International Journal of Farming and Allied Sciences
Available online at www.ijfas.com
©2024 IJFAS Journal-2024-13-2/13-31/ 20 Jul, 2024
ISSN 2322-4134 ©2024 IJFAS

Study of leaf characteristics and yiled of lemon grass under the effect of animal manure and planting pattern

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ABSTRACT: This study was carried out in order to investigate the effect of the application of different animal manures types and the planting pattern on leaf characteristics and yield of lemon grass (Cymbopogon citratus). The experiment was carried out in the form of one-time split plots in the form of a basic randomized complete block design with three replications. The main factor was livestock manure in 4 levels (chicken manure, sheep manure and cow manure and control) and the secondary factor was the planting pattern in three levels (lister, furrow and basin. The results of variance analysis of the data showed that the effect of manure treatment on the characteristics of stem fresh weight, stem dry weight, and leaf fresh weight was significant. The effect of planting pattern treatment on the traits of number of shoots, plant weight, leaf length was significant. Also, the interaction effect of animal manure and planting pattern on the traits of number of shoots, stem fresh weight, stem dry weight and plant weight were significant. The mean comparison results showed that the highest number of leaves per unit area was 294 leaves in the treatment of planting on the lister with the use of chicken manure. The highest amount of fresh weight of lemon grass stem was related to the treatment of the planting pattern on the stack under the conditions of application of chicken manure at the rate of 5.61 $kg.m^{-2}$. Also, the highest amount of plant weight of 12.51 $kg.m^{-2}$ belonged to the treatment of planting on the stack along with the application of chicken manure. The application of chicken manure caused the highest fresh weight of leaves to be obtained at the rate of 5.84 $kg.m^{-2}$. Based on the results of this study, it was found that the use of animal manure in different planting patterns had a positive effect and led to the improvement of leaf characteristics and increase in wet and dry yields of lemongrass plants.

Key words: chicken manure, leaves, lemon grass and yield

INTRODUCTION

Lemongrass (*Cymbopogon citratus* L.) is one of the important medicinal plants that as a medicinal plant has compounds that have medicinal properties and the most medicinal properties of this plant are obtained from the essential oil extracted from the leaves of this plant (Almansour, 2021). Lemon grass biomass is used as a natural product for the extraction of essential oil, widely used in the food, pharmaceutical, perfumery, cosmetics, and environmentally compatible pesticides, steam, distillation,

and other industries (Nazarnejad et al., 2021). Nazarnejad et al. (2022) also mentioned the medicinal properties of lemon grass and stated that this tropical plant has many medicinal properties and attributed these medicinal properties to the compounds in the essential oil of this plant.

Adhering to the desired pattern is one of the most important agricultural operations affecting the performance of agricultural plants (Cha et al., 2016). In order to achieve better growth and increase plant performance, the best planting pattern should be considered (Krimian et al., 2019). The method of planting can affect the way crops grow and this way can affect the rate of growth and the final yield of the plant (Yarami et al., 2022). In the study of Singh et al. (2000), different planting methods for lemon grass plant are mentioned and it is stated that in planting this plant on the stack, the growth characteristics of the plant may be improved and the number of leaves in the plant may be increased. In the study of Najafinejad et al. (2019), the comparison of the averages of two different planting patterns showed that the lower plant density compared to the larger plant density of the stem diameter, and as a result, the plant fresh weight was more favorable. Yazdan Dost Hamdani and Rasai (2013) in their study on the rapeseed plant stated that the vegetative and reproductive units of the rapeseed plant were affected by different planting patterns. In another experiment, it was found that a change in the planting pattern led to a change in the final weight of the stem as well as the biomass of aerial organs (Najafinezhad et al., 2010).

Plants need fertilizer for balanced nutrition, and all types of fertilizers may contain macro or micro elements or a combination of them, which may be in mineral and organic forms (FAO, 2022). In the last few decades, the use of chemical inputs in agricultural lands has caused environmental problems such as the pollution of water resources, the decline in the quality of agricultural products, and the reduction of soil fertility (Sharma, 2022). On the other hand, organic fertilizers in the soil increase the water holding capacity in the soil, increase the organic matter and pH balance of the soil, increase the cation exchange capacity, supply nutrients needed by plants such as nitrogen, and improve the soil structure (Tahmasabi et al., 2022). Compared to chemical fertilizers, organic fertilizers have a variety of high-consumption and low-consumption nutrients that can be gradually provided to the plant as rich sources of nutrients and help to improve the soil structure. For this reason, they bring more consumption efficiency and significantly reduce pollution and environmental hazards compared to chemical fertilizers (Ismailian and Amiri, 2017). In sustainable farming systems, the use of organic fertilizers is of particular importance in increasing crop production and maintaining sustainable soil fertility (Mahmoud et al., 2019). The use of animal organic fertilizers in order to improve the physicochemical and biological properties of the soil, increasing the accumulation, mineralization and availability of nutrients, especially nitrogen, reducing acidity and its economic benefits for many plants, especially in the soils of arid and semi-arid regions that have low fertility. It is vital (Ismailian and Amiri, 2017). An increase in plant growth due to the application of animal manure compared to the control treatment has been reported in various studies (Krimian et al., 2019). The use of animal manure and especially chicken manure has a more positive effect on increasing the growth and number of shoots in lemon grass (El-sayed et al., 2018). Also, some other researchers also reported more leaf weight in the plant along with higher leaf area index in the treatment of chicken manure application (EL-Ziat et al., 2015). Nemati and Dehmardeh (2019) also reported an increase in vegetative growth and, as a result, more yield in sour tea plants. In the study of Ghanbari Adevi et al. (2021) on the golden plant, it was also found that the best response of this plant was to chicken manure, which achieved a higher yield compared to the use of other animal manures and chemical fertilizers. In the study of Ebrahimi Pak et al. (2023) on two plants, corn and wheat, it was found that the use of organic fertilizers, especially animal manure, increased the growth and, as a result, the final dry weight and biological yield. This study was conducted in order to investigate the effect of three animal fertilizers and

different planting patterns on vegetative performance, physiological characteristics and the amount of essential oil of lemongrass plant.

