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Effect of Organic and Bio Fertilization on the Growth and Flowering of *Rudbeckia hirta* Plants

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ABSTRACT

The present experiment was carried out at the Nursery of Ornamental Plants, Faculty of Agriculture, Minia University, Egypt during the two successive seasons of 2020 and 2021 to study the effect of organic compost and bio fertilizers (EM and/ or yeast) on growth, flowering and chemical compositions of *Rudbeckia hirta* plant. This species is known as an annual ornamental plant and used as flowerbed, pot plants and cut flower as well as it utilizes as a medicinal plant. This experiment was conducted in a complete randomized block design in a split plot arrangement with 3 replicates with 6 pots in each. The organic compost levels (0, 5, 10 and 15 g/ pot) were the main plots, while the bio fertilizer treatments (0, yeast, EM and yeast + EM) were located in the sub plots, obtained results revealed that the treatment with the mixture of the two bio fertilizers resulted in the best values for the growth and flowering parameters compared to other treatments. Also, the plants that treated with EM were more responsive than those treated with yeast or untreated ones in all studied traits. Moreover, results showed that the plant height, number of days to flowering, number and diameter of inflorescences, length of flower stalk, diameter and fresh weight of flower stalk as well as foliar N, P and K % were positively affected by the different compost and bio fertilization treatments. The combined treatments between EM + yeast at 50 ml/ plant with organic compost at 15 or 10 g/ pot gave the highest values compared to the other treatments in the 1st and 2nd seasons for all studied parameters.

KEYWORDS: *Rudbeckia hirta*, Bio fertilizers, EM , Yeast, Organic Compost.

1. INTRODUCTION

The genus *Rudbeckia* is belongs to Asteraceae family, it consists of about 30 species that endemic to North America (Palmer et al., 2009) and this genus includes annuals, biennials and perennial species (Oates et al., 2012). The annual species, *Rudbeckia hirta* L. (black-eyed Susan), includes a diverse range of flower colors and forms. The tetraploid cultivars of *R. hirta* typically having large flower and great height (Palmer et al., 2009). It grows from a taproot which produces stiff, coarse and upright pubescent stems 0.3 to 0.9 m tall (Tyrl et al., 2008). Each stem of the plant produces a solitary bloom up to 6 cm or more in diameter with 8 to 20 yellow ray flowers (Ajilvsgi, 2003). In addition, it blooms from summer to early fall (Ladybird Johnson Wildflower Center, 2019). The wildlife and pollinator insects as bees prefer black-eyed Susan flowers to collect pollens and nectar (Illinois Wildflowers, 2019). In addition, it is an annual ornamental plant that used as flowerbed, pot plants and cut flowers. On the other hand, *R. hirta* contains phenolic compounds as flavonoids, hydroxycinnamic acids and anthocyanins as well as other biologically active substances. It has been used in the traditional medicine in North America, homeopathy (Lukashou and Gurina, 2019).

Bio-fertilizers are safe for humans, animals, environment and prevent pollution compared to chemical fertilizers as well as limit the excessive use of chemical fertilizers. In addition to the expensive cost of chemicals, it might suppress the stability of soil organic matter and activity of microflora (Pokorna-Kozova, 1984). This was prompted many of researchers to use organic and bio fertilizers in their studies. According to their findings, adding organic and/or bio fertilizers to soils enhanced nutrient availability and plant uptake, increased crop yield, decreased the cost of chemical fertilizers and reduced environmental pollution. (Khalid et al., 2000; Koreish, 2003; Koreish et al., 2004; El-Naggar, 2010; Mazher et al., 2014; Mohamed and Ghatas, 2016 and Salman et al., 2020). Moreover,

Effective microorganisms (EM) is a culture containing about 60 microorganisms such as Lactobacillus plantarum, L. casei and Streptocous lactis, photosynthesis bacteria, algae and yeast (Formowitz et al., 2007; Mohamed and Ghatas, 2016). However, the results of Javaid (2006) and Singh (2007) found that application of EM improved the yield and quality as well as chemical constituents of ornamental plants. Ebeid et al. (2022) reported that applied yeast extract improved the growth and chemical characteristics of *Melia azedarach* seedlings compared to the control. Adding compost to the growing media could be beneficial for increasing nutrients and retention capacity of nutrients (Alvarez et al., 2017) and chemical characteristics (Bustamante et al., 2021). Moreover, organic media is rich in major and minor nutrients that plants and microorganisms need for its growth, in addition to enhancing soil porosity, regulating air and water as well as improving water holding capacity in the soil (Al-Showily and Hussein, 2022). Organic fertilizers like compost play a significant role in promoting plant growth (Marak et al., 2020). They added that combinations of bio fertilizers and compost resulted in increased of plant height, flower bud emergence, stalk length, number of flowers per plant, flower diameter and flower yield of China aster (*Callistephus chinensis* L.). Therefore, the main aim of this work is to evaluate the effect of organic fertilizer as compost and bio-fertilizers as EM and/ or yeast and their interactions on the growth and flowering characteristics of *Rudbeckia hirta* L.

