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PHYSIOLOGICAL AND CHEMICAL RESPONSE OF SUNFLOWER TO SOME ORGANIC NITROGEN SOURCES AND CONVENTIONAL NITROGEN FERTILIZERS UNDER SANDY SOIL CONDITIONS

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ABSTRACT: Two sunflower (*Helianthas annus* L. cv. Vidoc hybrid) field experiments were performed in El-Khattara region (Sharkia Governorate, Egypt) during 2005 season to study the effect of organic- N sources and their combination as well as to compare the effect of organic sources and ammonium sulfate (A.S.) as a conventional fertilizer added individually or in combinations on growth, yield components, oil percentage as well as uptake of some macronutrients by plant grown on a sand soil. The organic sources were farmyard manure (FYM), chicken manure (Ch.M) and palma residues (Pa.R); Ch.M and (FYM + Ch.M of 1/1 ratio of added N) were superior to the other treatments and gave the highest yield, dry matter yield, NPK uptake by plant at all growth stages as well as seed yield at maturity stage. The promotive effect of the different organic sources of nitrogen on the yield and its components may follow the order; Ch.M> Pa.R> FYM. This was more emphasized when the materials were mixed with ammonium sulfate at the ratios of 3/1 and 1/1 organic source N / A.S-N. Uptake of N, P and K by sunflower plants was affected by the addition of different nitrogen sources and nitrogen addition treatments. The highest nutrient content and uptake by straw were obtained when treated with Ch.M followed by Pa.R at all growth stages, while it was Pa.R followed by Ch.M for seeds. The oil content was shown to respond to N supply but the changes in individual fatty acids were not statistically different.

Key words: Sunflower, sandy soil, organic manures, nitrogen sources, seed oil, fatty acids.

INTRODUCTION

Egypt's consumption of oil increased during the past years. According to EL-Fayoumy *et al.*, (1999) and FAO, (2006) Egypt production of edible oil represents only about 10% of the actual consumption. In 2005 the production average of sunflower was 39,000 tons, whereas the consumption amounted to 376,000 tons. Sunflower is one of the most widely cultivated oil crops in the world which is grown for edible oil. In 1998, the seed world production was 28.5 million and, as edible vegetable oil, only soybean and rapeseed canola oil production exceeded that of sunflower (FAO, 1999). Due to the sunflower ability to tolerate short periods of water deficit (Hattendorf *et al.*, 1988) the potential exists for it to become an important crop in semi-arid environments and wherever available irrigation water is limited.

The effect of sowing date and irrigation on seed yield of standard genotypes has been extensively studied (D'Amato and Giordano, 1992; Lanza *et al.*, 1992; Sarno *et al.*, 1992; Chiaranda and D'Andria, 1994; Dimic *et al.*, 1996), whereas the changes in oil recovery and fatty acid profile of sunflower due to fertilizing using different nitrogen sources have been poorly investigated. Therefore, more care should be given to this crop to improve the productivity to meet the shortage of vegetable oils. In Egypt, sunflower is adapted to wide types of soils and climate conditions. This wide adaptability enables sunflower to be grown under the low productive soils, particularly, in the newly reclaimed areas in Egypt.

The low fertility of desert soils quality particularly the sandy soil needs many efforts to improve their hydro-physical properties as well as their productivity. Thus, application of organic matter to such soils is needed. Organic materials contain significant amounts of macro-nutrients (i.e., N, P and K). Many organic materials contain other components that can contribute significantly to the increase in crop yields, including micro-nutrients.

Application of animal waste to soils is a common practice which when conducted judiciously can provide a cost-effective utilization strategy for recycling organic matter and essential plant nutrients as well as assist in solid waste disposal. The production benefits gained from animal sludge has been extensively documented (Adegbidi and Briggs, 2003; Yang *et al.*, 2004; Hiltbrunner *et al.*, 2005 and Zhou *et al.*, 2005).

