Effects of three levels of mycorrhiza and four levels of planting bed on total wet and dry weight of shoots and the number of lateral branches of white periwinkle (Catharanthus alba)

Sepehri B.1*, Zarghami R.2, Salari A.3 and Nemati N.1

1Department of Agronomy, Varamin-Pishva Branch, Islamic Azad University, Varamin, Iran.
2Agricultural Biotechnology Research Institute of Iran, Karaj, Iran.
3National Research Centre on Plant Biotechnology, Indian Agricultural Research Institute, New Delhi 110 012, India.

Medicinal and ornamental plant of periwinkle (Catharanthus alba) contains the valuable alkaloids of vinblastine and vincristine in vegetative parts and Ajmalicine in its root that play a role in the chemotherapy types of cancers. This study was conducted for evaluating the effects of three levels of biological fertilizer of mycorrhiza (control (m0), Glomus mosseae (m1) and Glomus intraradices (m2)) and four levels of seed bed (the bed a; included the typical agricultural soil, bed b; contained a mixture of agricultural soil and sheep manure and rotten leaf and Aeolian sand, bed c; included the normal agricultural soil mixed with vermicompost and bed d; contained the normal agricultural soil mixed with compost) and their interactions on total shoot wet and dry weight and number of side branches containing the alkaloids of medicinal and ornamental plant of periwinkle (C. alba) as potted and in a factorial randomized complete block design with three replications and each replication including 12 treatments and each treatment including 4 pot with a total of 144 pots and each pot including two plants that were performed as the indirect culture (first in the nursery and then transfer to the pot), in Tehran. According to the results, the mycorrhizal type of G. interaradices (treatment m2) showed the highest significant effect on the characteristics of total wet and dry weight of shoots and the number of lateral branches. In studying the effect of planting beds, the bed b (agricultural soil mixed with sheep manure, rotten leaves and Aeolian sand) had the highest effect on all the characteristics. But in the interactions of mycorrhiza and planting bed, the treatment bm1 (bed b inoculated with mycorrhizal type of G. mosseae) and bm2 (bed b inoculated with mycorrhizal type of G. interaradices) showed the highest effect on total wet and dry weight of shoots, respectively. Finally, the bed b showed more favorable results in the yield of the medicinal plant of periwinkle.

Key words: Catharanthus alba, shoot wet and dry weight, mycorrhiza, animal manure, vermicompost, compost.

INTRODUCTION

A significant number of drugs originally derived from plants (Gaines, 2004) since the mid-twentieth century and after identifying the adverse effects resulting from the use of chemical medicines, the medicinal plants and herbal medicines research and production developed and soon replaced chemical medicines (Aminpoor and Mousavi, 1995). Since the climate of Iran is very diverse, it is considered as a good place for growing a variety of
plants. So a variety of medicinal plants can be grown as wild and by planting in large quantities (Ghasami, 2001). Periwinkle (Catharanthus alba), from the family of oleander, is a shrub and perennial plant that is annually cultivated in the cold areas (Dobelis, 1989). The plants of this family include about 300 genera and 1,300 species that mainly grow in the tropical areas. Among these species, only a few medicinal plants have been found that periwinkle is one of them (Omidebei, 2009). Almost all plants belonging to the family contains a variety of alkaloids and glycosides (Brunet, 1995). According to studies conducted by Mukhopadhyay et al. (1983) and Maloney et al. (2006), Catharanthus plants contain more than 85 alkaloids. The plant contains important alkaloids like, vinblastine and vincristine in shoots (to treat some kinds of cancers) and ajmalicine in the root (hypertension) (Sajjadi, 2000).

Now a days, these alkaloids (vinblastine, vincristine, and vinorelbine) are producing synthetically and used as medication to treat the cancers and as a controlling agent for normal reactions of immune system. The extracts and derivatives of Periwinkle plant such as vinpocetine are also known as non-harmful medicines (Hassan, 2012). The alkaloids of vinblastine and vincristine are produced in the young leaves and the alkaloids of ajmalicine are produced in the roots of the plant. Proper use of nutrients during the medicinal plant cultivation, has main role in increasing the yield, and also affect the quality and quantity of their active ingredients (Omidebei, 2009).