2. MATERIALS AND METHODS

The present experiment was conducted at the Nursery of Ornamental Plants, Faculty of Agric., Minia Univ., Egypt during the two successive growing seasons of 2020 and 2021 in order to investigate the impact of organic and bio fertilizers on the growth and flowering characteristics of *Rudbeckia hirta* L. Fresh seeds (from Aswan Botanical Garden) were sown as broadcast in a prepared 1 x 1.5 m seedbed in mid- February for the two seasons. After 8 weeks of well-developed seedlings (15 cm tall), were individually transferred to PVC pot (25 cm in diameter) packed with clay loam soil. The physical and chemical characteristics of the used soil were assessed in accordance with Page et al. (1982) and displayed in Table (1 a).

2.1. Compost treatments:

Plant waste materials were used to create the organic compost that was used at rates of 5, 10, and 15 g/pot, and chemical composition was determined in line with Westerman (1990) and shown in Table (1b). Compost was added before seedling transplanting and each rate was mixed with the used soil.

2.2. Bio fertilizer treatments:

EM (1 ml contains 0.6 x 10^7 microorganisms) was added either separately or in a mixture with yeast at three equal doses to the soil around each seedling as 50 ml/plant.

Effective microorganisms (EM) biofertilizer consist N-fixing bacteria, photosynthetic bacteria, lactic acid, and yeasts. E.M. was gotten from the Department of Genetics, Laboratory of Biofertilizers, Faculty of Agriculture, Minia University. The 1st dose was added after 2 weeks from transplanting, while the remaining doses were added every month for both seasons. Meanwhile, the dry yeast (*Saccharomyces cerevisia*), was 95% and the live cells were 11.6 x 109/g. In order to maximize yeast activity, the yeast suspension was made by combining dry yeast and sugar (1:1) w/w in warm water (38o C). It was then allowed to stand for two hours before being sprayed (Skoog and Miller, 1957). The yeast suspension was also added either separately or in a mixture with EM at 3 equal doses to the soil at the rate of 50 ml/ pot. The first dose was added after 15 days from transplanting, while the remaining 2 doses were every month for the 1st and 2nd seasons.

2.3. Experimental layout:

The experiment was arranged in a complete randomized block design in a split plot arrangement with 3 replicates and 6 pots in each. The compost levels (control, 5, 10 and 15 g/ pot) were the main plots (A), while the bio fertilizer treatments (control, yeast, EM and yeast + EM) were in the sub plots (B).

2.4. Data recorded:

The following parameters of *Rudbeckia hirta* plants were measured throughout each growing season, plant height (cm), number of days from transplanting to flowering (days), number of inflorescences/ plant, inflorescence diameter (mm), flower stalk length (cm), flower stalk diameter (cm) and flower stalk fresh weight (g). Also, to determine the contents of N, P, and K (%), leaves were dried on oven at 60 °C for 72 hours based on Westerman (1990).

2.5. Statistical analysis:

The collected data of the two seasons were subjected to the statistically analyzed of variance using MSTAT–C (1986) and LSD test at 5% was used to compare the means of the various treatments.

Table 1a. Physical and chemical characteristics of the used soil.