Materials and methods

This study aims to investigate the effect of animal manures and planting pattern on the quantitative and qualitative yield of lemon grass in Ben Moala area of Shush city with the coordinates of 48 degrees and 15 minutes east longitude, 32 degrees and 17 minutes north latitude and 112 meters above sea level in 2022. Done. Accomplished. The soil type of the experimental field was loam-clay-silty. This experiment was carried out in the form of one-time split plots in the form of a basic randomized complete block design with three replications. The main factor included the use of animal manure (chicken, sheep, cow manure and no manure) and the secondary factor was different planting patterns (lister, furrow and basin). The consumption of chicken, cow and sheep manure was 5, 10 and 10 tons per hectare, respectively. Pajooshes were prepared from Zargiah company of Fars province. The operation of land preparation including plowing, disking and leveling was done, then plotting was done based on the plan and the fertilizer of each plot was chosen randomly and fertilizer spraying was done with the necessary precision in all the plots (except the control) after mixing the fertilizers with The soil was cultivated based on the distance between each row of 70 cm and the distance of the plants in the row was 40 cm, then the initial irrigation was done. To measure the traits, the number of stems per plant was first counted. Ten plants were randomly selected from the middle row of each sub-plot and after separating the stems, leaves; their wet weight and the total were recorded as the fresh weight of leaves, stems and plants. LAI and other leaf characteristics such as leaf length and width, fresh weight and dry weight of leaves were also measured.

For this purpose, three plants from the middle row were selected from each sub-plot and the average height was considered as plant height. Three plants were randomly selected from the middle row of each sub-plot, and after separating their stems, their fresh weight was recorded. The samples taken to measure the wet weight of the stem after being weighed and recorded in the oven for 48 hours at a temperature of 75 degrees were dried and recorded as the dry weight of the stem. Three plants were randomly selected from the middle row of each sub-plot and the total weight of the plants was recorded as plant weight. To determine the leaf area index after plant growth and full shading from the middle row of each sub-plot by removing the marginal effects of three plants, randomly selected and three indicators for each plant (one parallel to the crop row and two diagonally) left and right) were recorded and the leaf surface index was determined. From the middle row of each sub-plot, three and their total number of leaves were counted and the average number of leaves in three plants was considered as the number of leaves per plant. Three were selected from the middle row of each sub-plot and after separating the leaves and measuring the length of the leaves and taking the average of them, this trait was recorded. Three were selected from the middle row of each sub-plot and after separating the leaves and measuring the width of the leaves and taking the average of them, this trait was recorded. Also, three plants were selected from each plot and the total number of their leaves was separated and the average fresh weight of leaves in three plants was considered as the fresh weight of leaves per plant. After separating the leaves of the three plants selected from the middle row of each sub-plot and weighing them in order to obtain the average wet weight (3-6-9) of the leaves in the dry oven and by weighing them, the dry weight of the leaves was obtained. Statistical analysis of data was done using SAS statistical analysis software version 9.1. Mean comparisons were also done using the LSD method at the five percent level.

Results and discussion

Characteristics of lemongrass leaves

The results of variance analysis of the data showed that the effect of manure treatment on leaf fresh weight was significant at the level of one percent probability and the effect of planting pattern treatment on average leaf length was significant at the level of five percent probability. This was despite the fact that the interaction effect of manure and planting pattern was not significant on any of the leaf characteristics of lemon grass plant (Table 1).

Table 1- Variance analysis of lemon grass leaf characteristics under the influence of animal manures and different planting patterns

S.O.V	DF	LAI	Leaf number	Leaf length	Leaf width	Leaf fres weight	Leaf dr weight
Rep	2	16.1*	240242 ns	*1161	0.006 ns	1.36 ns	0.1 ns
Manure(A)	3	0.51 ns	255588 ns	70.4ns	0.017 ns	**4.84	0.16 ns
Error-a	6	2.68	107235	169	0.018	0.35	0.05
Planting pattern (B)	2	0.08 ns	336775 ns	*472	0.010 ns	0.91ns	0.16ns
A*B	6	0.65 ns	258199 ns	76.6 ns	0.007 ns	0.9 ns	0.03 ns
Error	16	0.47	160330	100	0.016	0.4	0.07
CV(%)		14.8	21.3	9.42	8.68	13	8.5

Ns indicate non-significance and * and ** indicate significance at the level of five and one percent, respectively.

LAI: The results of this study showed that the leaf area index of lemon grass was not affected by the different levels of the two manure treatments and the planting pattern, and no difference was observed between the different levels of these two treatments in terms of the leaf area index (Table 1).

Number of leaves per plant: The number of leaves per plant was one of the traits that the two treatments of manure and planting pattern did not have a significant effect on, and no statistically significant difference was observed between the different levels of these two treatments in this regard (Table 1). In the study of Najafi et al. (2012) on the corn plant, it was also found that the treatments of using animal manure and also the cultivation method had no effect on the number of leaves per plant and they stated that the number of leaves per plant is more influenced by genetics and less by agricultural factors. This attribute has an effect.

Average leaf length: Considering that the planting pattern treatment had a significant effect on the average length of leaves, the results showed that the highest amount of leaf length was 113.36 cm belonging to the indoor planting pattern and this opinion had a statistically significant difference with the other two levels of this treatment. The results also showed that, although there was no statistically significant difference between the two planting patterns on the stack and basin, but the average length of the leaves in these two treatments was equal to 101.9 and 103.15 cm, respectively. And these two planting patterns had statistically significant differences with the planting pattern with atmosphere (Figure 1). In this study, it was found that there was a difference between different planting patterns in terms of average leaf length, and the results indicated that indoor cultivation was superior in this respect and compared to the two treatments on the stack and basin, it increased by 11 and 10%, respectively. shows. Planting pattern has an effect on the amount of light received and the absorption of water and salts from the soil on the growth rate and consequently the length of lemongrass leaves. In this study, due to the availability of more water in the atmosphere and more absorption of water and solutes by the plant, its growth increased and the length of the leaves also increased, and this

increase was more than the two treatment levels of basin cultivation and on the stack. . In the study of Dabagh Mohammadi Nesab et al. (2016) there was also a difference between different planting patterns in terms of size and weight of sorghum and vetiver leaves, and the mentioned plants in the pile cultivation pattern had fewer leaves in the plant compared to other patterns, which It was consistent with the findings of this study. They also stated that one of the reasons for the increase in the number of leaves per plant is the increase in the number of leaves per plant. Also, due to the increase in the development of the leaves and the leaf surface index, the size and weight of the leaves have also increased in the mentioned cultivation pattern (Dabbagh Mohammadi Nesab et al., 2016). Anyway, in this study, it was found that the average length of the leaves showed a better response to atmospheric cultivation and in this method, the length of the leaves was more than other planting methods. In the atmospheric soil cultivation method, the nutritional and growth conditions for carrying out the vital processes of the plant, such as the absorption and transfer of nutrients and the rate of photosynthesis and its allocation, become more favorable and lead to an increase in the surface of the corn leaf (Houshmand et al., 2014). Also, Singh et al. (2000) stated in their study that the planting method has an effect on the leaf characteristics of the lemongrass plant and may change the length, width, and surface of the final leaf of the plant, thus affecting the leaf surface index of the plant.