Organic-biological agriculture is one of the new methods for producing the products with minimal residues of chemical fertilizers in its own texture (Hassan, 2012). One of the ways to achieve the sustainable agriculture is using the microorganisms which have an important role in meeting the nutritional requirements of plants (Nadian, 1998).

Mycorrhizal symbiosis provides a better competitive strategy for the host plant (Kothamasi and Babo, 2001). It was also reported that vermicomposts contain the active biological substances that act as growth regulators (Tomati et al., 1988). The first advantage of municipal waste compost is having high organic material and low mass (Soumare et al., 2003). In addition to compensating the food shortages, helping stabilize soil aggregate in the light soil and entering the useful micro-organisms in soil, the animal manure will lead to save water.

MATERIALS AND METHODS

The mentioned experiment was conducted as a factorial randomized block design with three replicates and 12 treatments each (totally 36 treatments). This research has two factors. The first factor (A) includes:

A) Typical agricultural soil (a) that is without the use of any additives with pH= 7.74, total nitrogen= 0.137 ppm, phosphorus= 24 ppm, K= 428 ppm, percent of organic carbon= 1.37% and CEC= 19.52 Cmol/kg and EC= 2.43 Ds/m.

B) A mixture of agricultural soil and sheep manure and rotten leaves (b) that is a mixture of agricultural soil, completely rotten sheep manure, rotten leaves, Aeolian sand with the equal proportions with pH= 7.49, total nitrogen= 0.464 ppm, phosphorus= 122 ppm, K= 1494.9 ppm, percent of organic carbon= 6.46% and CEC= 16 Cmol/kg and EC= 7.96 Ds/m.

C) A mixture of agricultural soil with vermicompost (c) which includes two-thirds of agricultural soil and one-third of vermicompost with pH= 7.27, total nitrogen= 0.983 ppm, phosphorus= 94 ppm, K= 578.6 ppm, percent of organic carbon= 9.83% and CEC= 19.2 Cmol/kg and EC= 5.34 Ds/m.

D) A mixture of agricultural soil with compost (d) that includes two-thirds of agricultural soil and one-third of compost with pH= 7.47, total nitrogen= 0.148 ppm, phosphorus= 24 ppm, K= 277.3 ppm, organic carbon= 1.43% and CEC= 2.148 Cmol/kg and EC= 2.77 Ds/m.

The second factor (B) includes three levels of mycorrhiza. First level: control (m0), second level (m1): the bed inoculated with mycorrhiza of Glomus mosseae with the amount of 100 gm⁻² and the third level (m2): the bed inoculated with mycorrhiza of Glomus intraradices with the amount of 100 gm⁻² and 105 (CFU) each. After preparing the planting beds, the mycorrhiza fungi with the amount of 100 gm⁻² was added to the planting beds (except for the control treatment) and then the seeds were planted. In each treatment, hundred seeds of periwinkle with the distance of 2 cm from each other were planted. After 76 days (3 to 4 leaves), the seedlings were transferred from nursery to pots. Each of seedlings were planted in the pots containing its planting bed soil with respective treatments (control (m0) and inoculated mycorrhizal types, m1 and m2). The amount of Mycorrhiza used was 10 g per pot that were treated at a depth of 5 cm from the surface of pot soil. The height of each pot was 40 cm and the diameter of each pot opening was 20 cm span. Until two months after the transfer to the pot, irrigation of pots was conducted every 12 h and each time with the amount of 960 cc. But after two months and considering the cooler weather and shortness of day and completion of plant growth, it was reduced to once every 24 h. After completion of vegetative and reproductive growth the number of lateral branches was counted (the lateral branches with flowers and capsules were counted). At the end of the experiment, the plants were cut from the soil surface and from the rosette area (Mahbobi Khomami, 2006) to take the wet weight of all samples.

