

4-RESULTS AND DISCUSSION

4.I. WATER RELATIONS

4.1.1. Actual water consumptive use (Actual evapotranspiration):

Evapotranspiration is the combination of two processes, evaporation and transpiration. Evaporation is direct evaporation of water from the soil surface and/or from the plant surface. Transpiration is the flow of water vapor from the interior of the plant to the atmosphere (Jones et al, 1984).

1. 1. Seasonal actual evapotranspiration (ETa)

Values of seasonal actual evapotranspiration (ETa) as affected by row width and phosphorus fertilizer levels in 2001 and 2002 seasons are presented in Table 4 and polluted in Fig 1.

The overall average of (ETa) for row width and phosphorus fertilizer levels were 46.65 and 45.50 cm in 2001 and 2002 seasons, respectively.

A. Effect of row width

Results of 2001 season, indicate that ETa values were 50.4 and 42.9 cm for normal furrows (70 cm) and wider furrows (140 cm) respectively. Seasonal ETa was decreased by 14.88 % when sunflower plants were grown in wide furrows (140 cm) as compared to normal furrows (70 cm).

Results of 2002 season show that averages of ETa were 49.6 and 41.4 cm for the same row width treatments, respectively. It is clear that ETa was decreased by 16.5 % (water consumption) with wide furrows compared to normal furrows.

In both seasons, results indicate that the highest actual evapotranspiration value was obtained with narrow rows treatment, which received more irrigation water compared with wider rows. These results may be attributed to the reduction in water runoff in the case of wide rows. In other words, the closed furrows irrigation method decreased the irrigated area to half. Plants grown on the closed furrows suffered from drought after irrigation for more days than those grown under normal furrows as a result of soil moisture deficit under the plants caused by closing furrows. This result is in a good agreement with that obtained by *Salib et al.*(1998), who found that normal furrows irrigation increased seasonal water use of sunflower by 13.1and 12.3% in 1996 and 1997 seasons, respectively over closed furrows irrigation.

B. Effect of P levels:

Seasonal ETa values in 2001 season as listed in Table 5 indicate that averages of ETa were 41.90, 44.55, 47.15, 48.6, and 51.10 cm for P1 (6.50 kg P/ fed), P2 (8.11 kg P/ fed), P3 (9.75 kg P/ fed), P4 (11.38 kg P/ fed), and P5 (11.38 kg P/ fed), respectively.

However in 2002 season, values were 39.75, 43.15, 46.05, 48.85 and 49.7 cm for the same P treatments. These results indicate that ETa values increased with increasing P levels. The increased values of ETa with the highest level of P (P5) were about 18.0 and 20 % for 2001 and 2002 seasons, respectively as compared with the lowest level of P (P1). This may be due to the important role of P in elongation of roots and maturity of plants, which encourage sunflower plants to absorb more water from the soil with more division of cells. These results are in a good agreement with those obtained by *Cook and Gasser* (1955).

C. Effect of interaction:

The obtained results show that ETa was increased for normal furrows (R1) treatment with all P levels. In 2001 season result indicates that the highest ETa (55.8cm) was obtained from normal furrow treatment (R1) combined with 13.0 kg P/fed (P5), while, the lowest ETa (39.6 cm) was obtained from wide furrow treatment (R2) assigned to 6.5 kg P/ fed (P1). In 2002 season, the maximum and minimum ETa values of 53.8 cm and 37.2 cm were recorded with R1 P4 treatment and R2 P1 treatment, respectively.

Generally, it could be concluded that seasonal water use ETa was increased for normal furrows (70 cm apart, R1). Also, it increased with increasing P levels up to 13.00 kg P/fed (P5).

Table (4): Seasonal water consumptive use (cm) as affected by row width and phosphorus levels for sunflower plants in 2001 and 2002 seasons.

Seasons		2001		T			
Geasons		2001	.6		2002		
Treatment			Row	width			
P (kg/ fed)	R1	R2	Av	R1	R2	Av	
P1	44.2	39.6	41.9	42.3	37.2	39.75	
P2	48.7	40.4	44.55	47.9	38.4	43.15	
Р3	51.2	43.1	47.15	50.5	41.6	46.05	
P4	52.3	44.9	48.6	53.8	43.9	48.85	
P5	55.8	46.3	51.1	53.6	45.8	49.7	
Average	50.4	42.9	46.65	49.6	41.4	45.5	

R1 = normal furrows (70 cm) row width treatment

R2 = wider furrows (140 cm) row width treatment

P1 = 6.50 kg P/ fed

P2 = 8.13 kg P/ fed

P3 = 9.75 kg P/ fed

P4 = 11.38 kg P/ fed

P5 = 13.00 kg P/ fed

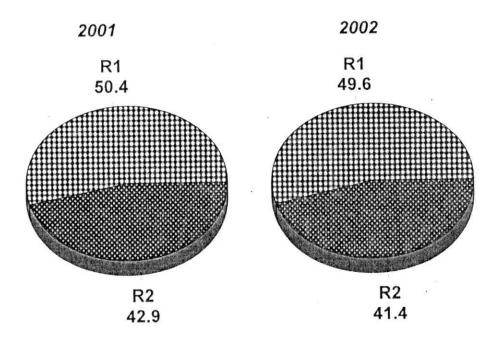


Fig (1): Seasonal water consumptive use for sunflower plant in 2001and 2002 seasons.

1. 2 Monthly water consumptive use

Monthly water consumptive use (ETa) as affected by row width and phosphorus fertilizer levels in 2001 and 2002 seasons is presented in Table 5 and Fig 2

The average values of Monthly ETa overall the row width and phosphorus fertilizer levels were 9.3 and 9.1 cm in 2001 and 2002 seasons, respectively.

A .Effect of row width

In 2001 season results indicate that average monthly ETa values for R1 were 16.0, 18.0, 14.4 and 2.0 cm. for June, July, August and September, respectively, while values for R2 were 14.0, 15.6, 11.7 and 1.8 for the same respective months.

In 2002 season results clearly show that averages of monthly ETa were 1.9, 15.3, 17.7, 14.3, 0.5 for May, June, July, August and September, respectively, while, values for R2 were 1.5, 12.6, 15.0, 11.9 and 0.4 for the same respective months.

In both seasons results reveal that closed furrows (R2) treatment decreased monthly ETa during all concerned months when compared with normal furrows (R1) treatment. It is obvious that, monthly ETa started low when plants were small and increased gradually with increasing plant age to reach the maximum value during the flowering stage (July) which may be due to the increase in mean air temperature and high demand of

water by the plants in this period. These results are in harmony with those obtained by Khalil (1997), who found that daily ETa rates were lower during the initial period and increased to reach their maximum values when plant aged 55-75 days after sowing (during July) then decreased again at late season till harvesting.

B. Effect of phosphorus fertilizer levels

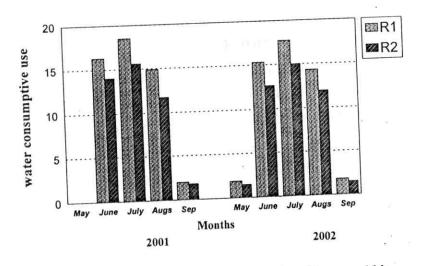
Results of 2001 season show that monthly ETc during the months of season was increased with increasing P levels up to P5. Averages during July were 15.4, 16.1, 16.9, 17.3 and 18.5 cm for P1, P2, P3, P4 and P5. These results were true in all concerned months. The overall monthly averages were 15.0, 16.8, 13.1, and 1.9 for June, July, August and September, respectively.

Results of 2002 season, recorded also that monthly ETc during the months of season was increased with increasing P levels. Increasing P rates from P1 to P4 increased monthly ETc during July from 14.8 cm to 17.6 cm. All months showed the same trend and the overall monthly averages were 1.7, 14.0, 16.4, 13.1 and 0.5 for May, June, July, August and September respectively.

Results of both seasons (Table 6) indicate that phosphorus fertilizer levels positively affected monthly ETa value. Monthly ETa during all indicated months was increased with increasing P levels up to P5. Moreover, it is clear that the optimum monthly ETa was recorded in July with all P levels.

Table (6) Actual monthly consumptive use of water (in cm) of sunflower grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

Seaso	n			2	001					20	002		
							Mo	onths					
Treatm		O May	June	July	7 August	September	Average	May	June	July	August	September	Average
	PI	0.0	14.8	16.2	12.1	1 7	9.0	1.3	12.6	15.9	12.1	0.4	8.5
	P2	0.0	15.5	17.1	13.9	1.8	9.7	1.9	14.6	17.1	13.8	0.4	9.6
R1	Р3	0.0	16.1	18.3	14.8	2.0	10.2	2.0	15.8	17.9	14.3	0.4	10.1
	P4	0.0	16.4	18.5	15.2	2.1	10.4	2.0	16.7	18.7	15.5	0.5	10.7
	P5	0.0	17 2	20.1	15.8	2.2	11.1	2.2	16.8	18.9	15.6	0.5	10.8
	Av	0.0	16.0	18.0	14.4	2.0	10,1	1.9	15.3	17.7	14.3	0.4	9,9
	P1	0.0	12 8	14.6	10.8	1.4	7.9	1.2	11.4	13.6	11.2	0.4	7.6
	P2	0.0	13.2	150	11.2	1.6	8.2	1.4	11.9	13.8	11.0	0.4	7.7
R2	P3	0.0	14.2	15.5	11.6	L9	8.6	1.6	12.7	15.3	11.6	0.5	8.3
	P4	0.0	14.8	16.1	121	2 0	9.0	1.7	13.1	16.2	12.5	0.5	8.8
li	P5	0.0	15.0	16.8	12.9	2.2	9.4	1.8	13.8	16.2	13.4	0.5	9.1
	Av	0.0	14.0	15.6	11.7	1.8	8.6	1.5	12.6	15.0	11.9	0.5	8.3
	P1	0.0	13.8	15.4	11.5	1.6	8.5	1.3	12.0	14.8	11.7	0.4	8.0
Av. for all	P2	0.0	14.4	16.1	12.6	1.7	9.0	1.7	13.3	15.5	12.4	0.4	8.7
P levels	Р3	0.0	15.2	16.9	13.2	2 0	9.5	1.8	14.3	16.6	13.0	0.5	9.2
	P4	0.0	15.6	17.3	13.7	2.1	9.7	1.9	14.9	17.5	14.0	0.5	9.8
	P5	0.0	16.1	18.5	14.4	2 2	10.2	2.0	15.3	17.6	14.5	0.5	10.0
Av. For mo	onths	0.0	15 0	16.8	13.0	1.9	9.3	1.7	14.0	16.4	13.1	0.5	9.1



Fig(2a): Monthly water cosumptive use as affected by row width phosphorus levels for sunflower in 2001 and 2002 seasons.

