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Effect of organic manure and chemical fertilizers on the growth, production and seed quality of sunflower (*Helianthus annuus* L.)

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Abstract Field experiments were conducted from March to July 2016 at the Botanical Garden of Islamia College University, Peshawar, to evaluate the effects of poultry manure and sulfur on the growth, production, and seed quality of sunflower. Results showed organic manure gives maximum growth and yield considering all the growth parameters. When the effect of organic manure was compared, it was evident that poultry manure produced the highest yield. The combined application of poultry manure and sulfur on growth, yield, and oil contents of sunflower showed a more significant effect than application alone.

Keywords: Poultry manure, Sulfur; Sunflower, Yield

Introduction

Sunflower (*Helianthus annuus* L.) is one of the most important oilseed crops containing high-quality edible oil (Kaya and Kolsarici, 2011). Its seed used as food, frying, cooking and poultry feed worldwide. The iron-rich sunflower seeds are by weight, 47% fat and 24% protein. The seed proteins of sunflower are characterized by a moderately low albumin level and high level of globulin proteins. The globulins represent 55 to 60%, albumins 17 to 23%, glutamines 11 to 17%, Prolamines 1 to 4%, and the combined non-protein nitrogen and the insoluble residue is less than 11% of the total nitrogen in the meal (Dorrell, 1978).

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Sunflower oil has excellent nutritional properties and has a relatively high concentration of linoleic acid (Seiler, 2007). The sunflower occupies a vital position to oilseed crops in Pakistan. Because of short duration, sunflower can acclimatize to different conditions of the weather and soil environment (Thavaprakash *et al.,* 2003). In Pakistan, the whole region below farming of sunflower is 506,000 ha and production since this region is 755,000 tons (seed) with an average yield of 1.6 t ha^{-1} (Pakistan, 2009). Sunflower provides different physically vigorous compounds to possess a physiological property which can be dependable for the restorative prospective in a comprehensive series of sickness situations. Poultry manure is a combination of manure and bedding material produced in large amount every year in the country. If correctly handled, poultry waste is a precious organic source of significant plant nutrients and soil amendment to improve soil fertility. Supplying poultry manure to farming lands is a verified, environmentally sound method for recycling essential nutrients as well as crop yield (Mullins and Bendfeldt, 2001).

Poultry manure contains nitrogen, phosphorus, potassium and micronutrients essential for plant growth. They also found significant crop growth and yield, especially sunflower with the addition of poultry litter (He *et al.,* 2001). Sulfur is progressively known as the fourth plant fertilizer behind from nitrogen, phosphorus, and potassium (Tandon and Messick, 2002). Production of seeds as well the content of oils and proteins in sunflower increase as with the increase in the concentrations of sulfur. The sulfur is also associated with the growth and metabolism of plants, significantly affecting the proteolytic enzymes (Najar *et al.,* 2011). Application of sulfur at 60 kg ha^{-1} recorded consistent improvement in plant height, leaf area index, and dry matter production over 30 $kgha^{-1}$.

This could be observed in the pivotal role of sulfur in regulating the metabolic and enzymatic processes, including photosynthesis and respiration as reported by a previous study (Intodia and Tomar, 1997). The sulfur may take time to become available for the plants and affect plant growth (Wani *et al.*, 2001). The present study focused on the effects of poultry manure and sulfur on the growth, production, and seed quality of sunflower.

Materials and methods

Plant variety and location of the experiment

The experiment was conducted on the sunflower variety (Hyson 33) at the Botanical Garden of Islamia College University, Peshawar. Healthy and quality seeds were collected from the Botany Department of Agriculture University,

Peshawar. The Geographic coordinates of Peshawar at An Latitude: 34°00′28″ N, Longitude: 71°34′42″ E and Elevation above sea level: 340 m = 1115 ft. The mean highest temperature of Peshawar during summer is above 40 ℃ (104 ℉), and the lowest temperature is 25 ℃ (77 ℉). During winter the mean minimum temperature is 4 ℃ (39 ℉), and the most is 18.35 ℃ (65.03 ℉). In March the highest rainfall has been recorded, while the highest summer rainfall was recorded in August. Based on a 25-year record, the average 25-year precipitation has been observed as 400 millimeters.