At the peak of flowering, the samples were taken from the young plant leaves with the highest amount of alkaloids (vinblastine and vincristine). According to the reports, harvesting the plant at the time of full bloom had the highest amount of alkaloids, particularly the alkaloids of vincristine (Lata, 2007). The samples were placed in the oven in 45°C for one week (Zarezadeh et al., 1997) to measure the total dry weight of shoots. Yanavan method was used to measure total alkaloids (Zarezadeh, 1997). To measure vinblastine and vincristine, HPLC method was used (British Pharmacopoeia, 2008; Skoog and West, 1994). The statistical analysis was conducted by using statistical software (Mstac) and the Duncan's multiple-range test was used to compare the mean

*Corresponding author. E-mail: Babak5464@yahoo.com.

Author(s) agree that this article remain permanently open access under the terms of the Creative Commons Attribution License 4.0 International License.
Arbuscular mycorrhizal fungi are different in efficiency for increasing the water uptake from soils. This ability seems to be related to the amount of external mycelium produced by each arbuscular mycorrhizal fungi generated and the amount of root colonization according to living and active structures of fungus (Marulanda et al., 2003). Hassan (2012) stated that VAM mycorrhizal fungus significantly increases the wet weight of the branches and leaves of periwinkle (Catharanthus roseus (L.) G. DON). In another experiment on pink flower periwinkle (Catharanthus roseus (L.) G. DON), Sepehri et al. (2012) stated that using two mycorrhizal factors of G. mosseae and G. intraradices caused a significant difference at the level of 1% in the yield of total wet weight of shoots and top branches containing alkaloids. On a white flower periwinkle (C. alba), Sepehri et al. (2013) stated that using two mycorrhizal factors led statistically significant difference at the level of 1% in the yield of wet weight of top branches containing alkaloids. Research on wheat inoculated with mycorrhiza by Panwar (1992) was proved that mycorrhizal fungus increases the weight of root and shoot. In the research on the kinds of planting bed, the results showed the plants cultivated on the planting bed b with the mean of 54.4 g per plant had the highest total wet weight of shoots followed by the plants cultivated on the planting bed d with the mean of 51.15 g per plant and then the plants cultivated on the planting bed c with the mean of 49.51 g per plant had statistically significant difference with the planting bed a with the mean of 43.61 g per plant.

Also, the bed b showed a significant difference compared to the beds c and d, but two beds of c and d did not have any significant difference (Figure 2). While improving the soil texture, organic fertilizers (manure, compost and vermicompost) lead to increase the soil permeability, decrease the soil bulk density, capability of holding soil water and also increase the soil nutrient and makes it easy to absorb water and nutrients through the roots to the plant that it causes to increase plant growth and total wet weight of shoots. Khalil et al. (2007) reported that the highest wet and dry weight of single

### RESULTS AND DISCUSSION

The results obtained from study of the effects of mycorrhiza and planting bed and their interactions on total shoot dry and wet weight and number of lateral branches (Table 1).

#### Total wet weight of shoots

The analysis of variance (Table 1) indicate statistically significant difference at the level of 1% in using two factors of mycorrhiza and four levels of planting bed, and a significant difference at the level of 5% in the interactions between the different levels of mycorrhiza and planting bed on the total wet weight of shoots. The results of mean comparison (Figure 1) shows that the highest yield of total wet weight of shoots with the mean of 52.93 g per plant related to the treatment m2 (mycorrhiza type of G. intraradices), and then treatment m1 (mycorrhiza type of G. mosseae) with the mean of 51.07 g per plant had a significant difference with the treatment m0 (control, 45.01 g). However, no significant difference was statistically observed between the two types of mycorrhiza regarding total wet weight of shoots. The plants with mycorrhizal symbiosis, drain the water from the soil faster and more efficiently than non-mycorrhizal plants and lead to more decrease of the soil water potential, because in the mycorrhizal plants, the shoots usually develop more, the leaf area increases and this increases the need for evapotranspiration in mycorrhiza.

On the other hand, the root system of mycorrhizal plants is developed more and branches off more than mycorrhizal root and the diameter of lateral roots in them decreases and root length increases. All of these factors lead the mycorrhizal roots to have more contact level with the soil and so absorb the water from the soil faster.
Figure 1. Effect of two kinds of mycoriza on total shoot wet weight [m0= Control m1= Glomus mosseae; m2= Glomus intraradices]; [a= typical agricultural soil; b= agricultural soil mixed with rotten sheep manure, rotten leaves and Aeolian sand; c= agricultural soil mixed with vermicompost; d = agricultural soil mixed with compost].

