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Article

The role of vermicompost on yield and alkaloid concentration of fenugreek

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Abstract: The current study was conducted to investigate the effect of different levels of vermicompost (0, 6, 12 and 18 g.pot^{-1}), peat-moss (12mg.pot^{-1}) and Di-Ammonium Phosphate (DAP) (1g.pot^{-1}) on some yield components (length, No. and weight of pods and No. and weight of seeds) and alkaloids concentration in seed of fenugreek according to the complete randomized design with six replicates. The study was achieved by using high-performance liquated chromatography (HPLC) technology. The analysis of HPLC data shows that the four alkaloids (choline, trigonelline, carpaine and gentianine) have been separated and purified. The result showed a significant difference between different fertilizer levels on yield components and alkaloid concentration, and treatment 12g.pot^{-1} gives a high value of the studied characteristics mentioned above. Also, results showed that seeds are rich in trigonelline.

Keywords: alkaloids, vermicompost, trigonelline and fenugreek

Introduction

Fenugreek (Trigonella foenum-graecum L.) is a popular legume crop farmed primarily in India and has high levels of soluble dietary fiber and phytochemicals, contributing to various pharmacological effects [1]. It has a group diversity of nutrients and bioactive compounds required for improving the health and functionality of biological systems; it contains many beneficial amino acids that play important physiological roles in the body [2]. Since ancient times, earthworms have provided natural services to humans by providing vermicompost and vermiwash, which positively affect soil fertility and crop improvement [3]. Earthworms are known as ecosystem engineers because they change the physical, biological and chemical systems of the soil through their activities such as digging, casting, feeding and reproduction[4,5] Earthworms ingest organic waste by physically breaking down into gizzards and then exposed to various enzymes like chitinase, cellulose, lipase, amylase and protease that secreted by the gut wall and associated microbes into the lumen of the gut, these enzymes cut off complex bio-molecules into simple forms. The mucus secreted from the gut wall gives stability to vermicompost. Earthworms absorb only 5-10% of the ingested material for their growth, and the remaining is excreted as casting [6].

Vermicompost improves the soil structure and moisture, increases the availability of nutrients and enhances plant resistance to pathogens[7,8]. The application of vermicompost promotes root growth and increase in yield [9]. It also has positive effects on the chemical and physical traits of soil. It supports the growth of lentils

[10], in addition to NPK fertilizer, by giving high morphological and chemical characteristics of bean plants [11].

Materials and Methods

This experiment was conducted in a plastic house at the Faculty of Science, Mustansiriyah University, during the growing season (2021-2022) to study the effect of vermicompost fertilizer, peat-moss and Di-Ammonium Phosphate (DAP) on some yield contents and alkaloids concentration of fenugreek. The experiment included six treatments consisted four levels of vermicompost fertilizer (0, 6, 12 and 18 g.pot^{-1}) that symbol (Con., Ver.1, Ver.2 and Ver.3) respectively, one level of peat-moss (12g.pot^{-1}) and one level of Di-Ammonium Phosphate (DAP) (1g.pot^{-1}) with six replicates for each treatment according to complete randomized design (CRD). These fertilizers were added before planting, and then seeds were planted on 15/12/2021. After 140 days from seed germination, yield was collected to enumerate length, weight, number of pods, and weight and number of seeds. Alkaloid compounds were extracted from the seed, and the separation condition was estimated according to 12—-chromatographic conditions: alkaloid concentration was determined using an HPLC instrument within the conditions indicated in Table 1 [13]. Identification of alkaloids in different treatments was counted by comparing the retention time of samples with the standard, as shown in Table 2 and Figure 1.

Seq.	Alkaloid	Retention time	Area
1	Choline	2.007	**99747**
2	Trigonlline	3.258	**117624**
3	Carpaine	4.348	**107380**
4	Gentianine	5.16	**107773**

Table 1. Separation condition chromatographic for some alkaloids in fenugreek seeds.