Collection of fertilizers and soil

Two types of organic and inorganic fertilizers were used. The organic fertilizer was poultry manure, and inorganic chemical fertilizer was sulfur in the form of calcium sulfate. The poultry manure was collected from the poultry farm of Lund khwar and the sulfur ($CaSO_4$) from the Department of chemistry, Islamia College University, Peshawar. The pots were filled from the soil of 5 kg. Both of the factors (fertilizers) were mixed with soil in pots before sowing. The texture of the soil was silt loam. The sowing was done on 11 April during 2016.

Experimental layout

The experiment was conceded in a two-factorial experiment under the completely randomized design (CRD) with four poultry manure fertilizer levels and four sulfur doses, with three repetitions, comprised of 48 experimental units. A total of 16 treatment combinations of poultry manure and chemical fertilizer along with control were distributed randomly, and the space between pots was kept 10 cm.

Statistical procedure

The data obtained from the experiment was composed of different parameters and were subjected to the process of Analysis of variance (ANOVA) to revise the difference among treatments as well as its relations.

Data recording

Data were recorded at the harvesting time. The following parameters were recorded during the experiment, plant tallness, size of the flower, number of grains per flower and oil content.

Results

Growth and yield components

Effect of poultry manure and sulfur on plant height (cm)

Data on mean plant height (cm) recorded at the harvest stage of crop are presented in Table 1. The result showed that the effect of poultry manure and sulfur on the height of the plant was found significant. The utmost plant height (115.43 cm) was obtained in those treatment fertilized with 300 mg of sulfur and 15 g of poultry manure, while the minimum plant height (75.90 cm) was noted in the control (Figure 1).

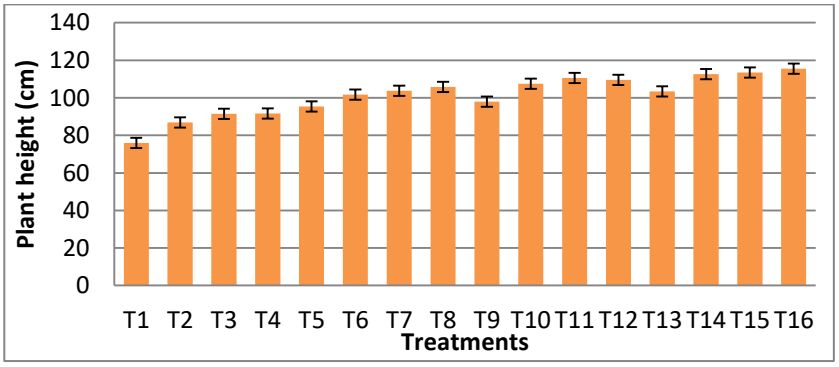

Figure 1. Effect of poultry manure and sulfur on plant height of sunflower

Effect of poultry manure and sulfur on size of flower (cm)

The effect of poultry manure and sulfur on flower size was also highly significant differed (Table 1). The utmost flower size (8.63 cm) was obtained in those treatments fertilized with 300 mg of sulfur and 15 g of poultry manure, while the minimum flower size (5.73 cm) was noted in the control (Figure 2).

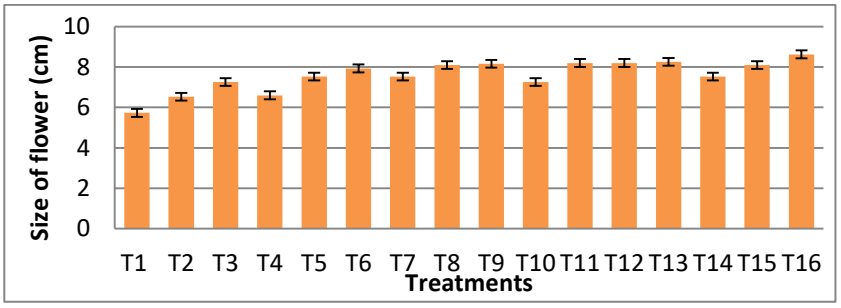

Figure 2. Effect of poultry manure and sulfur on flower size of sunflower

Effect of poultry manure and sulfur on number of grains per flower

The effect of poultry manure and sulfur on the number of grains per flower was also highly significant (Table 1). The utmost grains number (407.00) was obtained in those treatments fertilized with 300 mg of sulfur and 15 g of poultry manure, while the minimum number of grains (237.67) was noted in the control (Figure 3).

