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Assessment of Organic Amendments on Growth and Flower Yield of Sunflower (*Helianthus annus*)

A.G. Adebayo, H.A. Akintoye, O.O. Aina, M.T. Olatunji and A.O. Shokalu

National Horticultural Research Institute, Ibadan

Abstract: Experiments were carried out between November 2008 and August 2009 to evaluate the effects of organic amendments on growth and flower yield of Sunflower. The treatments consisted of cured poultry manure (Pm), cured cow dung (Cd) and composted organic waste of different combination on dry weight basis: cassava/poultry manure 3:1 (Cp3Pm), cassava/poultry manure 2:1(Cp2Pm), elephant grass/poultry manure 3:1 (Eg3Pm) and elephant grass /poultry manure 2:1(Eg2Pm) and top soil as control. Organic amendments at 5ton haG^{1} (15.8g) were added to pots containing 6 kg top soil except the control. The experiments were arranged in a completely randomized design (CRD) and replicated three times. Data on number of leaves, stem girth and plant height were collected at two (2) weeks interval from four (4) weeks after planting (WAP). Yield data were also collected at flowering and at maturity. Results indicated that Cp3pm significantly recorded higher plant height at 4WAP, but significantly had low stem and root dry matter weight. However, cow dung (CD) significantly produced higher flower diameter (12.13cm) and head weight (39.3g) at harvest.

Key words: Sunflower % Soil amendments % Vegetative development % Yield and compost

INTRODUCTION

Sunflower (*Helianthus annus* L.) over the years has emerged as an important ornamental and oilseed crop in the world. It was introduced into Nigeria after 1965 [1]. It is a successful crop both in irrigated and in rain fed areas and grow well, when planted in areas with adequate sunlight, light–textured and well drained sandy loam soil [2]. World area under sunflower cultivation is 22.3ml hectares, with seed production and average yield stand at 27.7ml tons and 1.2thaG^{1} respectively. Although, there is a clear upward trend in the sunflower production in the country, but statistical data on production level are not available [3]. Grain yield above 1ton haG^{1} has been reported depending on cultivars planted [1].

One of the factors required for optimum yield of crops is adequate nutrient in the soil and its proper management. Organic amendments are cheap sources of improving nutrients status of soil and compost is one of the organic amendments that are made from plant and animal left over, but have been decomposed by the existing micro-organism in the presence of air and water. The main objective of making compost manure is to re-cycle nutrients in the plants and animal left over back to the soil for plant growth. Research have shown that compost and other organic manures can serve as soil amendments to improve soil nutrient status and water holding capacity [4, 5], particularly in sandy soils. They stabilize soil pH, increase soil organic matter and ultimately improve plant growth and yields. Compost may be utilized as an alternative to polyethylene mulches [6] and serve as an alternative form of weed control [7] and increase soil fertility in crop production systems. The advantage of ready availability of materials for their preparation, gradual release of plant nutrients without being wasted through leaching or erosion, destruction of harmful weeds and toxic materials during preparation and being environmentally friendly has made composted manure popular among farmers. The aforementioned advantages of compost application in crop production have long been recognized. However to obtain maximum benefit, certain conditions [8] must be considered and these include: suitably balanced ratio of nutrients, possible presence of toxic materials unaffected by biological degradation in the soil, possible presence of harmful microorganisms and suitable degree of stabilization of organic material. Effectiveness of compost depends primarily on source and type of organic material, method of composting and compost maturity. Mature compost provides a stabilized form of organic matter and has the potential to enhance nutrient release in the soil more than do raw organic wastes [9]. An adequate choice and treatment of composted materials may suffice the above points. However this varies with type of organic materials.

Corresponding Author: A.G. Adebayo, National Horticultural Research Institute, Ibadan, Nigeria
E-mail ajisafeag@yahoo.com.

This study was therefore aimed at assessing the effectiveness of combination of locally available organic amendments in increasing the growth and flower yield of Sunflower.

