Effects of Biological Fertilizer on Growth and Yield of Millet (*Panicum miliaceum*) under saline condition

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Abstract

Introduction: Millet is one of the traditional cereal in arid and semi-arid tropics that it had high tolerance to drought and salinity stress. Salinity is one of the most important abiotic stresses. Reducing the limiting effects of salinity, it has a positive impact on agricultural production. Humic acid substances play a major role as the most stable part of organic matter directly on the release nutrients, cation exchange capacity, inhibiting the release of phosphorus and heavy metals and toxic. Vermicompost is a kind of compost produced by worms as a result of the transformation and digestion of organic remains, occurs while passing through the digestive tract of the animals. The aim of this study was comparing granular humic and vermicompost fertilizer on increasing millet grain yield under saline condition and effect of humic acid granular fertilizer and vermicompost on reducing the effects of soil salinity.

Materials and method: In order to evaluation the effect of organic fertilizers such as vermicompost and humic fertilizer on amendment of salty soils to improve soil conditions as well as reduce or eliminate the use of chemical fertilizer a pot experiment was conducted in Yazd. This factorial experiment took place in a randomized complete block design with 4 replications. The First factor include salinity levels (1 and 10 dS m^{-1}), the second factor consists of three levels (0, 2 and 4%) humic Fertilizer and the third factor consists of three levels (0, 5 and 10 %) vermicompost fertilizer that applied in growth of millet Proso.

Results: The results indicated that plant dry weight influenced by humic acid and vermicompost. According to the results, chlorophyll was only affected by humic acid treatment and leaf area was affected by vermicompost. In this study, interaction effect of vermicompost, salinity and humic acid on plant height, grain yield was significant. The results indicated that the use of vermicompost increased plant dry weight. The highest plant dry weight were obtained with the use of 2% humic acid. It seems that application of organic fertilizer can be adjusted adverse effects of salt stress and relatively tolerant plants sowed without a significant reduction in yield and yield components.

Conclusion: According to the results of this study Vermicompost and humic acid improved some of the growth characteristics of millet. Interaction effect of humic acid and vermicompost had a significant effect on chlorophyll content index, plant dry weight and grain yield. Also with the applying salinity stress least amount of grain yield was obtained, this was indicated the negative impact of salinity stress on plant. Simultaneously with application of salinity in the soil Na$^+$ occupying exchangeable phase some of the cations and increased concentration in the soil solution. Leading to easier access and more absorbed by the plant. Therefore, biofertilizers can be used in order to reduce the effects of salinity stress.

Keywords: Humic acid, Vermicompost, Salinity, Millet Proso

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Study of Cotton Yield Gap with Boundary-Line Analysis in the Aq-Qala and Ali Abad Katul cities in the Golestan Province, Iran

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Abstract

Background and objectives: One of the main problems in crop production in Iran is the difference between actual yield and attainable yield which is called yield gap. Thus, identifying yield constraints and yield gap are important. Estimation the amount of yield gap and determination of it's causes requires using proper methods. Boundary line analysis is a statistical method that can quantify the response of yield to an environmental or management factors in a situation in which other parameters are variable. Indeed, this method is able to determine the response of yield to a desired factor while other factors are appropriate and done to determine factors and variables influencing the yield reduction.

Materials and methods: The objective of this study was to evaluate the gap yield of cotton cultivation during 2014 and 2015 in the villages of Aq-Qala and Ali Abad Katul cities, in the Golestan province. The statistical community was cotton farmers of the two Regions. One hundred farmers were selected randomly. Management factors consisted of nitrogen and phosphorus (P_2O_5) used as a base fertilizer, seed rate, density, irrigation frequency, the planting and harvest dates. By drawing distribution of the yield data against different variables management, has been chosen the highest yield of any inputs or management at different levels.

Results: The results showed there is a 1425 Kg ha^{-1} difference (gap) between actual yield (average farmers' yield) and attainable yield (maximum farmers' yield). The results showed that 80 percent of farms studied in terms of planting date, 70 percent in nitrogen, 64 percent in phosphorus, 63 percent in seeding, 71 percent in density, watering 74 percent and 16 percent of harvest dates were outside the optimal. The results show that while the average yield of farmers is 2657 Kg ha^{-1}, they can achieve up to 4082 Kg ha^{-1} by improving their agricultural management. For this purpose, the following should be considered: (1) using at least 65 Kg of N fertilizer per hectare, (2) using at least 40 kg of P_2O_5 per hectare as a base fertilizer (3) at least four irrigations (4) plant density of 7 to 8 plant in per m^2 (5) planting date the late of April and (6) harvest date the early of October and (7) seed rate 50 Kg ha^{-1}.

