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Effect of municipal solid waste compost and gibberellic acid on morphological and physiological traits of tulip (*Tulipa* spp.) cv. Bright Parrot

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ABSTRACT

Tulip is one of the most important potted and cut flowers in the world. It is a monocothiledone plant, belongs to the Liliaceae family. In this study, the effects of municipal solid waste compost (MSWC) in four levels (0, 10, 20 and 30%) and gibberellic acid in three levels (GA_3) (0, 50 and 100 mgl^{-1}) on flowering time and quality of early flowering tulips were evaluated. The research was done based on a completely randomized block design (RCBD) with three replications. In this experiment, bulbs sprouting time, leaves number, flowers number, stem length, flower diameter, flowering time, bulbs number, chlorophyll and carotenoid levels of the plant were measured. Results showed that in most traits, MSWC 10% and peat were more suitable than the other treatments. MSWC 30% delayed flowering time about 7 days. The most flowers and bulbs number were obtained in the plants treated with 100 mgl^{-1} GA_3. Treatments containing MSWC 10 and 20% provoked the highest amount of chlorophyll in leaves. Also, high amount of MSWC caused soil salinity and decreasing the vegetative and reproductive growth in the plants.

Keywords: Cultivation bed, Plant growth regulators, Bulbous plants, Flowering

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INTRODUCTION

Nakhaee et al., [11] had been examined the effects of growth regulators on morphological traits of amaryllis. Gibberellic acid and benzyladenine treatments caused a significant increase in flowering stems length, plant diameter, number of flowers and inflorescences as well as to accelerate flowering. Mommy and Payvast [10] examined the municipal solid waste compost to replace peat in cucumber transplant production. Compost in an amount greater than 5% is not recommended in cucumber transplant production. MSWC is not much used on bulbous plants.

Tulip (*Tulipa* spp.) belongs to Liliaceae family is a bulbous flower. Tulip has the highest cultivation rate among the bulbous flowers.

flowers. Approximately 21,078 acres are under cultivation of tulip bulbs in the Netherlands. Industrial bulbous flowers are estimated over 1 billion dollars in the world that generally owned to tulips, lilies and narcissus (Bushman, 2005). Now, Netherlands has the unique position among the nations of the world in the production and export of tulip bulbs and cut flowers. Iran has a great potential for wild species of tulip that is considered as an excellent germplasm center of this plant [19]. The world today, due to the development and industrial production of cut flowers and potted flowers as well as standards transplant production in vegetable, more recycled and cheap organic substrates are required. Compost is a humus substance that is emerged from organic materials decomposition and biological oxidation by microorganisms in the presence of moisture, temperature and oxygen. MSWC is one of the organic medias, that is produced more by household wastes and it is a way to restore the organic materials into environment cycle in very low cost [1, 4]. MSWC usage in suitable amounts, causes soil

fertility and prevents growth of weeds. Compost has macro- and micro nutrients that are required for plants and it provides these materials to the plants gradually. Humus particles, folic acid and compounds containing nitrogen, obtained from compost have intense absorbent action that attracts nutrients and provide them to plants readily [19]. Compost generally increases soil biological activity and helps to soil fertility. The use of compost increases resistance of plants to diseases. It also increases humus and soil organic matters and provides some vitamins, hormones and enzymes that are needed for plants. Chemical fertilizers can't supply these [19]. The maximum number of leaves in *Petunia*, an ornamental plant, was achieved in plants treated with vermicompost 20 and 40% [2]. In cucumber, seedlings had better quality to produce transplants, just in peat and peat mixture + MSWC 5% [10].

Gibberellins are terpenoids compounds composed of isoprene units and contain 20 carbons. Today, 90% of gibberellins have been identified.

This study aims to use waste compost as cheap fertilizer instead of chemical fertilizers to prevent weed growth and usage of gibberellin can raise the quality of flowering stem in tulip (*Tulipa* spp.).

MATERIALS AND METHODS

This study was conducted in the plastic greenhouse at the Faculty of Agriculture, Azad University, Rasht in 2011. In this experiment, the hybrid tulip bulbs type of parrot-like cv. *Bright parrot* were used. MSWC treatments were at 4 levels (0, 10, 20 and 30 %) and gibberellin treatments (GA3) were at 3 levels (0, 50 and 100 mg.l). The bulbs for 14 hours were treated in solution with concentrations of gibberellic acid. Then, it was planted in plastic pots in a mixture of peat soil containing MSWC 0, 10, 20 and 30%. In each pot, one bulb was planted. This study has been carried out based on a factorial completely randomized design with 3 replications in each replicate with 4 pots. Morphological traits such as bulbs sprouting time, leaves number, flowers number, stem length, flower diameter, flowering times, the number of bulbs, chlorophyll and carotenoid levels were measured. The amount of nitrogen, potassium and phosphorus were measured by spectrophotometer, Kjeldahl flamephotometer and spectrometry, respectively. And also pH and Ec were measured (Table1).

