Middle East Journal of Agriculture Research, 3(3): 543-548, 2014
ISSN 2077-4605

Growth, yield and leaf content of Jews mallow plant (*Corchorus olitorius*) by soil fertilizer with different level of compost manure and chemical fertilizer

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ABSTRACT

Two field experiments were carried out during the two seasons of 2010 and 2011 at the experimental station of National Research Centre, Beheira Governorate (North of Egypt) to investigate the effect of different level of organic compost manure at (30, 45 and 60 kg N/fed.) with three levels of chemical fertilizer NPK at (30, 60 and 90 unit/fed.) on the growth, yield and leaf content of Jews mallow plants (*Corchorus olitorius*) under sandy soil condition. The important results are as following:

1- Jews mallow plants growth expressed as (plant length, number of leaves /plant, fresh and dry weight of leaves (g) as well as fresh and dry weight of whole plant) and total yield as well as its leaf contents of the percentage of protein, N, P and k were higher in the order of application of 60 > 45 > 30 kg N/fed. of compost manure.

2- The growth and yield and leaves contents of nutritional value of Jews mallow plants attributes increased as N P K rates increased from 30 up to 90 units/fed.

3- By adding the high levels of compost manure 60 kg N /fed. with application of high level of chemical fertilizer (90 unit /fed.) produced the vaguer plant growth, total yield and its leaf contents of protein, nitrogen, phosphorus and potassium contents.

Kew words: Jews mallow, organic, chemical fertilizers, growth, yield and leaf content.

Introduction

Corchorus olitorius called Jews mallow or jute mallow in English. It is an important green leafy vegetable in many countries including Egypt, Sudan, India, Bangladesh, Malaysia, as well as Japan, the Caribbean and Cyprus (Samra *et al*., 2007). *Corchorus olitorius* is a vegetable eaten in both dry and semi-arid regions and in the humid areas of Africa. It is extremely consumed as a health vegetable, because it contains abundant β-carotene and other carotenoids, vitamins B1, B2, C and E, and minerals. The vegetable also has varying proportion of dietary fiber and protein required for health (Schipper, 2000). The vegetable is cultivated for the stem bark which is used in the production of fiber (Jute) and for its mucilaginous leaves which are also used as food vegetable (Zakaria *et al*., 2006). The leaf extract of the plant is also employed in folklore medicine in the treatment of gonorrhea, pain, fever and tumor (Ndlovu and Afolayan 2008). And its leaves and roots are eaten as herbal medicine in South East Asia. The composition of *Corchorus olitorius* leaves per 100 g fresh edible portion is: water 80.4 g (74.2– 91.1), energy 243 kJ (58 kcal), protein 4.5 g, fat 0.3 g, carbohydrate 12.4 g, fiber 2.0 g, Ca 360 mg, P 122 mg, Fe 7.2 mg, β-carotene 6410 µg, thiamin 0.15 mg, riboflavin 0.53 mg, niacin 1.2 mg, ascorbic acid 80 mg (Samra *et al*., 2007).

The addition of organic fertilizer to the soil generally promotes plant growth more than the commercial fertilizer. Also, organic manure primary constituents, e.g., organic matter, phosphorus and nitrogen are ergonomically beneficial to the crop growth. Organic fertilizer has been suggested to compliment inorganic or chemical fertilizer and bridge the demand and supply for fertilizer and for economic and environmental reasons (Adeniyan and Ojeniyi, 2005). Organic manure increases soil nutrient status and enhances the biological, chemical and physical properties of the soil (FAO, 2005). Organic manure increases the nutrient status of the soil through gradual release of nutrients to the soil (Egherevba and Ogbe, 2002; Ibeawuchi *et al.,* 2006) and supports crop performance and yield (Adebayo and Akoun, 2002). However, Mazen, *et al* (2010) found that, the contents of NPK of Jews mallow leaves gradually increased as the ratio of organic manure increased. The fresh and dry weights and biosyntheses of pigment contents of the variously treated test plants were increased by increasing the organic manure levels in the soil. Also, total carbohydrate and protein contents of organic manure treated test plants were positively affected. With respect to the proline content and total free amino acids, in most cases, it decreased significantly, expect at 75%. However, Jonathan, *et al* (2012) observed that the Jews planted on 100% compost manure had the best growth followed by 50%, 30% and 0% compost manure respectively (in terms of plant height, leaf number, stem girth, and leaf area). The results obtained for biological efficiencies showed that 100% compost manure had the best above and below ground biomass with of 30.5% and 32.8% followed by 30% compost manure (24.8% and 23.4%) and 10% compost manure (15.9% and13.9%), the least was 2.5 and 11% above ground and 3.3% and 14.2 below ground of the 0 % compost manure plants