Character	Value	Character		Value
Sand %	28.25	Available P (%)		15.17
Silt %	29.90	Exch. K^+ (mg/100 g)		2.34
Clay %	41.85	Exch. Ca^{++} (mg/100 g)		31.75
Soil type	Clay loam	Exch. Na^+ (mg/100 g)		2.41
OM (%)	1.58		Fe	8.50
CaCO3 (%)	1.54	DTPA Ext. (ppm)	Cu	2.07
pH (1:2.5)	7.83		Zn	2.74
E.C. (m mhos/cm)	1.05		Mn	8.24
Total N %	0.09			

Table 1b. Chemical analysis of the used organic compost.

pH	Humidity (%)	OM (%)	N (%)	P (%)	K (%)	Fe (ppm)	Mn (ppm)	Cu (ppm)	Zn (ppm)	C/N
7.95	24	43	1.6	0.6	1.1	1730	120	185	55	16.5

3. RESULTS

3.1. Plant height (cm):

Data in Table 2 pointed out that the plant height of *R. hirta* was significantly affected by all the tested organic and bio fertilization treatments in comparison with the control during the first and second seasons. There was significant differences among compost levels on the plant height in both growing seasons. The highest values of the plant height was noted combined with the application of 15 g, followed by 10g/ pot in the two seasons compared to the untreated plants. Also, there were significant differences between bio fertilizer treatments for the plant height in two experimental seasons. The highest values of the plant height (79.00 and 85.08 cm) were noticed with the combination of EM with yeast, followed by EM treatment alone (74.50 and 80.08 cm) compared to the other treatments in the 1st and 2nd seasons, respectively. However, the interaction between the tested treatments were significant for the plant height in the two seasons. The highest values of plant height (87.00 and 94.33 cm) were recorded with the combination of EM + yeast with compost at 15 g/ plant, followed by EM + yeast with 10 g/ plant (83.33 and 89.33 cm) for both seasons, respectively. On the other side, the untreated plants gave the lowest values of the plant height (64.09 and 63.67 cm) in the first and second seasons, respectively.

3.2. Number of days from transplanting to flowering (days):

The results in Table 2 revealed that all of compost, bio fertilizer treatments and the interaction between them significantly affected the number of days from transplanting to flowering in both seasons. Adding compost to the growth medium significantly decreased the number of days over check control plants in both seasons. Additionally, as rates of the organic compost increased, a gradual reduction in the mean number of days until flowering was observed. On the other side, application of the bio fertilizers, either as alone or in combination decreased the number of days to flowering compared to the control. The treatment with the mixture of the two bio fertilizers (EM + yeast) recorded the least number of days to flowering (67.83 and 68.00 days) in the first and second seasons, respectively, while the control plants were the highest one (86.09 and 85.49 days) in the 1st and 2nd seasons, respectively. The interaction between compost and bio fertilizers demonstrated the great impact of combining bio fertilizers (yeast+EM) with the highest rate of compost (15g/pot) on reducing the days to flowering (58.33 and 59.67 days) in both seasons, respectively.

3.3. Number of inflorescences/ plant:

Table 3 reveals that all of organic compost, bio fertilizer treatments and the interactions between them significantly affected the number of inflorescences per plant in both seasons. However, an increment of the number of inflorescences was due to the application of organic compost at different levels compared to the control in the two seasons. The gradual increases in this parameter was found as a result of increasing the level of compost addition in the 1st and 2nd seasons. A great influence on the number of inflorescences was observed in plants treated with bio fertilizers compared to the control. In this concern, the highest values of number of inflorescences (42.92 and 43.17) were

Table 2. Effect of organic and bio fertilizers on the plant height (cm) and number of days from transplanting to flowering (day) of *Rudbeckia hirta*.

Compost levels (A)	Plant height (cm)									
	1st season					2nd season				
	Bio fertilizers (B)									
	Control	Yeast	EM	(Yeast + EM)	M	Control	Yeast	EM	(Yeast + EM)	M
Control	55.00	62.67	66.67	69.67	63.50	55.67	69.00	65.00	70.33	65.00
5 g/ pot	62.67	69.33	73.67	76.00	70.42	64.00	76.00	80.00	86.33	76.58
10 g/ pot	67.67	71.67	77.67	83.33	75.09	65.67	76.33	86.33	89.33	79.42
15 g/pot	71.00	76.67	80.00	87.00	78.67	69.33	84.00	89.00	94.33	84.17
M	64.09	70.09	74.50	79.00		63.67	76.33	80.08	85.08	
LSD 5% A	2.39					2.61				
B	2.17					2.20				
AB	4.44					4.06				
	Number of days from transplanting to flowering (days)									
Control	95.00	82.00	81.00	77.00	83.75	95.00	82.00	79.00	73.67	82.42
5 g/ pot	88.00	72.00	73.33	70.33	75.92	86.30	71.33	72.67	69.00	74.83
10 g/ pot	82.67	70.00	68.67	65.67	71.75	82.67	69.00	69.00	69.67	72.59
15 g/pot	78.67	70.33	64.33	58.33	67.92	78.00	68.67	64.00	59.67	67.59
M	86.09	73.58	71.83	67.83		85.49	72.75	71.17	68.00	
LSD 5% A	2.61					3.30				
B	1.65					1.71				
AB	3.86					4.42				

Table 3. Effect of organic and bio fertilizers on the number of inflorescences/ plant and inflorescence diameter (mm) of *Rudbeckia hirta*.

