Dhaka Univ. J. Biol. Sci. **32**(1): 83-90, 2023 (January) DOI: https://doi.org/10.3329/dujbs.v32i1.64193

GROWTH AND YIELD PERFORMANCE OF SUNFLOWER (*HELIANTHUS ANNUUS* L.) AS INFLUENCED BY COW DUNG AND NPK FERTILIZERS

MD. ALAUDDIN[1], MK RAHMAN* AND AHMZ ALI

Department of Soil, Water and Environment, University of Dhaka, Dhaka-1000, Bangladesh

Keywords: Coastal belt, Cow dung, Growth and yield of sunflower, NPK fertilizer

Abstract

A field experiment was conducted at the research farm of Charfasson Govt. College, Bhola, Bangladesh in rabi season in 2015-2016 to evaluate the effect of cow dung and chemical fertilizers on growth and yield of sunflower *cv.* BARI-2 (Keroni-2). Highest plant height (208.4 cm), leaf area (410.5 cm^2) and leaf area index (12.75) were recorded in T_{16} (7.5 ton CD ha^{-1} +$N_{120}P_{90}K_{150}$kg ha^{-1}). Highest dry matter yield *viz.* stem (60.67g $plant^{-1}$) found in treatment T_{16} (7.5 ton CD ha^{-1}+$N_{120}P_{90}K_{150}$kg ha^{-1}). Maximum dry weight of leaf (25.33g $plant^{-1}$) and dry weight of root (12.83g $plant^{-1}$) were found in treatment T_{15} (7.5 ton CD ha^{-1} +$N_{80}P_{60}K_{100}$kg ha^{-1}). Highest dry weight of seed (64.7 g $plant^{-1}$) and dry wt. of 100 seed (9.8 g) were found in treatment T_{15} (7.5 ton CD ha^{-1} +$N_{80}P_{60}K_{100}$kg ha^{-1}) but the highest number of seed (735.7$plant^{-1}$) and florescence diameter (52.67 cm) were observed in treatment T_{13} (5 ton CD ha^{-1} +$N_{120}P_{90}K_{150}$kg ha^{-1}). Maximum total dry matter yield per plant was 92.01 g and per hectare was 5.75 ton in T_{16} (7.5 ton CD ha^{-1}+$N_{120}P_{90}K_{150}$kg ha^{-1}). Results revealed that the combined application of cow dung and NPK fertilizers produced better growth and yield of sunflower in field condition at the coastal belt of Bangladesh.

Introduction

Sunflower (*Helianthus annuus* L.) is one of the most important oil seed crops of the world because of the adequate concentration of unsaturated fatty acids in its oil and occupies second place next to soybean as a source of vegetable edible oil[1-2]. It is also considered as one of the major oil producing crops because of its high-quality oil, protein contents, consumable parts of this plant and moderate production requirements[3]. In addition, it is one of the crops, which have high availability to planting and produce high yield under stress such as drought, salinity or temperature. Its seed contains a good percentage of oil (48-53%) is edible from this crop; about 80% of the oil is used for edible purpose and rest being non-edible, used for industrial purposes, protein (14-19%), crude fiber (16-27%), ash (2-3%), soluble sugar (7-9%) and hull (21-27%)[4]. In Bangladesh, sunflower as an oilseed crop was introduced by the Bangladesh Agricultural Research Institute (BARI) and Mennonite Central Committee (MCC). Bangladesh experienced a large deficiency of edible oil. Almost two thirds of the total edible oil consumed annually is imported. Recently, farmers of the

*Author for correspondence: <khalil93@du.ac.bd>. [1]Department of Soil Science, Charfasson Govt. College, Bhola, Bangladesh.

coastal districts *viz.* Patuakhali, Barguna, Pirojpur have introduced sunflower cultivation in winter season.