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respectively. Moreover, the compost manure was able to improve mineral composition of this vegetable. It was observed that, phosphorus and potassium were the best mineral elements of Jews and mineral elements (iron, magnesium, calcium, phosphorus and potassium) were observed to increase as the concentration of the compost manure in the soil increased to 100%. However, zinc decreased with compost manure treatment, while manganese concentrations increased to 30% compost manure. Compost manure application was found to increase the soil pH by ±2. The pH values of the soil treated with compost manure increased significantly with the compost manure percentages in the soil. It was found to have increased from 4.8 to 6.7 and 7.0 in the potted plant with the highest yield. In the same respect, Emuh (2013) found that, the application of 20 t/ha of poultry manure may contribute to improve *C. olitorious* L. production.

Nutrition is an important aspect of cropping system and this includes adequate supply of essential nutrients like nitrogen (N), phosphorus (P) potassium (K) to the plant.

Nitrogen fertilizer greatly improves the micronutrient content, e.g. Fe, P, Ca, carotene and vitamin C. *Corchorus olitorius* leaves contain antioxidative phenolic compounds, of which 5-caffeoylquinic acid is the most important. However, Olaniyi, and Ajibola, (2008) found that, the soil application of N, P and K significantly increased the plant height, number of leaves, fresh shoots, dry matter of *corchorus olitorius* above the control (in which no fertilizer was used). It is therefore concluded that the growth and yields of *corchorus olitorius* could significantly be improved by the soil application of N, P and K fertilizers at the optimum rate of 45kg N/ ha, 30kg P/ ha and 20 kg K/ ha, respectively. Fertilizer studies in South Western Nigeria showed positive responses of *Corchorus olitorius* to nitrogen (Nihort, 1986). Phosphorus is important in root development. Tropical soils are often low in available phosphorus and therefore require extraneous inputs of phosphorus for optimum plant growth, especially for rapid growing of annual crops such as leafy vegetables (Zapata and Axman, 1995) *Corchorus olitorius* under this study. The role of nitrogen, phosphorus and potassium in crop fertilization, leading to increased absorption of these elements can be attributed to increase top growth particularly as a result of nitrogen absorption (Olaniyi, 2000). Likewise, application of any essential element should have a marked effect on yield if the soils were deficient in the element. It is, therefore, necessary to determine the growth and seed yield performance of *Corchorus olitorius* as affected by nitrogen, phosphorus and potassium fertilizers application. Also, increasing the use of chemical fertilizer led to high cost in vegetable production and creates pollution of their agricultural environment as well as affects the soil fertility; therefore it has become essential to use untraditional fertilizers as supplements or substitutes for chemical nitrogen fertilizer**.** However, Ahmed *et al* (2000) found that the high level of nitrogen fertilization increased the fresh yield of rocket leaves by 50.0 and 16.4% in the 1st and 2nd cuts, respectively, while these increases in dry yield were 31.6 and 16.8%, respectively as compared to their low nitrogen levels control values. In the same respect, Nwangburuka *et al* (2012) suggesting that, selection directed toward plant height and number of branches will enhance leaf yield of *Corchorus olitorius* plants. In the same respect, Aisha *et al* (2013) found that, addition of 70 % of recommended rate (RR) of chemical fertilizer resulted the tallest and the heaviest fresh and dry weight of spinach plants and its different organs, as well as the heaviest total leaves yield (ton/fed.) and its nutritional values, i.e. protein, N, P, K and No_3 content in leaves tissues.