It could be concluded that for the good water management of sunflower crop, adding irrigation water must be timely and efficiently, especially through July to obtain the best results which give high WUE. Also, results insure that increasing P addition should be accompanied with more soil water supply. This may be due to the important role of phosphorus in increasing distribution of plant root leading to the increased water absorption from large area of root zoon. These results are in a good agreement with those of Baldev et al., (1999). Doorenbos et al (1979), Khalil (1997) and Tyagi et al (2000).

1. 3. Water Use Efficiency (WUE):

Water use efficiency is expressed as kg seeds/ m³ of water consumed by plants. It has been used to evaluate different irrigation methods in producing yield per unit of water consumed by the crop plants.

Average values of water use efficiency (WUE) for sunflower as affected by row width and phosphorus fertilizer levels in 2001 and 2002 seasons are listed in Table 6 and plotted in Fig.3.

Values of WUE irrespective of row width and P levels together were 0.582 and 0.542 kg seed/ m³ water consumed in 2001 and 2002 seasons, respectively.

A .Effect of row width:

Results of 2001 season, indicate that WUE values were 0.575 and 0.589 for R1 and R2, respectively. The close furrows (R2) reduced water consumption by 14.9 %, whereas the seed yield was reduced by about 12.1 %.

Results of 2002 season, show that WUE, followed the same trend and WUE values were 0.501 and 0.583 for R1 and R2, respectively The close furrows (R2) reduced water consumption by 16 %, whereas the seed yield was reduced by about 3 % only.

In both seasons, with respect to WUE results indicate that closed furrows irrigation (R2) treatment, surpassed the normal furrows irrigation (R1) treatment by 2.37 % and 14.1 % in 2001 and 2002 seasons, respectively. It could be noticed that planting sunflower crop under closed furrows irrigation method (R2) is more efficient in water utilization than the normal furrows (R1). This notice is based on the higher values of seed yield and lower water use (specially in 2002 season) obtained from R2 compared to R1. On the other hand, planting sunflower on closed furrows (R2) produced seed yield approximately equal to that obtained from normal furrows (R1) but it improved water use more than did normal furrows (R1) row width.

In this connection, Salib et al. (1998) studied the effect of irrigation method on (WUE). Their results indicated that

closed furrows (wide row) treatment surpassed the normal furrows irrigation method by 2.7 % and 2.4 % in 1996 and 1997 seasons, respectively.

These results are in a good agreement with those found by Doorebos et al (1979), Jana et al (1982), Gaafar and El- Wakil (1986), Green and Read (1993), Singh et al (1995), Khalil (1997) and El- Marsafawy et al (1998).

B. Effect of phosphorus fertilizer levels

Results of 2001 season show that WUE values were 0.534, 0.614, 0.616, 0.603 and 0.546 for P1, P2, P3, P4 and P5 respectively. Increasing P levels up to P3 increased WUE by 21.4 % compared with P1 (lowest P level).

Results of 2002 season show that WUE values were 0.546, 0.573, 0.576, 0.550 and 0.464 for P1, P2, P3, P4 and P5, respectively. Increasing P levels up to P3 increased WUE by only 5.2 % compared with P1 (lowest P level).

In both seasons, results show that phosphorus fertilizer levels affected water use efficiency. The highest WUE was obtained for P3 treatment (0.616 and 0.576 kg seed/ m³ water consumption in 2001 and 2002 seasons, respectively). These results are in full agreement with those reported by *Dhoble* (1998) and Salib et al (1998).

Table (6): Water use efficiency (WUE) in (kg seed/ m³ water consumed) of grown in 2001 and 2002 seasons as affected by row width and phosphorus

Season		2001		2002			
Treatment			Row widt	h			
P (level) kg/ fed	R1	R2	Av.	R1	R2	Av.	
P1	0.559	0.508	0.534	0.514	0.579	0.546	
P2	0.583	0.644	0.614	0.521	0.626	0.573	
P3	0.586	0.646	0.616	0.526	0.626	0.576	
P4	0.617	0.589	0.603	0.512	0.588	0.550	
P5	0.531	0.560	0.546	0.431	0.479	0.464	
Average	0.575	0.589	0.582	0.501	0.583	0.542	

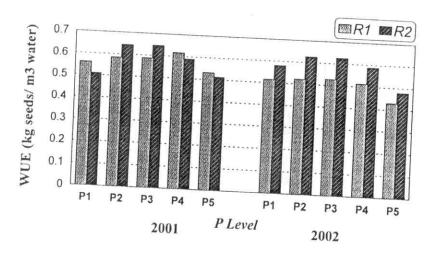


Fig (3):Water use efficiency WUE (kg seeds/m3 water consumed) for sunflower plant grown in 2001 and 2002 seasons. as affected by row width and phosphorus levels

4.1.2. Potential evapotranspiration ETp

Values of (ETo) and ETc (mm/ month) throughout sunflower growing season duration, estimated from the climatic data of Giza region by Modified -Penman, Penman- Monteith and Doorenbos - Pruitt and Kc values (FAO, No. 56) in 2001 and 2002 seasons are shown in Table 7.

Generally, results indicate that there was difference between calculated ETc for the two seasons. This may be due to the variation in the weather conditions.

In 2001, seasonal estimated ETc values were 474.0 mm, 466.0 mm and 399.9 for Modified-Penman, Penman – Monteith and Doorenbos – Pruitt, respectively.

In 2002, seasonal estimated ETc values were 466.0 mm, 450 mm, and 400.0 mm for Modified-Penman, Penman - Monteith, and Doorenbos – Pruitt respectively.

It is clear that, Modified Penman formula gave the maximum ET crop values in both seasons compared with other methods of estimation. On the other hand, monthly ETc values of three methods reveal that ETc values started small according to the small plant cover in the early stage, then increased to reach their maximum values in mid season (July) as a result of high temperature and then tended to decline again until the crop maturity (September).

Table (7): Crop Coefficient (Ke), Eto and ETc (mm/month) estimated by some formulae for sunflower at Giza region in 2001 and 2002 seasons.

Season				2001						2	002		
			lified man		man iteith		enbos uitt		lified man		ıman ıteith		renbos uitt
Month	Ke	ЕТо	ЕТс	ЕТо	ЕТс	ЕТо	ЕТс	ЕТо	ETc	Eto	ЕТс	ЕТо	ЕТс
May	0.6	0		0	0	0	0	16.2	9.72	12	7	13.7	8
June	0.8	178	142	175	140	153	122.4	177	141.6	170	136	151	121
July	1	221	221	217	217	186	186	211	211	207	207	183	183
August	0.7	151	106	149	0	125	87.5	144	101	138	97	123	86
September	0.4	12.6	5.0	12.5	5.0	10.1	4.04	7.16	2.87	6.68	3.00	5.96	2.00
Total	0.7	562.6	474.0	553.5	466.0	474.1	399.9	555.4	466.0	533.7	450.0	476.7	400.0

These results may be due to the differences in climatic factors on which calculated formulae are based on as well as plant canopy (Table 3). In this concern, *Chang (1971)* reported that the rate of ETo depended on evaporation power of the temperature, wind speed, relative humidity and solar radiation. The obtained results are in harmony with those obtained by *Khalil (1997) and EL-Marsafawy et al (1998)*.

4.1.3. Comparison of ET crop with the actual ET:

To evaluate the three mentioned methods and their efficiency in calculating ET crop as compared with actual ET to select the best one for Giza region this step was made as shown in Table 8 and illustrated in Fig 4. Results of 2001 season indicate that ratios between ET crop and actual ET were 0.93, 0.91, and 0.78 for Modified Penman, Penman Monteith and Doorenbos-Pruitt, respectively. However, in 2002 season, the recorded values were 0.91, 0.89 and 0.79 for the same respective formulae. The over all averages in two seasons were 0.93, 0.90 and 0.79 for the same respective formulae.

Results of both seasons reveal that Modified – Penman method is the most efficient in calculating ET crop of Sunflower (Ero- Floor C.V.) in Middle Egypt (i.e. Giza region) than Penman- Monteith and Doorenbos -Pruitt methods.

Table (8): Comparison between the actual (ET) and estimated (ET) for sunflower plants grown at Giza region in 2001 and 2002 seasons.

Season	20	001	20	002	Average		
Estimated (ET)	ЕТ	Ratio	ET	Ratio	ЕТ	Ratio	
Modified Penman	474.0	0.93	466	0.92	470	0.93	
Penman Monteith	466.0	0.91	450	0.89	458	0.90	
Doorenbos-Pruitt	399.9	0.78	400	0.79	400	0.79	
Actual (ET)	512		505		508		

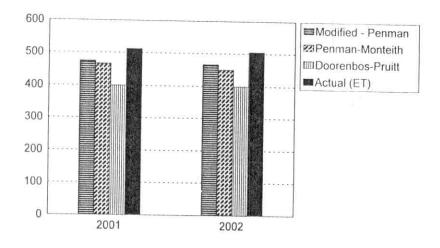


Fig 4 : Comparison between the actual(ET) and estimated (ET) for sunflower plant grown at Giza region in 2001 and 2002 season .

4.2. GROWTH PARAMETERS

4.2.1. Plant height at 45 days old:

Averages of plant heights at 45 days from sowing, as affected by row width and phosphorus fertilizer levels in 2001 and 2002 seasons are presented in Table 9 and illustrated in Fig. 5.

A. Effect of row width:

Results of Table 10 indicate that row width had no significant effect on plant height in both growing seasons and the averages of plant height in season 2001 were 147 and 143 cm for R1 and R2, respectively. The corresponding averages of plant height in season 2002 were 136 and 133 cm, respectively.