Several experiments showed that nitrogen fertilizer increased seed yield of sunflower. Basha (2000) showed a significant response yield of sunflower to nitrogen levels and a highly significant increase in seed and

oil yield. El-Zahar and El-Kafoury (1999) and El-Zahar *et al.*, (1999) reported that the highest seed and oil yields of Vidoc cultivar were obtained from the highest N-fertilizer of 60 kg N fed^{-1} and application of 20 kg N fed^{-1} gave the highest seed oil recovery. Lawlor (2002) stated that metabolic processes, based on protein, lead to increases in vegetative and reproductive growth and yield is totally dependent upon the adequate supply of nitrogen. Scheiner *et al.* (2002) pointed out that nitrogen fertilization affected the seed yield and number of seeds per head. Moreover, yield increased by 17% when N was added, regardless of the rate of application. Thomas *et al.* (2006) reported that using sludge-scrubber by-product mixture as a nitrogen fertilizer gave a significant increase in leaf area, dry shoot, root masses and seed yields for mature plants. Higher nitrogen concentration resulted in higher shoot dry matter production per plant and the effect was apparent from 29 days after sowing (Cechin and Fatima-Fumis, 2004). The differences in dry matter production were mainly attributed to the effect of nitrogen in leaf production and on individual leaf dry matter.

The purpose of the current investigation is to study the effects of some organic-N sources and their combinations as well as to compare the effect of organic sources and ammonium sulfate (A.S.) as a conventional fertilizer added individually or in combinations on growth, yield components, yield quality, oil as well as uptake of some macronutrients by plant grown on a sandy soil.

MATERIALS AND METHODS

Two field experiments were carried out during the season 2005 at El-Khattara region (El-Sharkia governorate, Egypt) to study the response of sunflower to some organic-N sources and their combination as well as some nitrogen sources and nitrogen addition treatments under sandy soil conditions. A representative soil sample (0 - 30 cm) was taken before planting to determine some physical and chemical properties (Table 1). Nitrogen sources used were: ammonium sulfate (A.S) and three organic sources which included farmyard manure (FYM), chicken manure (Ch.M) and palma residues (Pa.R) which is an agro-industrial wastes. Organic-N sources were applied at 119 kg N ha^{-1} according to the total nitrogen in each source. The chemical compositions of the organic sources are shown in Table 2.

Organic sources (FYM, Ch.M and Pa.R) were added and mixed thoroughly with soil two weeks before seeding. A randomized complete block experimental design

with three replicates, having a plot area 4 X 2.5 m^2, was used. Each plot consisted of 8 rows 50 cm apart, two plants/hill and 20 cm between hills. Sunflower seeds (*Helianthus annus* L.) cv. Vidoc hybrid were sown after soil preparation. Seeding was carried on June 15th, 2005. The

Table 1. Physical and chemical properties of the soil of the experiment

Particle size distribution (%)				Textural class	OM (g kg^{-1})	$CaCO_3$ (g kg^{-1})
C. sand	F. sand	Silt	Clay			
57.44	34.67	5.92	1.97	sand	5.9	6.9

Φ pH	EC (dS m^{-1})	§Cations (cmol kg^{-1})				Anions (cmol kg^{-1})			
		Ca^{+2}	Mg^{+2}	Na^{+1}	K^{+1}	CO_3^{-2}	HCO_3^{-1}	Cl^{-1}	SO_4^{-2}
8.00	0.52	1.2	0.7	1.4	1.6	0.0	1.8	1.5	1.6

Available nutrients (mg kg^{-1})					
Macronutrients			Micronutrients		
N	P	K	Mn	Zn	Cu
17.5	5.16	23.2	2.30	0.68	0.43

Φ (1 : 2.5) soil : water suspension

§ Soluble cations and anions in (1: 2.5 w : v) soil: water extract.