Column length	50x4.6nm l.D
Mobile phase	**Acetonitrile –V/V (55:45)**
Flow rate	**0.9 ml.sec-1**
Detection	**UV 220nm**
Temp.	**30C°**
Sample volume	**20ml**

Table 2. Retention time and area of standard alkaloids.

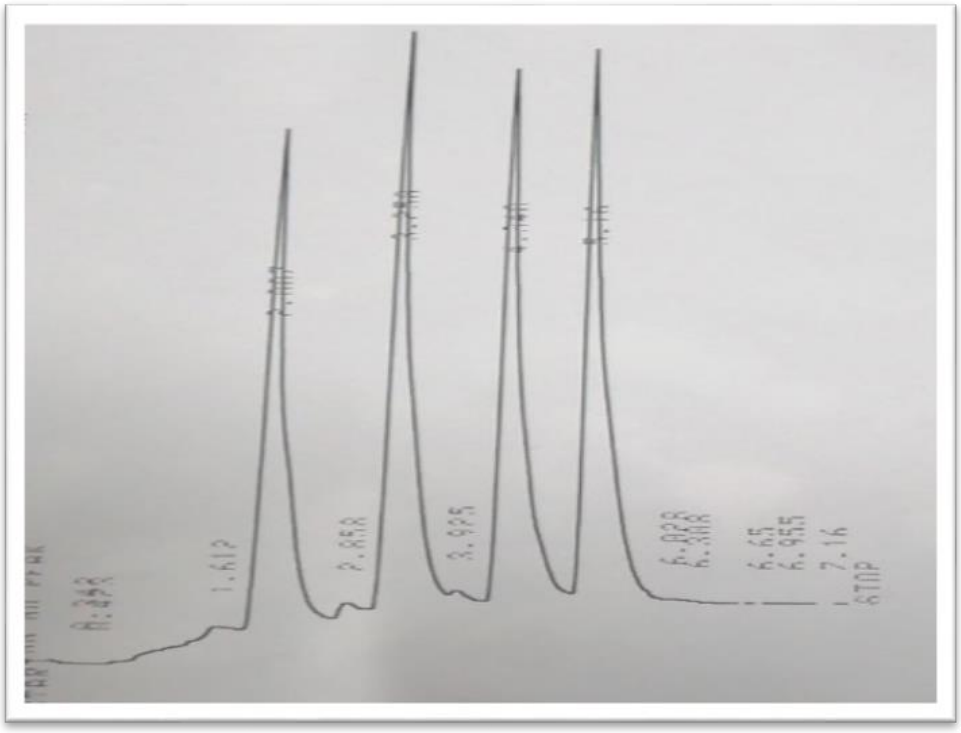

Figure 1. HPLC chromatogram of standard four alkaloids.

Statistical Analysis:

Means were compared at least significant differences (LSD) at $P \leq 0.05$ level and data analysis using Gen-Stat [14].

Result

Pod length (cm):

As shown in Table 3, applying different fertilizers had a significant effect at a 5% probability level on fenugreek yield. Data indicated that the highest length of the pod was achieved in treatment Ver.2, 9.86cm, significantly differed from all other treatments, while the lowest value obtained at control treatment reached 7.44cm. Furthermore, no significant differences were recorded between peat-moss and Ver.3 treatments, giving (9.22 and 9.10) cm, respectively, but there is a significant difference between Ver.1 and DAP, giving (8.25 and 8.14) cm, respectively.

Pod weight (g):

Table (3) shows that significant differences were recorded in pod weight with increasing vermicompost levels at (0, 6, 12 and 18) $g.pot^{-1}$ reached (6.07, 7.00, 9.39 and 8.65) g, respectively. Furthermore, there is no significant difference between peat–moss and DAP treatments that give (8.05 and 7.53) g, respectively.