In both seasons, results indicate that averages of plant height at 45 days old tended to be higher in the narrow rows than those in the wide rows treatment with no significant difference. These results show some agreement with those obtained by *Shinde et al, (1990)* and *EL-Marsafawy et al (1998)* who found that average plant height for maize crop at 75 days old was superior with 70 cm apart (narrow rows) compared with 140 cm apart (wide rows).

B. Effect of P levels:

The heights of sunflower plants grown in 2001 season (Table 9) were significantly affected by P levels. The highest average value (155 cm) was obtained from using the highest P level (P5). Plant height of such treatment (P5) was significantly increased by 12 % over that of treatment received P1 level.

Table (9): Plant height (cm) of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

Season		2001			2002	
Treatment			Row	width		
P (kg/ fed)	R1	R2	Av	R1	R2	Av
P1	140	136	138	132	129	131
P2	142	138	140	135	132	134
Р3	144	141	143	137	134	136
P4	153	144	149	140	134	137
P5	157	154	155	138	135	137
Average	147	143	145	136	133	135

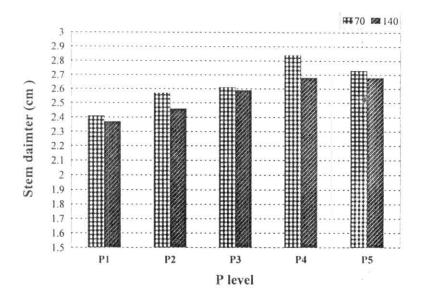
L.S.D	5%	5%
RW	N.S	N.S
P	8.3	N.S
RW X P	N.S	N.S

Table (10): Stem diameter (cm) of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels .

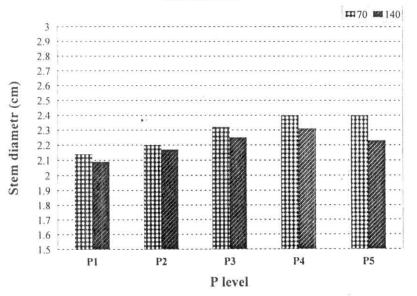
Season		2001	boutin	2002				
Treatment		(4)	Row	width				
P (kg/ fed)	R1	R2	Av	R1	R2	Av		
Pl	2.4	2.4	2.4	2.1	2.1	2.1		
P2	2.6	2.5	2.5	2.2	2.2	2.2		
Р3	2.6	2.6	2.6	2.3	2.3	2.3		
P4	2.8	2.7	2.8	2.4	2.3	2.4		
P5	2.7	2.7	2.7	2.4	2.2	2.3		
Average	2.6	2.6	2.6	2.3	2.2	2.2		

L.S.D	5%	5%
RW	N.S	N. S
P	0.1	0.1
RW x P	N.S	N.S

Season:2001







Fig(5): Stem diameter (cm) of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

cm for R1 and R2. In 2002 season, similar trend like that obtained in 2001 season was found as stem diameter was not significantly affected by row width. The average values were 2.3 and 2.2 cm for R1 and R2, respectively.

Results of the two seasons showed no significant effect of row width on stem diameter. These results agree well with those obtained by *El-Naggar* (1991) and Malik et al (1992) who found that growth parameter as plant height and stem diameter was unaffected by row width.

B. Effect of phosphorus fertilizer levels:

Results of 2001 season which are shown in Table 10 reveal that stem diameter was significantly affected by phosphorus levels. The highest value (2.8 cm) was obtained with applying P4, while the lowest value (2.4 cm) was obtained with applying P1. Average stem diameter was increased by 11.1 % with P4 as compared with P1.

Average stem diameter in 2002 season was significantly affected by phosphorus levels. The highest and lowest values were 2.4 and 2.1 cm resulted from applying P4 and P1, respectively. The obtained stem diameter with P4 was 12.5 % higher than that obtained with P1.

In both seasons, results revealed that stem diameter was significantly increased by increasing P levels.

4.2.3. Number of leaves/ Plant at 45 days old:

Number of leaves/ plant at 45 days old as affected by row width and phosphorus fertilizer levels in 2001and 2002 seasons is recorded in Table 11 and illustrated in Fig 7.

A. Effect of row width:

Results of 2001 season indicate that row width did not significantly affect the number of leaves/ plant. Averages were 21.8 and 20.7 for R1and R2 row width, respectively.

Comparable results were obtained in 2002 season. Averages were 21.1 and 20.8 cm for the same respective row width treatments.

In both seasons, results indicate that average number of leaves/ plant tended to increase with R1 treatment compared with R2 treatment, but the increase did not reach the level of significance. These results are in a good agreement with that obtained by *Sharma* (1994) who reported that applying three irrigations caused an increase in leaves number/ plant by 1.0 leaf over those received one or two irrigations.

B. Effect of phosphorus fertilizer levels:

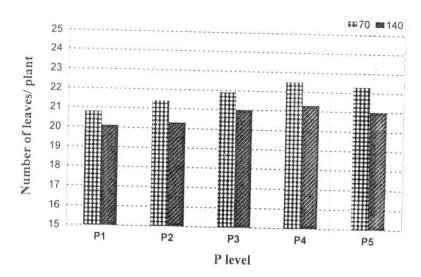
In 2001 season, number of leaves/ plant was significantly affected by phosphorus levels. The highest value of 21.9 was obtained with applying P4 treatment. While lowest value of 20.5 was obtained with applying P1. Average number of leaves/ plant was increased by 6.39 % with addition of 11.38 kg P/ fed (P4) as compared with 6.5 kg P / fed (P1).

Table (11): Number of leaves/ plant of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels

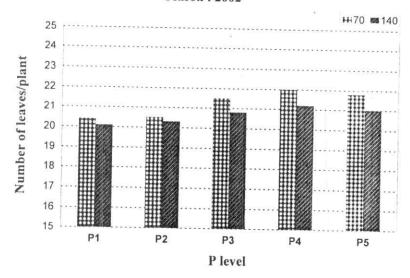
Season		2001			2002				
Treatment	Row width								
P (kg/ fed)	R1	R2	Av.	R1	R2	Av.			
P1	20.8	20.1	20.5	20.4	20.1	20.3			
P2	21.4	20.3	20.9	20.5	20.3	20.4			
P 3	21.9	21.0	21.5	21.5	20.8	21.2			
P4	22.5	21.3	21.9	22.0	21.2	21.6			
P5	22.3	21.0	21.6	21.8	21.0	21.4			
Average	21.8	20.7	21.3	21.1	20.8	21.0			

L.S.D	5%	5%
RW	N.S	N. S
P	1.0	0.7
RWxP	N.S	N.S

Season:2001



Season: 2002



Fig(6): Number of leaves/plant of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

Number of leave/ plant in 2002 season, was positively and significantly affected by phosphorus levels. The highest value of 21.6 leaves resulted from adding P4. The lowest one of 20.3 was obtained with P1. Average number of leaves/ plant increased by 6.01 % with adding P4 as compared with adding P1.

In both seasons, results reveal that phosphorus levels significantly affected the number of leaves/ plant. The highest and lowest values were obtained with using P4 & P1, respectively. These results are disagreeable with those obtained by Murad et al. (2000) who noticed that number of leaves/ plant was not significantly affected by increasing P rate from 0 to 90 kg P_2 O_5 / ha.

4.2.4. Plant dry weight at 45 days old:

Plant dry weight at 45 days old (maximum growth period) as affected by row width and phosphorus fertilizer levels in 2001 and 2002 seasons is recorded in Table 12 and illustrated in Fig. 8.

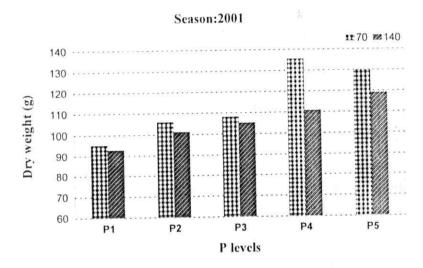
A. Effect of row width:

Results of 2001 season indicate that dry weight was not significantly affected by row width. Averages were 115 g and 106 g for R1 and R2, respectively. The narrow rows treatment (R1) however tended to be superior by 7.83 % compared with wide rows (R2).

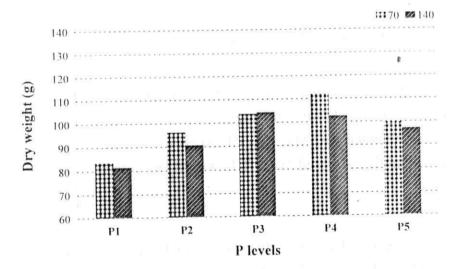
Table (12): Dry weight (g) of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels

Season		2001			2002	
Treatment			Row	width		
P (kg/ fed)	R1	R2	Av.	R1	R2	Av.
P1	95.3	93.0	94.2	83.5	81.5	82.5
P2	105.9	101.2	103.6	96.6	90.6	93.6
P3	108.1	105.2	106.7	103.8	104.4	104.1
P4	135.6	110.8	123.2	111.9	102.6	107.3
P5	130.0	119.1	124.6	99.7	97.1	98.4
Average	115	106	110	99	95	97
L.S.D		5%	282	5%	· ·	
RW		N.S		N.S	a t o	

RW N.S N.S
P 13.8 8.3
RW x P N.S N.S







Fig(7): Dry weight/plant of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

Regarding the results of 2002 season, no significant differences were found between dry weight values of plants grown on narrow and wide rows. Averages were 99 and 95 g for the narrow rows treatment (R1) and wide rows (R2) treatments respectively. Again the narrow rows treatment (R1) tended to be superior by 4.04 % compared with wide rows (R2).

In both seasons, results indicate that average values of dry weight of the 45 days old plants were higher with narrow rows (R1) than those with wide rows (R2) treatment, but the difference between two row width treatments did not reach the level of significancy. These results are quite agreeable with those obtained by *Dahiphale and Pawar (1993) Venkanna et al (1994) and Khalil (1997)*.