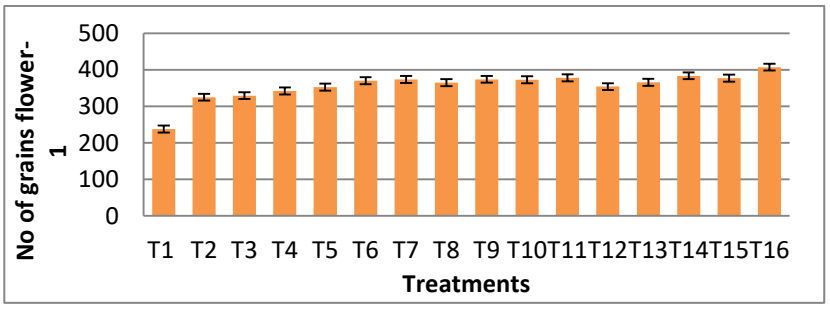

Figure 3. Effect of poultry manure and sulfur on grains no flower-1 of sunflower

Effect of poultry manure and sulfur on oil content and oil yield

The consequence of poultry manure and sulfur on the oil content of sunflower was found significant (Table 1).

Table 1. Interaction effect of poultry manure and sulfur on yield characters of sunflower **(**PM x S**)**

Treatment Combination (PM x S)	Plant Height (cm)	SE (±)	Size of Flower (cm)	SE (±)	No of Grains Flower	SE (±)	Oil Content (%)	SE (±)
Effect of poultry manure and sulfur on growth characters with standard error (g, mg/pot)								
PM0S0	75.90	0.81	5.73	0.45	237.67	23.11	30.60	1.15
PM0S100	86.83	1.05	6.53	0.25	324.67	18.14	35.43	0.90
PM0S200	91.40	0.81	7.26	0.25	329.00	21.93	36.26	0.92
PM0S300	91.63	0.86	6.60	0.26	341.67	15.37	34.60	1.15
PM5S0	95.47	0.76	6.53	0.25	352.33	14.18	34.56	0.90
PM5S100	101.63	0.76	7.93	0.51	369.67	15.01	37.50	1
PM5S200	103.70	0.50	7.53	0.25	373.33	10.40	41.43	0.60
PM5S300	105.73	0.90	8.10	0.36	364.67	8.38	38.43	0.60
PM10S0	97.90	1.9	8.16	0.35	373.67	8.08	43.10	0.65
PM10S100	107.50	0.8	7.26	0.45	372.67	14.50	41.10	1.15
PM10S200	110.50	0.8	8.20	0.36	377.00	12.01	39.33	0.85
PM10S300	109.60	1.31	8.20	0.36	353.67	18.87	41.43	0.92
PM15S0	103.47	0.87	8.26	0.15	365.67	25.77	42.46	1.16
PM15S100	112.57	1.02	7.53	0.25	383.33	11.59	43.40	0.85
PM15S200	113.43	1.00	8.10	0.7	377.00	19.31	43.20	1.38
PM15S300	115.43	1.51	8.63	0.35	407.00	16	44.23	0.64
CV (p=0.05)	1.03		4.60		4.48		2.20	

PM= poultry manure, S= sulfur, SE= standard error, 0= control

The highest content of oil (44.23%) was obtained in those treatments fertilized with 300 mg of sulfur and 15 g of poultry manure, while the minimum oil content (30.60%) was noted in the control (Figure 4).