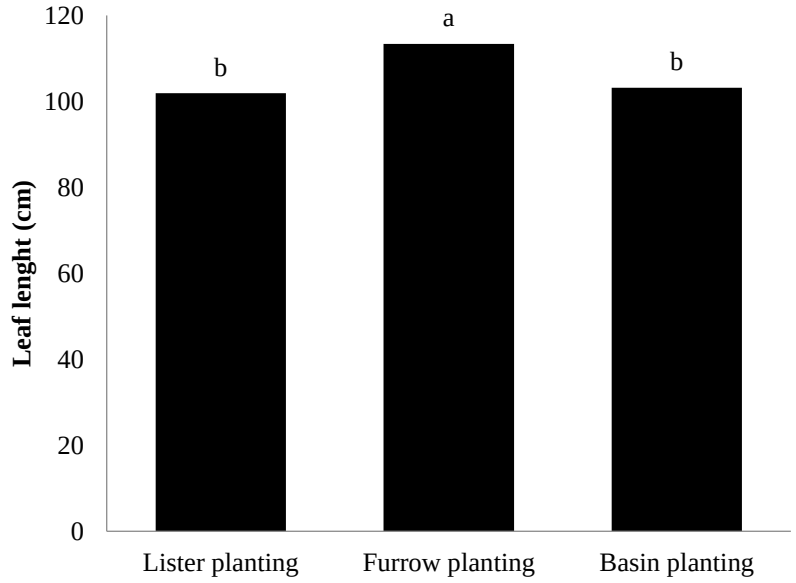

Figure 1- The effect of different planting patterns on the average length of lemongrass leaves
-Columns that have at least one letter in common have no statistically significant difference

Average leaf width: The results showed that the two treatments of manure application and planting pattern had no effect on the average width of the leaves, and no statistically significant difference was observed between the different levels of these two treatments in terms of the average width of lemongrass leaves (Table 1).
Fresh weight of leaves: although the fresh weight of leaves was not affected by the treatment of the planting pattern, but the results showed that the manure treatment had a significant effect on the fresh weight of the leaves, and the results showed that the application of chicken manure caused the highest fresh weight. Leaves were obtained at the rate of 5.84 kg.m-2 and in this respect, it had a statistically significant difference with other levels of manure application. Also, the results showed that

the lowest fresh weight of the leaves was 4.12 kg belonging to the sheep manure application treatment, and in this respect, there was no significant difference with the cow manure application treatment (4.53 kg per hectare), but with The control treatment (4.92 kg/ha) had a significant difference (Figure 2). In this study, it was found that the fresh weight of leaves in the lemongrass plant was higher under the conditions of application of chicken manure than the application of other fertilizers. The use of chicken manure, because it has higher nitrogen content than other fertilizers, has increased the ability to increase vegetative growth in the plant to a greater extent, and as a result, the weight of the leaves has also increased with the increase in leaf growth. In a study on lemongrass plant, leaf characteristics such as leaf area index and leaf weight increased significantly with the use of chicken manure (El-sayed et al., 2018), which is with the findings of this The study was consistent. Also, some other researchers reported more leaf weight per plant along with higher leaf area index in the treatment of chicken manure application (EL-Ziat et al., 2015). Due to the higher nitrogen content, the use of chicken manure has increased the length of the vegetative growth period in addition to increasing the vegetative growth, which results in an increase in the growth of stems and leaves, and as a result, an increase in the fresh weight of the leaves in the plant (Lambers 2008), and this increase in this The study for lemon grass and in the treatment of chicken manure use was about 16% compared to the control treatment. The increase in leaf weight due to the application of animal manure, especially chicken manure in some other studies (Al-Fraiha et al., 2011), confirms the results of this study. These researchers reported an increase in leaf fresh weight and as a result an increase in plant yield in Majorana hortensis L. due to the use of chicken manure and stated that the effect of using chicken manure in combination with other animal manures can be increased to a greater extent. . Chicken manure has more nitrogen in its composition and the increase in the weight of the leaves is due to the increase in growth caused by the use of this fertilizer. It should be kept in mind that among the nutritional elements, nitrogen is a widely used element and due to its role in the production of amino acids, amides, nucleotides, nucleoproteins, enzymes, cell division, increasing vegetable growth, growth and development. Plant balance, increasing the intensity of the green color of the leaves, increasing the amount of plant proteins and increasing the production of fruit and seeds are the most important and essential elements in plant nutrition (Jehansoz and Mohsenabadi, 2013). On the other hand, in order for a crop plant to use light to increase plant growth and then increase the weight of different organs and produce biomass, it must have a sufficient reserve of nitrogen in its leaves (Salvajioti et al., 2008). This requires providing available nitrogen in the field. Some researchers have attributed the effect of nitrogen in increasing the dry weight of leaves and then increasing the yield to the regulatory role of nitrogen in the production of amino acids and plant hormones related to the division and expansion of the cell wall (Montai et al., 2016). And some other researchers attribute the role of nitrogen to the development of developmental stages, which leads to the production of more dry matter in the later stages due to the increase in the leaf surface index, the durability of the leaf surface and receiving more light energy (Siam et al., 2008).

With the use of organic fertilizers, the physical, chemical and biological properties of the soil are improved and cause better plant growth and more photosynthetic materials are produced and transferred to the seeds. Also, due to the availability of more soil moisture, the length of the grain filling period has increased and as a result, the weight of a thousand seeds increases. In an experiment during the evaluation of the effect of sugarcane compost and nitrogen on the performance of grain corn, it was stated that the weight of a thousand corn grains increased with the increase in the consumption of sugarcane compost (Zadeh-Omidi and Marashi, 2019).