B. Effect of phosphorus fertilizer levels:

Results of 2001 season reveal that phosphorus levels significantly affected dry weight/ plant. The highest value of 124.6 g was obtained with applying P5, while the lowest one of 94.2 g was obtained with applying P1. Average dry weight/ plant was significantly increased by 32.4 % with P5 as compared with P1.

Results of 2002 season also, reveal that dry weight/ plant was significantly affected by phosphorus levels! The highest value of 107.3 g was resulted from adding P4, while the lowest one of 82.5 g was obtained for P1. Average dry weight/ plant was increased by 30 % with adding P4 as compared with P1

Results of both seasons reveal that phosphorus levels significantly affected dry weight/ plant. The highest values were recorded for the high levels of P, while the lowest values were recorded for low P level. This effect of P may be due to its role in development and elongation of roots thus to use water more efficiently. These results are in harmony with those obtained by Reddy et al. (1997) who noticed that increasing P rate up to 60 kg/ha increased dry matter and seed yield of sunflower.

4.3. YIELD AND YIELD COMPONENTS

4.3.1. Head diameter:

Data of averages head diameter at harvest as affected by row width and phosphorus fertilizer levels in 2001and 2002 seasons are shown in Table 13 and Fig 9.

4.3.1.1. Effect of row width:

Results of 2001 season show that head diameter was not significantly affected by row width treatment and its averages were 21.7 and 21.0 cm for R1and R2, respectively. The narrow rows treatment (R1) showed slight superiority compared to wide rows (R2) with an increase of 3.2 % in head diameter.

With respect to 2002 season, results also indicate no significant differences between head diameter values due to different row width. Averages were 21.6 cm and 21.0 cm for R1 and R2 treatments, respectively. Again, the narrow rows treatment (R1) was slightly superior as compared with wide rows (R2) with an increase of 2.8 % in head diameter.

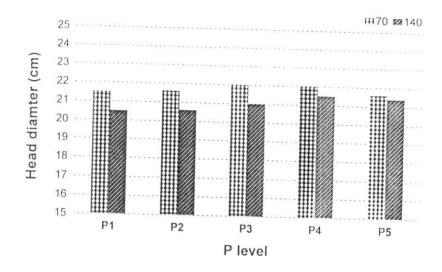
Regarding the results of both seasons, no significant differences were found between head diameter due to the effect of row width treatment. Slight increases, however were found with R1 as compared with R2. These results go along with those obtained by *Nour EL-Din et al. (1994) and Salib et al. (1998)* who planted sunflower in normal furrows and closed furrows

Table (13): Head diameter (cm) of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

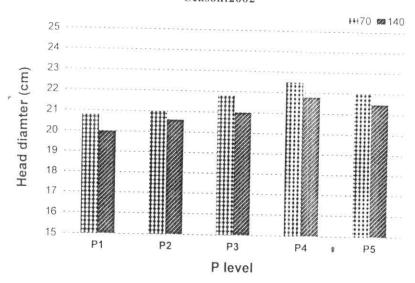
Season	2001			2002			
Treatment	Row width						
P (kg/ fed)	R1	R2	Av.	R1	R2	Λv.	
PI ,	21.5	20.5	21.0	20.8	20.0	20.4	
P2	21.6	20.6	21.1	21.0	20.6	20.8	
Р3	22.0	21.0	21.5	21.8	21.0	21.4	
P4	22.0	21.5	21.8	22.5	21.8	22.2	
P5	21.6	21.4	21.5	22.0	21.5	21.8	
Average	21.7	21.0	21.4	21.6	21.0	21.3	

L.S.D	5%	5%
RW	N.S	N.S
P	N.S	N.S
RW x P	N.S	N.S

Season: 2001



Season:2002



Fig(9): Head diameter (cm) of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels

and found that plant height and head diameters were higher with normal furrows irrigation.

4.31.2. Effect of phosphorus fertilizer levels:

Results of 2001 season show that head diameter was not significantly affected by P levels. The highest value of 21.8 cm was obtained with applying 11.38 kg P/fed, while the lowest value of 21.0 cm was obtained with applying 6.5 kg P/fed. The corresponding head diameter values in 2002 season were 22.0 and 20.4 cm for 11.38 and 6.50 kg P/ fed, respectively.

In both seasons, results reveal that increasing phosphorus levels up to P4 increased head diameter values but the increase did not reach the level of significancy. These results are in harmony with those of *Surendra et al (2003), Tomar et al (1999), Fagbayide et al (1998) and El-Ahmer et al (1990)* who found that application of 6.56 and 13.2 kg P/ fed, had no significant effect on head diameter in two successive seasons.

4.3.2. Head weight:

Average head weight values as affected by row width and phosphorus fertilizer levels in 2001 and 2002 seasons are shown in Table 14 and Fig. 10.

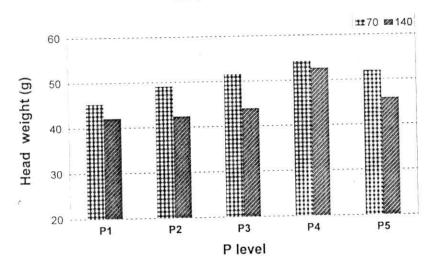
4.3.2.1. Effect of row width:

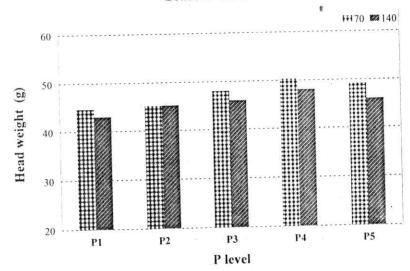
Results of 2001 season indicate that row width significantly affected head weight and averages were 50.1 and 45.7 g for R1 and R2 row width, respectively. The treatment of

Table (14): Head weight (g) of sunflower plant grown in 2001 and 2002 seasons as affected by row width and phosphorus levels

Season		2001			2001 2002		
Treatment		Row width					
P (kg/ fed)	R1	R2	Av.	R1	R2	Av.	
P1	45.3	42.1	43.7	44.6	43.0	43.8	
P2	49.1	42.4	45.8	45.1	45.2	45.2	
P3	51.5	44.0	47.8	48.0	46.0	47.0	
P4	54.1	52.6	53.4	50.3	48.1	49.2	
P5	51.9	46.0	49.0	49.2	46.0	47.6	
Average	50.1	45.7	47.9	47.4	45.7	46.6	

L.S.D	5%	5%
RW	4.1	N.S
P	3.1	2.9
RW x P	N.S	N.S





Fig(10): Head weight (g) of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus

R1 was superior as compared with R2 with an increase of 8.78 %.

In 2002 season, results show that averages were 47.4 and 45.7g for the same respective row width treatments. The treatment of R1 tended to be superior compared to R2 with an increase of 3.6 %.

In both seasons, results indicate that average head weight (g) was increased with R1 treatment compared to R2 treatment, but the increase was significant in 2001 season only. These results are in harmony with those obtained by Attia et al. (1990), El-Naggar (1991) and Khlil (1997).

4.3.2.2. Effect of phosphorus fertilizer levels:

In 2001 season, head weight was significantly affected by phosphorus levels. Averages were 43.7, 45.8, 47.8, 53.4, 49.0 (g) for P1, P2, P3, P4 and P5 respectively. The highest and lowest values 53.4 and 43.7 were obtained with applying P4 and P1 treatments respectively. Average head weight was significantly increased by 18.1 % due to the addition of P4 as compared with P1.

Averages of head weight in 2002 season show positive and significant effect of phosphorus levels. The maximum value of 49.2 (g) resulted from adding P4. The lowest one of 43.8 was obtained with P1. Average head weight was significantly increased by 11.0 % by adding P4 as compared with P1.

In both seasons, results show that phosphorus levels significantly affected head weight. The highest and lowest values were obtained with adding P4 and P1, respectively. This may be due to the important role of phosphorus fertilizer in meristematics activity, net photosynthesis rate which in turn increased the metabolizes translocation to the plant head. Adding to the effect of P in increasing all growth parameters, which led to increasing head weight. Similar results were found by *El-Kady* (1987) who found that increasing P fertilizer up to 6.5 P/ fed increased head diameter, seed yield/ plant, seed yield/ fed, oil percent and oil yield/ fed.

4.3.3. Seed weight/ head:

Averages of seed weight/ head as affected by row width and phosphorus fertilizer levels in 2001 and 2002 seasons are presented in Table 15 and illustrated in Fig 11.

A. Effect of row width:

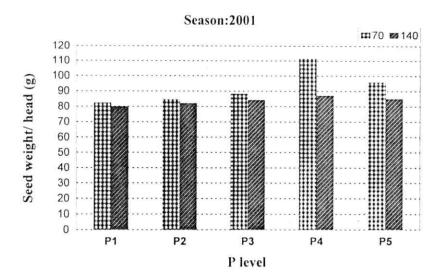
Results of 2001 season show that seed weight/ head was not significantly affected by row width. Averages were 93 g and 84 g for R1 and R2 row width, respectively. However the narrow rows treatment (R1) tended to be superior by 9.7 % compared to wide rows (R2).

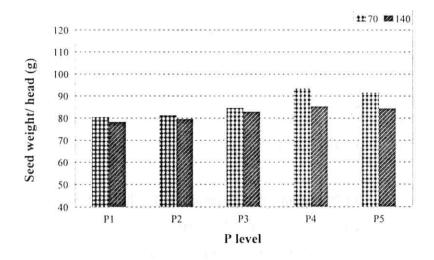
Also results of 2002 season show no significant differences between values of seed weight/ head due to different row width. Averages of seed weight/ head were 86 and 82 g for

Table (15): Seeds weight/ head (g) of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

Season		2001			2001 2002			
Treatment		Row w			width			
P (kg/ fed)	R1	R2	Av.	R1	R2	Av.		
PI	82.3	79.9	81.1	80.4	78.3	79.4		
P2	84.6	82.2	83.4	81.2	79.6	80.4		
Р3	88.3	84.3	86.3	84.6	82.9	83.8		
P4	111.5	87.2	99.4	93.3	85.3	89.3		
P5	95.9	85.2	90.6	91.5	84.4	88.0		
Average	93	84	88	86	82	84		

L.S.D	5%	5%
RW	N.S	N.S
P	N.S	N.S
RW x P	N.S	N.S





Fig(11): Seed weight/head of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels

R1 and R2 treatments, respectively. There was a tendency for the narrow rows treatment (R1) to be superior by 4.7 % compared to wide rows (R2).