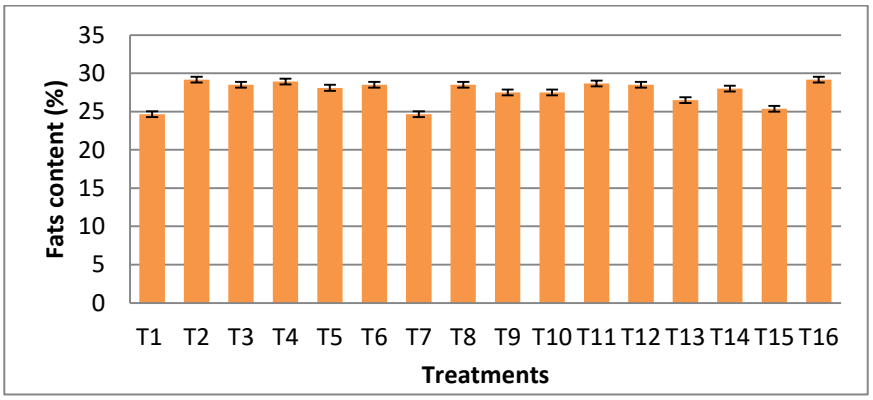

Figure 4. Effect of poultry manure and sulfur on oil content of sunflower

Mineral composition

Macronutrients

Potassium (%): The macronutrients content in sunflower seeds was also greatly affected by the poultry manure and sulfur. The effect of poultry manure and sulfur on the potassium content of sunflower was also highly significant (Table 2). The most value for the potassium (42.50) was recorded by the application of both factors of poultry manure and sulfur higher than control (17.50) (Figure 5).

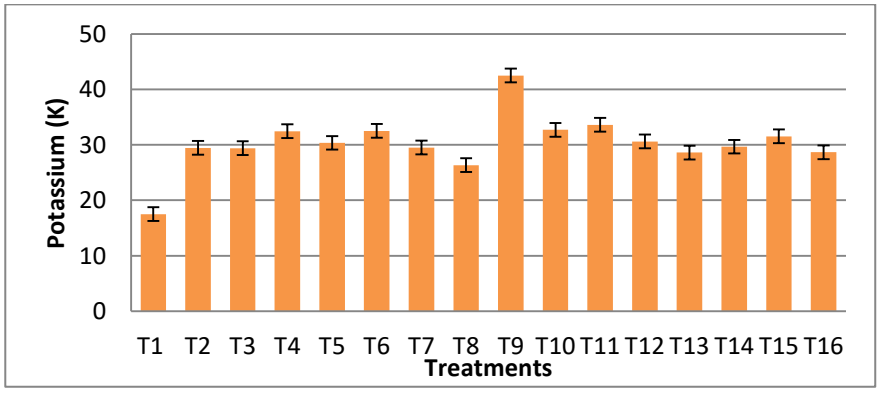

Figure 5. Effect of poultry manure and sulfur on the potassium content of sunflower

Calcium (%): The effect of poultry manure and sulfur on the calcium content of sunflower was also highly significant differed (Table 2).

Table 2. Interaction effect of poultry manure and sulfur on macronutrients content of sunflower **(**PM x S**)**

Treatment Combination (PM x S)	Potassium (%)	SE (±)	Calcium (%)	SE (±)	Magnesium (%)	SE (±)
Effect of poultry manure and sulfur on nutrient content with standard error (g, mg/pot)						
PM0S0	17.50	0.3	0.95	0.03	1.93	0.011
PM0S100	29.46	0.15	0.97	0.006	1.93	0.020
PM0S200	29.40	0.1	0.97	0.004	1.97	0.010
PM0S300	32.46	0.35	0.98	0.005	1.98	0.011
PM5S0	30.36	0.23	0.97	0.004	1.90	0.003
PM5S100	32.50	0.2	0.96	0.012	1.95	0.015
PM5S200	29.50	0.2	0.95	0.016	1.94	0.005
PM5S300	26.33	0.15	0.93	0.007	1.92	0.015
PM10S0	42.50	0.2	0.93	0.014	1.97	0.009
PM10S100	32.70	0.2	0.93	0.012	1.91	0.003
PM10S200	33.60	0.1	0.94	0.012	1.93	0.011
PM10S300	30.60	0.1	0.93	0.011	1.92	0.006
PM15S0	28.60	0.1	0.96	0.001	1.93	0.025
PM15S100	29.66	0.15	0.93	0.010	1.92	0.008
PM15S200	31.53	0.05	0.92	0.005	1.92	0.012
PM15S300	28.66	0.15	0.95	0.005	1.94	0.012
CD (p= 0.05)						

