992) reported that competition effects, due to high plant population, for water, nutrients and light can lead to a decline in seed size and head diameter, as well as, to increasing plant height. This finding indicated that increasing plant density can compensate for reductions in yield attributes.

Also, it would suggest that higher levels of plant density should be tried to reach the optimum level of plant density needed for sunflower.

There were no significant differences in yields between 40,000 and 36,000 plants/ fed., but were significant between each of them and 30 thousand plans/ fed., over the two seasons. Average over the two seasons, P_3 and P_2 outyield P_1 by 121.9 and 101.4 kg/ fed, respectively. These results confirmed those reported by Eschie *et al.* (1996).

The fresh defoliated leaves, as an average of both seasons, amounted to 0.72 and 1.70 ton/ fed. With defoliation at 40 and 60 DAS respectively. Such increase supports the fact that defoliates fresh weight depends upon the age of defoliation and may be due to increases in leaf size and content of assimilates in 60, compared to 40 DAS. Defoliation at 40 DAS led to drastic decline in assimilates translocation to seeds of heads. This finding was in line with Connor and Sadras (1993) who indicated that around 40 DAS represents the peak time of leaf expansion, generation and photosynthesis occurrence. As a result, that may be responsible for 100-seed weight decline. However, the 60 days old leaves reached a stage of greater leaf senescence and reduced leaf expansion, representing the time during which leaves had little contribution to the biomass production (Sadras *et al.*, 1991). Consequently late defoliation of 60 DAS insignificantly decreased 100-seed weight and seed yield/ fed over the two seasons.

Seed yield/ fed had the same course of change with 100-seed weight over the two seasons to suggest that leaves defoliation of sunflower plants at 60 days old could be applied by the small farmer who could not afford to grow a sole summer forage crop, without any deleterious effects on seed yield.

The first order interaction, i.e. nitrogen level × plant density (Table 3) showed that plant height increased along with increases in both nitrogen level and population density during the two seasons. As a result, the highest plant height was obtained from 50 kg N/ fed application at the highest density of 40,000 plants/ fed, whereas the lowest height was the result of 30 kg N and 30 thousand plants/ fed treatment. These results may be attributed to increasing in internodes elongation due to increases in plant apical meristem activity and sunflower plants intracompetition to light.

In addition, such interaction significantly affected head diameter and seed yield/ head in both seasons. Consequently, the highest head diameter and seed yield/ head were obtained with 30 thousand plant population (P_1) and lowest N level (N_1). It is evident, especially in the second seasons that higher applications of nitrogen alleviated the drastic effect of high population density on head diameter and seed yield/ head. These results were in disagreement with Narwal and Malik (1985), who reported that plant height, head diameter and seed yield/ head were insignificantly affected by the interaction of nitrogen and plant population.

The 3-factor interaction (Table 4) indicated that 100-seed weight increased in the three defoliation treatments with increase in N level and plant population. Application of 50 kg N/ fed at 30 thousand plant gave the highest 100-seed in the non defoliation during the two seasons. Seed yield/ fed was also significantly affected by the 3-factor interaction during the two seasons. Both non defoliation and defoliation at 60 DAS treatments gave the maximum seed yield at the greatest plant density and N level.

Data in Table (5) indicated significant and negative correlations between seed yield and plant height as well as between 100-seed weight and head diameter in both seasons. However, during the two seasons, seed yield was significantly and positively correlated with each of head diameter and head seed yield. In addition, a significant and positive correlation was also found between 100-seed weight and seed weight of head. These results were in accordance with Nawar (1994) and El-Tabbakh (2000).

The present study showed that sunflower seed yield responded differently to leaves removal, whose effects varied from significant to non significant by increasing defoliation time from 40 to 60 DAS. In addition, increasing N level and population density was associated with insignificant increases in weight of defoliated leaves as well as seed productivity. This investigation, also revealed the possibility of growing sunflower as a dual purpose crop for both seed and forage production, where the two products proved to be non-competitive when leaf defoliation was carried out at the appropriate plant growth stage.

Table (1): Significant levels of the studied traits of sunflower during 2006 and 2007 seasons:

Source of variance	D.F.	Defoliated leaves fresh wt (t/fed)		Plant height		Head diameter		Seed yield/ head		100-seed weight		Seed yield/ fed		Cereal units (CU$_s$)	
		2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Nitrogen levels (N)	2(2")	*	*	*	*	*	*	n.s	n.s	*	*	*	*	*	*
linear	1	*	*									*	*		
quadratic	1	n.s	n.s									n.s	n.s		
Error (a)	4(4)	0.0052	0.0060	16.29	12.43	0.09	0.12	0.37	0.32	0.098	0.150	3673.00	2856.00	0.81	0.85
Population densities (P)	2(2)	n.s	n.s	*	*	*	*	*	*	*	*	*	*	n.s	n.s
N × P	4 (4)	n.s	n.s	*	*	*	*	*	*	n.s	n.s	n.s	n.s	n.s	n.s
Error (b)	12(12)	0.050	0.066	15.51	14.50	0.057	0.040	0.05	0.06	0.029	0.042	1865.00	1548.00	0.42	0.41
Time of defoliation (T)	2 (1)	*	*	n.s	n.s	n.s	n.s	n.s	n.s	*	*	*	*	n.s	n.s
N × T	4 (2)	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
P ×T	4 (2)	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
N × P × T	8 (4)	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	*	*	*	*	n.s	n.s
Error (c)	36(18)	0.110	0.143	17.17	15.57	0.076	0.063	0.23	0.17	0.044	0.370	1408.00	1232.00	0.55	0.40