In both seasons, results indicate that average value of seed weight/ head was slightly increased with the narrow rows treatment compared to that of wide rows treatment, but this increase was not significant. These results are in a good agreement with those obtained by Nour EL-Din et al (1994) and Khlil (1997).

4.3.3.2. Effect of phosphorus fertilizer levels:

In 2001 season, as recorded in Table15 data show that phosphorus levels did not significantly affect seed weigh/ head. The highest value of 99.4 g was obtained with applying 11.38 kg P/ fed (P4). The lowest value of 81.1 g was obtained with applying 6.5 kg P/fed (P1). Average seed weight/ head was increased by 18.41 % with addition of 11.38 kg P/fed as compared with 6.5 kg P/fed.

In 2002 season, phosphorus levels also did not significantly affect seed weight/ head. The maximum value of 89.3 g was resulted from adding P4, while the lowest one of 79.4 g was obtained with P1. Average seed weight/ head was increased by 11.1 % with adding P4 as compared with P1.

The results of two seasons reveal that increasing phosphorus levels increased seed weight/ head but this increase did not reach the level of significancy. The highest and lowest values were obtained by using P4 and P1, respectively. These results go along with those of *Tomar et al (1999)*, *Shivaprasad et al*, (1996) and El-Kady (1987), who found that increasing P fertilizer up to 6.5 P/ fed increased head diameter and seed yield/ plant.

4.3.4. Number of seeds/ plant:

Average number of seed /plant as affected by row width and phosphorus fertilizer levels in 2001and 2002 seasons is recorded in Table 16 and illustrated in Fig 12.

4.3.4.1. Effect of row width:

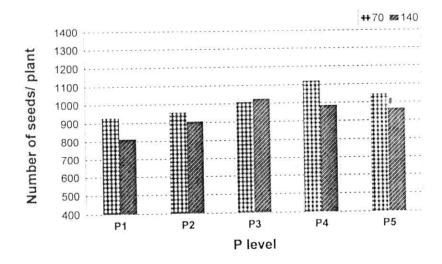
Results of 2001 season indicate that row width significantly affected the number of seeds/ plant and averages were 1012 and 939 seeds/ plant for R1 and R2, respectively. The narrow rows treatment (R1) was superior by 7.21 % compared to wide rows (R2).

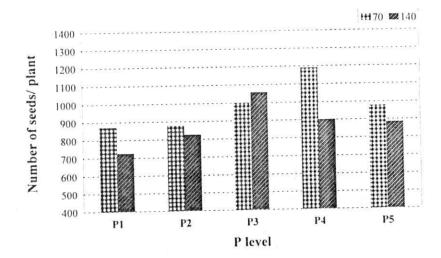
Similar to 2001 the results of 2002 season, indicated that row width significantly affected the number of seed/ plant. The average values were 983 and 879 seeds/ plant for the same respective row width treatments. The narrow rows treatment (R1) was superior by 10.6 % compared with wide rows (R2).

Table (16): Number of seeds/ plant of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

Season	2001			on 2001 2002			2002	
Treatment			Row	width				
P (kg/ fed)	R1	R2	Av.	R1	R2	Av.		
P1	929	814	872	871	726	796		
P2	955	906	931	876	826	851		
P3	1008	1025	1017	1001	1058	1030		
P4	1121	985	1053	1190	902	1046		
P5	1045	965	1005	978	885	931		
Average	1012	939	983	983	879	931		

L.S.D	5%	5%
RW	51.1	112.8
P	80.1	178.4
RW x P	N.S	N.S





Fig(12): Number of seed/plant of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

Regarding both seasons, results indicate that number of seeds /plant was significantly affected by row width treatment. The narrow rows treatment (R1) was superior compared to wide rows (R2). These results are in good agreement with those obtained by *Tomar et al. (1999)*, *Nour El-Din et al. (1994) and Vivek et al. (1994)* who revealed that increasing irrigation frequency from irrigation at 0.3 IW: CPE to irrigation at 0.9 IW: CPE significantly increased number of seeds/ head, filled seeds/ head and yield by 465.2 seed, 16.3 %, and 4.37q/ ha, respectively.

4.3.4.2. Effect of phosphorus fertilizer levels:

Average number of seeds/ plant in 2001 season as shown in Table 16 indicates that it was significantly affected by P levels. The highest value of 1053 seeds/ plant was resulted from adding P4 treatment. It was significantly increased by 17.18 % when compared with P1.

In 2002 season, phosphorus fertilizers significantly affected the number of seeds / plant. The highest value of number of seed/ plant 1046 seed/ plant was obtained from P4 treatment. High level of P (P4) significantly increased the number of seeds/ plant by about 23.9 % as compared to P1.

Results of both seasons, show that phosphorus fertilizer levels significantly affected the number of seeds/ plant. The highest and lowest values were obtained with P4 and P1

treatments, respectively. Similar results were found by *Tomar et al.* (1999) and Surendra et al. (2003).

4.3.5. 100- Seed weight (g):

Average 100-seed weight value (g) as affected by row width and phosphorus fertilizer levels in 2001 and 2002 seasons is listed in Table 17 and polluted in Fig.13.

4.3.5.1. Effect of row width:

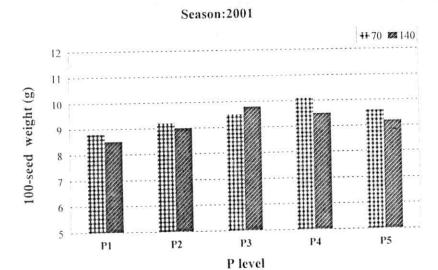
Results of 2001 and 2002 seasons show that 100- seed weight was not significantly affected by row width. Averages of 2001 season were 9.44 and 9.20 g for the narrow rows (R1) and wide rows (R2) treatments, respectively, while the corresponding values for 2002 season were 9.18 and 8.82 g for R1 and R2 treatments, respectively.

Results of both seasons indicate that average value of 100- seed weight was increased with the narrow rows treatment R1 compared to wide rows treatment R2, but this increase did not reach the level of significancy. These results are in harmony with those obtained by *Vannazzi et al.* (1988), Attia et al., (1990) and El-Naggar (1991), who pointed out that irrigating sunflower plants at 14 days intervals gave higher values of 1000-seed weight than those irrigated at 7 days or 21 days intervals. Using irrigation intervals to be comparable with row width depend on the quantity of water needed to irrigate narrow row (high level) and wide row (low level).

Table (17): 100 - Seed weight (g) of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels

Season	n 2001 2002		2001			
Treatment			Row	width		
P (kg/ fed)	R1	R2	Av.	R1	R2	Av.
P1	8.8	8.5	8.7	8.7	8.4	8.6
P2	9.2	9.0	9.1	9.2	9.0	9.1
Р3	9.5	9.8	9.7	9.3	9.1	9.2
P4	10.1	9.5	9.8	9.4	8.9	9.2
P5	9.6	9.2	9.4	9.3	8.7	9.0
Average	9.44	9.2	9.4	9.3	9.18	9.02

L.S.D	5%	5%
RW	N.S	N.S
P	N.S	N.S
RW x P	N.S	N.S



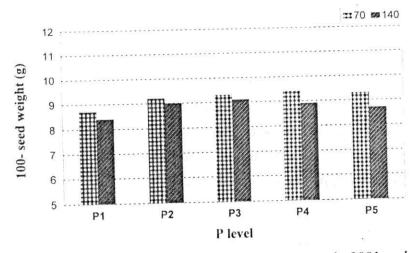


Fig (13): 100- seed wight (g) of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

4.3.5.2. Effect of phosphorus fertilizer levels:

In 2001 season, results reveal that phosphorus levels did not significantly affect 100- seed weight. In spite of the insignificancy, P4 treatment tended to yield the highest value (9.8 g) while, the lowest value (8.7 g) was obtained with P1 treatment. Average 100- seed weight was increased by 11.22 % with addition of P4, as compared with P1.

In 2002 season, phosphorus levels also did not significantly affect 100 - seed weight. The maximum value of 9.2 g was resulted by adding P3 or P4 treatment. The lowest one of 8.6 g was obtained by P1. The maximum value was increased by 6.52 % when compared with the minimum ones.

Results of both seasons indicate that increasing phosphorus levels increased 100 - seed weight values, but the increase was not significant. The highest and lowest values, however, were obtained by using P4 and P1, respectively. These results go along with those of Surendra et al (2003) and Nour El-Din et al. (1994) who found that 1000 -seed weight was unaffected by applying 15 or 30 kg P2O5/ fed.

4.3.6. Seed yield (kg/fed):

Averages seed yield (kg/ fed) as affected by row width and phosphorus fertilizer levels in 2001 and 2002 seasons are shown in Table 18 and illustrated in Fig.14.

4.3.6.1. Effect of row width:

Results of 2001 season, show that seed yield was significantly affected by row width treatment and averages of 1177 and 1025 kg/ fed were recorded for R1 and R2 row width, respectively. The seed yield/ fed in narrow rows treatment (R1) increased by 12.91 % as compared with wide rows (R2).

On the other hand, results of 2002 season failed to show significant differences between seed yield/ fed due to different row width and the obtained averages were 1041 and 1010 kg/ fed for the narrow rows (R1) and wide rows (R2) treatments, respectively. The narrow rows treatment (R1) showed slight increase (2.97 %) over wide rows (R2).