MATERIALS AND METHODS

Experiments were conducted between November 2008 and August 2009 at Floriculture Programme of National Horticultural Research Institute (7° 25" and 3° 52"E) Ibadan. The details of the physico-chemical properties of the top soil used for the pot experiment collected at a depth of 0-15cm, air dried, sieved (2mm) and analyzed at ROTAS Soil Laboratory, Ibadan, by standard procedures are given in Table 1. Samples taken were bulked to form a composite sample. It was then air- dried, crushed and sieved through 2mm mesh for the determination of the physical and chemical properties of the soil. Total nitrogen (N) was determined by Kjeldhal method after digestion of material [10].Available P was determined using Bray 1 method. [11]. Particle size analysis was determined using the method of Bouyoucous [12]. Exchangeable bases were done by extraction with 1m NH_4OAC. Calcium (Ca) and Magnesium (Mg) in the extract were determined by atomic absorption spectrophotometer [13] Effective CEC was the summation of exchangeable bases (Ca, Mg, K, Na), Potassium (K) was determined by flame photometer. pH (H_2O) using a pH meter [14]. Percentage organic carbon was by chromic acid digestion [15].

The treatments consisted of cured poultry manure (Pm), cow dung (Cd) and composted organic waste of different combination on dry weight basis: cassava peel and poultry manure (Cp3Pm) 3:1. Cassava peel and poultry manure (Cp2 Pm) 2:1 elephant grass and poultry manure (Eg3Pm), 3:1 elephant grass and poultry manure (Eg2 Pm) 2:1 and top soil as control (Cts). Organic amendments at 5 ton ha^{-1} (15.8 g/pot) were added to pots containing 6 kg top soil. The experiments were arranged in a completely randomized design (CRD) with three replicates. Data on vegetative growth parameters: plant height, stem girth and number of leaves were collected at weekly interval from four (4) weeks after planting (WAP). The compost was prepared using Passively Aerated Composting Technique in a plastic pot as applied by [9]. The compost components of the treatments were mixed together at different ratio as stated, on dry weight basis. Organic amendments were also analyzed by standard procedures and the results are given in Table 2. The organic amendments at 5tons per hectare (15.8g per 6 kg of soil) were mixed thoroughly with 6 kg soil per pot and applied 10 days before planting. Four seeds of Sunflower (Giant yellow) were planted per pot, but later thinned to one seedling, two weeks after planting (2WAP). The experiments were arranged in a completely randomized design (CRD) and replicated three times. The pots were supplied with water every twenty four hours and weeding was done manually, on weekly basis. Random samples of four plants per plot were selected and tagged. Data on growth parameters were taken at weekly interval on the tagged plants from 4 WAP. Data on flower diameter and dry matter partitioning data were taken at flowering and harvest stages respectively. Data collected were subjected to analysis of variance (ANOVA) using SAS 2000 model and significantly different means were compared using Duncan's Multiple Range Test at $P<0.05$ confident level [16].

Table 1:Pre-cropping physical and chemical properties of soils used

Soil property	
pH	7.70
Sand mg g^{-1}	770.00
Clay mg g^{-1}	56.00
Silt mg g^{-1}	174.00
Ca c mol kg^{-1}	1.80
Mg c mol kg^{-1}	0.74
Na c mol kg^{-1}	0.35
K c mol kg^{-1}	0.21
Exch. Acidity	0.06
ECEC me/100g	3.16
C mg g^{-1}	11.10
N mg g^{-1}	1.30
Av. P mg g^{-1}	1.95
Cu mg g^{-1}	0.34
Zn mg g^{-1}	1.18
Fe mg g^{-1}	6.15
Mn mg g^{-1}	45.45

Table 2: Chemical properties of the compost mixes used for the experiment

Treatment	Ca %	Mg %	Mn ppm	Cu ppm	Zn Ppm	Fe %	Na %	K %	P %	C %	N %	C:N
Cd	1.57	0.510	112.00	19.30	115.40	0.09	0.41	1.49	0.12	36.10	1.12	32:1
Pm	2.87	0.300	501.00	27.10	374.20	0.78	0.69	0.26	0.99	15.67	0.62	25:1
Cp2pm	2.15	0.270	284.00	19.00	326.00	0.50	0.44	1.40	0.77	19.46	1.03	15:1
Cp3pm	2.86	0.280	136.00	10.20	65.80	0.08	1.58	3.77	0.28	34.94	1.20	29:1
Eg2pm	0.51	0.005	318.00	71.70	471.30	1.23	0.20	0.09	0.28	37.00	0.96	38:1
Eg3pm	5.26	0.300	314.00	20.80	396.50	0.51	0.45	3.91	0.97	14.64	0.99	15:1

Cd= Cow dung; Pm= Poultry manure; Cp3Pm= Cassava peel + poultry manure (3:1)

Cp2Pm= Cassava peel + poultry manure (2:1); Eg3Pm= Elephant grass + poultry manure (3:1)

Eg2Pm= Elephant grass + poultry manure (2:1)

RESULTS AND DISCUSSION

Seasonal Changes and Sunflower Performance: The growth and yield data for the two plantings are presented in Tables 3, 4. It was generally observed that the values of growth parameters (plant height, plant girth and number of leaves) obtained in the first planting which was during dry season (November 2008–March 2010) were generally higher than the second planting (April 2009- August 2009) done in the raining season. Yield data (Flower diameter and seed weight) also follow same pattern. This observation may be due to lower occurrence of disease causal organism during the dry season. This observation was in agreement with [17, 18] who observed that seasonal variation affect growth of crops.

