

**IMPACT OF INTEGRATION OF CROP MANURING AND
NITROGEN APPLICATION ON GROWTH, YIELD AND
QUALITY OF SPRING PLANTED SUNFLOWER
(*HELIANTHUS ANNUUS* L.)**

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Abstract

Studies were carried out during 2004 and 2005 to assess the comparative productivity of sunflower to integration of crop manuring and nitrogen application. Integration of organic and inorganic fertilizers comprised of treatments control (no fertilizer), farm yard manure at 20 t ha⁻¹, poultry manure at 8 t ha⁻¹, 100-75-50 NPK kg ha⁻¹, farm yard manure (20 t ha⁻¹) + 25-75-50 NPK kg ha⁻¹, farm yard manure (20 t ha⁻¹) + 50-75-50 NPK kg ha⁻¹, farm yard manure (20 t ha⁻¹) + 75-75-50 NPK kg ha⁻¹, farm yard manure (20 t ha⁻¹) + 100-75-50 NPK kg ha⁻¹, poultry manure (8 t ha⁻¹) + 25-75-50 NPK kg ha⁻¹, poultry manure (8 t ha⁻¹) + 50-75-50 NPK kg ha⁻¹, poultry manure (8 t ha⁻¹) + 75-75-50 NPK kg ha⁻¹ and poultry manure (8 t ha⁻¹) + 100-75-50 NPK kg ha⁻¹. Maximum achene yields of 2895 kg ha⁻¹ and 2792 kg ha⁻¹ were obtained with the treatment of 50-75-50 NPK kg ha⁻¹ + PM at 8 t ha⁻¹ during both years, respectively. Inorganic fertilizers 100-75-50 NPK kg ha⁻¹ produced relatively more achene yield than organic manures (FYM at 20 t ha⁻¹ and PM at 8 t ha⁻¹) and poultry manure gave higher yield than farm yard manure. The mean crop growth rate of 28.92 and 27.90 g m⁻² day⁻¹ and mean net assimilation rate of 9.75 and 9.51 g m⁻² day⁻¹ gave significantly highest values in the same treatment having positive correlation with achene yield. All the quality traits were significantly affected by the various combinations of organic and inorganic fertilizers.

Introduction

Pakistan is facing a severe shortage of edible oil because its domestic production is far below the demand. Consequently, a huge amount of foreign exchange is spent on oil import, which is increasing every year. Total availability of edible oils during 2004-05 was 2.764 million tons, where local production stood at 0.857 million tons which accounted for 31% of the total availability, while the remaining 69% was made available through imports. Sunflower is an important oilseed crop and adopted to agro-ecological conditions of Pakistan. In Pakistan sunflower was grown on an area of 315.66 thousand hectares with total production of 569 thousand tons with an average yield of 1802.57 kg ha⁻¹ (Anon., 2006). The potential of any variety can only be fully exploited by the judicious use of inputs at proper growth stages. Post-green revolution period has seen a tremendous rise in use of fertilizers for enhancing productivity of field crops. This has resulted in the deterioration of land resources on one hand and contaminating the environment on the other along with raising the cost of production.

Agricultural scientists are engaged to establish agricultural systems with lower production cost and conserving the natural resources. Therefore, recent interest in the manuring has re-emerged because of high fertilizer prices and importance of green manure, farm yard manure and poultry manure in maintaining long term soil productivity besides meeting timely requirement of nutrient. There is also a positive interaction

between the organic manures and urea as nitrogen source (Bocchi & Tano, 1994). Sunflower hybrid gave a higher yield from a combination of organic manures with nitrogen and phosphorus (Dayal & Agarwal, 1998). The highest seed and stalk yield was recorded in sunflower with the application of poultry manure as compared to other organic manures (Vanaja & Raju, 2003). Keeping this in view, the present study was undertaken to evaluate the performance of spring planted hybrid sunflower by the integrated use of organic and inorganic fertilizers, under agro-ecological conditions of Faisalabad, Pakistan.