Figure 2. Effects of planting beds on total shoot wet weight. a= typical agricultural soil (control) [am0= the bed of a without mycorrhiza; am1= the bed of a inoculated with mycorrhiza of Glomus mosseae; am2= the bed of a inoculated with mycorrhiza of Glomus intraradices]; b = agricultural soil mixed with rotten sheep manure, rotten leaves and Aeolian sand [bm0= the bed of b without mycorrhiza;bm1= the bed of b inoculated with mycorrhiza of Glomus mosseae ;bm2= the bed of b inoculated with mycorrhiza of Glomus intraradices [c = agricultural soil mixed with vermicompost;cm0= the bed of c without mycorrhiza;cm1= the bed of c inoculated with mycorrhiza of Glomus mosseae ;cm2= the Aeolian bed of c inoculated with mycorrhiza of Glomus intraradices [d = agricultural soil mixed with compost;dm0= the bed of d without mycorrhiza;dm1= the bed of d inoculated with mycorrhiza of Glomus mosseae ;dm2= the Aeolian bed of d inoculated with mycorrhiza of Glomus intraradices].
plant of *Dracocephalum moldavica* was obtained under the condition of using the organic fertilizer especially animal manure. In another experiment, Sepehri et al. (2013) also stated that using the manure, compost and vermicompost causes a significant difference at the level of 1% on the yield of wet weight of top branches containing alkaloid white flowers periwinkle (*C. alba*).

In another experiment on pink flower periwinkle (*Catharanthus roseus* (L.) G. DON), Sepehri et al. (2012) reported that the animal manure, compost and vermicompost caused a statistically significant difference at the level of 1% on total wet weight of shoots and the wet weight of top branches containing alkaloids. In the interactions study, it was observed that in the control treatment (m0), the plants cultivated on the planting bed b with the mean of 52.49 g per plant had the highest total wet weight of shoots followed by the planting bed d with the mean of 46.79 g per plant and then the planting bed c with the mean of 46.3 g per plant had a statistically significant difference with the planting bed a with the mean of 34.4 g per plant.

Also, the beds b and d as well as the beds c and d did not have any significant difference with each other (Figure 3). But in the treatment m1 (inoculated with the mycorrhizal type of *G. mosseae*), it was observed that none of planting beds had statistically significant difference with each other on total wet weight of shoots. In the treatment m2 (inoculated with the mycorrhizal type of *G. intraradices*), it was observed that the plants cultivated in the planting bed b with the mean of 57.88 g per plant had the highest total wet weight of shoots and this bed had significant difference with the two beds a and d but it did not show any significant difference with the planting bed d. Also, no statistically significant difference were observed between the beds a, c and d. While, by study and compare of the three treatments m0, m1 and m2, it was observed that in the beds of a, the plants cultivated in the treatments am1 and am2 had a statistically significant difference with the plants cultivated in the treatment am0 which the highest amount of it, was related to treatment am2 with the mean of total wet weight of 49 g per plant.

However, no significant difference was observed between the treatments am1 and am2. Three planting beds of b, the treatments bm0, bm1 and bm2, did not have any statistically significant differences with each other. Also, in the planting beds of c, three treatments cm0, cm1 and cm2 did not have any significant differences with each other. But, in three planting beds of d, the plants in the bed dm2 with the mean of total wet weight...
weight of 53.9 g per plant, showed statistically significant difference compare to the bed of dm0, but no significant difference was seen between the beds of dm1 and dm2 as well as between two beds of dm0 and dm1. It seems that these results were not due to the direct effect of manure, vermicompost and compost on the percentage of mycorrhizal symbiosis but they resulted from the effects of nutrients of above organic fertilizers on the direct and indirect development of fungus network and its effect on stimulating the root growth of host plant. Also using the vermicompost improves the growth and finally increases the yield of total wet weight of shoots by a positive effect on the percentage of mycorrhizal symbiosis and development of external hyphae and subsequently by the effect of mycorrhizal fungi on the development and prosperity of the host plant root growth. In a similar experiment, the interactions of different levels of mycorrhizal and planting beds on the wet weight of top branches containing alkaloid of white flower periwinkle (C. alba) did not report any significant effect (Sepehri et al., 2013). But in other research on pink flower periwinkle (C. roseus (L.) G. DON), the same researchers stated that the interactions between different levels of mycorrhiza and planting bed caused a significant increase of 5% in wet weight of top branches containing alkaloid and a significant increase of 1% in total wet weight of shoots (Sepehri et al., 2012).