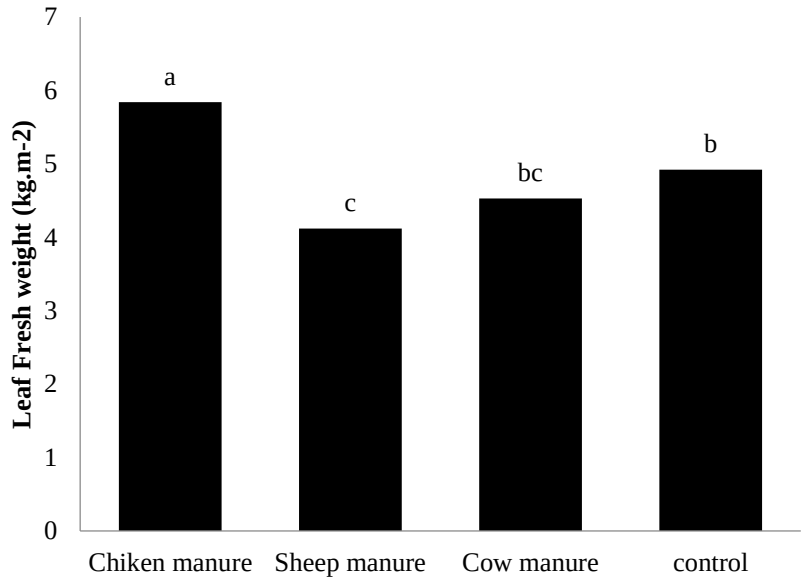

Figure 2- The effect of different fertilizers on the fresh weight of lemongrass leaves
-Columns that have at least one letter in common have no statistically significant difference

Leaf dry weight: Leaf dry weight was one of the traits on which the two treatments of planting pattern and manure had no significant effect (Table 1.(

Characteristics of the lemon grass plant

Based on the results of the analysis of variance of the test data, it was found that the effect of manure treatment on the characteristics of fresh weight of stem and dry weight of stem was significant. Also, the effect of planting pattern treatment on the traits of number of shoots and plant weight, as well as the interaction effect of manure and planting pattern on the traits of number of shoots, stem fresh weight; stem dry weight and plant weight were significant (Table 2**).**

Table 2- Variance analysis of lemongrass plant characteristics under the influence of animal manures and different planting patterns

S.O.V	DF	Higth	Number of stalk	Stem fresh weight	Stem dry weight	Plant weight
Rep	2	*1868	7254ns	3.36*	0.06 ns	8.86 ns
Manure(A)	3	168 ns	4437 ns	2.77*	0.18*	13.3 ns
Error-a	6	323	2866	0.35	0.02	3.29
Planting patter (B)	2	188 ns	*8370	1.31 ns	0.003 ns	8.89**
A*B	6	45 ns	**6570	1.53*	0.1*	6.23**
Error	16	4/83	1348	0.46	0.02	1.39
CV(%)		6.34	16.8	15.7	18.1	11.7

Ns indicate non-significance and * and ** indicate significance at the level of five and one percent, respectively.

Plant height: The results of the variance analysis of the experimental data showed that there was no statistically significant difference between the different levels of the two treatments of animal manures and the planting pattern in terms of the height of the lemon grass plant (Table 2).

Number of pods per unit area: The number of pods per unit area was one of the traits that was affected by the mutual influence of animal manure and planting pattern, and the results showed that among the different experimental treatments, the highest number of pods per unit area was 294 pods in the treatment of planting on the lister. It was obtained along with the use of chicken manure, and this treatment did not have a statistically significant difference with the treatment of the basin planting pattern at the level of the treatment using chicken manure (241 stalk), sheep (290 stalk), control (253 stalk). This was despite the fact that the lowest number of leaves per surface unit was 145 leaves in the treatment of the planting pattern on the lister and with the application of sheep manure (Figure 3). In this study, it was found that the treatment of using chicken manure in the pattern of planting on the pile produced 50% more pojush compared to the treatment that had the lowest amount of pojush per unit area, which indicates that the pattern of planting on the pile is better and the use of chicken manure in increasing Vegetative growth and the number of shoots per plant. Poultry manure accelerates the release of elements and its absorption by the plant, has increased the rate of vegetative growth of the lemongrass plant and has led to an increase in the number of leaves in the plant. In a similar study on the lemon grass plant, it was found that the use of animal manure and especially chicken manure had a more positive effect on increasing the growth and number of leaves in the lemon grass plant (El-sayed et al., 2018), which the results of these researchers It confirms the results of this study. Also, similar results have been reported regarding the increase in vegetative growth in corn plants with the use of chicken manure, and they stated that the addition of 15 tons per hectare of chicken manure increased the growth rate of corn plants by 81% (Obi et al., 2013). Anyway, the greater effect of using chicken manure in increasing the number of paws in lemongrass plants is most likely due to the increase in the amount of nitrogen in this fertilizer and the direct effect of this element in increasing the growth of claws and as a result increasing the number of claws per unit area. with An increase in the number of spikelets per plant in Rosmarinus officinalis due to the use of chicken manure compared to other fertilizers has been reported in another study (Awodun, 2007). In the study of Tanu et al. (2004), it was found that the use of chicken manure compared to other fertilizers has led to a greater increase in leaf growth in a species of lemon grass, which was consistent with the findings of this study. The use of organic fertilizers had a positive effect on increasing the number of tillers in lemongrass plants (Nazarnejad et al., 2021) and in this sense, the results of their study confirmed the results of this study. In another study on lemon grass plant, Kumar and Chauhan (2017) stated that as the age of the lemon grass plant increases, the number of leaves increases and the occurrence of stresses such as saltiness can reduce their number, which with the application Some organic fertilizers have somewhat moderated the negative effects of these stresses and increased the number of panicles per plant. According to Ghafarinejad (2016), the increase in the growth rate and ultimately the performance of treatments containing chicken manure compared to other sources of fertilizers is probably due to the fact that this manure is richer in terms of nutrients than other sources of fertilizers.