Materials and Methods

Studies were conducted for two consecutive years of 2004 and 2005 at the research area of Agronomy Department, University of Agriculture, Faisalabad Pakistan on a sandy clay loam soil having an average of 0.029% N, 7.85 ppm P₂O₅ and 152 ppm K₂O. The experiment comprised of 12 treatments; control (no fertilizer), farm yard manure at 20 t ha⁻¹, poultry manure at 8 t ha⁻¹, 100-75-50 NPK kg ha⁻¹, farm yard manure (20 t ha⁻¹) + 25-75-50 NPK kg ha⁻¹, farm yard manure (20 t ha⁻¹) + 50-75-50 NPK kg ha⁻¹, farm yard manure (20 t ha⁻¹) + 75-75-50 NPK kg ha⁻¹, farm yard manure (20 t ha⁻¹) + 100-75-50 NPK kg ha⁻¹, poultry manure (8 t ha⁻¹) + 25-75-50 NPK kg ha⁻¹, poultry manure (8 t ha⁻¹) + 50-75-50 NPK kg ha⁻¹, poultry manure (8 t ha⁻¹) + 75-75-50 NPK kg ha⁻¹ and poultry manure (8 t ha⁻¹) + 100-75-50 NPK kg ha⁻¹. The experiment was laid out in a randomized complete block design having 4 replications. Net plot size was 4.5 m x 7 m. All the FYM, PM and PK were applied in plots at sowing as per treatment. Nitrogen was applied in plots as per treatments in two splits; ½ N at first irrigation and ½ N at flowering stage. Urea, single super phosphate and potassium sulphate were used as sources of inorganic (NPK) fertilizers. Sunflower (Hysun - 33) was sown during February in the pattern of 75 cm apart single rows with the help of dibbler and a seed rate of 6 kg ha⁻¹ keeping plant to plant distance of 25 cm. Two seeds per hill were placed. One plant per hill was maintained at 2-4 leaf stage of the crop. The first irrigation was applied 30 days after sowing and afterwards the crop was irrigated at a regular interval of 15 days. The crop exhibited no sign of insect/pest attack and disease incidence, therefore no protection measures were adopted. Crop was kept free of weeds by providing interculture and hand hoeing. Crop was harvested manually in last week of May, 2004 and 2005. Harvested crops were sundried and threshed manually. The achene and biological yields were recorded on plot basis and then converted to Kg ha⁻¹. The dry weight per plant was calculated and used to estimate crop growth rate (CGR) as proposed by Hunt (1978).

$$\text{CGR} = \frac{w_2 - w_1}{t_2 - t_1} \quad (\text{g m}^{-2} \text{ day}^{-1})$$

where w_1 and w_2 are dry weights (g m⁻²) at first and second harvests taken at times t_1 and t_2 , respectively.

Net assimilation rate (NAR) was determined by using the formula given by Hunt (1978).

$$\text{NAR} = \frac{\text{TDM}}{\text{LAD}} \quad (\text{g m}^{-2} \text{ day}^{-1})$$

where TDM is total dry matter recorded at harvest of crop and LAD (leaf area duration) was calculated by using the following formula.

$$LAD = (LAI_1 + LAI_2) \times (t_2 - t_1)/2$$

where LAI₁ and LAI₂ are leaf area indices recorded at times t₁ and t₂, respectively. The leaf index was calculated using the formula given by Watson (1947).

$$LAI = \frac{\text{Leaf Area}}{\text{Land Area}}$$

Data were analysed statistically using Fisher's analysis of variance technique (Steel & Torrie, 1997) and least significant difference test was used to compare treatments means.

Results and Discussion

Data revealed that significant effect of different combinations of organic and inorganic fertilizers on achene and biological yield was found during both years (Table 1).