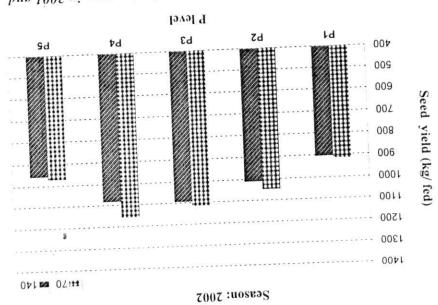
In both seasons, results indicate that row width positively affected seed weight/ fed. In the first season, the treatment R1 was superior to R2. It could be concluded that seed yield/ fed was increased with increasing available water to sunflower plant grown in narrow rows as the plants received more quantity of water from large wet area compared to wide rows. Available water affects vegetative growth of plants, head weight, seed number and weight/ plant and 100-seed weight as well as enhancing the translocation of metabolites to the head during flowering, seed formation and seed filling periods. In this connection, *Doorendos et al.* (1979) indicted that the flowering period is most sensitive to water deficits which cause considerable yield decrease as fewer flowers come to full development. Also, the results obtained are in good agreement

Table (18): Seed yield (kg/ fed) of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

Season		2001			2002		
Treatment			Row	width			
P (kg/ fed)	R1	R2	Av.	R1	R2	Av.	
P1	1039	933	986	914	904	909	
P2	1143	1036	1090	1048	1010	1029	
Р3	1210	1119	1165	1115	1094	1104	
P4	1302	1060	1181	1157	1083	1120	
P5	1193	977	1085	970	956	963	
Average	1177	1025	1101	1041	1010	1025	

L.S.D	5%	5%
RW	66	N.S
P	105	288
RW x P	N.S	N.S

Fig(14): Seed yield (Kg/ Jed) of sunflower plants grown in 2001 and 2002.



P level ld Ъ ЬЗ td Ьę 400 009 Seed yield (kg/fed) 009 004 008 006 1000 1500 011 07 FF

Season: 2001

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with those found by Gaafar and El-Wakil (1986), El-Naggar (1991), Nour El-Din et al. (1994), Sarakr et al. (1997) and Velu and Palanisami (2001).

4.3.6.2. Effect of phosphorus fertilizer levels:

Results of 2001 season indicated that increasing phosphorus levels significantly increased seed yield. The highest value of 1181 kg / fed was obtained with applying P4 while the lowest value of 986 kg / fed was obtained with applying P1. Average seed yield was significantly increased by 16.51 % with addition of 11.38 kg P/fed (P4) compared with 6.5 kg P /fed.

Data of seed weight in 2002 season, as shown in Table 19 indicate that, seed yield was significantly affected by phosphorus levels. The maximum value of 1120 kg / fed resulted from adding P4 treatment. The lowest one of 909 kg / fed obtained by adding P1. The increases in average seed yield for P4 reached to 18.84 % as compared to P1.

Regarding results of both seasons data reveal that phosphorus levels significantly affected seed weight/ fed. The highest and lowest values were obtained by using 11.38 and 6.5 kg P/fed, respectively. These results may be due to the role of P in improving blooming and increased seed production such as seed numbers, viability and seed size, in addition to its effect in water and nutrient absorption by roots which due to increased total yield.

These results are in the same line with those obtained by Surendra et al (2003), Dhoble (1998) and Sathiyavelu et al. (1994) who found that increasing application rate of P from 20 to $60 \text{ kg P}_2\text{O}_5$ / ha increased mean seed yield of sunflower plant.

4.3.6.3. Effect of interactions:

No significant interactions were found between row width and phosphorus fertilizer levels in 2001 and 2002 seasons. Results show that planting sunflower crop in narrow rows (R1) with increasing P levels up to 11.38 kg/fed (P4) gave the highest seed weight / fed values of 1302 and 1157 kg / fed in 2001 and 2002 seasons respectively. While the minimum values were 933 and 904 kg /fed in 2001 and 2002 seasons respectively, resulted from planting sunflower in wide rows (R2) with applying 6.5 kg P/fed (P1).

4.3.7. Biological yield (kg/ fed):

Data of biological yield (kg/ fed) as affected by row width and phosphorus fertilizer levels in 2001 and 2002 seasons are shown in Table 19 and illustrated in Fig.15.

4.3.7.1 . Effect of row width:

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Results of 2001 season show that biological yield kg/ fed was significantly affected by row width treatments and averages were 4397 and 3814 kg / fed for R1 and R2 row width, respectively. The narrow rows treatment (R1) was superior

compared to the wide rows (R2) with an increase of about 13.26%

Also, results of 2002 season show that row width significantly affected the biological weight kg/ fed and the obtained averages were 4089 and 3647 kg / fed for R1 and R2 treatments, respectively. Again, the narrow rows treatment (R1) was superior by 10.81 % compared to wide rows (R2).

Regarding both seasons, results indicate that biological yield kg/ fed was significantly affected by row width treatment. The treatment of R1 showed a good superiority over R2. These results are in a good agreement with those obtained by *Vęlu and Palanisami* (2001) and *Khade et al* (1989).

4.3.7.2. Effect of phosphorus fertilizer levels:

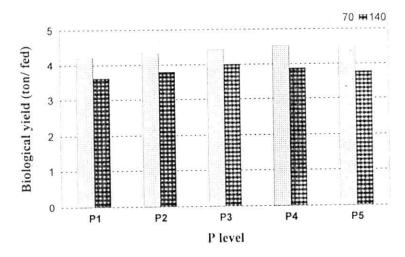
In 2001 season, the results indicate that phosphorus levels significantly affected the biological yield. The highest value (4213 kg / fed) was obtained with applying P3 treatment, while the lowest value (3913 kg / fed) was obtained with applying P1 treatment. Average biological yield was significantly increased by 7.12 % with addition of 9.75 kg P/fed as compared with 6.5 kg P/fed

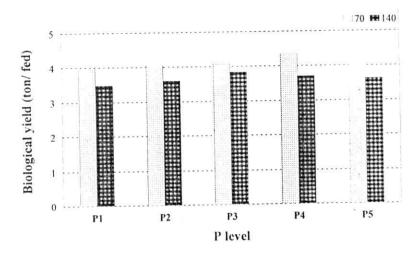
Average biological yield in 2002 season show that, it was significantly affected by phosphorus levels. The maximum value (4025 kg / fed) being obtained from adding P4 treatment .The

Table (19): Biological weight (kg/ fed) of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

Seasons	2001			2002		
Treatment	Row width					
P (kg/ fed)	R1	R2	Av.	RI	R2	Av.
P1	4200	3625	3913	3950	3480	3715
P2	4325	3795	4060	4050	3595	3823
Р3	4425	4001	4213	4070	3835	3953
P4	4520	3875	4198	4350	3700	4025
P5	4515	3775	4145	4025	3625	3825
Average	4397	3814	4106	4089	3647	3868

L.S.D	5%	5%
RW	144	112
P	277	177
RW x P	N.S	N.S





Fig(15):Biological yield of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

lowest one (3715 kg / fed) was obtained by P1 treatment. compared with P1 treatment. Biological yield was significantly increased by 7.70 % with adding P4 treatment as compared with P1 treatment.

Respecting, both seasons, resultes reveal that phosphorus levels significantly affected the biological yield (kg/fed). The highest values were obtained with using P3 (in the first season) and P4 (in the second season). The lowest one was recorded for P1 in both seasons. This results may be due to phosphorus compounds play a major role in the formations of sugar nucleatides, such as ATP, which have an intimate role in storeing and transfering energy in all part of plant as well as increaseing all biological reactions sutch as photosynthesis. These results are in the same line of those obtained by *Surendra et al.* (2003) who reported that biological yield was increased with increasing P rates.

4.4. CHEMICL ANALYSIS

4.4.1. Seed oil percentage:

Average values of oil percentage in sunflower seeds as affected by row width, phosphorus fertilizer levels and their interaction in 2001 and 2002 seasons are recorded in Table 20 and shown in Fig. 16.

4.4.1.1. Effect of row width:

Results of 2001 season indicate that row width did not significantly affect seed oil percentage and the obtained averages were 45.3 and 44.5 for R1 and R2, respectively.

The results of 2002 season show no significant differences between seed oil percentages due to row width treatment and the averages were 44.8 and 44.5 for the same respective row width treatment.

In both seasons, results indicate that seed oil percentage was increased with R1 treatment compared to R2 treatment, but the increase did not reach the level of significancy. However, it can be mentioned that decreasing available soil moisture in the root zone with using the wide rows tended to decrease seed oil content. These results may be due the effect of water deficits on decreasing the translocation of metabolites in plants as well as reducing in sugar transformation into fatty acids during seed development and this in turn caused a decrease in oil percentage. These results are in good agreement with those obtained by

Singh et al. (1995), Tomar et al. (1996b), Khlil (1997) and Salib et al. (1998) who found that normal furrows irrigation increased oil content of sunflower by 0.7 and 0.8% compared to closed furrows irrigation.

4.4.1.2. Effect of P levels:

Average values in 2001 season as listed in Table 20 indicate no significant effect of P levels on oil percentage. Averages were 44.2, 44.7, 45.0, 45.8 and 44.9 for P1, P2, P3, P4 and P5, respectively. The highest value (45.8) was resulted from using P4 treatment. Oil percentage was increased by 3.49 % with using P4 level as compared with P1 treatment.

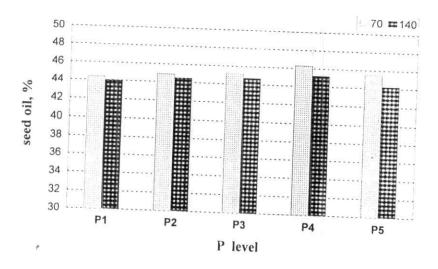
In 2002 season, however phosphorus fertilizers significantly and positively affected seed oil percentage. The highest value (45.15 %) obtained from adding P4 treatment, while the lowest value (43.90 %) resulted from adding P1 treatment.

Regarding the results of both season, data show that increasing P levels up to P4 (11.38 kg P/ fed) tended to produce high value of oil %. Similar results were found by *El-Kady* (1987), *Hiremath et al.* (1991) and Fagbayide et al. (1998) who stated that in Nigeria, when sunflower plants were given 0-100 kg P/ ha as super phosphate seed oil content was increased by 40 kg P/ ha.