The objectives of this investigation were to determine: the best vegetative growth and yield and the leaves content of macro elements on *Corchorus olitorius* plants as affected by soil application by different levels of Nile compost manure and chemical fertilizer (NPK).

Materials and Methods

Two field experiments were carried out at the experimental station of National Research Centre at Nubaria, Behira Governorate, Egypt during the two growing seasons of 2010 and 2011 in order to study the effect of the addition of different levels (30, 45 and 60 kg N/fed.) of organic manure (Nile compost) produced by recycling the agricultural residues with various concentrations of chemical fertilizer NPK (30, 60 and 90 unit /fed.) on vegetative growth, total yield and leaf content of Jews mallow plants (*Corchorus olitorius*.) cv. Balady. The physical and chemical properties of organic manure (Nile compost) are shown in Table (1). The experimental site had a sandy soil texture with pH of 7.6, Ec of 0.19 and the organic matter was 0.21% with 14.00, 8.90 and 15.60 mg/100g soil of N, P and K respectively. Seeds of Jews mallow were obtained from Horticultural Research Institute, Agriculture Research Center and sown on February 25th and Marsh 2^{ed} in 2010 and 2011, respectively. The area of experimental plot was 10.5 m^2. All experimental units were 3.0 X 3.5 m. The normal agriculture practices of Jews mallow under drip irrigation system were followed according to the recommendations of Agriculture Ministry. The levels for organic manure fertilizer and chemical fertilizer NPK were applied during soil preparation in a split plot design with three replicates, Nile organic manure treatments occupied the main plots, while the application of chemical fertilizer (NPK) were distributed randomly in the sub plots. This experiment included 9 treatments which included all combinations between the three levels of organic manure fertilizers (30, 45 and 60 kg N/ fed.) with three levels of chemical fertilizer (30, 60 and 90 unit /fed.).

Table 1: Physical and chemical properties of Nile compost.

Character	Nile compost values
Weight of cubic meter (kg)	400
Moisture%	30
pH	7
Ec (m. mhos)	5
Organic carbon %	41
Organic matter %	70
Total nitrogen %	2
C/N ratio	1: 17
Total phosphorus %	0.6
Total potassium %	6.0
Iron mg/kg	7900
Manganese mg/kg	190
Copper mg/kg	20
Zinc mg/kg	4.75

At the vegetative growth stage, random samples of five plants from each plot were taken 50 days from sowing for determination of plant length (cm), number of leaves per plant, fresh and dry weight of leaves /plant (g) as well as fresh and dry weight of whole plants. The total leafs yield (ton/fed.) and the chemical constituents of leafs were determined as the percentage of N, P and K according to the methods of Pregl (1945), Troug and Mayer (1939) and Brown and Lilleland (1946) respectively. However, total crude protein % was extracted and determined according to A.O.A.C (1975).

All obtained data were subjected to the statistical analysis and means were compared according to LSD at 5% level test described by Gomez and Gomez (1984).

Results and Discussion

Growth characters:

Effect of Nile compost manure levels:

The effects of different levels of Nile compost manure on plant growth characters are presented in (Table 2). The plant height was ($P < 0.05$) taller at application of 60 kg N/fed. of Nile compost manure than at application of 30 or 45 kg N/fed. (Table 2) in both seasons. Jews mallow plant height was most significantly depressed at application of 30 kg N/fed of Nile compost manure compared medium and high levels (45 or 60 kg N/fed.). Although, number of leaves /plant, fresh and dry leaves weight (g) as well as fresh and dry weight of whole plant were higher in the order of application of 60 > 45 > 30 kg N/fed. of Nile compost manure (Table 2). This agreed with the findings of (Adebayo and Akoun, 2002 and Jonathan, *et al* 2012) who reported that the Jews mallow planted on 100% compost manure had the best growth followed by 50%, 30%, and 0% compost manure respectively (in terms of plant height, leaf number, stem girth, and leaf area). The ($P < 0.05$) higher plant height, number of leaves, fresh and dry weight of leaf and whole plant at higher application of Nile compost manure may be attributed to these manure drop-pings, which were a potential source of nutrients to the soils. The decomposed Nile compost manure droppings enhanced mineralization of nutrients in the soils. Egherevba and Ogbe (2002) and Ibeawuchi *et al* (2006) reported that organic manure increased the nutrient status of the soil through gradual release of nutrients to the soil. Similarly, Duncan (2005) and Agbede *et al* (2008) reported that organic manure increased nitrogen, phosphorous and potassium contents of the soil, while Olanikan (2006) reported that organic manure increased organic matter status of the soil and enhanced crop production.

Effect of chemical fertilizer levels:

Average plant height, number of leaves/plant, fresh and dry weight of leaves as well as fresh and dry weight of whole plant significantly increased as the applied NPK rates increases from 30 unit/fed up to 90 unit NPK /fed.(Table 2). These findings were true in both experimental seasons. The increased in Jews plant growth under NPK treatments, reconfirmed the role of chemical fertilizer in promoting vigorous vegetative growth in leafy vegetables (Tisdale and Nelson, 1990). This also showed that chemical fertilizer stimulates formation of new leaves and increases the size and height of plant. Increasing the use of chemical fertilizer led to high cost in vegetable production and creates pollution of their agricultural environment as well as affects the soil fertility; therefore it has become essential to use untraditional fertilizers as supplements or substitutes for chemical fertilizer. In the same respect, Ahmadi *et al.,* (2010) reported that, number of leaves/plant and nitrate content in

leaves were increased by increasing chemical fertilizer NPK, while different fertilizer levels had no significant effect on petiole length. Generally, the obtained data clearly showed that, the Jews mallow plant recorded a good response to the application of chemical fertilizer (NPK) and its growth might be recording better values if the application rate were increased over than the 90 unit/fed. In spite the response of Jews plant to the addition of chemical fertilizer many investigators recorded other data supported that data written in this study (Ahmadi *et al.,* 2010, Vignesh *et al.,* 2012) on spinach plants and Islam *et al.,* 2011 on radish plant and (Zapata and Axman, 1995, Olaniyi, 2000 and Olaniyi, and Ajibola, 2008) on Jews mallow plants.

Effect of the combination between compost manure and chemical fertilizer levels:

The interaction within Nile compost manure levels and the concentration of chemical fertilizer NPK affected the Jews mallow plant growth characters as shown in Table (2). However, this effect was more clearly in two seasons of this study. Where the statistical analysis of the obtained data reveals that, the differences within different interaction treatments were significant for of dry weight of whole plant (two seasons) and fresh and dry weight of whole plant in second season only. But the registries data (Table 2) showed clearly that, the biggest plant length, leaves number, fresh and dry weight of leaves and its varies organs all of these characters recorded with that plants received high rates of Nile compost manure (60 kg N/fed.) with high chemical fertilizer NPK level (90 unit/fed.).

Total yield and its leaf contents:

Effect of Nile compost manure levels:

Data in Table (3) showed clearly that the addition of organic compost fertilizer which produced from recycling the agricultural residues caused an increase in total leaf yield (fresh and dry weight) of Jews plant and its chemical leaf contents (the percentage of protein, N, P and K). Moreover, obtained data revealed that increasing the rate of organic compost up to (60 kg N/fed.) resulted in the highest total yield of Jews plant 11.54 (ton/fed.) in the first season and 12.87 (ton/fed.) in the second season respectively. Compared 10.48 ton/fed. in the first season and 10.85 ton/fed. in the second season respectively by using the low level 30 kg N/fed. However, the obtained data reported that high and medium addition of organic manure (60 or 45 kg N /fed.) significantly increased total yield and chemical leaf quality compared low level 30 kg N/fed.. In other words, addition of (60 kg N/fed.) of organic compost manure fertilizer had superiority on total yield and the chemical leaf contents (the percentage of protein, N, P and K) compared medium and low level (45 or 30 kg N/fed.) in both seasons. It could be suggested that, the superiority of high level of organic compost manure these may be due to the effect of its manure was producing good growth of Jews mallow plants (Table 2) which reflected on the total yield as well as the chemical leaf quality. Similar results were obtained by (Adeniyan and Ojeniyi, 2005, Duncan 2005, Agbede *et al* 2008, Mazen, *et al* 2010 and Emuh 2013) on Jews mallow plants.