In the conditions of planting in the form of a pattern on the lister, more soil covers the feet of the plants and as a result, the conditions for the growth and expansion of a larger number of plant stems have been provided. According to Rahmani et al. (2012), plant growth may be affected due to different spatial arrangement in different planting patterns. In the present study, under the conditions of application of chicken manure, the pattern of cultivation on the stack and under the conditions of application of sheep manure, the basin planting pattern had the highest number of shoots per plant, while under the conditions of no application of animal manure (control treatment), the pattern of basin planting in terms of number Stalk had the upper hand in the bush. In the study of Singh et al. (2000), different planting methods for lemongrass plant are mentioned and it is stated that in planting this

plant on the stack, the growth characteristics of the plant may be improved and the number of tillers in the plant may be increased, which is It can be one of the advantages of planting a plant on a pile, which is attributed to the increase of soil at the base of the plant, as well as the lightness of the soil on the pile, which provides the conditions for increasing the number of leaves in the plant. Bezdan Dost Hamdani and Rasai (2013) in their study on rapeseed stated that the vegetative and reproductive units of rapeseed were affected by different planting patterns and the results of their study were consistent with the results of this study. The results of the studies have shown that cultivation on stacks compared to conventional methods causes better control of weeds (Yousfi et al., 2015) and by reducing the competition between plants, more water and food It has been in the possession of the plant, as a result of which the number of aphids in the lemon grass plant has also increased. In their study, Esdalehzadeh et al. (2009) also reported an increase in growth and vegetative units in the plant with the pattern of planting on the stack compared to other cultivation methods, which was consistent with the findings of this study**.**

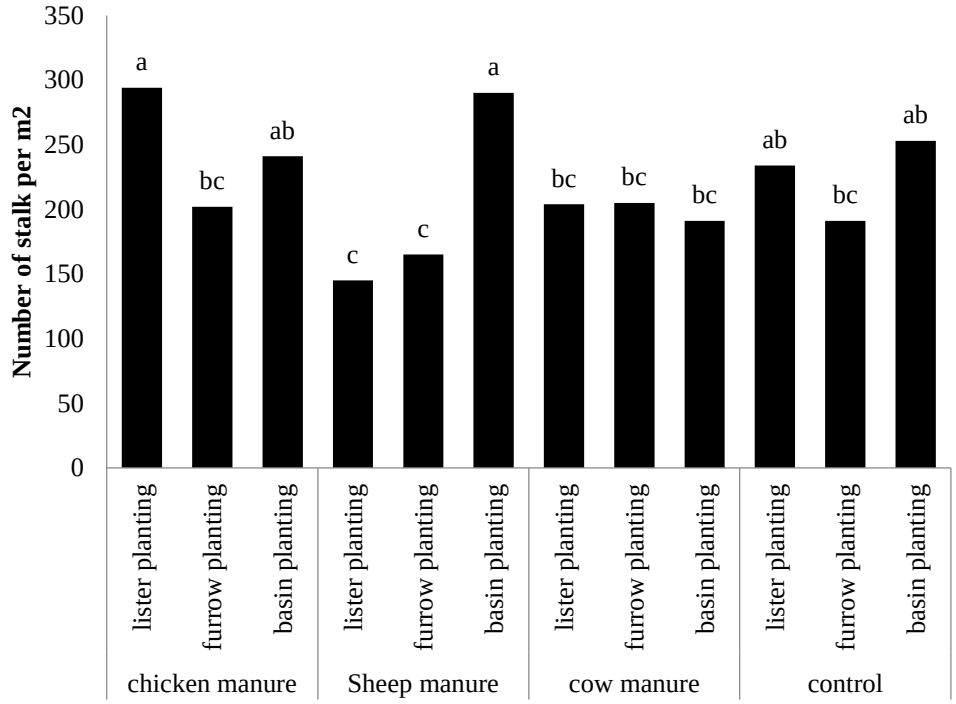

Figure 3- The interaction effect of animal manure and planting pattern on the number of lemon grass stalks per unit area

-Columns that have at least one letter in common have no statistically significant difference

Stem fresh weight: Lemon grass stem fresh weight was also one of the traits that was affected by the mutual influence of animal manure and planting pattern, and the results showed that the highest lemon grass stem fresh weight related to the treatment of the planting pattern on the stack under the conditions of application of chicken manure was 61 It was 5.5 kg.m-2. The results showed that at different levels of animal manures, the response of lemon grass plant in terms of plant fresh weight was different to different treatments of the cultivation pattern, so that in the treatments of the application of chicken manure and control, the planting pattern on the stack was superior, but with the application of sheep and cow manure, respectively, the patterns Basin and indoor planting were superior. According to these results, it was found that the lowest plant fresh weight of 3.19 kg.m-2 was obtained in the model of indoor planting along with the application of sheep manure (Figure 4). In the

present study, the fresh weight of the stem at all levels of the planting pattern in the treatment of using chicken manure was higher than in other treatments of using organic fertilizers, which indicates the positive effect of using this fertilizer on increasing the weight of the stem. The increase in stem fresh weight was reported in some other studies in lemon grass (El-sayed et al., 2018), which was in line with the results of this study. The increase in growth caused by the use of chicken manure is attributed to the higher nitrogen content of this fertilizer compared to other fertilizers because nitrogen is the main factor in increasing the growth of aerial organs and provides the necessary conditions for the vegetative growth of the plant (Detpiratmongkol et al. ., 2014). In addition, the application of chicken manure provides the necessary conditions to increase microbial activities in the soil, which leads to an increase in the accessibility of plants to elements in the soil, and as a result, the rate of plant growth also increases (Follet et al., 1981). . An increase in the growth rate and final weight of the stem due to the application of chicken manure in Nigella sativa was also reported (Valadabadi et al., 2011), which was consistent with the findings of this study. The fresh weight of the stem in a type of lemon grass showed a greater increase in the conditions of application of chicken manure compared to other fertilizers, which is due to the increase in vegetative growth due to the availability of more nitrogen for the plant and the better response of the lemon grass plant to this fertilizer. gave (Tanu et al., 2004). In the study of Nazar Nejad et al. (2021), it was found that the use of organic fertilizers led to an increase in the fresh and dry weight of the shoots in the lemon grass plant, and the use of organic fertilizers could significantly reduce the negative effects of salinity in the lemon grass plant. And from this point of view, the results of their study confirmed the results of this study. The increase in growth and, as a result, the increase in stem weight in treatments containing chicken manure compared to other fertilizer sources is probably due to the fact that this manure is richer in terms of nutrients than other fertilizer sources (Ghafarinejad, 2016). It should also be kept in mind that in addition to chicken manure being richer than sheep and cow manure, the speed of decomposition of chicken manure and the release of its nutrients in the soil is higher than other sources of fertilizers (Norouzi et al., 2019). The result is that by accelerating the acquisition of nutrients, the growth rate and final weight of the stem has also increased, and this situation was observed in different treatments of the planting method.