Table (20): Oil percentage in seeds of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

Season		2001			2002	
Treatment			Row	width		
P kg/ fed	R1	R2	Av.	RI	R2	Av.
P1	44.40	44.00	44.20	44.18	43.62	43.90
P2	44.90	44.50	44.70	44.41	44.07	44.24
P3	45.20	44.70	44.95	44.84 44.69	44.69	44.77
P4	46.30	45.20	45.75	45.59	45.32	45.46
P5	45.50	44.20	44.85	45.00	44.57	44.79
Average	45.26	44.52	44.89	44.80	44.46	44.63

L.S.D	5%	5%
RW	N.S	N.S
P	N.S	1.15
RW x P	N.S	N.S



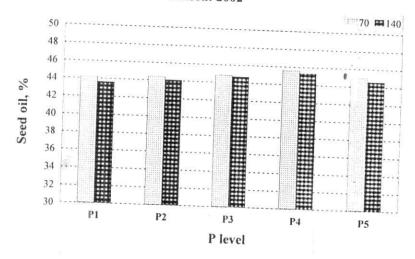


Fig (16): Seed oil percentage in seeds of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

4.4.1.3. Effect of interaction:

No significant interaction was found between row width and phosphorus levels with respect to the percentage of oil. A favorable effect of increasing phosphorus levels, however, occurred with R1. Also, the effect of P levels was not significant when plants were planted in R2. Maximum oil % values of 46.30 % and 45.59 were obtained for R1 and P4 in 2001 and 2002 seasons, respectively, while minimum oil % of 44.00 % and 43.90 were obtained for R2 and P1 in 2001 and 2002 seasons, respectively.

4.4.2. Nitrogen percentage in seeds:

Average nitrogen percentages in sunflower seeds as affected by row width, phosphorus fertilizer levels and their interaction in 2001 and 2002 seasons are shown in Table 21 and illustrated in Fig. 16.

4.4.2.1. Effect of row width:

In 2001 season nitrogen percentage was not significantly affected by row width and the averages of N % were 2.69 and 2.85 for R1 and R2, respectively. Oposite to the trends obtained with the formerly mentioned parameters, nitrogen content tended to be superior in plants of R2 as compared with those of R1 treatment.

Also, in 2002 season no significant differences were found between nitrogen percentage values due to row width treatment and averages of N % were 2.97 and 3.20 % for the same respective row width treatments, wide row treatment

accompanied with 7.18 % increase of N content as compared with R1.

In both seasons, results indicate that N percentage in seeds was slightly increased with R2 treatment compared to R1 treatment, but this increase didn't reach the significancy level. It could be mentioned that decreasing available soil moisture in the root zone (R2 situation) resulted in increasing N percentage in seeds. This tendency could be due to the limited plant growth under the R2 conditions.

4.4.2.2. Effect of P levels:

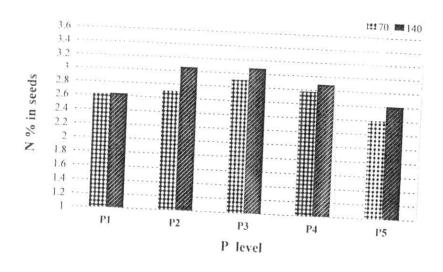
Results of nitrogen percentages in 2001 season indicate that, nitrogen content was significantly affected by P levels and the averages of N content were 2.57, 2.88, 2.99, 2.83 and 2.59 % for P1, P2, P3, P4 and P5, respectively. The highest value (2.99) was resulted from adding P3 treatment. Nitrogen percentage in seeds was increased by 3.01 % with using P3 treatment as compared with using P1 treatment.

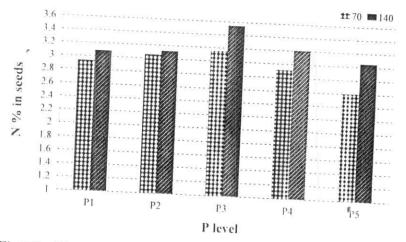
In 2002 season, results show that increasing P levels, also, significantly increased seed N percentage and the averages were 2.94, 3.09, 3.35, 3.06, and 2.99 % for the same respective P levels. The highest value was 3.35 % resulted from P3 treatment, while the lowest value was 2.94 % resulted from P1 treatment. The difference between the highest and lowest value was about 12.24 %.

Table (21): Nitrogen percentage in seeds of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosophorus levels

Season		2001			2002	
Treatment			Row	width		
P (kg/ fed)	R1	R2	Av.	R1	R2	Av.
ė1	2.510	2.620	2.571	2.802	3.085	2.944
P2	2.698	3.059	2.879	3.056	3.116	3.086
Р3	2.902	3.083	2.992	3.149	3.543	3.346
P4	2.775	2.883	2.829	2.912	3.209	3.060
P5	2.554	2.630	2.582	2.932	3.049	2.991
Average	2.680	2.853	2.771	2.930	3.200	3.085

L.S.D	5%	5%
RW	N.S	N.S
ř.	0.315	0.303
RW x P	N.S	N.S





Fig(17): Nitrogen percentage in seeds of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

Regarding both seasons, results show that increasing P levels up to P3 produced the highest values of N % in both growing seasons for sunflower plants grown under Giza region condition. This may be due to the important role of phosphorus fertilizer in cell division and elongation of roots and its effect on nutrient uptake. Similar results were found by *Hiremath et al.* (1991) and Susheel et al. (1995) who noticed that increasing phosphorus fertilizer levels up to 60 or 90 kg P₂O₅\ ha increased N and P uptake compared with 0 or 30 kg P₂O₅/ ha.

4.4.2.3. Effect of interaction:

No significant interaction was found between row width and P levels in 2001 and 2002 seasons. However, Results indicate a favorable effect of increasing P levels under R2 treatment. Slightly higher N percentages (3.08 and 3.54 %) were obtained with R2 P3 in 2001 and 2002 seasons, respectively, while the lowest N percentage (2.62 and 2.80 %) were recorded for R1x P1 in 2001 and 2002 seasons, respectively.

4.4. 3. Phosphorus percentage in seeds:

Data of average phosphorus percentages as affected by row width, posphorus fertilizer levels and their interactions in 2001 and 2002 seasons are shown in Table 22 and Fig. 18.

4.4.3.1. Effect of row width:

Results of 2001 season show that no significant differences were found between values of P % due to the different row width

and averages of P content were 0.253 and 0.250 for the R1 and R2 treatments, respectively.

With respect to 2002 season, results indicate that P % also, was not significantly affected by row width and the averages were 0.251 and 0.245 for the same respective row width treatments.

In both seasons, results indicated that R1 treatment was slightly superior in increasing P content in sunflower plants than was R2 treatment, but this increase didn't reach the significant level.

4.4.3.2. Effect of P levels:

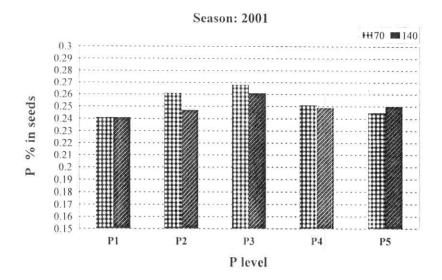
Data of 2001 season indicate that P content was not significantly affected by P levels. The highest value (0.265) was resulted form P3 treatment. Increasing in P % reached about 9.05 % when P3 treatment was used as compared with P1 treatment.

In 2002 season, results showed the same trend of 2001 season. The average values were 0.238, 0.250, 0.261, 0.251 and 0.243 % were obtained with adding P1, P2, P3, P4 and P5, , respectively. An increase in P % by (8.81 %) was achieved when P3 treatment was used over the treatment of P1.

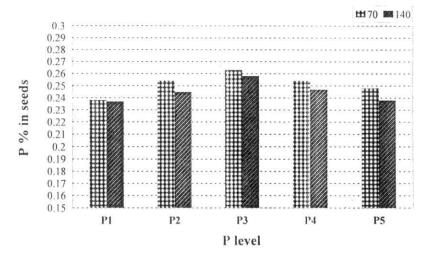
Table (22): Phosphorus percentage in seeds of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

Season		2001			2002	
Treatment		p or re	Row	width		
P (kg/ fed)	R1	R2	Av.	R1	R2	Av.
P1	0.241	0.241	0.241	0.238	0.237	0.238
P2	0.261	0.247	0.254	0.254	0.245	0.250
Р3	0.268	0.261	0.265	0.263	0.258	0.261
P4	0.251	0.249	0.250	0.254	0.247	0.251
P5	0.245	0.250	0.248	0.248	0.238	0.243
Average	0.253	0.250	0.251	0.251	0.245	0.248

L.S.D	5%	5%
RW	N.S	N.S
P	N.S	N.S
RW x P	N.S	N.S







Fig(18): Phosphorus percentage in seeds of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

In both seasons, results show that phosphorus fertilizer levels had no significant effect on P % in sunflower seeds. But increasing P levels up to P3 tended to increase P % in seeds. This is concluding that varying the level of P supply to the plant has relatively little effect on the total P concentration in the seeds. These results agree well with those obtained by *Susheel et al.* (1995) who noticed that application of 60 or 90 kg P₂O₅/ ha increased N and P uptake.

4.4.4. Potassium percentage in seeds:

Values of potassium percentage in seeds as affected by row width, phosphorus fertilizer levels and their interactions in 2001 and 2002 seasons are shown in Table 23 and illustrated in Fig.19.

4.4.4.1. Effect of row width:

Results of 2001 season indicate that K % was not significantly affected by row width treatments. The averages were 0.691 and 0.659 % for R1 and R2 treatments, respectively. The treatment of R1 tended to be superior to R2 treatment.

In 2002 season, a trend similar to that of 2001 season was found as there is no significant effect of row width treatment. The highest value of 0.684 was obtained with R1 treatment, while the lowest value of 0.650 was obtained with R2 treatment. The difference between R1 and R2 reached about 4.97 %.

In both seasons results reveal no significant effect was obtained due to row width treatments. This result is in agreement with that obtained by *Tomar et al (1996a)*.

4.4.4.2. Effect of phosphorus fertilizer levels:

In 2001 season, the K percentage was significantly affected by phosphorus levels. The highest value (0.731 %) was obtained with applying P4 and the lowest value (0.600 %) was obtained with applying P1. The percentage of K was increased by 11.90 % with P4 as compared to P1.