Compost levels (A)	Number of inflorescences/ plant									
	1st season					2nd season				
	Bio fertilizers (B)									
	Control	Yeast	EM	(Yeast + EM)	M	Control	Yeast	EM	(Yeast + EM)	M
Control	19.33	26.67	28.33	34.33	27.17	21.33	27.33	28.33	34.33	27.83
5 g/ pot	23.67	33.00	36.33	39.67	33.17	25.67	34.33	37.67	41.00	34.67
10 g/ pot	28.00	34.67	41.33	45.33	37.33	30.33	36.00	42.33	46.00	38.67
15 g/pot	33.00	40.00	45.33	52.33	42.67	34.67	40.67	47.00	51.33	43.42
M	26.00	33.59	37.83	42.92		28.00	34.58	38.83	43.17	
LSD 5% A	1.39					1.20				
B	1.32					1.21				
AB	2.67					2.41				
	Inflorescence diameter (mm)									
Control	56.00	60.33	64.00	70.33	62.67	57.67	61.67	62.67	66.67	62.17
5 g/ pot	59.00	64.00	65.00	71.33	64.83	61.00	65.33	63.67	68.00	64.50
10 g/ pot	62.33	67.33	72.33	74.67	69.17	64.33	69.67	70.67	72.67	69.34
15 g/pot	66.33	70.00	70.00	81.33	71.92	68.33	72.67	73.33	79.33	73.42
M	60.92	65.42	67.83	74.42		62.83	67.34	67.59	71.67	
LSD 5% A	2.17					2.51				
B	1.70					1.60				
AB	3.65					3.73				

recorded with the mixture of the two bio fertilizers (EM + yeast) in the 1st and 2nd seasons, respectively. The interaction of compost and bio fertilizers demonstrated the advantage of adding the highest rate of compost and combination of bio fertilizers for increasing the number of inflorescences (52.33 and 51.33) compared to the other treatments in both seasons, respectively.

3.4. Inflorescence diameter (mm):

Addition of organic compost to the growing medium significantly increased the inflorescence diameter comparing with that from untreated plants in both seasons (Table 3). A gradual increase was recorded in inflorescence diameter with increasing the rate of organic compost. Also, bio fertilizer treatments significantly increased the inflorescence diameter compared to the control. However, a clear increment in inflorescence diameter was recorded by the combination of EM + yeast treatment (74.42 and 71.67 mm) in the 1st and 2nd seasons, respectively. The interaction between organic compost and bio fertilizer treatments showed the great influence on inflorescence diameter. The highest values (81.33 and 79.33 mm) of this trait were noticed with the highest rate of organic compost (15g/pot) with the combination of EM + yeast, followed by 10 g/ pot with the same combination (74.67 and 72.67 mm) in both seasons, respectively.

3.5. Flower stalk length (cm):

The data obtained from the flower stalk length are listed in Table 4. As can be seen using organic compost was positively effective on this character in the two studied seasons. There is a gradual increase in length of the flower stalk with increasing level of compost added up to 15 g/ pot level. Similar to this, it was found that the application of bio fertilizers caused a difference in the investigated trait when compared to the control plants. Among the bio fertilizers evaluated in this research, the longest flower stalk (22.42 and 23.50 cm) was found in combination between EM and yeast, while the shortest flower stalk (12.58 and 11.75 cm) was found in untreated plants in the first and second seasons, respectively. However, the interaction between the organic compost and bio fertilizer treatments was statistically significant. It is seen that the highest values of the flower stalk length (27.67 and 28.33 cm) were found in plants that supplied with the highest compost rate combined with the mixture of bio fertilizers compared to the other treatments in two growing seasons, respectively.