**Total dry weight of shoots**

Using two factors of mycorrhiza and four levels of planting bed caused a statistically significant difference at the level of 1% and in the interactions of different levels of Mycorrhiza and planting bed caused significant difference at the level of 5% on the yield of total dry weight of shoots (Figure 4; Table 1). Both treatments of m1, m2 showed statistically significant difference with control treatment (m0). The treatment of m2 (mycorrhizal type of G. intraradices) with a mean of 15.05 g per plant had the highest effect on total dry weight of shoots but no significant difference was observed between two treatment (m1 and m2). Increased uptake of water and nutrients required for plant led to increase the growth and photosynthesis of plants and improve the yield and increase the dry matter in plants. In the research on white flower periwinkle (C. alba), Sepehri et al. (2013) found that using two mycorrhizal types of G. mosseae and G. intraradices caused a statistically significant difference of 5% in the yield of dry matter of top branches containing alkaloids. Also in other research on pink flower periwinkle (C. roseus (L.) G. DON), Sepehri et al. (2012) stated that using two mycorrhizal types of G. mosseae and G. intraradices caused statistically significant difference of 5% in the yield of dry matter of top branches containing alkaloids and 1% difference in total dry weight of shoots. Hassan (2012) stated that VAM mycorrhizal fungi significantly increased the dry weight of branches and leaves in periwinkle (C. roseus (L.) G. DON). Also, in the research on corn, Subramanian and Charest (1997) observed that corn aerial biomass inoculated with mycorrhiza (Glomus intraradices) increased. In a research on single-cross corn, Sajedi and Sajedi (2009) found that mycorrhiza increased the biological yield and
total dry weight of shoots and roots compared to the control treatment.

The results obtained from the effect of planting beds suggest that the plants cultivated on the planting bed b with the mean of 16.06 g per plant, the plants cultivated on the planting bed c with the mean of 14.41 g per plant and the plants cultivated on the planting bed d with the mean of 13.74 g per plant showed statistically significant difference with the planting bed with the mean of 11.15 g per plant. Also, the bed b showed a significant difference with other three planting beds in total dry weight of plants but two other beds of c and d do not have any significant difference with each other (Figure 5). While improving the soil and adding nutrients to the soil, using the organic fertilizers (manure, compost and vermicompost) lead to root development, optimal absorption of water and nutrients, and also improving the efficiency of photosynthesis and making matters in the plant and thus increasing the shoot growth and dry matter in the plant (Sepehri et al., 2012).

In a research on D. moldavica, Rahbarian et al. (2009) reported that using the animal manure increases the dry weight of plant. The results of research conducted by McCallum et al. (1998) on the use of compost in Cotton cultivation show that compost improves the germination of seed and increases the dry matter produced compared with the treatments without the use of compost. In a research on single-cross hybrid corn, Jahani et al. (2011) found that using vermicompost increased total dry weight of shoots compared to the control treatment.

In another experiment, the use of animal manure, compost and vermicompost caused a statistically significant difference of 1% in the yield of the dry weight of top branches containing alkaloid of white flowers periwinkle (C. alba) (Sepehri et al., 2013). In study of the interactions of mean comparison result (Figure 6), it was observed that in the control treatment (m0) the planting bed of b, c and d as well as the beds of b and d had a significant difference with the planting bed a, but three mentioned planting beds did not show any significant difference in total dry weight of shoots. In this treatment, the highest total dry weight was related to the planting bed of b with the mean of 13.08 g per plant and the lowest was related to the bed a, with the mean of 8.903 g per plant.