Table 1 - Chemical properties of culture substrates used in the experiments

Chemical properties / Substrate	**%N**	P (ppm)	K (ppm)	EC(ms/m)	pH
100% peat	4.9	50	260	4.3	7.07
Waste composted 10% + peat 90%	6.3	90	460	5.6	7.5
Waste composted 10% + peat 90%	7	140	680	6.7	7.55
Waste composted 10% + peat 90%	7.6	190	880	8.7	7.56

Statistical analysis

Data Analysis was performed using SPSS software and mean comparison was done according to Turkey Test. The graphs were plotted using Excel software.

RESULTS AND DISCUSSION

In this review, MSWC and GA_3 treatments were effective on the measured parameters. They were statistically significant (Table 2).

Bulbs sprouting time

In variance analysis, treatments were not significant on germination. But the observation showed that minimum time of germination, was obtained in peat moss and GA_3 (100 mg.l) (25.08). The longest bulb sprouting time is obtained on the bed of peat moss containing MSWC 30% (37.25 days). Substrates containing high percentage of MSWC delayed Tulip germination. It seems that it occurred due to higher EC and pH of compost treatments. Hassanpour Asil et al., [7] reported that the shortest germination in Iris was observed in GA_3 600 mg.l (13.07) that is significantly differente with control treatment (15.44 days). Seed and vegetative materials such as corms, tubers, bulbs and rhizomes, even under good conditions of environment, do not germinate immediately after bud maturing. Gibberellin can be applied as complement of cold periods as well as a factor to short-term greenhouse gas [8, 9, 10]. Ribeiro and Santos [13] reported that media with high electrical conductivity reduced water retention and had negative effects on the adsorption process. High germination has been observed in lower EC and pH. High EC will prevent the development of transplant [8].

Table 2- variance Analysis of tulip morphological and physiological characteristics

Sources of variation	Mean square										
	Bulbs sprouting time	Length of stem	Number of leaves	Flowering time	Number of flower	Flower diameter	Number of bulbs	carotonoid	Cholorophill a	Cholorophill b	total Cholorophill
Replicaion	55.046 ^{ns}	3.53 ^{ns}	0.340 ^{ns}	25.36 ^{ns}	0.024 ^{ns}	37.250 ^{ns}	0.261 ^{ns}	0.575 ^{ns}	0.052 ^{ns}	2.086 ^{ns}	0.099 ^{ns}
Compost	42.060 ^{ns}	811.80**	13.84**	75.48**	0.293*	83.098*	0.879**	0.75 ^{ns}	7.77**	18.15**	30.09*
Gibberellin	14.87 ^{ns}	8.69 ^{ns}	4.74 ^{ns}	04.29 ^{ns}	0.459*	25.719 ^{ns}	2.67**	0.86 ^{ns}	1.52 ^{ns}	3.60 ^{ns}	9.91 ^{ns}
Compost × Gibberellin	38.126 ^{ns}	7.90 ^{ns}	1.54 ^{ns}	06.36 ^{ns}	0.174 ^{ns}	33.864 ^{ns}	0.160 ^{ns}	1.54 ^{ns}	1.93**	11.34**	16.65*
Error	30.82	2.79	1.56	13.08	0.095	23.629	0.173	0.72	0.51	1.22	5.21
Total	-	-	-	-	-	-	-	-	-	-	-
Coefficient of variation (%)	19.40	36.06	34.68	05.84	21.46	13.98	17.40	58.01	52.73	78.30	66.84

** Significant in 5% , **significant in 1% , ns: non significant*

Stem length

The results of data comparison indicated that control treatment (peat soil) had the maximum stem length (36.05 cm) and MSWC 30% showed the lowest length (13.22 cm) (Figure1).