Organic agriculture practices aim to enhance biodiversity, biological cycles and soil biological activity to achieve optimal natural systems that are socially, ecologically and economically sustainable[4]. Rapid crop production with inappropriate farming practices deteriorates organic matter in soil, which results in decreased microbial activity that eventually affect its physical, chemical and biological conditions which lead to decline in land productivity and crops yields. To solve this problem, synthetic fertilizers were always thought to be a better way to improve the soil fertility and crop productivity but unfortunately, the excessive use of these creates a number of serious environmental and health risk[5,6]. Now a days increase in the prices of chemical fertilizers, lack of consistency in feeding the soil and endangering human health caused to the increase of the use of manure for fertility[4]. Excessive nitrogen fertilization of sunflower not only generates that environmental risk, it may also affect the grain quality, decreasing its oil content and reduce yield through an increase of plant lodging[5]. Problems associated with continuous use of chemical fertilizers included nutrient imbalance, increased soil acidity, degradation in soil physical properties and loss of organic matter. To minimize these hazards, naturally occurring organic fertilizers, namely animal and plant manures, fall residues, and food and urban wastes are better alternate of commercially available fertilizers. Reports proved that organic farming improves soil composition, fertility, and soil fauna, which in the long run have a beneficial effect on crop production[5]. Organic manure contains large macro-nutrient quantities (N, P and K)[6].

Manure can improve soil fertility, increase water-holding capacity, decrease soil erosion, improves amount of oxygen, and promotes beneficial organisms and productivity[7]. Sunflower is highly productive in sandy loam as well as clay loam soil. Therefore, farmers could cultivate this crop widely both in rabi and kharif seasons in the coastal area of Bangladesh. Moreover, it reduces climate change vulnerability by emission of large amount of CO_2. But cultivation of this crop is less popular in Bangladesh.

The present experiment was carried out to assess the growth and yield of sunflower (*Helianthus annuus* L.) under cow dung, NPK fertilizers application, and combined effects of cow dung and NPK fertilizers at the southern coastal belt of Bangladesh.

Materials and Methods

A field study was carried out at the research farm of Charfasson Govt. College, Bhola, Bangladesh during rabi season. Soil samples (0-15 cm depth) were collected from the research farm. The sample was air- dried, ground and sieved through 2 mm sieve for analysis and kept in polyethylene bags. The soil had a pH of 8.36 (1:2.5 W/V H_2O), organic C 0.63%[8]. Available N 0.24%[9], available phosphorus 0.06%[10], available potassium 1.23%[11],

available S 0.15%[12], sand 12.3%, silt 51.34% and clay 36.36%, textural class- silty clay loam[13], and water holding capacity 37%. Soybean seeds, BARI-2 (Keroni-2) were collected from BADC, Barishal. The experiment was laid out in a completely randomized block design (CRBD) with three replications. The unit plot size was 3 m x 2 m. There were sixteen treatments and three replications *viz.* T_1: control (- CD and -NPK), T_2: 2.5 ton CD ha^{-1}, T_3: 5 ton CD ha^{-1}, T_4: 7.5 ton CD ha^{-1}, T_5: $N_{40}P_{30}K_{50}$kg ha^{-1}, T_6: $N_{80}P_{60}K_{100}$kg ha^{-1}, T_7: $N_{120}P_{90}K_{150}$kg ha^{-1}, T_8: 2.5 ton CD ha^{-1}+$N_{40}P_{30}K_{50}$kg ha^{-1}, T_9: 2.5 ton CD ha^{-1}+$N_{80}P_{60}K_{100}$kg ha^{-1}, T_{10}: 2.5 ton CD ha^{-1}+$N_{120}P_{90}K_{150}$kg ha^{-1}, T_{11}: 5 ton CD ha^{-1}+ $N_{40}P_{30}K_{50}$kg ha^{-1}, T_{12}: 5 ton CD ha^{-1}+$N_{80}P_{60}K_{100}$kg ha^{-1}, T_{13}: 5 ton CD ha^{-1}+$N_{120}P_{90}K_{150}$kg ha^{-1}, T_{14}:7.5 ton CD ha^{-1}+$N_{40}P_{30}K_{50}$kg ha^{-1}, T_{15}:7.5 ton CD ha^{-1}+$N_{80}P_{60}K_{100}$kg ha^{-1} and T_{16}: 7.5 ton CD ha^{-1}+$N_{120}P_{90}K_{150}$kg ha^{-1}. The NPK doses were chosen following BARC[14]. At the time of initial land preparation, cow dung was applied and at final land preparation, N, P and K were applied as urea, TSP and MoP, respectively. Seeds were sown on 29 December, 2015. Sixty seeds were sown in each plot. Length between row to row 40 cm and width between seed to seed 25 cm. Intercultural practices i.e. weeding, spading, fencing, applying pesticide *etc.* were applied when needed. Different agronomic parameters *viz.* plant height, leaf number, leaf area and leaf area index were measured at the intervals of 30, 60 and 90 days after sowing. Finally, plants were harvested after 90 days of sowing seeds at the maturity. Different organs of sunflower plants *viz.* root, stem, leaf and seed were collected and dried in an oven at temperature of 65^0C. The dry weight of different parameters and seed weight, number of seeds and 100 seeds weight were measured and kept in paper bags separately. Analysis of variance was done with the help of Microsoft Excel 2007 program and the mean differences among treatments were evaluated by LSD test at 5% level.