Soil Analysis: The results of the physical and chemical analysis of the potted soil before cropping are presented in Table 1. The soil was mostly sandy loam in texture with pH of 7.7. Total N content was 1.3mg g^{1}, Available P 1.95 mg g^{1}, K 0.21 c mol kg^{1}, Fe 6.15 mg g^{1}, Zn 1.18mg g^{1}and Mn value was 45.45mg kg$^{-1.}$ The major nutrient content of the soil were inadequate. This agrees with the report of [2] that most Nigerian soils are deficient in major nutrient, thus the need for use of sustainable soil amendments.

Organic Amendments Analysis: The nutrients concentrations of major organic materials used for the composting are shown in Table 2. The results indicated the differences in nutrients composition of the compost mixes. Cassava/Poultry manure mixed in ratio (Cp3pm) 3:1 on dry weight basis contains the highest concentration of Nitrogen (1.20%), followed by cow dung (1.12%). Poultry manure, Cp2pm 2:1 and Eg3pm 3:1 had almost same P content, while Ep2pm 2:1 and Cp3pm 3:1 contains 0.28% P content respectively and cow dung had the lowest P content. The materials also differ in K content, with Poultry manure and Ep2pm 2:1 having the lowest content, while Ep3pm 3:1 and Cp3pmP 3:1 contain 3.91% and 3.77% respectively. Depending on nutrients situation of soils, each of the amendments is suitable for ameliorating nutrient deficiency in soils.

Table 3: Effect of organic amendment on vegetative development of Sunflower at flowering

	Number of leaves		Plant height		Stem girth	
Treatment	----------		----------		----------	
Planting	1st	2nd	1st	2nd	1st	2nd
Control	32.33a	29.17a	90.10a	78.99a	0.98a	0.78ab
Cd	31.00a	27.44a	106.32a	92.05a	1.13a	0.86a
Pm	32.77a	31.28a	108.42a	96.57a	1.22a	0.84a
Cp2pm	35.05a	31.11a	114.87a	95.50a	1.23a	0.89a
Cp3pm	31.44a	30.78a	101.78a	83.83a	1.13a	0.84a
Eg2pm	30.31a	30.55a	104.97a	88.30a	1.19a	0.86a
Eg3pm	31.92a	28.33a	101.61a	82.17a	1.12a	0.81a

Means represented by same letters are not significantly different

Cd= Cow dung; Pm= Poultry manure; Cp3Pm= Cassava peel + poultry manure (3:1); Cp2Pm= Cassava peel + poultry manure (2:1); Eg3Pm= Elephant grass + poultry manure (3:1); Eg2Pm= Elephant grass + poultry manure (2:1)

Table 4a: Effect of organic amendment on yield parameters and dry matter composition of stem, root and leaves

			Dry weights (g)		
Treatment	Flower diameter (cm)	Head weight (kg)	Stem	Root	Leaves
Control	13.27a	8.94ab	25.20a	9.43aa	18.6a
Cd	14.35a	9.43ab	30.81a	7.28a	16.43a
Pm	14.19a	9.18ab	29.48a	11.74a	19.86a
Cp2pm	13.92a	9.01ab	35.73a	12.00a	22.23a
Cp3pm	14.17a	12.22a	36.78a	7.39a	15.83a
Eg2pm	14.35a	8.49ab	31.94a	9.54a	18.75a
Eg3pm	12.57a	6.73b	33.10aa	10.26a	17.08a
2nd planting					
Control	6.49b	0.51b	24.4ab	8.1ab	16.6a
Cd	12.13a	3.93a	36.6a	11.9ab	14.34a
Pm	6.88b	0.51b	38.7a	8.7ab	18.00a
Cp2pm	7.37b	0.69b	47.3a	8.7ab	20.32a
Cp3pm	9.27b	0.82b	12.15b	5.8b	13.38a
Eg2pm	9.08b	2.37ab	46.3a	16.0a	16.57a
Eg3pm	7.27b	0.20b	29.9ab	5.3b	15.81a