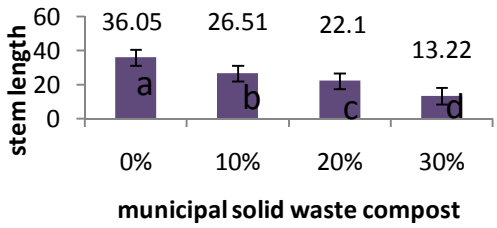

Figure 1 - Effect of different levels of municipal solid waste compost on tulip stem length

The results showed that by adding MSWC into the peat and some nutrients in soil and increasing EC, stem length is decreased and there were more dwarf plants. That it would be desirable for planting outdoors. Topuoglu [17] stated that stem length in poinsettia plants treated with MSWC 25% was increased. Tezertezakia et al., [18] have studied usage of fertigation and MSWC for greenhouse pepper hybrids. External application of gibberellin can provide some chiling requirements of tulip bulbs. Gibberellin will stimulate development of female plants and produce auxin. This lead to rise internodes. Stimulatory effects of gibberellin on tulip stems growth and flowering in tulip bulbs in lack of roots with no cold period has been proven [4]. Maximum stem length in common tuberose flower (134.65 cm) was obtained in GA_3 (100 mg.l). Most of these results were inconsistent with the results of this study. It seems that MSWC less than 10% is suitable to improve the growth of tulip.

Number of leaves

Simple effects of gibberellin and interaction effects of compost and hormone x on the number of tulip leaves were not significance at the 1%, but the simple effect of municipal solid waste compost on leaves number was significant (Table 2). Control and compost 10% (5.80 and 5.66) and compost 30% (3/1) had the maximum and the lowest number of leaves, respectively (figure2).

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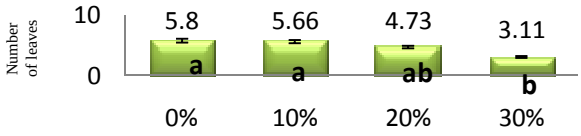

Figure2 - The effect of different levels of municipal solid waste on tulip leaves number

Compost reduces internode distances and produce more leaves that cause compaction and dense and beauty in dracaena plant. This is due to the high electrical conductivity.

MSWC contains phosphorus and nitrogen that will enhance vegetative growth and increase the number of leaves (Table 1). But compost containing high PH possibly causes inactivation in compounds in plant or reduces absorption of other nutrients (Table 1). And only compost 10% had the highest number of leaves. Leaves number is reduced by increasing in compost concentration that is due to salt stress. In poinsettia, treatment with MSWC 25% had the highest number of leaves [17]. Padasht and Gholami [12] reported same results with bark 80% and MSWC 20%.

Flowering time

Comparison results indicated that treatment 30% of municipal solid waste compost with the average of 73/37 days and control treatment with the average of 66/30 days had maximum and minimum bulb planting to flowering time (Figure3). In the results of this study, there was no significant effect of gibberellins on flowering time in tulip and high percentages of municipal solid waste compost which delayed flowering time in tulips. Control treatment had the least time to flowering.

Cold treatment within GA_3 on bulbs, accelerate flowering and stimulates stem length, it helps to prevent bud blast [15, 16]. However, the effect of gibberellic acid depends on bulb cold treatment. Siynortar et al., [15] stated that the earliest flowering was observed at gibberellic acid 100 ppm. Sah et al., [16] reported that in the tulips, flowering was accelerated by GA4 +7. Changes in gibberellin levels play the main role in transition from vegetative stage to reproductive stage. Shorten the duration from planting to flowering has a direct relationship with gibberellic acid treatment. The bulbs were treated with gibberellic acid, had the same flowering time [4, 5, 7, 9].

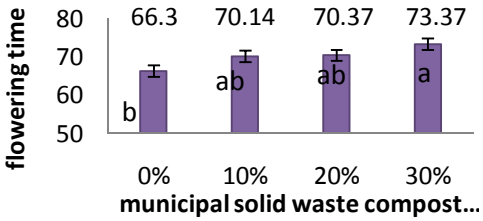

Figure 3 - Effect of different levels of municipal solid waste compost on the time of flowering tulips

Number of flowers

The results of data comparison on number of flowers in tulips showed that MSWC 10% in peat soil (1/94) and gibberellin 100 mg.l (2) had the highest number of flowers (Figure 4 and 5).