PM= poultry manure, S= sulfur, SE= standard error, 0= control

The most value for the calcium (0.98) was recorded by the applications of both factors of poultry manure and sulfur higher than control (0.95) (Figure 6).

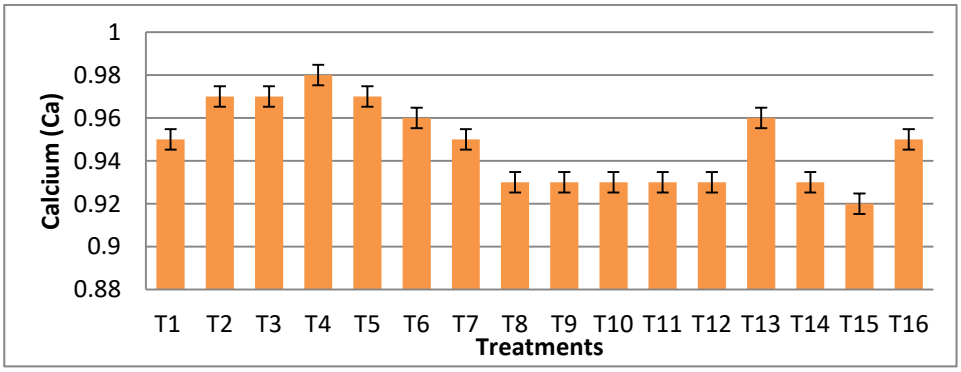

Figure 6. Effect of poultry manure and sulfur on the calcium content of sunflower

Magnesium (%): The effect of poultry manure and sulfur on the magnesium content of sunflower was also highly significant differed (Table 2). The highest value for the magnesium (1.98) was recorded by the application of both factors of poultry manure and sulfur higher than control (1.93) (Figure 7).

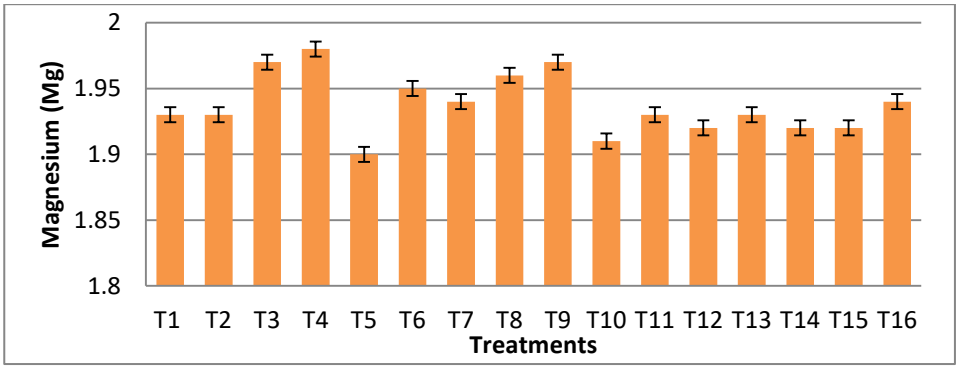

Figure 7. Effect of poultry manure and sulfur on the magnesium content of sunflower

Micronutrients

Sodium (%): The micronutrients content in sunflower seeds was also greatly affected by the poultry manure and sulfur (Table 3).