In the treatment m1 (inoculated with the mycorrhizal type of G. mosseae), it was observed that the planting beds of a, b and c as well as the beds of b, c and d had statistically significant difference with each other but no significant difference was observed between the planting beds of a and d. In this treatment, the highest total dry weight of shoots was related to the planting bed of b with the mean of 18.83 g per plant and the lowest was related
to the planting bed of a, with the mean of 11.68 g per plant. In the treatment m2 (inoculated with the mycorrhizal type of G. intraradices), it was observed that the planting beds of b and d had significant difference with the bed of a, but no statistically significant difference in total dry weight of shoots was observed between three planting beds of b, c and d. Also, no significant difference was observed between two planting beds of a and c. In this treatment, the plants cultivated in the planting bed of b with the mean dry weight of 16.25 g per plant and with negligible difference with the plants cultivated in the planting bed of d with the mean dry weight of 16.12 g per plant had the highest total dry weight of shoots and the plants cultivated in the planting bed of a, with the mean of 12.87 g per plant had the lowest total dry weight of shoots.

Figure 6. Interactions of different levels of mycorrhiza and planting bed on total dry weight of shoots (g per plant).

A research on grain sorghum by Alizadeh et al. (2009) was observed, the combined application of mycorrhiza and vermicompost cause a significant increase in biological yield. They stated that this increase is not due to a direct effect of vermicompost on mycorrhizal symbiosis but it is due to the effect of nutrients of vermicompost on direct and indirect development of fungus network and its effect on stimulating the root growth of host plant. It seems that the use of vermicompost leads to improve the growth and ultimately increase the seed yield in the plant through the positive effect that it has on the percentage of mycorrhizal symbiosis and development of external hyphae and subsequently the effect that mycorrhizal fungi has on the development of host plant root growth.

In another research, Hassan (2012) stated that the beds of cm0, cm1 and cm2, it was observed that two beds of cm1 and cm2 have a statistically significant difference with the beds of cm0 in the control treatment. But no statistically significant difference was observed between two beds of cm1 and cm2. The bed of cm1 with the mean of 16.17 g per plant had the highest significant effect on total dry weight of shoots compared to control treatment. In three planting beds of dm0, dm1 and dm2, the bed of dm2 with the mean of total dry weight of 16.12 g per plant showed significant difference with two beds of dm0 and dm1, but no significant difference was seen between two beds of dm0 and dm1.
interactions between VAM mycorrhizal fungi and bacteria Bacillus and rabbit droppings caused a significant increase in dry weight of branches and leaves of periwinkle (C. roseus (L.) G. DON) two consecutive seasons. In other research on the medicinal plant of anise (Pimpinella anisum L.) conducted by Darzi et al. (2010) found the interactions of Vermicompost and biological phosphate fertilizer caused a significant increase in biological yield of plant.

In a research on the periwinkle from the variety of Alba (C. alba), Sepehri et al. (2013) did not report any significant effect of different levels of mycorrhiza and planting bed on the dry weight of top branches containing the active ingredient. Also, in the research on the interactions of different levels of mycorrhiza and planting bed in the pink flowers periwinkle (C. roseus (L.) G. DON), no significant effect on the yield of total dry weight of shoots and the dry weight of top branches containing active ingredient was reported (Sepehri et al., 2012).

**Number of lateral branches**

The results of research (Table 1) indicate a significant difference at the level of 5% in using two factors of mycorrhiza, at the level of 1% in using four levels of planting bed and lack of statistically significant differences in the interactions between the different levels of mycorrhiza and planting bed on total wet weight of the shoots. Both types of mycorrhiza showed a significant difference in the yield of number of lateral branches with the control (m0).

However, no significant difference was observed between the two types of mycorrhiza. In treatment m2 (mycorrhiza G. interaradices) with the mean of 9.32 number per plant and treatment m1 (mycorrhiza type G. mosseae) with the mean of 9.288 number per plant included the number of lateral branches. But in many references, the positive effects of organic fertilizers on the development of mycorrhizal fungi, the composition of microbial communities, fauna, flora, soil, and the intensification of metabolic processes in the soil, root, branches and leaves has been emphasized (Fay and Osborne, 1996). The results suggested that mycorrhizal symbiosis increases the absorption of immobile nutrients in the soil such as phosphorus and zinc significantly (Al-Karaki, 2000).