Effect of chemical fertilizer levels:

Addition of high level of chemical fertilizer (90 unit /fed.) for Jews mallow plants had the highest total yield and the percentage of protein, nitrogen, phosphorus and potassium in both seasons in leaves tissue compared to medium rate (60 unit) and the low rate (30unit) as shown in Table (3). The statistical analysis of the obtained data reveals that, both medium level (60unit) and the high level of chemical fertilizer (90 unit) significantly increased total yield and the percentage of protein, nitrogen, phosphorus and potassium in leaves tissue compared to the low level (30unit) these were true in both seasons. However, obtained data revealed that increasing the level of chemical fertilizer up to (90 unit /fed.) resulted in the highest total yield of Jews plant (11.41 ton/fed. in the first season and 12.30 ton/fed. in the second season respectively compared 10.45 ton/fed. in the first season and 11.52 ton/fed. in the second season respectively by using the low level 30 unit/fed. Many investigators had a similar trend of results which support that data written here (Ahmadi *et al.,* 2010, Vignesh *et al.,* 2012) on spinach plants and Islam *et al.,* 2011 on radish plants and (Zapata and Axman, 1995, Olaniyi, 2000 and Olaniyi, Ajibola, 2008 and Nwangburuka *et al* 2012) on Jews mallow plants and (Ahmed *et al* 2000 and Renata *et al* 2012) on Rocket plants.

Effect of the combination between compost manure and chemical fertilizer levels:

The interaction treatments between using the different levels of organic manure and chemical fertilizer levels on total yield and some chemical contents of Jews leaves tissue are shown in Table (3). It is clear that the interaction was insignificant on the percentage of total yield, protein, nitrogen, phosphorus and potassium contents on leaves tissues. However, by adding the high levels of compost manure 60 kg N /fed. with

application of high level of chemical fertilizer (90 unit /fed.) produced the vaguer percentage of total yield and its leaf contents of nitrogen, phosphorus and potassium contents. These results were true in the both seasons.

Table 2: Effect of different levels of organic compost manure and chemical fertilizer on growth characters of Jews mallow plant during 2010 and 2011 seasons.