Table 3. Interaction effect of poultry manure and sulfur on micronutrients content of sunflower **(**PM x S**)**

Treatment Combination (PM x S)	Sodium (%)	SE (±)	Zinc (%)	SE (±)	Manganese (%)	SE (±)
Effect of poultry manure and sulfur on nutrient content with standard error (g, mg/pot)						
PM0S0	4.50	0.26	0.44	0.016	0.32	0.010
PM0S100	5.66	0.32	0.75	0.01	0.28	0.011
PM0S200	5.56	0.15	0.65	0.022	0.51	0.39
PM0S300	5.46	0.30	0.66	0.012	0.43	0.010
PM5S0	5.23	0.05	0.83	0.010	0.44	0.020
PM5S100	6.33	0.35	0.91	0.015	0.64	0.008
PM5S200	6.30	0.2	0.93	0.015	0.32	0.005
PM5S300	7.40	0.1	0.72	0.019	0.22	0.011
PM10S0	8.46	0.25	0.74	0.007	0.57	0.001
PM10S100	6.66	0.15	0.55	0.021	0.28	0.012
PM10S200	7.36	0.20	0.74	0.035	0.32	0.012
PM10S300	8.36	0.11	0.64	0.038	0.43	0.012
PM15S0	6.53	0.25	0.94	0.012	0.37	0.015
PM15S100	7.36	0.11	0.84	0.028	0.62	0.005
PM15S200	8.43	0.11	0.94	0.027	0.54	0.015
PM15S300	7.73	0.20	0.84	0.027	0.46	0.020
CD (p= 0.05)						

PM= poultry manure, S= sulfur, SE= standard error, 0= control

The most value for the sodium (8.46) was recorded by the application of both factors poultry manure and sulfur higher than control (4.50) (Figure 8).

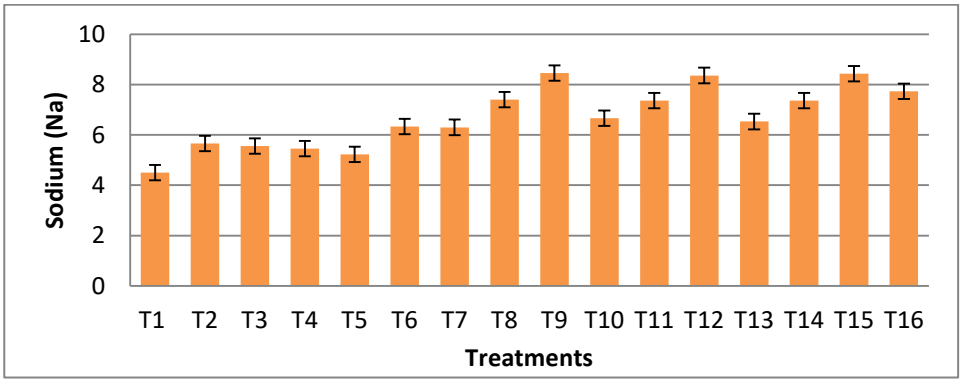

Figure 8. Effect of poultry manure and sulfur on the sodium content of sunflower

Zinc (%): The effect of poultry manure and sulfur on the zinc content of sunflower was also highly significant (Table 3). The highest value for the zinc (0.94) was recorded by the application of both factors of poultry manure and sulfur higher than control (0.44) (Figure 9).