Results and Discussion

Height (cm), leaf number (no. plant^{-1}), leaf area (cm^2) and leaf area index: Plant height (cm), leaf number (no. $plant^{-1}$), leaf area (cm^2) and leaf area index of sunflower were measured at 30, 60 and 90 days after sowing seeds (Tables 1 and 2).

Plant height, leaf number, leaf area and leaf area index gradually increased with the growth period irrespective of the treatments (Table 1). Moreover, the parameters also increased with the increased rates of cow dung and fertilizers in most of the cases.

Maximum height of plant, leaf area and leaf area index at maturity were found 208.4 cm, 410.5cm^2 and 12.75, respectively, in T_{16}:(7.5 ton CD ha^{-1}+ $N_{120}P_{90}K_{150}$kg ha^{-1}) treatment. Minimum values were recorded in the control treatment in all the cases of growth parameters. Muhsin *et al.*[6] observed that the application of organic manure had a significant effect on sunflower seed yield, biomass yield, head diameter, 500 seed weight, seeds per head, leaf area, leaves per plant, plant height, and stem girth at both growing locations.

Table 1. Effects of cow dung and NPK fertilizers on height (cm) and leaf number (no.plant^{-1}) of sunflower plant.

Treatments	Days after sowing					
	Plant height (cm)			Leaf number (no.plant^{-1})		
	30d	60d	90d	30d	60d	90d
T_1: Control (-CD and -NPK)	22.0^{d}	91.7^{e}	97.2^{e}	9.3^{d}	18.0^{c}	24.2^{c}
T_2: 2.5 ton CD ha^{-1} (50 % RDF)	26.7^{cd}	118.0^{d}	125.2^{d}	10.0^{cd}	23.7^{b}	30.0^{b}
T_3: 5 ton CD ha^{-1} (100 % RDF)	29.5^{c}	110.0^{de}	117.6^{de}	11.3^{c}	22.7^{bc}	32.5^{b}
T_4: 7.5 ton CD ha^{-1} (150 % RDF)	36.8^{b}	130.3^{cd}	144.4^{cd}	12.7^{bc}	27.0^{b}	36.5^{ab}
T_5: $N_{40}P_{30}K_{50}$kg ha^{-1} (50% RDF)	28.7^{cd}	143.7^{c}	155.6^{c}	12.0^{bc}	23.7^{b}	33.7^{b}
T_6:$N_{80}P_{60}K_{100}$kg ha^{-1} (100% RDF)	47.7^{ab}	167.0^{b}	180.1^{b}	14.0^{ab}	33.3^{ab}	37.2^{ab}
T_7: $N_{120}P_{90}K_{150}$kg ha^{-1} (150% RDF)	38.0^{b}	170.3^{b}	190.5^{ab}	14.0^{ab}	29.7^{ab}	39.0^{ab}
T_8: 2.5 ton CD ha^{-1}+$N_{40}P_{30}K_{50}$ kg ha^{-1}	40.7^{b}	158.3^{bc}	181.0^{b}	13.3^{b}	28.0^{b}	36.6^{ab}
T_9: 2.5 ton CD ha^{-1}+ $N_{80}P_{60}K_{100}$ kg ha^{-1}	38.7^{b}	184.0^{ab}	192.2^{ab}	12.0^{bc}	30.3^{ab}	39.5^{ab}
T_{10}: 2.5 ton CD ha^{-1}+ $N_{120}P_{90}K_{150}$kg ha^{-1}	48.0^{a}	188.0^{ab}	198.6^{ab}	15.3^{a}	33.7^{a}	41.2^{a}
T_{11}: 5 ton CD ha^{-1}+$N_{40}P_{30}K_{50}$kg ha^{-1}	39.0^{b}	161.7^{bc}	177.5^{b}	12.0^{bc}	22.7^{bc}	34.3^{b}
T_{12}: 5 ton CD ha^{-1}+ $N_{80}P_{60}K_{100}$ kg ha^{-1}	40.0^{b}	177.3^{ab}	193.7^{ab}	14.3^{ab}	24.7^{b}	35.7^{ab}
T_{13}: 5 ton CD ha^{-1}+ $N_{120}P_{90}K_{150}$kg ha^{-1}	48.7^{a}	179.3^{ab}	199.5^{ab}	12.7^{bc}	25.7^{b}	33.2^{b}
T_{14}: 7.5 ton CD ha^{-1}+ $N_{40}P_{30}K_{50}$kg ha^{-1}	42.3^{ab}	179.7^{ab}	196.4^{ab}	14.3^{ab}	24.7^{b}	36.4^{ab}
T_{15}: 7.5 ton CD ha^{-1}+ $N_{80}P_{60}K_{100}$kg ha^{-1}	44.0^{ab}	182.0^{ab}	202.6^{a}	14.7^{ab}	24.3^{b}	37.6^{ab}
T_{16}: 7.5 ton CD ha^{-1}+ $N_{120}P_{90}K_{150}$kg ha^{-1}	46.8^{ab}	195.0^{a}	208.4^{a}	15.3^{a}	27.0^{b}	39.5^{ab}
LSD at 5% level	7.25	20.80	20.79	1.64	5.4	5.62