Number of pods (pod):

Table 3 shows that the highest number of pods was recorded at treatment Ver.2, which gave 31.67 pods and was significantly different from all other treatments, while the lowest value was recorded at the control, which gave 16.33 pods. Also, there is no significant difference between Ver.3, DAP and peat-moss treatments

give (28.00, 25.33 and 25.00) respectively, significantly differing from Ver.1 treatment, which gives (20.33).

Weight of seeds (g):

Table 3 shows that the highest seed weight value was recorded at treatment Ver.2, which gave 7.19g, and was significantly different from all other treatments except treatment Ver.3, which gave 6.65g. In contrast, the lowest value was recorded at the control, 4.47 g. Also, the peat-moss treatment had the same effect as DAP and Ver. 1, giving (5.84, 6.37 and 5.60) g, respectively, but the DAP treatment significantly differed from Ver. 1 treatment.

Number of seeds (seed):

According to Table 3, the effect of fertilizer types on the number of seeds was significant at a 5% probability level. The highest number of seeds was observed with the Ver.2 treatment, which gave 182.00 seeds, while the lowest number was observed with the control treatment, which gave 119.70 seeds.

The value of treatment Ver.2 significantly differs from other treatments except for the treatment Ver.3, which gives 170.00seed. The DAP treatment had the same effect as Ver.3, which gave 158.30, but it was significantly different from Ver.2. Also, no significant differences were recorded between Ver.1 and peat-moss treatments, which gave (144.30 and 142.00) seed.

Level ($g.pot^{-1}$)	**Pod length (cm)**	**Pod weight(g)**	**Pod no. (pod)**	**Seeds weight(g)**	**Seeds no. (seed)**
Con.	7.44	6.07	16.33	4.74	**119.70**
Ver.1	8.25	7.00	20.33	5.60	**144.30**
Ver.2	9.86	9.39	31.67	7.19	**182.00**
Ver.3	9.10	8.65	28.00	6.65	**170.00**
Peat	9.22	8.05	25.00	5.84	**142.00**
DAP	8.14	7.53	25.33	6.37	**158.30**
L.S.D0.05	0.43	0.59	3.41	0.65	**13.57**

Table 3. Effect of different levels of fertilizers on yield content.

Choline concentration ($mg.ml^{-1}$):

As shown in Figure 2, the highest value of choline concentration was achieved in treatment DAP, reaching 200.38$mg.ml^{-1}$, while the lowest value was achieved in the Ver.1 treatment and gave 128.33$mg.ml^{-1}$. The Ver.3, control, peat-moss, and Ver.2 treatments followed the DAP treatment and gave (181.55, 153.38, 141.58 and 136.89) $mg.ml^{-1}$, respectively.

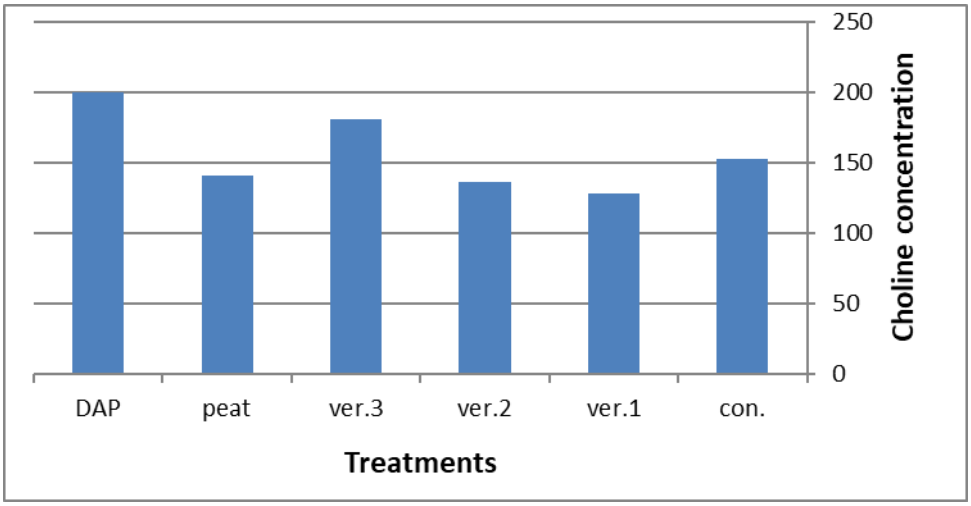

Figure 2. Effect of some fertilizers on choline concentration.