Table 2. Chemical characteristics of the organic-N sources used in the current study

Characteristics	FYM	Pa.R	Ch.M
Total carbon (g kg^{-1})	276	323	204
C/N ratio	19.7:1	12.9:1	8.7:1
Total macro nutrients (g kg^{-1})			
N	14.0	25.0	23.5
P	2.10	3.70	5.80
K	3.30	19.1	10.5
Total micro nutrients (mg kg^{-1})			
Fe	152	473	358
Mn	88	119	219
Zn	62	72	198

plants were thinned to a single plant per hill after 21 days from sowing. Phosphorus fertilizer was added to all plots before sowing at a rate of 31 kg P $ha.^{-1}$ as superphosphate (6.8 % P). Potassium sulphate (40 %, K) was applied as soil application at a rate of 99 kg K $ha.^{-1}$ in two equal splits, 30 and 45 days after sowing. Nitrogen was added at 119 kg N ha^{-1} according to the following treatments:

First Experiment

1- Control (without N); 2- FYM; 3- Ch.M; 4- Pa.R; 5- (FYM + Ch.M); 6- (FYM + Pa.R); 7- (Ch.M + Pa.R). Each of the following treatments receiving two sources of N (i.e. treatments 5 to 7) received the N as a ratio of 1/1 (i.e. 59.5 kg N ha^{-1} from each of the two concerned sources).

Second Experiment

1) Ammonium sulfate (A.S.)

2) FYM, 1/0 (119.0 kg N ha^{-1}); FYM / A.S 3/1 (89.25 kg N ha^{-1} as FYM + 29.75 kg N ha^{-1} as A.S.); FYM / A.S 1/1 (59.50 kg N $ha.^{-1}$ as FYM + 59.50 kg N ha^{-1}as A.S.) and FYM / A.S 1/3 (29.75 kg N ha^{-1} as FYM + 89.25 kg N ha^{-1} as A.S.).

3) Ch.M, 1/0 (119.0 kg N ha^{-1}); Ch.M / A.S 3/1 (89.25 kg N ha^{-1} as CH.M + 29.75 kg N ha^{-1} as A.S.); Ch.M / A.S 1/1 (59.50 kg N $ha.^{-1}$ as Ch.M + 59.50 kg N ha^{-1}as A.S.) and Ch.M / A.S 1/3 (29.75 kg N ha^{-1} as Ch.M + 89.25 kg N ha^{-1} as A.S.).

4) Pa.R, 1/0 (119.0 kg N ha^{-1}); Pa.R / A.S 3/1 (89.25 kg N ha^{-1} as Pa.R + 29.75 kg N ha^{-1} as A.S.); Pa.R / A.S 1/1 (59.50 kg N $ha.^{-1}$ as Pa.R + 59.50 kg N ha^{-1}as A.S.) and Pa.R / A.S 1/3 (29.75 kg N ha^{-1} as Pa.R + 89.25 kg N ha^{-1} as A.S.).

The experiment was executed in a factorial design comprising the two following factors: (1) Organic sources of N which included FYM (farmyard manure), Ch.M (chicken manure), and Pa.R (palma residues); (2) Ratio of organic-N / A.S (ammonium sulfate)-N which included ratios of 1/0 (i.e. no A.S addition), 3/1, 1/1 and 1/3. An extra treatment was done with N added as A.S only. Thus there were 12 treatments representing the different combinations of the two factors (3 organic sources X 4 different ratios) plus the A.S-N treatment.

Plant samples were taken at 45, 65 and 90 days after sowing (DAS) corresponding to vegetative, flowering and maturity stages, respectively. Dry matter yield (DW) as well as total contents of N, P and K in plant were measured.

At maturity, two rows of each plot were harvested, air dried, then straw yield, seed yield, seed oil percentage, oil yield and protein yield were calculated. In addition, representative ten plants were taken randomly from each plot to record the following characters: Head weight (g $plant^{-1}$), seed weight head $^{-1}$ (g), 100 seed weight (g), seed yield, straw