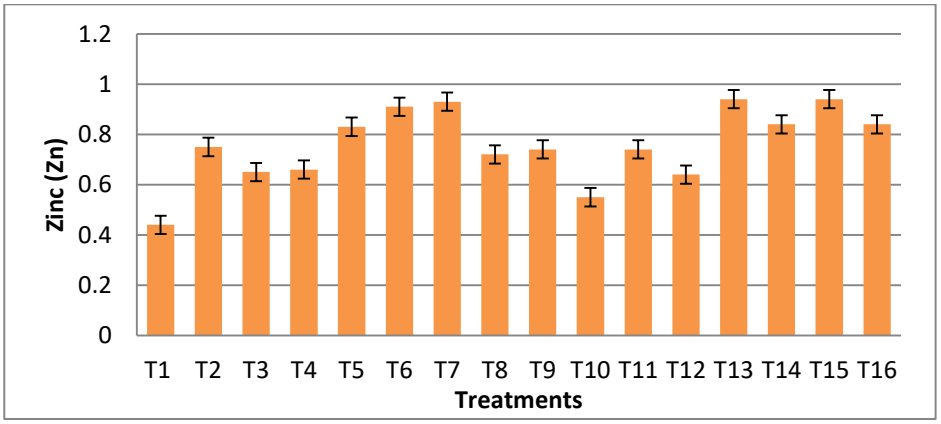

Figure 9. Effect of poultry manure and sulfur on the zinc content of sunflower

Manganese (%): The effect of poultry manure and sulfur on the manganese content of sunflower was also highly significant (Table 3). The maximum value for the manganese (0.64) was recorded by the application of both factors of poultry manure and sulfur higher than control (0.22) (Figure 10).

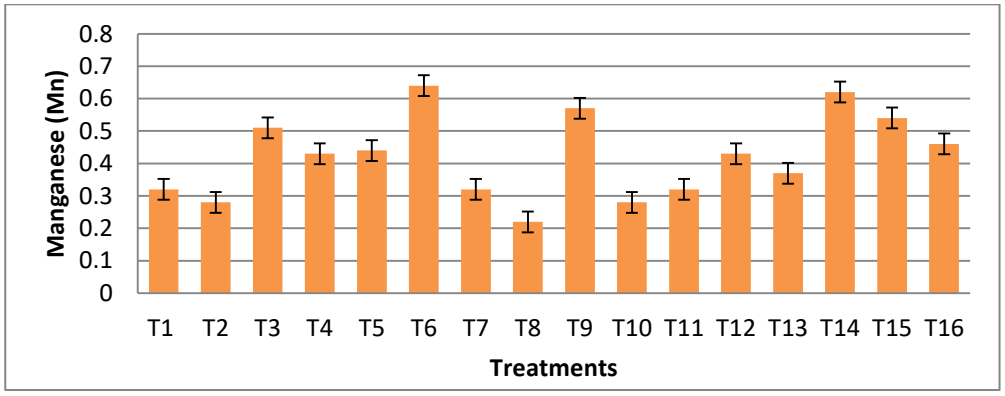

Figure 10. Effect of poultry manure and sulfur on the manganese content of sunflower

Discussion

The results demonstrated that the effect of poultry manure and sulfur on plant height was found significant. It is due to the poultry manure containing nitrogen, the main component of proteins and chlorophyll, its sufficient supply through the manure encourages photosynthesis, which resulted in improved crop growth especially plant height (Shah and Khanday, 2005). The sulfur also affects the plant height. This could be due to that sulfur regulates the metabolic and enzymatic processes, including photosynthesis and respiration (Poomurugesan and Poonkodi, 2008). The impact of both factors on the plant tallness was significantly compared to application alone. It is both poultry manure and sulfur are essential for the growth of the plant.

The result showed that the size of the flower was also affected by the appliance of poultry manure. The possible reason might be concerned with the positive response of agronomic characteristics associated with a yield to nitrogen. The increase record in flower size was due to a possible increase in photosynthetic efficiencies during the vegetative phase, which increased head dry matter (Syed *et al.,* 2006). The result clearly showed that the application of sulfur significantly affected the flower size of the sunflower. Production of proteins at the higher sulfur level may result in proper improvement in yield components, which sustained better crop growth (Ravi *et al.,* 2010). The interaction effect of poultry manure and sulfur on the size of the flower was also highly significant differed. It is due to the nitrogen and sulfur play important roles in proteins and chlorophyll synthesis, as well as vegetative and reproductive growth (Yadav *et al.,* 2010).

The result for poultry manure on a number of grains revealed that seed number was greatly affected by the application of poultry manure. The high

number of grains in sunflower may be due to the reason that more availability of nutrients, especially nitrogen, and phosphorus supply due to poultry manure applications (Hassan and Leitch, 2001). The effect of sulfur on a number of grains was also significantly different. It seems that the decrease in seed number was due to lack of fertilization, and with the addition of chemical fertilizers, more number of grains were obtained (Agele *et al.,* 2007). Among the interaction treatment, the effects of poultry manure and sulfur on a number of grains were also highly significant differed. The previous study stated that organic manure alone or synthetic fertilizers significantly increased achene and biological yield against control (Saeed *et al*., 2002).