Means represented by same letters are not significantly different

Cd= Cow dung; Pm= Poultry manure; Cp3Pm= Cassava peel + poultry manure (3:1); Cp2Pm= Cassava peel + poultry manure (2:1); Eg3Pm= Elephant grass + poultry manure (3:1); Eg2Pm= Elephant grass + poultry manure (2:1)

Effect of Organic Amendment on Vegetative Development of Sunflower: Growth parameters recorded in the first planting (November 2008-February 2009) were higher than the values obtained in the second planting (April 2009 –August 2009) (Table 3).This observation may be as a result of weather condition, as this period falls within the dry period of the year when rainfall was low and disease and pest infestation was very low.

The effects of organic amendments on plant height are shown in Table 3. Plant height increased from 4WAP for all the combinations of organic amendments. The values recorded by all the organic amendments were higher than the control at harvesting but these values were not significantly different from that of the control at this level of application. The highest plant height was recorded with poultry manure application (108.42 cm). The same trend was also recorded for number of leaves and stem girth. Cassava/Poultry manure mixed together on ratio 2:1 had the highest number of leaves (35) and also recorded the highest stem girth (1.23 cm). The higher values recorded for all the organic amendments over the control indicated that the use of these soil amendments is of benefit to sunflower production, but may require variation in the amount supplied per hectare. The higher plant growth as a result of organic amendment application may be associated with the fact that the materials release considerable amount of nutrients especially Nitrogen (N) for plant use [19]. This is essential for chlorophyll and protoplasm formation [20] and its absence or deficiency can cause yellowing of leaves and stunted growth plants [21].

Effect of Organic Amendment on Yield and Dry Matter Partitioning to Stem, Root and Leaves: Yield response and dry matter partitioning of sunflower to organic amendment are shown in Table 4. Organic amendments had no significant effect on flower diameter and head weight in the first planting, but cow dung application recorded the highest value for these yield parameters. In the second planting, organic amendment had significant effect on the flower diameter and head weight of sunflower. Cow dung significantly recorded the highest flower diameter (12.13cm) and head weight (3.93kg), these values were closely followed by cassava/poultry manure Cp3pm 3:1 for both parameters measured. The application of organic amendment at 5ton per hectare had no significant effect on dry matter content of sunflower in the first planting but Cp3pm 3:1 and Ep3pm 3:1 significantly recorded low dry matter content of root and stem in the second planting. The performance of cow dung and Cp3pm 3:1 over other amendments and control at this application rate may be as a result of the higher Nitrogen content in both treatments (Table 2). The higher stem height and number of leaves observed in both experiments with cow dung application in Table 2, followed by cassava peel mixed with poultry manure on 3:1, showed that cow dung and other compost mixes application aided vegetative development sunflower, but the superior performance of cow dung

may be due to its higher nitrogen content. Cow dung is a mixture of dung and urine, generally in the ratio of 3:1. It contains crude fibre, micronutrients, crude protein and materials that can be obtained in nitrogen -free extracts and ether extracts. The urine portion of cow dung consists of nitrogen, potash, sulphur and traces of phosphorus. When seed is treated with cow dung in various ways, it gets coated with cow dung residue that contains cellulose, hemi cellulose, micronutrients, metabolic nitrogen and epithelial cells from the animals, bile salt and pigment, potash, sulphur, traces of phosphorus and a large number of bacteria. This thin dry layer of residue on seed absorbs moisture from the surrounding soil to the advantage of the seed. The presence of bacteria in cow dung plays a significant role in the development of the seed. As these cow dung bacteria have the capacity to utilize cellulose, hemi cellulose and pectin, so these can quickly colonize the area around sown seed and compete with the pathogenic fungi and bacteria and prevent them from attacking the seed thus resulting in higher seedling establishment. Early reports of [22, 23, 17] that nutrient availability especially nitrogen (N) determined plant vegetative development. The consistent poor performance of non-fertilized plants and those planted with low nitrogen amendment revealed that when nutrients are available at adequate amounts, plants tends to grow at their optimum potential [24] reported significant reduction in plant growth parameters when soil is deficient in nutrient most especially nitrogen as they are often required for chlorophyll and protoplasm formation [16].

CONCLUSION

The nutrient composition of the organic amendment used for the experiment varied with its composition and according to mixing ratio. From this experiment, it was generally observed that addition of organic amendment increased both vegetative and yield of sunflower and cow dung at 5tons hG^{1} significantly increased the flower and head weight of sunflower.

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