In the treatment, the application of cow manure in the atmosphere caused the highest amount of stem fresh weight to be obtained. In some other studies, it has been stated that cultivation in atmospheric soil had a greater effect on plant fresh weight than other planting methods. Among other things, in the study of Tahmasabi et al. (2022), it was stated that the longitudinal growth of the stem is the result of the interstitial meristem activity between the nodes. The length of the internodes increases due to the increase in the number of cells and mainly the size of the cells, and it seems that the Kaffaroa plants have increased in height in order to achieve more radiation, and this is the reason for the increase in weight. The stem has an effect. They also stated that, on the other hand, the use of organic fertilizers has led to the provision of more nutrients needed by the plant, as well as improved absorption of water and nutrients, especially nitrogen, phosphorus, and low-use elements, which causes tissue continuity. Photosynthesizing green increases the production of photosynthetic materials, further development of the plant's root system to absorb nutrients, and also improves soil fertility and increases the growth and height of the plant and, as a result, the final fresh weight of the plant. It should be kept in mind that the type of spatial arrangement of the plant in different planting patterns has an effect on the amount of light and shading of the plant, and in this way it also affects the growth rate and finally the final weight of the plant (Khajepour, 2011). It has also been stated in this context that with the geometrical change of the planting pattern, the first change that occurred was related to the increase in the diameter of the stem, which was eventually accompanied by a change in the

growth rate of the plant and as a result, a change in the length of the leaf, the diameter of the stem and the area of the leaf. This has an effect on the final weight of the stem (Widdicombe and Thsleter, 2002). Also, in another experiment, it was found that the change in the planting pattern led to a change in the final weight of the stem as well as the biomass of aerial organs (Najafinezhad et al., 2010), which was consistent with the findings of this study. In the application of cow manure treatment, the lowest yield of the stem was related to the treatment of planting on the stack. In the study of Rahmani et al. (2013) it was also stated that the reason for the decrease in the yield of fodder in the pattern of planting one row on the lister can be attributed to the increase in the accumulation of salts on the listers after several irrigations, which was determined by measuring the saturated extract. Planting soil was obtained. In the conditions of planting lemongrass on the lister, the conditions for increasing the growth and also increasing the number of tillers in the plant are provided, and as a result, the growth characteristics of the plant, including the weight of the aerial parts of the plant, have also increased (Singh et al., 2000). In the study of Banakar et al. (2017) on the Ronas plant, it was found that uniform greening was observed in the methods of linear planting, mounding with sandblasting, mounding with soil, planting in a hot spot, and planting in the bottom of the atmosphere. However, in the method of planting on top of the stack, the germination of the seeds was uneven and their growth rate was also less. The reason for this non-uniformity in the greening and weak growth of the seedlings, which was accompanied by the gradual loss of some of them during the growing season, was the gradual increase in salinity and its accumulation on top of the stacks and near the place where the seedlings were established. The results of the effect of different planting methods on the yield and yield components of safflower showed that the field planting method significantly increased the yield and yield components compared to the lister planting method (Pourqasmi and Zahedi, 2009). Bahadurkhah and Kazemini (2014) also reported that in safflower, by changing the method of planting from the pile, which is the place of accumulation of salts, to the atmosphere, the damage caused by salinity decreased by 4.7%. However, in corn, the highest grain yield was obtained from the pattern of bottom sowing and conversion of soil to stack and planting two rows on one stack. In this case, the irrigation water is non-saline and therefore the problem of salt accumulation on the listers cannot exist (Afsharmanesh, 2014). In the present study, with the use of chicken and sheep manure and also without the use of animal manure, the lowest amount of stem fresh weight was obtained in the indoor planting method. In the study of Yazdan Dost Hamdani and Rasai (2013) on the rapeseed plant, it was also found that the lowest biomass of the aerial parts of the rapeseed plant was obtained in the indoor planting method, and the difference between this treatment and other experimental treatments was statistically significant, and the results of the study confirmed the results of this study.

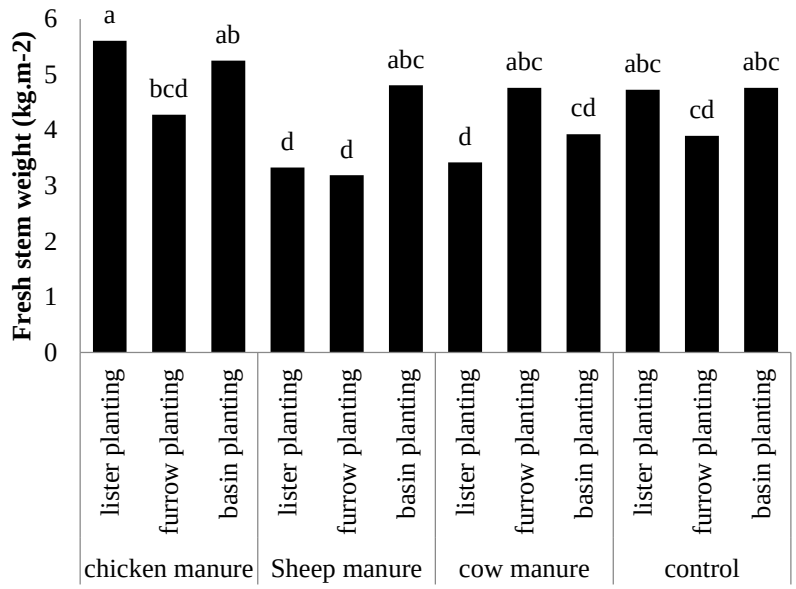

Figure 4- Interaction effect of animal manures and planting pattern on fresh weight of lemon grass stem