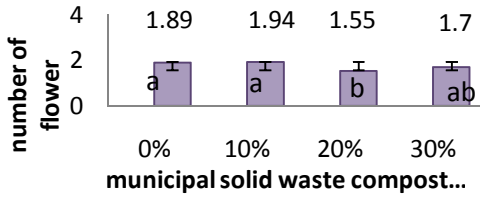

Figure4- Effect of different levels of municipal solid waste compost on the number of flowers per plant tulip

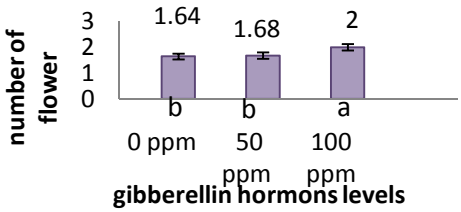

Figure5-Effect of different levels of the hormone gibberellin on the number of flowers per plant tulip

In this study, gibberellin due to the cell division, has increased the number of flowers. Also, due to better nutrition of tulips in a bed of peat soil contains municipal solid waste compost 10%, more flowers were produced. Nakhaei et al., [11] reported that gibberellic acid and benzyladenine treatments significantly increased the number of flowers.

Flower diameter

The results from compared data showed that MSWC caused more flower diameter. Compost 20% (36/99 mm) was the lowest one. In this study, flower diameter was increased with the application of municipal solid waste compost 10% and control treatment. Gibberellin had no effect on flower diameter.

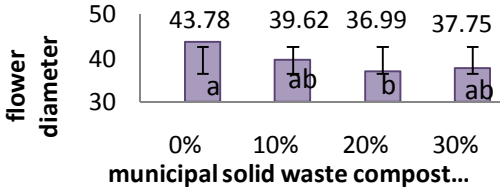

Figure 6 - Effect of different levels of municipal solid waste compost on the diameter of tulip

Number of Bulbs

The results of data comparison indicated that most of bulb numbers obtained in MSWC 10% , peat soil and GA_3 50 and 100 mg.l (Figures7 and 8).

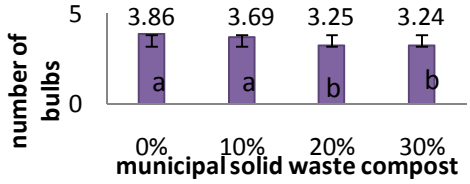

Figure 7- Effect of different levels of municipal solid waste compost on the number of tulip bulbs

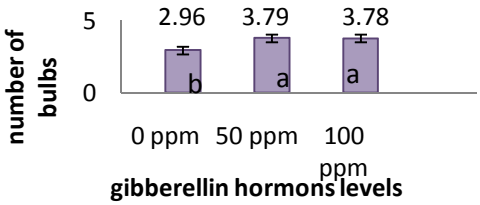

Figure 8 - Effect of different levels of the hormone gibberellin on the number of tulip bulbs

Another quantitative factor that is important in the cultivation of bulbous plants, especially tulipS (in some varieties) is the number of daughter bulbs produced. Thus, factors that stimulate bulb formation and increase it, are very important. In most horticulture crops especially ornamental plants, plant growth regulators are used. Number of narcissus bulbs increased, after spraying cytokinin [4]. Khalighi et al., [9] reported that nutrient solution contains NPK (4.6, 4.05 and 6 mg) and 500 ppm hormonal treatments of kinetin in sandy loam texture had the greatest impact on largeness, yield and number of tulip bulbs. Growth hormones such as gibberellin and cytokinines, due to the nature of cell division, increase the number of bulbs. It seems that macro and micro nutrients and enzymes and growth hormones found in compost has been increased the number of tulip bulbs.

Carotenoids Pigments

The results of data analysis indicated that simple effects of municipal solid waste compost and gibberellin and also interactions effects of them were not significant on carotenoid levels in tulip petals at 1% (Table 2). El Negro et al., [3] reported that treatment of gibberellic acid (50 mg.l) in combination with P_2O_5 100 ppm, increased petal carotenoids significantly compared to control, but in our results there are no significant effect of compost and gibberellin on petal carotenoids.

Chlorophyll pigments

The results of data analysis indicated that simple effects of gibberellin and interaction effects of compost × gibberellin on the concentration of chlorophyll a was not significant at the 1% , but the simple effect of MSWC and its interaction was significant at the 1% (Table 2). The results of data comparison indicated that municipal solid waste compost 20% (3.12mg/ml) and 20% municipal waste compost 20% × gibberellin 50 ppm(4.46microg ml) had the highest chlorophyll a (Fig. 9 and 10). Simple effect of gibberellin on the amount of chlorophyll b was not significant, but the simple effect of compost and interaction effects on them was significant at the 1% (Table 2). The results of data comparison indicated that treatment of MSWC 10% (4.24 mg.ml) and the treatment of compost 10% and gibberellin 0 mg.l (7.14 mg.l) showed the maximum amounts of chlorophyll b (Fig. 11 and 12). Simple effect of gibberellin on the total chlorophyll content was not significant, but the simple effect of MSWC and MSWC × GA_3 were significant at the 5% (Table 2). The results of the comparison indicated that MSWC 10 and 20% (5/82 and 6/35) and compost 20% × GA_3 50 mg.l (9/89) had the highest total chlorophyll content (Figure 13 and 14).