* Significant at 0.05 level
= Degrees of freedom for the defoliated leaves are given between paranthesis

Table (2): Means of sunflower traits as affected by nitrogen fertilizer, population density and defoliation time during 2006 and 2007 seasons:

Treatments	Defoliated leaves fresh wt (t/fed)		Plant height		Head diameter (cm)		Seed yield/ head (gm)		100-seed weight (gm)		Seed yield/ fed (kg/ fed.)		Cereal units (CU_s)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Nitrogen levels														
N_1	0.84	0.92	158.80	150.87	12.51	11.76	11.56	11.51	5.37	5.31	827.74	844.96	12.42	12.10
N_2	0.98	1.19	176.99	163.87	13.10	12.21	11.71	11.55	6.53	6.22	1001.11	970.39	14.92	14.11
N_3	1.11	1.21	184.76	180.76	13.21	12.57	11.62	11.94	6.76	6.56	1021.00	1000.96	15.42	14.46
$L.S.D._{0.05}$	0.135	0.150	2.82	2.47	0.21	0.24	NS	NS	0.17	0.27	42.41	34.40	0.63	0.41
Population density														
P_1	0.93	1.02	167.23	159.26	13.73	13.14	12.84	12.81	6.70	6.55	870.89	868.81	14.10	13.50
P_2	0.95	1.06	173.04	164.69	12.97	12.48	11.43	11.47	6.11	6.13	978.30	964.19	19.25	13.55
P_3	0.97	1.09	180.27	171.55	12.12	11.69	10.61	10.73	5.85	5.41	1000.67	982.81	14.35	13.60
$L.S.D._{0.05}$	NS	NS	13.00	12.16	0.55	0.63	0.80	0.90	0.22	0.24	25.60	22.57	NS	NS
Defoliation treat.														
D_0	-	-	175.04	166.01	11.60	11.59	11.59	11.48	6.63	6.50	1072.93	1054.89	14.39	13.86
D_1	0.63	0.69	172.10	164.43	11.47	11.76	11.76	11.95	5.41	5.10	714.15	730.37	14.12	13.86
D_2	1.27	1.43	173.43	165.05	11.24	11.54	11.54	11.58	6.58	6.35	1062.78	1040.56	14.75	13.95
$L.S.D._{0.05}$	0.23	0.26	NS	NS	NS	NS	NS	NS	0.13	0.15	20.73	18.51	NS	NS

NS : Not significant.

Table (3): Nitrogen level × population density interaction for plan height, head diameter and seed yield/ head during 2006 and 2007 seasons:

Nitrogen level	Population density	Plant height (cm)		Head diameter (cm)		Seed yield/ head (g)	
		2006	2007	2006	2007	2006	2007
30	P_1	154.24	146.50	13.93	12.82	12.43	12.53
	P_2	155.49	147.72	13.14	11.58	10.76	11.21
	P_3	166.67	158.39	12.27	10.39	9.99	10.51
40	P_1	163.48	147.26	13.33	12.37	12.79	12.82
	P_2	172.62	155.36	13.22	11.29	11.36	11.23
	P_3	179.87	162.00	12.14	10.28	10.98	10.89
50	P_1	182.98	180.00	13.01	12.32	12.30	13.07
	P_2	191.29	191.00	12.96	12.17	12.19	11.97
	P_3	195.00	198.30	12.46	11.71	10.88	10.80
$L.S.D_{0.05}$		4.05	3.91	0.25	0.21	0.15	0.25

Table (4): Three factor interaction for 100-seed weight and seed yield/ fed. during 2006 and 2007 seasons:

Nitrogen level	Population density	Defoliation treatments: Seed yield/ fed (kg) 2000 D_0	D_1	D_2	2001 D_0	D_1	D_2	100-seed weight (g) 2000 D_0	D_1	D_2	2001 D_0	D_1	D_2
30	P_1	842.00	549.00	784.00	754.00	493.00	708.0	5.90	3.93	4.23	6.50	4.30	4.67
	P_2	900.00	646.00	874.00	816.00	581.00	781.00	5.20	3.63	3.93	5.73	4.00	4.30
	P_3	1082.00	715.00	1059.00	1046.0	643.00	881.00	5.20	3.47	3.83	5.73	3.83	4.20
40	P_1	1070.00	647.00	757.00	1900.0	550.00	853.00	7.57	4.93	5.53	8.73	5.67	6.33
	P_2	1106.00	705.00	1027.00	909.00	599.00	863.00	6.20	4.63	5.20	7.10	5.33	6.00
	P_3	1225.00	891.00	1203.00	1059.00	758.00	1004.00	5.60	3.63	4.63	6.40	4.20	5.33
50	P_1	1135.00	740.00	1072.00	1022.00	666.00	1007.00	7.67	5.60	5.90	9.20	6.73	7.07
	P_2	1240.00	742.00	1161.00	1160.00	668.00	1035.00	6.60	4.63	5.97	7.90	5.60	7.13
	P_3	1307.00	793.00	1246.00	1113.00	714.00	1059.00	6.20	5.20	5.90	7.47	6.27	7.07
$L.S.D_{0.05}$		62.19			55.54			0.35			0.44		

Table (5): Simple correlation coefficients between some studied characters during 2006 and 2007 seasons:

Character	Head diameter 2006	2007	Head-seed weight 2006	2007	100-seed weight 2006	2007	Seed yield/ fed 2006	2007
Plant height	0.15^{ns}	$0.14^{n.s}$	0.20^{ns}	0.25^{ns}	0.23^{ns}	0.31^{ns}	-0.72*	-0.68*
Head diameter			0.90*	0.86*	-0.83*	-0.77*	0.61*	0.57*
Head seed weight					0.69*	0.65*	0.68*	0.72*
100-seed weight							0.28^{ns}	0.26^{ns}

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الملخص العربى

ميعاد التوريق والكثافة النباتية ومستويات التسميد النيتروجينى لاستخدام عباد الشمس كمحصول علف وزيت

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أجريت هذه الدراسة بمحطة البحوث الزراعية التابعة لكلية الزراعة جامعة الإسكندريةفى الموسم الصيفى عامى ٢٠٠٦ و٢٠٠٧ بغرض التقييم المحصولى والاقتصادى لمحصول عباد الشمس تحت تأثير معاملات الخف [بدون (D_0=) – الخف بعد ٤٠يوم (D_1=) أو الخف بعد ٥٠ يوم (D_2=) من الزراعة] والكثافة النباتية [٣٠ (P_1) – ٣٦ (P_2) – ٤٠ (P_3) ألف نبات/ فدان] والتسميد النتروجينى [٣٠ (N_1) – ٤٠ (N_2) – ٥٠ (N_3) كجم نيتروجين/ فدان] وفيما يلى أهم النتائج:

١- كانت الزيادة فى الوزن الطازج وقطر النورة والعائد معنوية عند ٤٠ كجم بينما كانت غير معنوية عند ٦٠ كجم نيتروجين/ فدان.

٢- أ- أطوال النباتات والمحصول البذرى/ فدان كانت متساوية فى الكثافتين الكثافتين P_1 و P_2 كما تفوقت هاتين الكثافتين تفوقاً معنوياً على الكثافة P_3 لهاتين الصفتين.

ب- صاحب زيادة الكثافة النباتية من٣٠ ألف إلى ٤٠ ألف نبات/ فدان نقصاً معنوياً فى المحصول البذرى/ فدان وقطر النورة ووزن ١٠٠ بذرة.

٣- أ- أدى استخدام أعلى مستوى نيتروجينى (٥٠ كجم نيتروجين/ فدان) مع أعلى كثافة نباتية (٤٠ ألف نبات/ فدان) إلى الحصول على أطول النباتات بينما صاحب استخدام نفس المستوى النيتروجينى مع أصغر كثافة نبات (P_1) أكبر تقديرات لكل من قطر النورة ووزن ١٠٠ بذرة.

ب- أدت معاملة عدم التوريق أو التوريق المتأخر مع استخدام أعلى مستوى نيتروجينى وأكبر كثافة نباتية إلى الحصول على أعلى محصول بذرى/ فدان.

٤- أ- دلت النتائج على حدوث استجابة خطية فى الوزن الطازج للأوراق والمحصول البذرى/ فدان لمستويات التسميد النيتروجينى حيث بلغت قيم معامل التقدير (٠,٨) و (٠,٩) لوزن الأوراق الطازجة بجانب (٠,٩) و (٠,٨٥) لمحصول البذور/ فدان خلال الموسمين على التوالى.

ب- قد أظهر تحليل التلازم بين الصفات المدروسة وجود تلازماً معنوياً وموجباً بين المحصول البذرى/ فدان وكل من قطر النورة (٠,٥١) ووزن ١٠٠ بذرة (٠,٧).

٥- يمكن زراعة محصول عباد الشمس كمحصول ثنائى الغرض (الأوراق كعلف أخضر بجانب المحصول البذرى بإجراء عملية التوريق المتأخر مع استخدام ٥٠ وحدة نيتروجين و ٤٠ ألف نبات/ فدان)