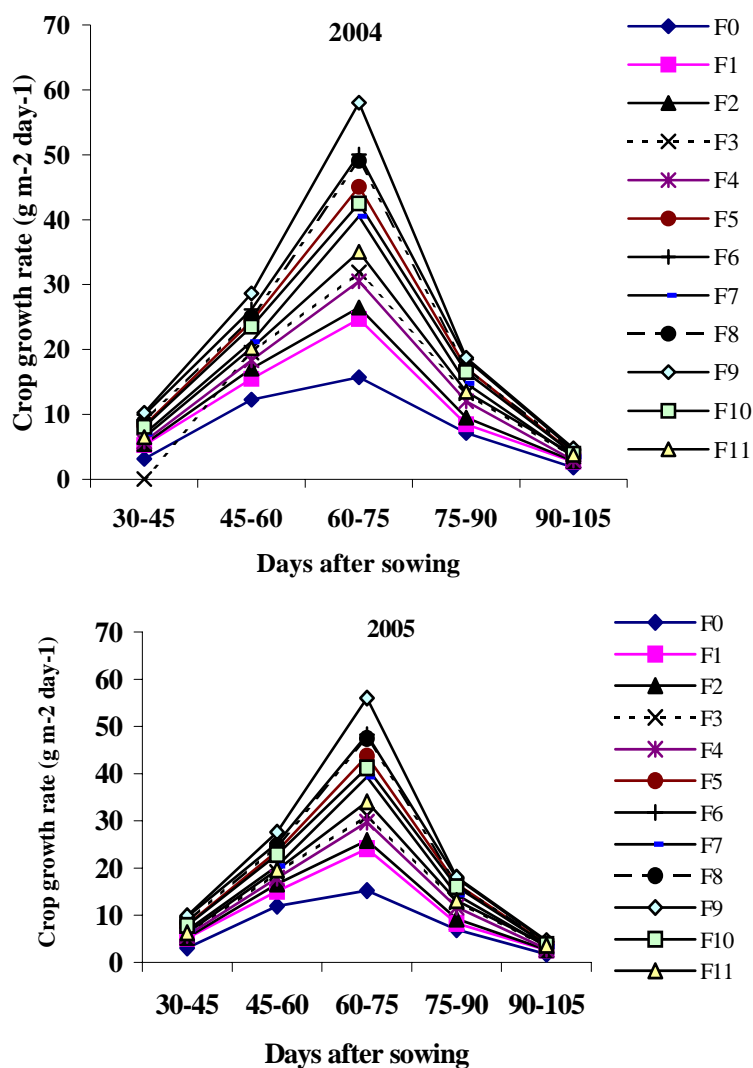
In 2004, the highest achene yield (2895 kg ha⁻¹) was obtained in the treatment of 50-75-50 NPK kg ha⁻¹ along with poultry manure at 8 t ha⁻¹ which was statistically similar to treatments of 75-75-50 NPK kg ha⁻¹ + FYM at 20 t ha⁻¹ and 25-50-75 NPK kg ha⁻¹ + PM at 8 t ha⁻¹ both giving achene yields of 2626 kg ha⁻¹ and 2595 kg ha⁻¹, respectively and maximum biological yield (16095 kg ha⁻¹) was also obtained in the same treatment. The minimum achene yield (965 kg ha⁻¹) and biological yield (8659 kg ha⁻¹) were recorded in the treatment where no fertilizer was applied. Inorganic fertilizer (100-75-50 NPK kg ha⁻¹) produced relatively more achene yield than organic manures (FYM at 20 t ha⁻¹ and PM at 8 t ha⁻¹). Almost similar trend of increasing achene and biological yield was found in 2005.

Application of inorganic fertilizers along with organic fertilizers increased the achene and biological yield significantly over the treatments where only organic or inorganic fertilizers were added. This increase could possibly be because of more availability of nutrients and their uptake which increased leaf area index, CGR, NAR, flowering and biomass. Similar findings were also reported by Tiwari & Parihar (1992), Ramesh *et al.*, (1999), Gorttappah *et al.*, (2000), Saeed *et al.*, (2002), who stated that organic manure alone or in combination with synthetic fertilizers significantly increased achene and biological yield against control. Efficient utilization of applied inputs in a particular set of environments is reflected by crop growth rate and net assimilation rate which are in fact the gain in weight of community of plants per unit of land and time. Results (Table 1) also revealed that various combinations of organic and inorganic fertilizers significantly affected the crop growth rate (CGR) and net assimilation rate (NAR) of sunflower during both years. In 2004, the maximum CGR (28.92 g m⁻² day⁻¹) and NAR (9.75 g m⁻² day⁻¹) were recorded in the treatment of 50-75-50 NPK kg ha⁻¹ + PM at 8 t ha⁻¹ which were followed by treatment of 75-75-50 NPK kg ha⁻¹ + FYM at 20 t ha⁻¹ where CGR of 26.27 g m⁻² day⁻¹ and NAR of 9.47 gm⁻² day⁻¹ were observed. The minimum mean CGR (9.57 gm⁻² day⁻¹) and NAR (4.32 gm⁻² day⁻¹) were recorded in the treatment where no fertilizer was applied. Similar trend was also observed in 2005. The periodic data of CGR and NAR under different treatments in both years are depicted in Fig. 1 & 2. It was observed that CGR and NAR increased sharply upto its maximum value and thereafter it suddenly declined in all the treatments and reached its minimum value towards maturity. Chandrashekara & Patil (1997) also observed significant increase in CGR and NAR at all growth stages except 30 DAS (days after sowing) and near maturity of crop. These results are in line with those of Roy *et al.*, (2001), Saeed *et al.*, (2002), Vijayakumar *et al.*, (2003) and Akhtar (2004).