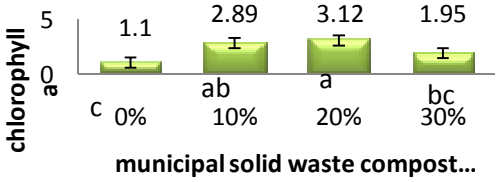

Figure 9 - The effect of different levels of municipal solid waste compost on the chlorophyll a content of tulip leaves

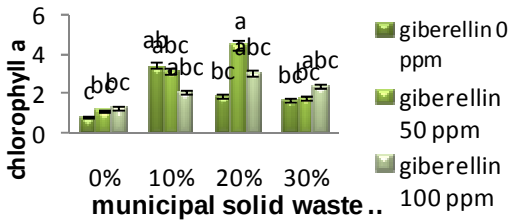

Figure10- Interaction effect between compost × gibberellin on the chlorophyll a content of tulip leaves

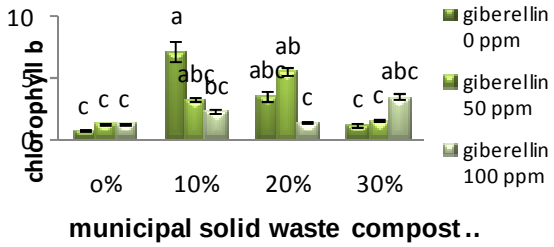

Figure11- Interaction effect of compost × gibberellin on chlorophyll b in tulips leaves

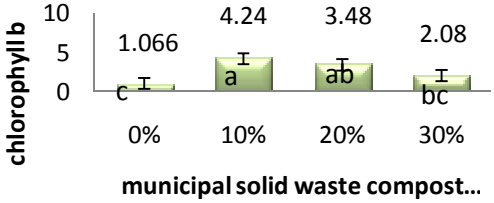

Figure12-The effect of different levels of municipal solid waste compost on chlorophyll b in tulip leaves

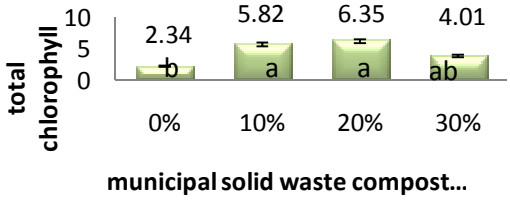

Figure13-the effect of different levels of municipal solid waste compost on total chlorophyll in tulip leaves

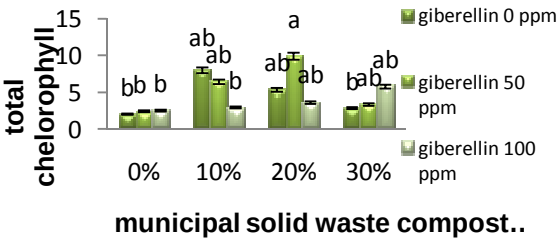

Figure14- Interaction effect between compos×gibberellin on Total cholorophyll content of tulip leaveS

In Amaryllis, media containing sand + composted leaves have the highest significant effects on leaf chlorophyll content. El Negro et al., [3] reported that treatments of gibberellic acid 50 mg.l in combination with P_2O_5 100 mg.l increased chlorophyll content of leaves significantly comparing with control. Nitrogen as a part of chlorophyll molecule in plants, enzymes and protein structures is very important. So each chlorophyll molecule contains four atoms of nitrogen. Nitrogen is involved in chlorophyll structure. Chlorophyll play important role in photosynthesis of green and organic plants. Positive results report from Ghaem Maghami [5], Samiei et al [14] and Arshad [2].

CONCLUSION

In this study, the effect of municipal solid waste compost and gibberellin levels were assessed on the quality of tulip plants. For most traits, MSWC 10% leaded to good results. MSWC 30% delayed flowering time about 7 days. The most flowers and bulbs number were obtained in GA_3 100 mg.l. MSWC 10 and 20% in combination with peat moss had the highest leaves chlorophyll content. It seems that soil salinity caused by high percentages of municipal solid waste compost that is a limiting factor for tulip growth. It is due to the high electrical conductivity and PH of MSWC. Municipal solid waste compost increased water holding capacity to prevent the growth of weeds and as a natural and cheap fertilizer can be as an alternative for chemical fertilizers.

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