Trigonelline concentration (mg.ml^{-1}):

As shown in Figure 3, the highest concentration of trigonelline was obtained at the Ver.3 treatment, giving 257.20mg.ml^{-1}, while the lowest concentration of trigonelline was obtained at the Ver.1 treatment that gave 172.42mg.ml^{-1}. The DAP, Ver.2, peat-moss and control treatments give (235.69, 227.47, 221.72 and 177.36) gm.ml^{-1}, respectively.

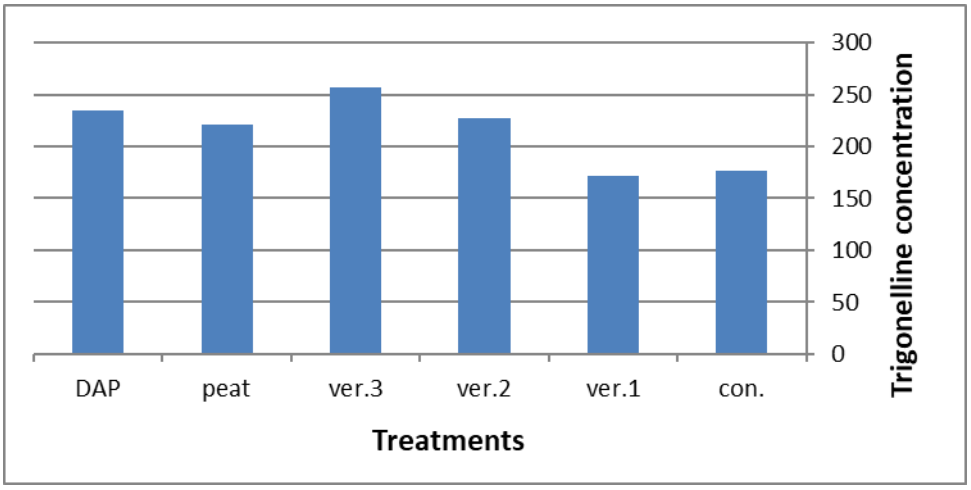

Figure 3. Effect of some fertilizers levels on trigonelline concentration.

Carpaine concentration (mg.ml^{-1}):

Figure 4 indicates that the highest concentration of carpaine was recorded at DAP treatment, 232.42mg.ml^{-1}, while the lowest concentration of carpaine was recorded at treatment control, which gives 111.57mg.ml^{-1}. The Ver.3, Ver.2, peat-moss and Ver.1 treatments followed the DAP treatments and gave (206.64, 177.82, 165.05 and 140.79) mg.ml^{-1}, respectively.

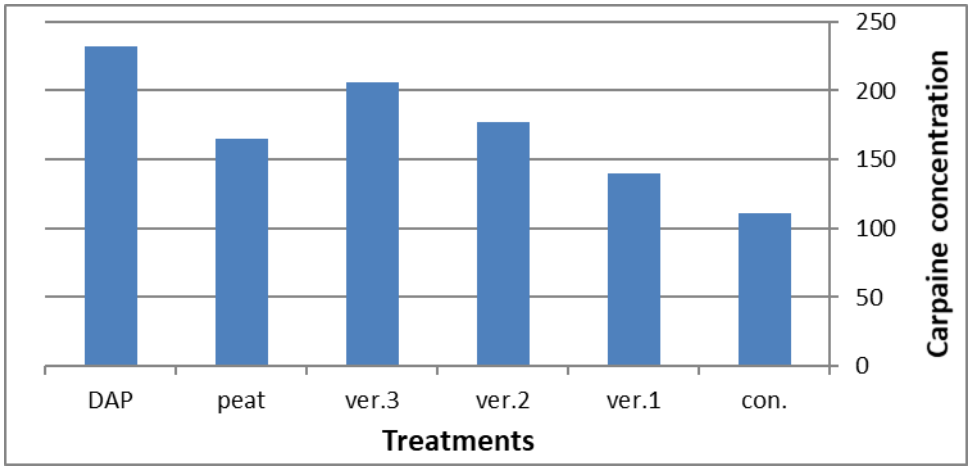

Figure 4. Effect of some fertilizers levels on carpaine concentration.