Table 1. Comparative agro-physiological response of sunflower to integration of crop manuring and nitrogen application.

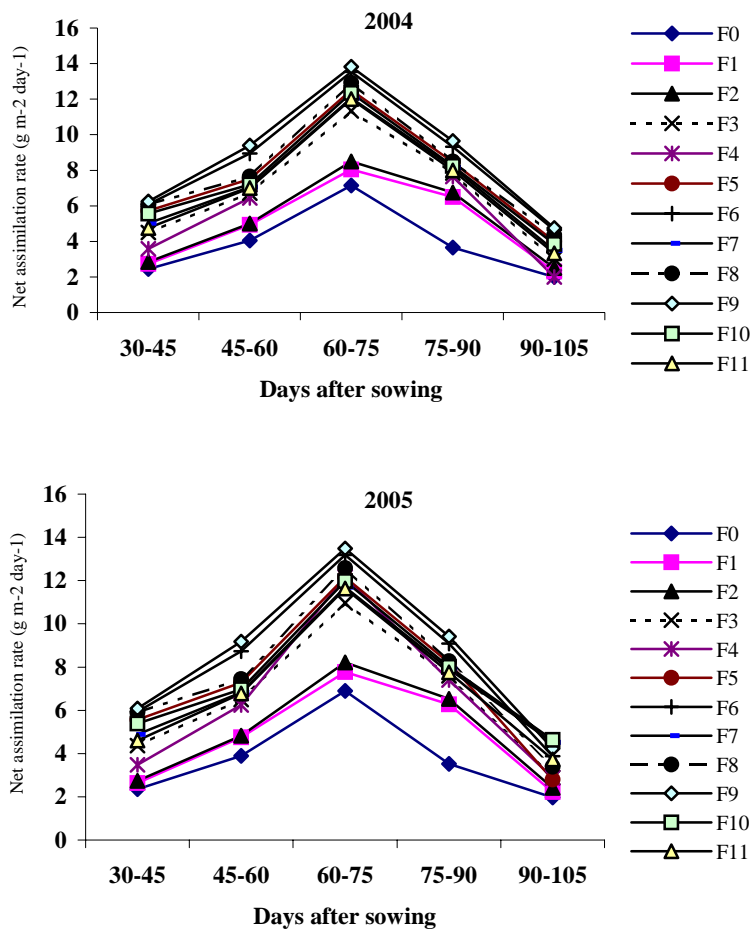
Treatment	Achene yield (kg ha ⁻¹)		Biological yield (kg ha ⁻¹)		Mean crop growth rate (g m ⁻² day ⁻¹)		Net assimilation rate (g m ⁻² day ⁻¹)	
	2004	2005	2004	2005	2004	2005	2004	2005
Control (no fertilizer)	965 h	937.60 h	8659 e	8356 f	9.57 l	9.23 l	4.32 l	4.16 j
Farm yard manure at 20t ha ⁻¹	1688 g	1646 g	1185 d	11500 e	13.48 k	13.15 k	5.56 k	5.36 i
Poultry manure at 8t ha ⁻¹	1824 fg	1805 fg	12186 cd	11930 de	14.62 j	14.22 j	5.75 j	5.57 h
100-75-50 NPK kg ha ⁻¹	2074 def	2022 def	13425 bed	13020 bede	17.67 h	17.23 h	7.60 h	7.35 f
FYM (20t ha ⁻¹) + 25-75-50 NPK kg ha ⁻¹	1981 efg	1907 efg	12857 bed	12472 cde	16.67 i	16.26 i	7.04 i	6.81 g
FYM (20t ha ⁻¹) + 50-75-50 NPK kg ha ⁻¹	2487 bc	2412 bc	14727 abc	14360 abc	23.71 d	22.99 d	8.53 d	8.29 c
FYM (20t ha ⁻¹) + 75-75-50 NPK kg ha ⁻¹	2626 ab	2531 ab	15412 ab	14950 ab	26.27 b	25.24 b	9.47 b	9.23 b
FYM (20t ha ⁻¹) + 100-75-50 NPK kg ha ⁻¹	2312 bcde	2244 bcde	14055 abcd	13720 abcde	20.87 f	20.24 f	8.06 f	7.81 e
PM (8t ha ⁻¹) + 25-75-50 NPK kg ha ⁻¹	2595 abc	2511 abc	15256 ab	14900 ab	25.19 c	24.36 c	8.78 c	8.39 c
PM (8t ha ⁻¹) + 50-75-50 NPK kg ha ⁻¹	2895 a	2791 a	16095 a	15610 a	28.92 a	27.90 a	9.75 a	9.51 a
PM (8t ha ⁻¹) + 75-75-50 NPK kg ha ⁻¹	2427 bed	2351 bed	14596 abc	14230 abcd	22.65 e	21.97 e	8.34 e	8.09 d
PM (8t ha ⁻¹) + 100-75-50 NPK kg ha ⁻¹	2238 cde	2174 cde	13938 abcd	13590 abcde	18.81 g	18.26 g	7.93 g	7.69 e
LSD 5%	376	350	2631	2400	0.09	0.06	0.11	0.17