-Columns that have at least one letter in common have no statistically significant difference

The dry weight of the stem: the results showed that although the control treatment in the method of basin planting pattern had the highest amount of dry weight of the lemon grass plant at the rate of 1.15 kg.m-2, but the results showed that this treatment compared to the treatment of the indoor cultivation pattern There was no statistically significant difference with the use of cow manure (1.11 kg.m-2) and the pattern of planting on the lister with the use of chicken manure (1.08). According to the results of this study, it was found that the treatment of the basin cultivation pattern along with the application of cow manure had the lowest amount of plant dry weight per square meter (0.61 kg.m-2) (Figure 5). Basin cultivation has led to a greater increase in the dry weight of the stem, while the use of chicken manure has increased the dry weight of the stem in the condition of planting on the stack Also, the use of cow manure has increased the dry weight of the stem to a greater extent. The use of some organic fertilizers in the lemon grass plant has led to an increase in the dry weight of the stem (El-sayed et al., 2018). Their results were in line with the results of this study. In this study, it was found that the lack of application of organic fertilizers led to a greater increase in the dry weight of the stem The gradual application of organic fertilizers has a positive effect on the growth of lemon grass and has increased the dry weight of the stem in this plant (D'ávila et al., 2016). Gendy et al., 2013), which confirmed the results of this study. The increase in the dry weight of the stem in Dracocephalum moldavica was reported with the use of organic fertilizers and they stated that the use of organic fertilizers increased the growth by providing nutrients, especially nitrogen, and also by providing the conditions for the plant to access other nutrients from the soil, which resulted in The dry weight of the stem also increased (Rahimzadeh et al., 2016). The increase in plant growth with the consumption of cow manure and as a result the increase in the weight of the plant can be attributed to the improvement of plant nutrition, including the increase in the concentration of nitrogen, phosphorus and zinc, because the concentrations of high-use and low-use nutrients in cow manure are more than in soil. Be it (Najafi et al., 2012). As a result, by adding animal manure to the soil, soil fertility and plant nutrition are improved and growth, plant height and as a result the final weight of the plant increases.

In the study of Dabagh Mohammadi Nesab et al. (2016) it was found that the dry weight of sorghum stem was different in different planting patterns and different amounts of nitrogen fertilizer, and the results indicated that the basin cultivation pattern is better in increasing the dry weight of the stem, which confirms the results of this study. It was a study and they stated in their study that the competition between plants may be different in different planting patterns, and considering the conditions for the growth of weeds, this factor also had an effect on the difference between different planting patterns in terms of stem dry weight. In this study, under the conditions of application of cow manure, the pattern of planting in atmospheric soil has led to a greater increase in the dry weight of the stem. In this context,

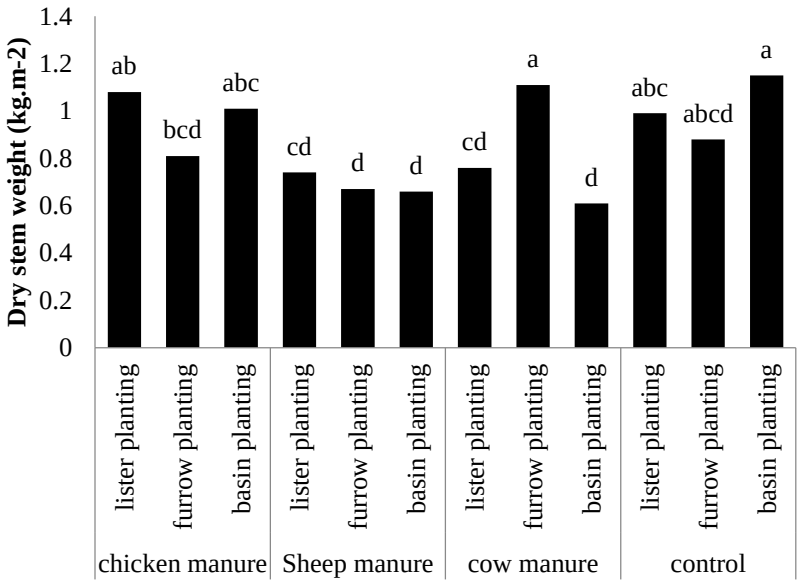

Figure 5- Interaction effect of animal manures and planting pattern on dry weight of lemon grass stem

-Columns that have at least one letter in common have no statistically significant difference.

The fresh weight of the plant: the results showed that the fresh weight of the lemongrass plant was also affected by the mutual influence of animal manure and the planting pattern, and the results indicated that the highest plant weight of 12.51 kg.m-2 belongs to the planting treatment in the atmosphere and The stack was combined with the application of chicken manure and in this regard, there was no statistically significant difference with some other treatments, including basin planting at the same level of the fertilizer treatment (12.03 kg.m-2). Although different levels of planting patterns in different manure treatments had different responses in terms of plant weight, but the results showed that in all manure treatments, except cow manure, the lowest plant weight was obtained in indoor planting, so that the lowest amount The weight of the plant was 44.7 kg.m-2 in the indoor treatment with the use of sheep manure, and in this respect, it had a 40% difference compared to the superior treatment (Figure 5). In this study, it was found that the application of chicken manure at different levels of the planting pattern had a more positive effect on the increase in plant weight, which indicates that chicken manure is better than other fertilizers in increasing the total plant weight in lemongrass plants, and at the level of The treatment of using chicken manure was superior to the planting patterns on the stack, basin and in the atmosphere respectively, and the planting pattern on the stack with the application of chicken manure had the highest efficiency in increasing plant weight. An increase in plant weight in lemon grass with the use of chicken manure has been reported in some other studies (El-sayed et al., 2018), which confirms the results of this study. The application of