^{abcde} Data bearing different superscripts in the same column differ significantly at 5% level.

Table 2 Effects of cow dung and NPK fertilizers on leaf area (cm^2) and leaf area index of sunflower plant.

Treatments	Days after sowing					
	Leaf area (cm^2)			Leaf area index		
	30d	60d	90d	30d	60d	90d
T_1: Control (-CD and -NPK)	49.8^{d}	85.7^{d}	82.3^{k}	0.47^{d}	1.52^{d}	1.30^{b}
T_2: 2.5 ton CD ha^{-1} (50 % RDF)	72.9^{cd}	146.6^{cd}	140.6^{j}	0.73^{d}	3.43^{cd}	2.32^{b}
T_3: 5 ton CD ha^{-1} (100 % RDF)	91.4^{c}	151.8^{cd}	155.3^{i}	1.04^{cd}	3.45^{cd}	3.95^{b}
T_4: 7.5 ton CD ha^{-1} (150 % RDF)	89.5^{c}	135.4^{d}	149.5^{i}	1.14^{cd}	3.73^{cd}	4.65^{b}
T_5: $N_{40}P_{30}K_{50}$kg ha^{-1} (50% RDF)	86.3^{cd}	221.7^{cd}	237.3^{h}	1.05^{cd}	5.22^{c}	6.20^{b}
T_6: $N_{80}P_{60}K_{100}$kg ha^{-1} (100% RDF)	136.9^{b}	321.3^{bc}	320.4^{d}	1.92^{bc}	9.57^{b}	9.22^{ab}
T_7: $N_{120}P_{90}K_{150}$kg ha^{-1} (150%RDF)	116.0^{bc}	256.3^{bc}	290.5^{e}	1.64^{bc}	6.77^{bc}	8.26^{ab}
T_8: 2.5 ton CD ha^{-1}+$N_{40}P_{30}K_{50}$ kg ha^{-1}	127.7^{bc}	262.5^{bc}	270.5^{f}	1.63^{bc}	7.50^{bc}	7.30^{ab}
T_9: 2.5 ton CD ha^{-1}+ $N_{80}P_{60}K_{100}$ kg ha^{-1}	126.2^{bc}	311.3^{bc}	320.2^{d}	1.51^{c}	9.42^{b}	8.75^{ab}
T_{10}: 2.5 ton CD ha^{-1}+ $N_{120}P_{90}K_{150}$kg ha^{-1}	179.6^{a}	389.0^{ab}	360.3^{c}	2.75^{a}	13.18^{a}	12.16^{a}
T_{11}: 5 ton CD ha^{-1}+$N_{40}P_{30}K_{50}$kg ha^{-1}	104.7^{bc}	182.7^{cd}	247.0^{g}	1.26^{cd}	4.92^{c}	7.50^{ab}
T_{12}: 5 ton CD ha^{-1}+ $N_{80}P_{60}K_{100}$ kg ha^{-1}	139.3^{b}	235.5^{cd}	325.2^{d}	2.00^{bc}	6.29^{c}	8.10^{ab}
T_{13}: 5 ton CD ha^{-1}+ $N_{120}P_{90}K_{150}$kg ha^{-1}	168.4^{ab}	328.0^{b}	381.2^{b}	2.13^{b}	8.40^{bc}	9.80^{ab}
T_{14}: 7.5 ton CD ha^{-1} + $N_{40}P_{30}K_{50}$kg ha^{-1}	114.3^{bc}	241.7^{b}	264.0^{f}	1.64^{bc}	5.98^{c}	7.80^{ab}
T_{15}: 7.5 ton CD ha^{-1}+ $N_{80}P_{60}K_{100}$kg ha^{-1}	177.1^{a}	267.3^{b}	359.4^{c}	2.51^{ab}	6.50^{bc}	9.62^{ab}
T_{16}: 7.5 ton CD ha^{-1} + $N_{120}P_{90}K_{150}$kg ha^{-1}	161.9^{ab}	425.7^{a}	410.5^{a}	2.47^{ab}	11.54^{ab}	12.75^{a}
LSD at 5 % level	37.56	89.39	8.75	0.57	3.07	5.62