3.6. Flower stalk diameter (cm):

The gathered data in Table 4 indicated the influence of different organic compost rates and/or bio fertilizers and their interactions on the flower stalk diameter. Organic compost had a significant influence on this trait of *Rudbeckia hirta*. Diameter of the thickest flower stalk was 0.32 and 0.35 cm, and this increment was noticed with the rate of 15 g/ pot in the course of the experiments, respectively. Concerning the effect of bio fertilizers on the flower stalk diameter, it was recorded that this trait was significantly affected by using the different bio fertilizer levels in both seasons. However, addition of the combination between EM + yeast resulted in the highest values (0.30 and 0.34 cm) of the flower stalk diameter compared to other bio fertilizer treatments in the 1st and 2nd seasons, respectively. The interaction between organic compost and bio fertilizer treatments showed the great effect for the plants that receiving 15 g compost with the mixture of the two bio fertilizers. Such treatment increased the flower stalk diameter to 0.40 and 0.44 cm in the 1st and 2nd seasons, respectively.

3.7. Flower stalk fresh weight (g):

Evidently data in Table 5 showed the increment in the flower stalk fresh weight due to using organic compost in the two experimental seasons. Applying the high rate of compost fertilizer significantly improved this trait (1.47 and 1.07 g) in both growing seasons compared with the other treatments, respectively. However, using mixture of bio fertilizer treatments increased the flower stalk fresh weight values to 1.33 and 1.14 g in the 1st and 2nd seasons, respectively. As for the control, it gave the lowest values of 0.62 and 0.49 g for two seasons, respectively. The interaction between the two factor treatments showed the superiority of planting in pots with 15 g/ plant and receiving the mixture of EM + yeast for improving the flower stalk fresh weight in the two seasons (2.15 and 1.68 g, respectively) as compared with the other interactions. It was noticed that the lowest values was recorded with the plants grown in clay loam medium without any compost or bio fertilizers, as the values were decreased to only 0.37 and 0.36 g in the 1st and 2nd seasons, respectively.

3.8. Leaf N, P and K contents (%):

N, P and K contents in *R. hirta* leaves, as illustrated in Table 6, were significantly increased as a result of adding organic compost compared to the control. The highest values of these contents were recorded with the highest rate (15 g/ pot) of compost, whereas the lowest ones were obtained from using clay loam in cultivation. The obtained data showed that the bio fertilizers treatments significantly affected N, P and K contents in the plant leaves. The highest values of N, P and K contents were recorded with the mixture of EM + yeast compared to the other bio fertilizer treatments. The interaction between organic and bio fertilizer treatments declared the great effect on N (3.85 and 3.73 %) and P content (0.47 and 0.45 %) for the plants that receiving 15 g compost with the combination of the EM + yeast in the 1st and 2nd seasons, respectively. Meanwhile the highest values of K % (1.67 and 1.69 %) were detected as a result of applying compost at 10 g/ pot level with the same mixture of bio fertilizers.

Table 4. Effect of organic and bio fertilizers on flower stalk length and diameter (cm) of *Rudbeckia hirta*.

Compost levels (A)	Flower stalk length (cm)									
	1st season					2nd season				
	Bio fertilizers (B)									
	Control	Yeast	EM	(Yeast + EM)	M	Control	Yeast	EM	(Yeast + EM)	M
Control	10.00	13.00	12.33	16.00	12.83	9.67	12.00	13.33	17.00	13.00
5 g/ pot	11.00	16.33	19.33	20.67	16.83	10.00	15.33	20.67	22.67	17.17
10 g/ pot	13.33	20.00	20.33	25.33	19.75	12.33	18.67	21.67	26.00	19.67
15 g/pot	16.00	21.67	23.00	27.67	22.09	15.00	20.00	24.00	28.33	21.83
M	12.58	17.75	18.75	22.42		11.75	16.50	19.92	23.50	
LSD 5% A	0.90					0.91				
B	1.44					1.43				
AB	2.64					1.63				
	Flower stalk diameter (cm)									
Control	0.11	0.15	0.18	0.21	0.16	0.14	0.17	0.22	0.26	0.20
5 g/ pot	0.14	0.18	0.29	0.25	0.22	0.17	0.20	0.25	0.30	0.23
10 g/ pot	0.21	0.28	0.29	0.34	0.28	0.22	0.27	0.32	0.34	0.29
15 g/pot	0.21	0.31	0.37	0.40	0.32	0.25	0.32	0.40	0.44	0.35
M	0.17	0.23	0.28	0.30		0.20	0.24	0.30	0.34	
LSD 5% A	0.02					0.01				
B	0.01					0.01				
AB	0.03					0.03				

Table 5. Effect of organic and bio fertilizers on flower stalk fresh weight (g) of *Rudbeckia hirta*.