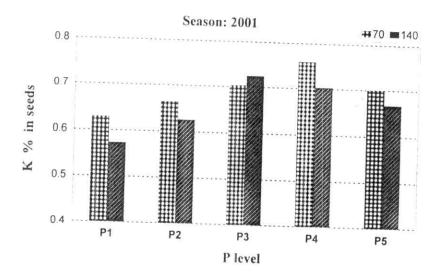
Results of 2002 season also, indicate that, K content in seeds was significantly affected by phosphorus levels. Averages K% were 0.594, 0.638, 0.704, 0.724 and 0.674 for P1, P2, P3, P4 and P5, respectively. Increasing K % by 17.95 % over that of P1 treatment was noticed with applying P4 treatment.

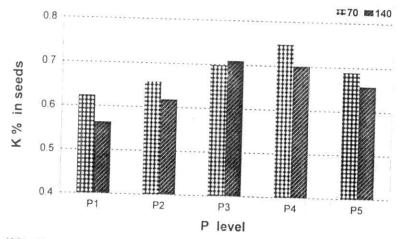
With respect the both seasons, results revealed that K % was significantly increased with increasing P levels. The highest values were recorded for P4 treatment while the lowest ones resulted from P1 treatment. These results are in the same line with those obtained by Fagbayide et al(1998) who studied the effect of application of (0, 20, 40, 60, 80, or 100 kg P/ ha.) on sunflower plant and found that uptake of N, P, K, Ca, and Mg were generally increased with increasing P rate.

Table (24): Potassium percentage in seeds of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

Season		2001			2002	
Treatment			Row w	ridth		
P (kg/ fed)	R1	R2	Av.	R1	R2	Av.
P1	0.628	0.573	0.600	0.624	0.564	0.594
P2	0.663	0.625	0.644	0.658	0.618	0.638
P3	0.703	0.725	0.714	0.699	0.709	0.704
P4	0.760	0.703	0.731	0.748	0.701	0.725
P5	0.700	0.667	0.683	0.689	0.658	0.674
Average	0.691	0.659	0.675	0.684	0.650	0.667

L.S.D	5%	5%
RW	N.S	N.S
P	0.1	0.101
RW x P	N.S	N.S





Fig(19): Potassium percentage in seeds of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

4.4.5. Protein percentage in seeds:

Protein percentages in seeds as affected by row width and phosphorus fertilizer levels in 2001 and 2002 seasons are presented in Table 25 and polluted in Fig. 20.

4.4.5.1. Effect of row width:

Results of 2001 season reveal that Protein percentage in seeds was not significantly affected by row width treatment. Averages were 16.75 and 17.83 % for R1 and R2 row width, respectively. The wide rows (R2) however, tended to be superior to narrow rows treatment (R1) with no significant difference.

Concerning 2002 season results show no significant differences between protein percentages in seeds due to different row width. Averages were 18.31 and 20.00 % for the narrow rows (R1) and wide rows (R2) treatments, respectively. Again the wide rows (R2) were superior to narrow rows (R1) treatment.

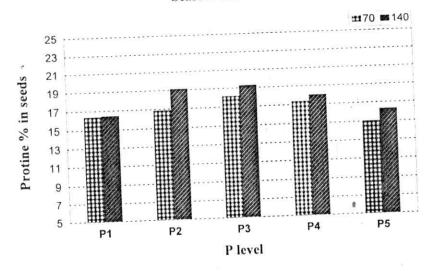
In both seasons, results indicate that protein percentage in seeds was increased with R2 treatment compared to R1 treatment, but this increase was not significant. It could be mentioned that decreasing available soil moisture in the root zone (R2 situation) led to an increase in seed protein percentage. These results are in a good agreement with those obtained by *Tomar et al (1996b)* who found that protein content decreased with higher levels of irrigation.

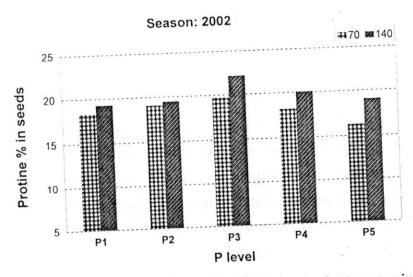
Table (25): Protein percentage in seeds of sunflower plants grown in 2001 and 2002 seasons as affected by row width and phosphorus levels.

Season		2001			2002	
Treatment			Row	width		
P (kg/ fed)	70	140	Av.	70	140	Av.
P1	15.03	16.31	15.67	16.26	19.06	17.66
P2	16.86	19.12	17.99	19.10	19.47	19.29
Р3	18.13	19.27	18.70	19.68	22.14	20.91
P4	17.34	18.02	17.68	18.20	20.06	19.13
P5	16.37	16.45	16.41	18.32	19.28	18.80
Average	16.75	17.83	17.29	18.31	20.00	19.16

RW x P	N.S	N.S
P	1.73	1.87
RW	N.S	N.S
L.S.D	5%	5%







Fig(20): Protine percentage in seeds of sunflower plants grown in 2001 ans 2002 seasons as affected by row width and phosphorus levels.

4.4.5.2. Effect of P levels:

Date of average protein percentage in seeds of plants grown in 2001 season (Table 25) indicate that protein % was significantly affected by P levels and the averages were 15.67, 17.99, 18.70, 17.68 and 16.41 % for P1, P2, P3, P4 and P5, , respectively. The highest value (18.70) was recorded from using P3 treatment. Increasing Protein % with the high level of P (P3) reached to about 16.20 % compared whit P1 treatment.

In 2002 season, phosphorus levels significantly affected protein %. Increasing P levels increased protein % and the averages were 17.66, 19.29, 20.91, 19.13 and 18.8 % for the same respective P levels. The highest value of 20.91 % was accompanied with P3 treatment, while the lowest value of 17.66 % was resulted from P1 treatment. Difference between the highest and the lowest values was 15.5 %.

In both seasons, results show that increasing P levels up to (9.75 kg P/fed) P3 produced the highest values of Protein % in both seasons. Such effect of P could be due to its vital role played in forming amino acids and phospho-protein in cells, which may led to an increase in Protein %. Similar results were found by *Hiremath et al (1991)*, *Susheel et al. (1995) and Tomar et al. (1996b)* who noticed that increasing phosphorus fertilizer levels up to 80 kg P₂O₅/ ha improved protein content in seeds by 8% over no P application.

4.4.6. Fatty Acid Composition of sunflower oil.

Fatty acids composition as affected by row width and phosphorus fertilizer levels in 2001 and 2002 seasons are recorded in Table 26 and Fig 20.

4.4.6.1. Effect of row width:

Results in Table 26 show no clear differences between fatty acid composition values due to row width treatment. The major fatty acid oleic and linoleic in 2001 were 45.95, 45.94 and 41.43 for R1 and R2 respectively. Corresponding values in 2002 season were 45.90, 45.91 and 41.45 for R1 and R2.

4.4.6.2. Effect of P levels:

Results in Table 26 show that P followed similar trend to that of row width. The major fatty acid oleic and linoleic varied from 45.89 to 45.96 % and from 41.42 to 41.46 as maximum and minimum values in tow season. Followed palmitic acid 6.77-6.82 and stearic acid 4.41 – 4.44%. arachidic, linoleic and behenic acids were detected as a minor fatty acids. Total saturated fatty acids ranged from 12.13 to 12.23 and total unsaturated fatty acids ranged from 87.78 to 87.86.

Generally, it could be observed that neither row width treatment nor phosphorus levels affected fatty acid composition of sunflower oil.

Table (27): Fatty acids composition as affected by row width and phosphorus fertilizer levels in 2001 and 2002 seasons.

Season	Row	P- levels	30	_	Fatty a	Fatty acids composition %	osition %					-
	WIGIN		C16:0	C _{18.0}	C ₁₈₁	C13.2	C183	C200	C,, 0	SI	Ē	TILTE
		PI	6.77	4 47	45.04	5		-	2		2	-
		60	200	1 (10.01	74.74	0.40	0.20	0.74	12.13	87.81	7.24
	D	1 6	0.77	4.0.2	45.94	41.43	0.45	0.21	0.76	12.16	87.87	,
	141	2. 1	6.79	4.44	45.95	41.43	0.46	0.21	0.76	12.20	010	100
		P4	6.81	4.43	45.96	41 44	CAR		0,10	07.70	10.70	,
		P5	6.80	4.42	45.95	41 43	0 0	0.21	0.70	12.2]	87.86	7.20
100							0.40	0.20	0.74	12.16	87.83	7.2
50		P1	6.78	4.42	45 94	41.43		0	1			
		P.2	6 70	4 47	20.56	71.7	7.7	0.70	0.74	12.14	87.80	7.7
	R	P	10 9	1 * *	10.72	71.11	0.46	0.22	0.75	12.18	87.84	7.2
		PA	0.07	† ;	45.95	41.44	0.46	0.22	0.76	12.23	87.85	7
		50	0.0	4.44	45.93	41.44	0.45	0.21	0.76	12.72	87.83	7.1
		CJ	0.80	4.43	45.93	41.43	0.45	0.21	0.74	12.13	87.81	7.17
		Pl	6.80	4.42								!
		P2	20.0	1 7	16.04	† † †	0.45	0.20	0.74	12.16	87.80	7.2
	R	D 2	10.0	7 :	16.04	41.45	0.45	0.22	0.74	12.21	87.81	7
		2 6	28.0	4.44	45.90	41.46	0.47	0.22	0.75	12.23	87.83	
		T :	0.80	4.43	45.90	41.45	0.47	000	0.75	12.20	0.00	
1		PS	6.80	4.42	45.89	41.43	770		0.7.5	07.71	28.18	7.7(
200							0.40	0.21	0.75	12.16	87.78	7.22
JZ			6.81	4 47	45.01	24.14			()			
		_	003	1 (10.01	7	0.45	0.21	0.74	12.18	87.81	771
	R2	1 20	70.0	75.5	45.92	41.46	0.45	0.21	0.75	12.20	87.83	7 20
	!	_	0.82	4.43	45.92	416	0.45	0.21	0.75	1221	67.03	21.7
_		_	08.9	4.43	45.92	41.44	0 46	100	77.0		00.70	7.17
-			6.80	4 41	45.00	5 17			t / .0	12.18	28.18	7.21
Whore				11	10.70	- -	1	000	1			

TS= Total Saturated Acids
TU= Total Unsaturated Acids