^{abcdefghijk} Data bearing different superscripts in the same column differ significantly at 5% level.

Generally, highest doses of both cow dung and fertilizers together produced comparatively higher results probably due to availability of nutrients was more. Shoghi-Kalkhoran *et al.*[3] observed that the integrated application of organic and inorganic fertilizers increased plant height and leaf area index of sunflower plants significantly (P<0.05%) over control. Agele and Taiwo[15] showed that cow dung manures enhanced sunflower growth in terms of plant height, leaf area, number of leaves and leaf area index over the control significantly. Filho *et al.*[16] showed that the sunflower plant cultivated in Haplic Luvisol with the highest dose of cattle manure (20% v/v) had a better performance over the control**.** Yazdanbakhsh *et al.*[17] suggested that the plants' biomass of sunflower plant was increased by adding modifiers (6%, 12%, 25%) such as cow manure and biosolids.

Dry matter yield: Dry weight of root, stem and leaf, and seed are presented in Table 3. The influence of cow dung and NPK fertilizers produced root biomass in the ranges from 0.83 to 12.83 g plant^{-1}, stem from 10.0 to 60.67 g plant^{-1}, leaf from 6.67 to 25.33 g plant^{-1}, total dry matter yield from 17.50 to 92.01 g plant^{-1}, total dry matter yield from 1.09 to 5.75 ton ha^{-1}, diameter of inflorescence from 24.67 to 52.67 cm, seed weight from 7.8 to 64.7 g plant^{-1}, number of seed from 129.3 to 735.7 plant^{-1} and weight of 100 seed in the ranges from 6.0 to 9.8 g . The highest root biomass, stem, leaf, total dry matter yield gram per plant, total dry matter yield ton per hectare, diameter of inflorescence, seed weight per plant, number of seed per plant and weight of 100 seeds were recorded in $T_{15'}$ $T_{16'}$ $T_{15'}$ $T_{16'}$ $T_{16'}$ $T_{13'}$ $T_{15'}$ $T_{13'}$ and T_{15} treatments, respectively. Treatments showed that the combinations of cow dung and NPK fertilizers produced better results than their individual effects. Among the treatments, T_{15} and T_{16} produced the best result in most of the cases. Results varied significantly ($p<0.05$).

The overall highest yields of root (12.83g) and stem (60.67g) were recorded at treatments T_{15} and $T_{16'}$ respectively. The results are in agreement with Muhsin *et al.*[6].