chicken manure, in addition to having more nitrogen content, is also rich in other nutrients, and as a result, it has led to an increase in the general growth of the plant, which has also increased the overall weight of the lemongrass plant (El-sayed, et al., 2018). They also stated that the lemon grass plant, because it belongs to the gramineae family and does not have the ability to fix nitrogen, therefore shows a better reaction to organic fertilizers with more nitrogen and leads to an increase in its growth, which in this study This fact was also evident and chicken manure, which had more nitrogen than other organic fertilizers, increased the weight of the lemongrass plant to a greater extent. An increase in plant weight and tuber yield due to the use of chicken manure compared to other organic fertilizers in potato plants has also been reported, and the reason for this increase in weight is increased growth due to the availability of more nitrogen and nutrients in chicken manure than other fertilizers. and it was stated that the timely application of this fertilizer at different levels of the ship has led to an increase in plant weight (Oustain et al., 2015) and their results were in line with the results of this study. In another study conducted by Rahman et al. (2014) on some medicinal plants, they stated that the use of chicken manure compared to other fertilizers led to a greater increase in plant weight and stated that the reason for this increase could be due to an increase The growth of the vegetative organs of the plant, especially the leaves, are involved in the final weight of the plant. While the use of chicken manure leads to an increase in plant weight, it does not have the disadvantages of using chemical fertilizers for the environment, and as a result, it is in line with the goals of sustainable agriculture (Toaima, 2014). It has been reported that the plant weight of lemongrass species due to the use of chicken manure compared to other fertilizers increased the vegetative growth of the plant (Tanu et al., 2004). Also, in a study on lemon grass plant, it was stated that the use of compost as an organic fertilizer could increase the weight of lemon grass plant compared to the control treatment (D'ávila et al., 2016).

In the Andrographis paniculata plant, the application of 12.5 tons per hectare of chicken manure caused the final weight of the plant to increase compared to the control treatment and the application of other fertilizers, and their results also confirmed the results of this study. Detpiratmongkol et al., 2014). Anyway, it has been stated that it seems that the increase in the weight of the plant with the consumption of animal manure is related to the increase in the activity of beneficial microorganisms, the improvement of the soil structure, the increase in the water holding capacity in the soil, the increase in the nutrient elements that can be absorbed by the plant in the soil, and the increase in the absorption of nutrients. It is related to plants and improvement of plant nutrition (Najafi et al., 2012). Also, according to Singh et al. (2000), in planting lemon grass plants in stacks, the conditions of receiving light in the plant are improved and it copes with weeds in a better way, and this increases the growth and, as a result, increases the biomass. Aerial organs are added in this plant. The weight of the lemongrass plant at different levels of the planting method with the use of chicken manure was higher than other fertilizer treatments. Poultry manure, with a high rate of decomposition, probably causes the soil temperature to increase at this time and cause an increase in growth and absorption of nutrients and as a result of early ripening of the product and an increase in yield because about 30% of the nitrogen in poultry manure is in the form of urea or ammonium. which is quickly released and used by the plant (Ghaffarinejad, 2016). In the study of Ghanbari Adevi et al. (2021) on the golden plant, it was also found that the best response of this plant was to chicken manure, which achieved a higher yield compared to the use of other animal manures and chemical fertilizers, and their results were consistent with the findings. It was consistent with this study.

Karimi et al. (2011) studied the methods of row cultivation in fields and stacks (combining three, six and nine lines on the stack) on the yield and yield components of wheat and showed that the highest grain yield and The straw was related to the three-line planting treatment of the plant on the stack, and

the results of their study confirmed the results of this study regarding the increase in plant weight in the conditions of planting on the stack along with the use of chicken manure. Yazdan Dost (2013) investigated the methods of basin, aerial and stack planting in rapeseed cultivation and recommended the method of stack planting in cases where the soil is heavy and there is a possibility of soil compaction. In the present study, with the use of chicken and sheep manure and also in the treatment of not using sheep manure, the lowest plant fresh weight was obtained in indoor planting. The aerial biomass in rapeseed was the lowest in the atmospheric planting method compared to other planting methods (Yazdan Dost Hamdani and Rasai, 2013).

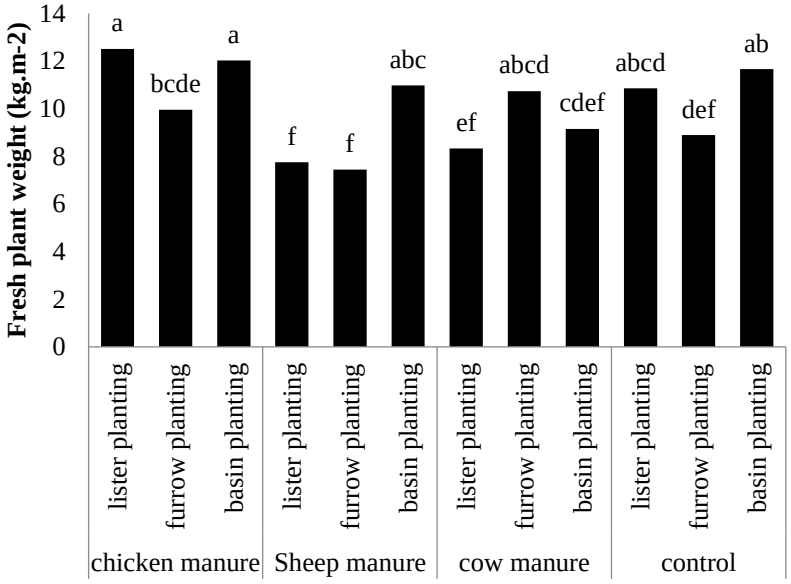

Figure 6- Interaction effect of animal manure and planting pattern on the weight of lemongrass plant

Columns that have at least one letter in common have no statistically significant difference

Conclusion

The application of animal manure has a positive effect on the properties of leaves and the amount of fresh and dry yield of plants. Also, the planting pattern is one of the important and effective factors on the growth and performance of agricultural plants. In this study, it was also found that the application of animal manure had a positive effect on the characteristics of leaves and the rate of growth and yield of lemon grass, and different planting patterns also led to changes in the rate of growth and yield of lemon grass. In this study, the results of the average comparison showed that there was a difference between the use of different fertilizers and also different planting patterns in terms of the measured traits, so that the highest number of leaves (294 leaves per unit area) also had the highest amount of fresh weight. The stem (5.61) and the highest plant weight (12.51 kg.m-2) of lemon grass belonged to the treatment of planting on the stack along with the application of chicken manure. Considering that the application of organic fertilizers and especially animal manure could improve the characteristics of the leaves and increase the amount of yield components and final and dry yield in the lemon grass plant and this increase is also due to the increase in vegetative growth and especially the growth of leaves and other aerial organs of the plant can be used to increase the performance of this plant in areas where lemon grass is cultivated.

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