Compost levels (A)	Flower stalk fresh weight (g)									
	1st season					2nd season				
	Bio fertilizers (B)									
	Control	Yeast	EM	(Yeast + EM)	M	Control	Yeast	EM	(Yeast + EM)	M
Control	0.37	0.44	0.59	0.67	0.52	0.36	0.39	0.47	0.58	0.45
5 g/ pot	0.53	0.67	0.75	0.89	0.71	0.43	0.63	0.73	0.81	0.65
10 g/ pot	0.74	0.80	0.93	1.61	1.02	0.55	0.67	0.87	1.48	0.90
15 g/pot	0.84	1.08	1.82	2.15	1.47	0.63	0.82	1.15	1.68	1.07
M	0.62	0.75	1.02	1.33		0.49	0.63	0.81	1.14	
LSD 5% A	0.05					0.03				
B	0.04					0.02				
AB	0.09					0.05				

4. DISCUSIONS

The combinations of bio fertilizers with organic compost resulted in the tallest plants height, enhanced flower bud emergence, stalk length, number of flowers/ plant, flower diameter, prolonged flower and flower yield of China aster (*Callistephus chinensis* L.) plants as revealed by Marak *et al*. (2020). However, The improvement in metabolite transport and photosynthesis rates in plants may be the cause of the increase in plant height, allowing for more rapid and effective vegetative growth. Similarly, previous results of Keisam *et al*. (2014) revealed that the most effective way to achieve maximum plant height in gladiolus plants was by combining organic fertilizer and bio-fertilizers.. Our results pointed out that the different organic compost levels and bio fertilizer treatments improved flower parameters. The delayed in the plant flowering stage was observed in control, while earliness in flowering was recorded with organic compost and bio fertilizer additions. The improvement in the flowering parameters may be attributed to the direct influences of organic and bio fertilization which led to enhance the cell proliferation efficiently. The similar earlier studies were also noted by Chandar *et al*. (2012) and Keisam *et al*. (2014) on gladiolus; Kumari *et al*. (2014) on chrysanthemum Zaredost *et al*. (2014) in marigold; Marak *et al*. (2020) in China aster. Moreover, using yeast as bio fertilizer had pronounced effect on different plants as lemongrass (Naguib, 2002; El-Hindi and El-Boraie, 2005 and

Table 6. Effect of organic and bio fertilizers on foliar nitrogen, phosphorus and potassium concentrations (%) of *Rudbeckia hirta*.

Compost levels (A)	Foliar nitrogen concentration (%)									
	1st season					2nd season				
	Bio fertilizers (B)									
	Control	Yeast	EM	(Yeast + EM)	M	Control	Yeast	EM	(Yeast + EM)	M
Control	1.78	2.10	2.25	2.38	2.13	1.75	2.03	2.17	2.36	2.08
5 g/ pot	1.84	2.14	2.36	2.70	2.26	1.84	2.13	2.02	2.63	2.16
10 g/ pot	2.38	2.60	2.84	3.24	2.77	2.33	2.62	2.81	3.00	2.69
15 g/pot	2.43	2.68	3.30	3.85	3.07	2.43	2.70	3.26	3.73	3.03
M	2.11	2.38	2.69	3.04		2.09	2.37	2.57	2.93	
LSD 5% A	0.04					0.14				
B	0.03					0.12				
AB	0.07					0.25				
	Foliar phosphorus (%)									
Control	0.17	0.24	0.32	0.35	0.27	0.19	0.23	0.31	0.35	0.27
5 g/ pot	0.23	0.28	0.36	0.40	0.32	0.24	0.27	0.35	0.39	0.31
10 g/ pot	0.26	0.32	0.38	0.44	0.35	0.27	0.30	0.37	0.43	0.34
15 g/pot	0.34	0.37	0.41	0.47	0.40	0.33	0.35	0.40	0.45	0.38
M	0.25	0.30	0.37	0.42		0.26	0.29	0.36	0.41	
LSD 5% A	0.02					0.01				
B	0.02					0.01				
AB	0.05					0.04				
	Foliar potassium (%)									
Control	1.31	1.41	1.54	1.60	1.47	1.33	1.43	1.54	1.59	1.47
5 g/ pot	1.39	1.46	1.57	1.65	1.52	1.41	1.48	1.56	1.66	1.53
10 g/ pot	1.46	1.52	1.61	1.67	1.57	1.48	1.53	1.60	1.69	1.58
15 g/pot	1.49	1.55	1.63	1.63	1.58	1.50	1.56	1.63	1.65	1.59
M	1.41	1.49	1.59	1.64		1.43	1.50	1.58	1.65	
LSD 5% A	0.03					0.38				
B	0.02					0.02				
AB	0.05					0.05				