Gentianine concentration (mg.ml^{-1}):

As shown in Figure 5, the highest value of gentianine concentration in treatment DAP reached 153.33mg.ml^{-1}, while the lowest value was achieved in control, gives 80.07mg.ml^{-1}.

The Ver.2, Ver.3, peat-moss, and Ver. 1 treatment followed the DAP treatment and gave (127.01, 123.67, 96.28 and 95.88) mg.ml^{-1}, respectively.

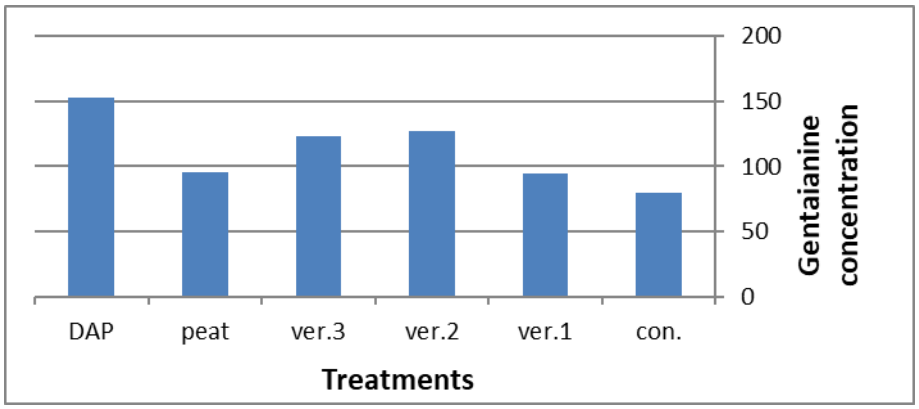

Figure 5. Effect of some fertilizers levels on gentianine concentration.

Discussion

The results showed that the highest components of yield were observed in the Ver.2 treatment, which gave the best results in yield contents compared with the control, which gave the lowest values for the components mentioned above.3, peat-moss, DAP and Ver.1 ranked second, third and fourth, respectively. These results agree with the results of [15,16] in fenugreek and Sesamum indicum.

[17] reported that vermicompost has many beneficial effects on plant growth, such as increasing seed germination, promoting root and shoot growth, and increasing flowering plant and yield content. Also, [18] reported that the vermicompost is a rich source of many micro and macronutrients, vitamins, hormones and valuable microorganisms. When applied to plants, the yield increased. Many studies have shown that adding vermicompost resulted in increased pod length in peanut and common bean plants [19]. Also, [20] found that the use of vermicompost led to increased grain yield in fenugreek plant

The availability of nitrogen in fertilizers plays an essential role in the manufacture and accumulation of alkaloids in plants because alkaloids are

nitrogenous compounds [21]. [22] found that adding vermicompost on Withania somnifrea led to increased yield and alkaloid content compared with chemical fertilizer and control. Alkaloids are one of the most critical metabolic components produced by medicinal plants from different pathways containing nitrogen in their structure; it has a bitter taste, most of which are highly soluble in organic solutions and have pharmacological effects against many diseases, fenugreek seeds contain trigonelline (0.5-0.7%)that use anti-cancer and anti-diabetic, choline 0.5% important in metabolism and smaller quantities of carpaine and gentianine which act as antioxidants [23].

Conclusion

The study concluded the investigation of the effect of vermicompost and other fertilizers on yield components and concentration of alkaloids in fenugreek.

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