Compost levels kg N/fed.	NPK levels unit/fed.	2010 season						2011 season					
		Plant length (cm)	Number of leaves/plant	Leaves weight (g)		Whole plant (g)		Plant length (cm)	Number of leaves/plant	Leaves weight (g)		Whole plant (g)	
				fresh	dry	fresh	dry			fresh	dry	fresh	dry
30	30	29.35	21.02	13.49	2.68	21.63	7.18	29.88	22.10	13.90	2.78	21.23	6.96
	60	34.40	22.70	14.67	2.93	25.27	8.41	31.23	22.80	14.75	3.11	23.30	7.85
	90	40.83	23.72	15.67	3.21	26.10	8.70	33.00	25.37	15.97	3.42	26.70	8.90
Mean		34.86	22.48	14.61	2.94	24.33	8.09	31.37	23.42	14.87	3.10	23.74	7.90
45	30	31.11	22.11	15.50	3.11	24.93	8.30	33.10	23.79	14.48	2.90	25.43	8.44
	60	36.17	25.04	16.40	3.45	29.13	9.71	33.15	25.75	15.84	3.25	25.63	9.02
	90	41.83	26.50	17.57	3.51	31.57	11.73	35.61	27.27	16.25	3.57	32.17	9.47
Mean		36.37*	24.55*	16.49*	3.36*	28.54*	9.91*	33.95*	25.60*	15.52*	3.24	27.74*	8.98*
60	30	32.92	23.67	16.07	3.22	27.52	8.72	36.53	24.84	16.95	3.41	33.02	9.97
	60	38.13	25.50	16.64	3.54	32.85	9.94	37.67	26.29	17.32	3.52	34.15	10.90
	90	42.67	27.47	17.80	3.64	35.68	12.37	42.37	27.57	17.88	3.70	34.20	11.32
Mean		37.91**	25.55**	16.84**	3.47**	32.02**	10.34**	38.86**	26.23**	17.38**	3.54	33.79**	10.63**
Level	30	31.13	22.27	15.02	3.00	24.69	8.06	33.17	23.58	15.11	3.03	26.56	8.46
	60	36.23*	24.41*	15.90*	3.30*	29.08*	9.35*	34.02*	24.95*	15.97*	3.29*	27.69*	9.25*
	90	41.78**	25.90**	17.01**	3.45**	31.12**	10.93**	36.99**	26.73**	16.70**	3.56**	31.02**	9.90**
LSD at 5% level	Compost	0.40	0.57	0.26	0.10	1.15	0.17	1.15	0.39	0.39	NS	0.43	0.63
	NPK	0.79	0.38	0.28	0.08	0.71	0.36	0.81	0.30	0.28	0.12	0.84	0.17
	Interaction	NS	NS	NS	NS	NS	0.62	NS	NS	NS	NS	1.45	0.30

Table 3: Effect of different levels of Nile compost manure and chemical fertilizer on total yield and leaf chemical contents of Jews mallow plant during 2010 and 2011 seasons.

Compost levels kg N/fed.	NPK levels unit/fed.	2010 season					2011 season				
		Total yield (ton/fed)	N %	Protein %	P %	K %	Total yield (ton/fed)	N %	Protein %	P %	K %
30	30	9.86	1.18	7.40	1.14	1.63	10.53	1.15	7.19	1.13	1.28
	60	10.67	1.29	8.08	1.19	1.74	10.83	1.49	9.29	1.16	1.64
	90	10.90	1.51	9.42	1.22	1.87	11.18	1.62	10.13	1.17	1.83
Mean		10.48	1.33	8.30	1.18	1.75	10.85	1.42	8.87	1.15	1.58
45	30	10.37	1.40	8.73	1.18	2.07	11.42	1.42	8.88	1.18	1.53
	60	10.67	1.67	10.44	1.23	2.22	11.77	1.94	12.11	1.22	1.81
	90	11.35	1.78	11.15	1.27	2.33	12.57	2.12	13.27	1.23	2.07
Mean		10.80	1.62*	10.11*	1.23*	2.21*	11.92*	1.83*	11.42*	1.21*	1.80*
60	30	11.12	1.91	11.96	1.28	2.38	12.60	1.59	9.94	1.25	2.23
	60	11.53	2.00	12.48	1.32	2.50	12.88	2.09	13.06	1.27	2.37
	90	11.97	2.33	14.57	1.35	2.58	13.13	2.36	14.75	1.28	2.59
Mean		11.54**	2.08**	13.00**	1.31**	2.49**	12.87**	2.01**	12.58**	1.27**	2.40**
Level	30	10.45	1.50	9..36	1.20	2.02	11.52	1.39	8.67	1.19	1.68
	60	10.96*	1.65*	10.33*	1.24*	2.15*	11.83*	1.84*	11.49*	1.22*	1.94*
	90	11.41**	1.87**	11.71**	1.28**	2.26**	12.30**	2.03**	12.72**	1.23**	2.16**
LSD at 5% level	Compost	0.34	0.08	0.52	0.02	0.14	0.22	0.10	0.65	0.01	0.06
	NPK	0.18	0.08	0.48	0.01	0.04	0.16	0.09	0.59	0.01	0.06
	Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

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