One of the most important properties of mycorrhiza is absorption of important and essential elements in the soil such as nitrogen and phosphorus that in this research has led to increase the number of lateral branches. Phosphorus causes the strength of the roots and improvement of element absorption by the root as well as an increase in diameter growth and strength of stem and the number of lateral branches of the plant. In a research on soybean, Taherianfard et al. (2011) stated that the simple effect of mycorrhizal causes a significant increase in the number of lateral branches. In studying the interactions between manure, mycorrhiza and irrigation, they also observed a significant increase in the number of

![Figure 7. Effects of two kinds of mycorrhiza on the number of lateral branches. m0= Control; m1= Glomus mosseae; m2= Glomus intraradices; a= typical agricultural soil; b= agricultural soil mixed with rotten sheep manure, rotten leaves and aeolian sand; c= agricultural soil mixed with vermicompost; d= agricultural soil mixed with compost.](image-url)
lateral branches of soybean compared to the control.

In the research on the effect of different levels of planting beds, two beds of b and c had significant difference compared to planting beds of a and d, but no statistically significant difference was observed between two beds of b and c. Also, no significant difference was observed between two beds of a and d in the number of lateral branches. In the research, the bed of b with the mean of 10.56 number per plant and then the bed of c with the mean of 9.43 number per plant had the highest significant effect on the yield of number of lateral branches while the lowest amount was related to the soil of a, with the mean of 7.26 number per plant.

The animal manure and vermicompost increase the vegetative growth and the number of lateral branches in the plant by improving the soil and making it lighter and by increasing the water holding capacity of the soil as well as adding the necessary nutrients to the soil while the lighter soil leads to increase the root development and better activity of roots in the soil. The rotten leaves of sycamore and Aeolian sand are also used in the soil of b that help to making the soil lighter and improving it more and are much needed to the medicinal plant of periwinkle (Sepehri et al., 2012). In another study on pink flower periwinkle (C. roseus (L.) G. DON), Hassan (2012) found that fertilizing the plants with compost or rotted manure of rabbits at all levels resulted in a significant increase in the number of branches compared to untreated plants in two experimental seasons. Study on pink flower periwinkle (C. roseus (L.) G. DON), Sepehri et al. (2012) found that organic fertilizers (manure, compost and vermicompost) caused a significant increase of 1% in the number of lateral branches containing alkaloids compared to control treatment.

Rahbarian et al. (2009) stated that the use of animal manure and regular irrigation increased the flowering branches in the medicinal plant of D. moldavica. Padasht (2004) found that the use of compost had the best effect on growth indices of Tagetes erecta and increased the wet weight, dry weight, accelerating the flowering, increasing the number of flowers and the number of lateral branches in the plant. In the interaction of mycorrhiza and planting bed, no significant effect was seen on the lateral branches. In a study on soybean conducted by Mostajeran and Khoozoi (1999), it was determined that in plants grown in soil with low phosphorus, the mycorrhizal infection resulted in high concentrations of phosphorus in the leaves and branches and more dry weight of stem and node compared to non-mycorrhizal treatment. The results of some researches indicate that mycorrhizal efficiency is reduced by increasing the fertility of the soil.

Conclusion

In this study, according to the results, the mycorrhizal type of G. interaradices (treatment m2) showed the highest significant effect on the characteristics of total wet and dry weight of shoots and the number of lateral branches. In studying the effect of planting beds, the bed b (agricultural soil mixed with sheep manure, rotten leaves and Aeolian sand) had the highest effect on all the characteristics. But in the interactions of mycorrhiza and planting bed, the treatment bm1 (bed b inoculated with mycorrhizal type of G. mosseae) and bm2 (bed b inoculated with mycorrhizal type of G. interaradices) showed the highest effect on total wet and dry weight of
shoots, respectively. Finally, the bed b showed more favorable results in the yield of the medicinal plant of periwinkle.

Conflict of Interests

The authors have not declared any conflict of interests.

REFERENCES


Hassan EA (2012). Effect of Rabbit Manure, VA Mycorrhiza and Bacillus sirculans on Growth, Flowering and Chemical Constituents of Periwinkle (Catharanthus roseus L.) Plants. 6(13):443-453.