Means in the same column having different letters differ significantly at 0.05 P.



F₀ = Control (no organic and no inorganic fertilizer)
 F₁ = Farm yard manure at 20 t ha⁻¹
 F₂ = Poultry manure at 8 t ha⁻¹
 F₃ = 100 - 75 - 50 NPK kg ha⁻¹
 F₄ = Farm yard manure (20 t ha⁻¹) + 25 - 75 - 50 NPK kg ha⁻¹
 F₅ = Farm yard manure (20 t ha⁻¹) + 50 - 75 - 50 NPK kg ha⁻¹
 F₆ = Farm yard manure (20 t ha⁻¹) + 75 - 75 - 50 NPK kg ha⁻¹
 F₇ = Farm yard manure (20 t ha⁻¹) + 100 - 75 - 50 NPK kg ha⁻¹
 F₈ = Poultry manure (8 t ha⁻¹) + 25 - 75 - 50 NPK kg ha⁻¹
 F₉ = Poultry manure (8 t ha⁻¹) + 50 - 75 - 50 NPK kg ha⁻¹
 F₁₀ = Poultry manure (8 t ha⁻¹) + 75 - 75 - 50 NPK kg ha⁻¹
 F₁₁ = Poultry manure (8 t ha⁻¹) + 100 - 75 - 50 NPK kg ha⁻¹

Fig. 1. Crop growth rate (g m² day⁻¹) as affected by different treatments in sunflower during 2004 and 2005.



F₀ = Control (no organic and no inorganic fertilizer)

F₁ = Farm yard manure at 20 t ha⁻¹

F₂ = Poultry manure at 8 t ha⁻¹

F₃ = 100 - 75 - 50 NPK ha⁻¹

F₄ = Farm yard manure (20 t ha⁻¹) + 25 - 75 - 50 NPK kg ha⁻¹

F₅ = Farm yard manure (20 t ha⁻¹) + 50 - 75 - 50 NPK kg ha⁻¹

F₆ = Farm yard manure (20 t ha⁻¹) + 75 - 75 - 50 NPK kg ha⁻¹

F₇ = Farm yard manure (20 t ha⁻¹) + 100 - 75 - 50 NPK kg ha⁻¹

F₈ = Poultry manure (8 t ha⁻¹) + 25 - 75 - 50 NPK kg ha⁻¹

F₉ = Poultry manure (8 t ha⁻¹) + 50 - 75 - 50 NPK kg ha⁻¹

F₁₀ = Poultry manure (8 t ha⁻¹) + 75 - 75 - 50 NPK kg ha⁻¹

F₁₁ = Poultry manure (8 t ha⁻¹) + 100 - 75 - 50 NPK kg ha⁻¹

Fig. 2. Net assimilation rate as affected by different treatments in sunflower during 2004 and 2005.

Table 2. Comparative quality response of sunflower to integration of crop manuring and nitrogen application.