Combined applications of cow dung and chemical fertilizers produced higher results than cow dung and chemical fertilizers when applied alone. The diameter of inflorescence of sunflower increased with the different rates of cow dung and chemical fertilizers and the maximum diameter (52.67cm) was found in the treatment T_{13} (5 ton CD ha^{-1}+ $N_{120}P_{90}K_{150}$kg ha^{-1}). It is clear that irrespective of the rates, diameter of inflorescence of sunflower remained statistically identical.

Yield of dry matter per plant and per hectare increased with increasing rates of cow dung and chemical fertilizers. Highest productions of dry matter in both the measures were recorded in the same treatment (T_{16}). Trend in changes in dry matter production in both the agronomic parameters were almost same which is quite obvious. Naveed *et al.* [18] suggested that the combined application of gypsum and composted cow dung for better production of sunflower in salt-affected soils, and augmented growth, yield, physiology, biochemistry and nutritional value in the sunflower seeds.

Table 3. Effects of cow dung and NPK fertilizers on the dry matter yield (root, stem and leaf) and seed yield parameters of sunflower.

Treatments	Root (g/plant)	Stem (g/plant)	Leaf (g/plant)	Total dry matter yield (g/plant)	Total dry matter yield (t/ha)	Diameter of in-florescence (cm)	Seed wt. (g/plant)	Number of seed ($plant^{-1}$)	Wt. of 100 seed (g)
T_1: Control (-CD and -NPK)	0.83^{d}	10.00^{c}	6.67^{c}	17.50^{f}	1.09^{g}	24.67^{c}	7.8^{c}	129.3^{c}	6.0^{cd}
T_2: 2.5 ton CD ha^{-1} (50 % RDF)	2.00^{cd}	11.33^{c}	8.00^{c}	21.33^{f}	1.33^{fg}	29.67^{bc}	13.3^{c}	250.0^{c}	5.3^{cd}
T_3: 5 ton CD ha^{-1} (100 % RDF	2.00^{cd}	15.33^{c}	8.67^{c}	26.00^{f}	1.63^{f}	32.00^{bc}	15.3^{c}	314.0^{c}	4.9^{d}
T_4: 7.5 ton CD ha^{-1} (150% RDF)	4.67^{c}	19.33^{bc}	9.33^{c}	33.33^{ef}	2.08^{ef}	34.33^{bc}	18.8^{c}	291.0^{c}	6.4^{c}
T_5: $N_{40}P_{30}K_{50}$kg ha^{-1} (50% RDF)	5.67^{bc}	22.67^{bc}	11.33^{bc}	39.67^{e}	2.48^{e}	40.33^{b}	24.0^{c}	439.0^{b}	5.5^{cd}
T_6: $N_{80}P_{60}K_{100}$kg ha^{-1} (100% RDF)	6.00^{bc}	20.67^{bc}	11.67^{bc}	38.34^{e}		48.67^{ab}	37.3^{bc}	466.0^{b}	7.9^{b}
T_7: $N_{120}P_{90}K_{150}$kg ha^{-1} (150% RDF)	6.67^{bc}	37.33^{bc}	16.00^{bc}	60.00^{cd}		47.67^{ab}	34.0^{bc}	570.0^{ab}	6.1^{cd}
T_8: 2.5 ton CD ha^{-1}+ $N_{40}P_{30}K_{50}$ kg ha^{-1}	7.00^{bc}	53.33^{ab}	18.00^{ab}	78.33^{b}	4.90^{bc}	48.33^{ab}	40.7^{b}	508.3^{b}	8.0^{b}
T_9: 2.5 ton CD ha^{-1}+ $N_{80}P_{60}K_{100}$ kg ha^{-1}	6.33^{bc}	38.00^{b}	15.33^{bc}	59.66^{cd}	3.73^{d}	46.67^{ab}	41.7^{b}	521.7^{b}	7.9^{b}
T_{10}: 2.5 ton CD ha^{-1}+ $N_{120}P_{90}K_{150}$kg ha^{-1}	8.67^{b}	32.67^{bc}	13.33^{bc}	54.67^{d}	3.42^{d}	47.00^{ab}	35.7^{bc}	647.0^{ab}	5.5^{cd}
T_{11}: 5 ton CD ha^{-1}+ $N_{40}P_{30}K_{50}$kg ha^{-1}	9.33^{ab}	44.00^{ab}	17.33^{b}	70.66^{bc}	4.42^{c}	44.67^{ab}	41.1^{b}	483.3^{b}	8.5^{ab}
T_{12}: 5 ton CD ha^{-1}+ $N_{80}P_{60}K_{100}$ kg ha^{-1}	8.00^{bc}	37.67^{b}	18.67^{ab}	64.34^{c}	4.02^{cd}	45.67^{ab}	52.7^{ab}	592.0^{ab}	8.7^{ab}
T_{13}: 5 ton CD ha^{-1}+ $N_{120}P_{90}K_{150}$kg ha^{-1}	10.33^{ab}	40.00^{ab}	19.33^{ab}	69.66^{bc}	4.35^{c}	52.67^{a}	57.3^{ab}	735.7^{a}	7.7^{bc}
T_{14}: 7.5 ton CD ha^{-1}+ $N_{40}P_{30}K_{50}$kg ha^{-1}	11.33^{ab}	46.67^{ab}	25.33^{a}	83.33^{ab}	5.21^{b}	45.67^{ab}	60.6^{a}	631.7^{ab}	9.6^{a}
T_{15}: 7.5 ton CD ha^{-1}+ $N_{80}P_{60}K_{100}$kg ha^{-1}	12.83^{a}	42.00^{ab}	16.67^{bc}	71.50^{bc}	4.47^{c}	51.00^{ab}	64.7^{a}	658.3^{ab}	9.8^{a}
T_{16}: 7.5 ton CD ha^{-1}+ $N_{120}P_{90}K_{150}$kg ha^{-1}	10.67^{ab}	60.67^{a}	20.67^{ab}	92.01^{a}	5.75^{a}	52.33^{a}	54.0^{ab}	616.7^{ab}	8.7ab
LSD at 5% level	3.5	22.21	7.41	9.46	0.53	11.83	16.65	187.4	1.31