The results indicated the percentage content for oil by the applications of poultry manure showed that the fats content in sunflower seed is highly affected by the poultry manure. It showed that with an increase in poultry manure concentrations, the fats content also increased (Aglave *et al*., 2009). The results for sulfur on the oil content showed that the effect of sulfur on oil content was also highly significant differed. It showed that with increase in sulfur concentrations, the oil content increased. Because sulfur is associated with the production of crops of superior nutritional and market quality (Usha Rani *et al*., 2009). It is apparent from the results that the oil content was mostly influenced by combinations of poultry manure and sulfur than application alone (Ghani and Hussain, 2000). Therefore, all the growth and yield components such as plant height, head diameter, number of achene per head are influenced by the application of poultry manure and sulfur, because of major nutrients and ultimately increase the yield of the crop.

The poultry manure and sulfur also greatly affected the macronutrients content in sunflower. Among the interaction treatment, the highest content for potassium was recorded (42.50%) at 10 g of poultry manure with control, while the minimum value was noted (17.50%) at control. Results showed that the content of potassium was highly influenced by the sulfur and poultry manure alone and in combination (Ingale and Shrivastava, 2011). Among the interaction treatment, the highest content for calcium was recorded (1.98%) at 300 mg of sulfur with control. While the minimum value was noted (1.90%) at 5 g poultry manure with control sulfur. It is so clearly shown that poultry manure, sulfur, and their interaction had a significant effect on magnesium concentration (Alam, 2007). Findings of calcium content in sunflower with the application of poultry manure and sulfur indicated that poultry manure influences the calcium content to some extent, but the sulfur had no affected, while their interaction on Ca content is also important (Adeniyan and Ojeniyi, 2005).

Among the interaction treatments, the highest content for magnesium was recorded (1.98%) at 300 mg of sulfur with control. While the minimum value was noted (1.90%) at 5 g poultry manure with control sulfur. It is noted from this result that poultry manure, sulfur, and their interaction had a significant effect on magnesium concentration. A similar study was found that nutrient concentration and uptake in different plant parts of jute with the combination of organic and inorganic fertilizer (Alam, 2007). These results are also in accordance with another research (Zhao *et al.,* 2000).

The poultry manure and sulfur also greatly affected the micronutrients content in sunflower. The result revealed that the highest content of sodium (8.46%) was observed by the application of combined treatment, and the lowest value was recorded (4.50%) at control. Therefore, it is clearly shown that both factors had an important effect on the sodium content of sunflower seeds (Adekiya and Agbede, 2009). Among the interaction treatment, the highest content for zinc was recorded (0.94%) at 15 g of poultry manure with 200 mg of sulfur, while the minimum value was noted (0.44%) at control. Our experiment showed that the poultry manure, sulfur, and their interaction greatly affected the zinc content. Also, it was found that chick manure improved uptake of Ca, K, Mg, Zn, P, and Cu by grown-up maize (Ayeni *et al.,* 2008).

Among the interaction treatment, the highest content for manganese was recorded (0.64%) at 10 g of poultry manure with 300 mg of sulfur. While the minimum value was noted (0.22%) at 5 g of poultry manure and 300 mg of sulfur. Our result showed that the manganese content was not greatly affected by sulfur, but affected by poultry manure and their combination. The results are in partial agreement with another research (Gupta and Shrivastava, 2004).

It is concluded that organic manure (poultry manure) and chemical fertilizer (sulfur) gave maximum yield in sunflower. While all quality parameters were also found to be the best by the application of poultry manure and sulfur. The interaction application of poultry manure and sulfur on the growth and production of sunflower was more effective than application alone. When organic materials were compared, it was found that poultry manure performed the best as a source of nitrogen to enhance yield as well as the quality of sunflower as compared to press mud, farmyard manure and a combination of press mud, poultry manure, and farmyard manure.

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