Treatment	Acheine protein content (%)		Oil content (%)		Oleic acid (%) in oil		Linoleic acid (%) in oil	
	2004	2005	2004	2005	2004	2005	2004	2005
Control (no fertilizer)	11.46 f	11.50 g	43.77 a	43.59 a	42.92 a	42.74 a	43.45 b	42.89 h
Farm yard manure @ 20t ha ⁻¹	14.85 e	14.92 f	43.36 a	43.14 a	41.50 b	41.29 b	46.20 f	45.55 g
Poultry manure @ 8t ha ⁻¹	15.05 e	15.14 ef	43.08 a	42.82 a	41.25 bc	41.00 b	46.35 f	45.74 g
100-75-50 NPK kg ha ⁻¹	15.26 de	15.39 def	40.62 bc	40.00 b	40.50 d	40.13 c	48.24 d	47.71 e
FYM (20t ha ⁻¹) + 25-75-50 NPK kg ha ⁻¹	15.15 e	15.27 ef	41.03 b	40.69 b	41.05 cd	40.72 bc	47.07 e	46.50 f
FYM (20t ha ⁻¹) + 50-75-50 NPK kg ha ⁻¹	16.05 abc	16.24 abc	39.05 cd	38.58 c	38.52 fgh	38.05 ef	49.43 bc	49.03 bc
FYM (20t ha ⁻¹) + 75-75-50 NPK kg ha ⁻¹	16.53 ab	16.76 ab	38.33 de	37.79 c	38.35 gh	37.81 f	49.57 ab	49.24 ab
FYM (20t ha ⁻¹) + 100-75-50 NPK kg ha ⁻¹	15.57 cde	15.72 cde	38.50 de	38.11 c	39.25 e	38.85 d	49.05 c	48.56 d
PM (8t ha ⁻¹) + 25-75-50 NPK kg ha ⁻¹	16.15 abc	16.35 abc	38.38 de	37.92 c	38.44 gh	37.94 ef	49.50 ab	49.20 abc
PM (8t ha ⁻¹) + 50-75-50 NPK kg ha ⁻¹	16.75 a	17.00 a	38.41 de	37.71 c	38.20 h	37.67 f	49.72 a	49.53 a
PM (8t ha ⁻¹) + 75-75-50 NPK kg ha ⁻¹	15.93 bcd	16.09 bcd	37.08 e	37.90 c	38.84 efg	38.45 de	49.25 bc	48.80 cd
PM (8t ha ⁻¹) + 100-75-50 NPK kg ha ⁻¹	15.50 cde	15.65 cdef	38.63 de	38.24 c	39.35 ef	38.95 d	49.00 c	48.51 d
LSD 5%	0.75	0.76	1.83	1.05	0.61	0.61	0.4194	0.4194

Means in the same column having different letters differ significantly at 0.05 P.

Data (Table 2) showed that different organic and inorganic fertilizers had significant effect on the quality parameters such as achene protein content, oil content, oleic acid and linoleic acid in oil. In 2004, the maximum protein content (16.75%) and linoleic acid in oil (49.72%) were recorded in the treatment of 50-75-50 NPK kg ha⁻¹ + PM at 8 t ha⁻¹. Minimum protein content (11.46%) and linoleic acid in oil (43.45%) were found in the treatment where no fertilizer was applied. Similar trend was also found in 2005. These results are in line with those of Ghani *et al.*, (2000) Nanjundappa *et al.*, (2001) and Khaliq (2004) who reported increase in achene protein content and linoleic acid in oil with nitrogen for organic and inorganic sources. In 2004, the highest oil content (43.77%) and oleic acid in oil (42.92%) were recorded in the treatment where no fertilizer was applied. The minimum oil content (37.08%) in the treatment of 75-75-50 NPK kg ha⁻¹ and oleic acid in oil (38.20%) were recorded in the treatment of 50-75-50 NPK kg ha⁻¹ + PM at 8 t ha⁻¹. Almost similar trend was found in 2005.

These results are in line with those of Steer & Seilor (1990) and Khaliq (2004) also reported that N supply rates affected fatty acid composition in sunflower oil, oil percentage and percentage of oleic acid responded negatively. Such results may be due to the adverse effect of nitrogen on oil content, is offset by an increase in protein content. Protein formation competes more strongly for photosynthates, as a result less of the latter are available for fat synthesis and nitrogen depressed the seed oil content. Large nitrogen supply increases the amount of seed oil per plant and depresses seed oil concentration (Steer *et al.*, 1984). The latter effect results from the dilution of oil in heavier seed produced under high nitrogen. Therefore, smaller N concentration does not offset the advantage that large N supply has on seed number and seed weight so that crop oil yield remains positively related to large N supply.

On the basis of results of two years, it can be concluded that the crop was fertilized at 50-75-50 NPK kg ha⁻¹ along with poultry manure at 8 t ha⁻¹ appeared to be most appropriate and suitable for harvesting a good crop of sunflower. Poultry manure should be applied in preference to farm yard manure. It is further noted that the inorganic fertilizers should not be applied alone, rather in combination with organic fertilizers to obtain the maximum yield of the crop by increasing the fertilizer use efficiency of applied inorganic fertilizers.

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