^{abcd} Data bearing different superscripts in the same column differ significantly at 5% level.

Seed yield: Weight of seed plant^{-1} and number of seed plant^{-1} varied significantly (P<0.05) (Table 3). The effects of treatments were found to be statistically significant (P<0.05) over the control in most of the treatments. However, the variations among the seed yields plant^{-1} and weight of seeds plant^{-1} due to treatments were found to be statistically identical in most of the cases. Highest yield of seed (64.7 g plant^{-1}) was recorded in T_{15} (7.5 ton CD ha^{-1}+ $N_{80}P_{60}K_{100}$kg ha^{-1}) treatment. The highest number of seeds plant^{-1} (735.7) was recorded in T_{13} (5 ton CD ha^{-1} +$N_{120}P_{90}K_{150}$kg ha^{-1}) treatment. Agele and Taiwo[15] reported that seed weight per plant and total seed yield of sunflower were obtained from plots amended with organic fertilizers in both experiments over control. Similarly, Filho *et al.*[16] reported that the highest dose of cattle manure had a better performance on number of seeds plant^{-1}, weight of seeds plant^{-1}, weight of 1000 seeds and the outer diameter of the capitulum head^{-1} of sunflower than other treatment and control. Haque *et al.*[19] also reported that the maximum doses of cow dung and poultry litter (9 ton ha^{-1} and 11 ton ha^{-1}) showed the best performance on pod yield (3.24 kg plot^{-1}) and pod yield (9 ton ha^{-1}) of crop respectively over the control.

Seed weight of 100 grains generally increased with the increasing rates of cow dung and chemical fertilizers. However, the variations among the treatments in most of the cases were not significant. The highest weight of 100 grains (9.8 g) was found in $T_{15'}$ (7.5 ton CD ha^{-1}+ $N_{80}P_{60}K_{100}$kg ha^{-1}) treatment. It might be concluded that the combined application of cow dung and NPK fertilizers (T_{15} and T_{16} treatments) for the overall growth and yield of sunflower was better in the soils of southern coastal belt of Bangladesh.