Abdou et al., 2014); sweet basil (Salman, 2006 and Abd El-Salam, 2014). Mady (2009) found that yeast improved the endogenous phytohormones (as auxins and cytokinins) and decreased abscisic acid.

Also, Khalil and Ismael (2010) proved that yeast could play a significant role in increasing the availability of nutrients to plants. Meanwhile, EM beneficial role as a bio fertilizer was indicated by Hussein *et al.* (2008) on marjoram; Mazrou (2008) and Abdou *et al*. (2014) on lemongrass. EM (Effective Microorganisms) contains many microorganisms as photosynthetic and lactic acid bacteria, yeast and others. It is effective in improving soil properties and growth and yield of crops (Ho and Hwan, 2000; Abdou *et al*., 2014; Al-Showily and Hussein, 2022).

5. CONCLUSION

In view of the current results concerning the effect of organic compost and bio fertilizers on the plant height, flowering characteristics as well as N, P and K foliar contents of *Rudbeckia hirta*, it may be concluded that these different treatments produced a beneficial effect on all studied parameters compared to untreated plants. However, the efficiency in inducing these parameters varied among the organic compost and bio fertilizers applied. Adding compost at 15 or 10 g/ plant was the most effective rates compared to the other treatments. Also, our results pointed out that adding any of bio fertilizers (EM or yeast) individually or in combination improved the plant height and flowering parameters of *R. hirta* compared to the control. Moreover, the best results was due to the combination between the two bio fertilizers, followed by EM allocation compared to the other treatments in the two studied seasons.

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الملخص العربي

تأثير التسميد العضوي والحيوي علي النمو والتزهير لنبات الرودبيكيا

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أجريت هذه الدراسة بمشتل نباتات الزينة – كلية الزراعة– جامعة المنيا خلال موسمي ٢٠٢٠ و ٢٠٢١ بغرض دراسة تأثير اضافة الكمبوست العضوي والأسمدة الحيوية علي نمو وازهار نبات الرودبيكيا. واشتملت معاملات الأسمدة الحيوية علي الخميرة و ال EM كل منهما بصورة منفردة أو الخلط بينهما، بينما اشتملت معاملات الكمبوست العضوي علي الكنترول و ٥ و ١٠ و ١٥ جم/ نبات. ونبات الرودبيكيا نبات زينة حولي ويزرع في أحواض الزهور أو كنبات أصص وأزهاره صالحة للقطف، أيضا يمكن استخدامه كنبات طبي. صممت هذه التجربة بنظام القطع المنشقة في ثلاث مكررات بكل منها ستة أصص، تم وضع مستويات الكمبوست العضوي في القطع الرئيسية، بينما اشتملت القطع المنشقة علي معاملات الأسمدة الحيوية. وكانت أفضل القياسات الخاصة بالنمو والازهار نتيجة اضافة الخليط من نوعي السماد الحيوي مقارنة بباقي المعاملات. وقد كانت النباتات المعاملة بالسماد الحيوي ال EM أكثر استجابة من تلك المعاملة بالخميرة أو بدون معاملة. ونتج عن اضافة الكمبوست تحسين صفات النمو والازهار وهي ارتفاع النبات، عدد الأيام من زراعة الشتلات الي التزهير، عدد وقطر النورات، طول الحامل الزهري، القطر والوزن الطارج للحامل الزهري، بالإضافة الي محتوي الاوراق من النيتروجين والفوسفور والبوتاسيوم مقارنة بالكنترول وكانت أفضل القيم عند استخدام الكمبوست بمستوي ١٥ جم يليه ١٠ جم/ نبات. وأفضل القيم الخاصة بالنمو والازهار والمكونات الكيميائية تم الحصول عليها عند اضافة خليط من الأسمدة الحيوية مع مستوي الكمبوست ١٥ أو ١٠ جم/ نبات.