References

1. Kaushik G, J Vishnu and R Arslam 2014. The result of nitrogen, sulfur and farmyard manure on growth and yield of sunflower (*Helianthus annuus* L.) under moderate conditions. Afr. J. Agron. **2**(6): 177-179.
2. Alauddin M, MK Rahman and AHMZ Ali. 2022. Influence of cow dung and NPK fertilizers on macronutrients and oil content of sunflower (*Helianthus annuus* L.). J. Biodivers. Conserv. Bioresour. Manag. **8**(2): 51- 60.
3. Shogi-Kalkhoran S, A Ghalavand, SMA Modarres-Sanavy, A Mokhtassi-Bidgoli and P Akbari 2013. Integrated fertilization systems enhance quality and yield of sunflower (*Helianthus annuus* L.). J. Agric. Sci. Tech. **15**: 1343-1352.
4. Rasool FU, B Hassan and IA Jahangir 2013. Growth and yield of sunflower (*Helianthus annuus* L.) as influenced by nitrogen, sulphur and farmyard manure under temperate conditions. SAARC J. Agril. **11**(1): 81-89.
5. Badar R and SA Qureshi. 2014. Composted rice husk improves the growth and biochemical parameters of sunflower plants. J. Bot. **10**(1):1-6.
6. Muhsin SJ, MN Ramadhan and AJ Nassir 2021. Effect of organic manure and tillage depths on sunflower (*Helianthus annuus* L.) production. IOP Conf. Ser. Earth Environ. Sci. **735**: 01-09.
7. Esmaeilian Y, AR Sirousmerh, MR Asghripour and E Amiri 2012. Comparison of sole and combined nutrient application on yield and biochemical composition of sunflower under water stress. Int. J. Appl. Sci. Tech. **2**(3): 214-220.

8. Walkley A and IA Black 1934. An examination of the Degtjareff method for determining soil organic matter and a proposed modification for the chromic acid titration method. Soil Sci. **37**: 29-38.
9. Marr IL and MS Cresser. 1983. The lithosphere. In: *Environmental Chemical Analysis*. Blackie and Son LTD. UK. pp. 155-182.
10. Jackson ML 1958. *Soil Chemical Analysis*. Prentice Hall, Inc., Engle Wood Cliffs, NJ, USA. pp.498.
11. Pratt PF 1965. Potassium. In: *Methods of Soil Analysis*. Part 2, Black, I.A. (ed). SAA Inc., Madison, Wisconsin. pp.1022-1030.
12. Bardsley CE and JD Lancaster 1965. Sulfur. In: *Methods of Soil Analysis*. Part 2. Black, I.A. (ed). ASA, Inc., Madison, Wisconsin, USA. pp. 1102-1114.
13. Bouyoucos GJ 1962. Hydrometer method improved for making particle size analysis of soils. Agron. J. **54**: 461-465.
14. BARC (Bangladesh Agricultural Research Council) 2018. *Fertilizer Recommendation Guide*. Bangladesh Agricultural Research Council (BARC). Farmgate, Dhaka-1215. pp. 223.
15. Agele SO and TG Taiwo 2013. Effects of methods of seedbed preparation and organic amendments on soil properties, growth and yield of sunflower (*Helianthus annuus* L.) in a humid zone of Nigeria. Int. J. Plant Soil Sci. **2**(1): 55-59.
16. Filho FCFM, EF Mesquita, HOC Guerra, MF Moura and LHG Chaves 2013. Effect of cattle manure on sunflower production and water use in two types of soil. Rev. Ceres. Vicosa **60**(3): 397-405.
17. Yazdanbakhsh A, SN Alvi, SA Valadabadi, F Karimi and Z Karimi 2020. Heavy metal uptake of salty soils by ornamental sunflower, using cow manure and biosolids: A case study in Alborz City. Iran. J Air, Soil and Water Res. **13**:1-13.
18. Naveed M, MK Aslam, Z Ahmad, T Abbas, A A Al-Huqail, M H Ali, I Ashraf and A Mustafa 2021. Growth responses, physiological alterations and alleviation of salinity stress in sunflower (*Helianthus annuus* L.) amended with gypsum and composted cow dung. J. Sustain. **13**:6792-6808.
19. Haque M, HO Rashid and E Pervin 2015. Effect of the combination of cow dung and poultry litter on the yield of okra (*Abelmoschus esculentus* L.). Basic Res. J. Agril. Sci. Review **4**(7): 193-198.

(Manuscript received on 24 November, 2022; accepted on 8 December, 2022)