Conclusion: Results of this research showed that yield gap of the studied area is 35% and by improving the management methods cotton yield could be improved. Boundary line analysis in yield gap studies could clearly show the responses of yield to management factors and by using these responses can be define the best management to achieve the highest yield.

Keywords: Yield Gap, Boundary-Line Analysis, Cotton, Management factors

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Assessment of Remote Sensing Based Vegetation Indices at Various Growth Stages for Estimation of Corn Biomass

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Abstract

Background and objectives: Traditional methods of biophysical crop parameters (including biomass) estimation in the form of finite sampling or final weighing of the harvested products, is time consuming, costly and difficult. In recent years, the use of satellite imagery and remote sensing technology has been considered to estimate these parameters. So far, several vegetation indices have been developed and used to evaluate and estimate the bio-physiological and biochemical parameters of the crops. Because of the ease of using these indicators, this method is one of the most commonly used remote sensing techniques to estimate such parameters. Considering that such studies have not been carried out so far in Kermanshah province, the current study was carried out to estimate the corn biomass in a fertile plain of Kermanshah province (Mahidasht) using Landsat 8 satellite imagery.

Materials and Methods: The dry weight of the crop biomass was measured at the time of the satellite passing from 15 farms at the study area. During the corn growth period, there were 8 satellite images which downloaded from the American Geological Survey web site. In this study, 17 vegetation indices (NDVI- TNDVI- MNDVI- SAVI- OSAVI - VI1-VI2-VI3-PD311-PD312-PD321-RVI-NRVI- MIRV1-NIR*-DVI-IPVI) which in previous studies showed acceptable correlation with crop biomass were used. The correlation coefficient between the measured biomass and the corresponding values of the vegetation indices were used to evaluate the accuracy of the algorithms. For each fieldwork, the index with higher correlation coefficient was determined as the appropriate index for that stage of crop growth, and a regression relation was presented between the amount of corn biomass and the desired index. Finally, estimated values of the biomass based on the regression equations were compared with measured biomass using normalized mean square error (NRMSE).

Results: The measured values of the biomass were low at the beginning of the growth period and gradually increased until the seventh visit (August 26) and then decreased in the last visit (September 11). The average of biomass in 15 farms was measured as 40195 and 36741 Kg ha^{-1} respectively in seventh and eighth fieldworks. Results of the study showed that the indices of PD311 for the first visit, PD321 for the second visit and the initial stages of growth, NIR* for the third, sixth, seventh and eighths, VI3 for the fourth visit, and the NRVI for the fifth visit, had the highest correlation coefficient with the measured values of biomass. The correlation coefficient of the appropriate index in the 8 fieldworks was 0.42, 0.5, 0.58, 0.71, 0.73, 0.66, 0.57 and 0.47, respectively. In overall, NIR * with the mean correlation coefficient of 0.52 was the most favorable index for the entire growth period. Based on values of NRMSE, it can be concluded that fitted relationships were able to estimate the amount of corn biomass except in the first stage of growth with a moderate to good accuracy. The amount of NRMSE in the last fieldwork, which is related to the final biomass yield, was 11.7%, indicating a good match between observed and predicted data.

Conclusion: The results of this study indicate that corn biomass can be estimated using vegetation indices with acceptable accuracy. The precision of this method was better for intermediate periods of crop growth than the early stages. It is better to use an appropriate vegetation index for each stage of crop growth instead of using an index for the entire crop growth period.

Keywords: Biomass, Remote sensing, Satellite Images, Vegetation index

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Effect of Mulch and Selenium and Boron Foliar Spraying on Some Quantitative and Qualitative Characteristics of Sunflower (*Helianthus annuus* L.) in Saline Soil

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Abstract

Background and objectives: Iran has a large surface area of saline soil and in this condition of saline soil, crop production is involved with a lot of problems including deficiency of some nutritional elements and outcome of this problems is decreasing of quantitative and qualitative yield. For this purpose, in saline soil conditions, an experiment was conducted to evaluate the effect of foliar spraying of selenium and boron elements, and mulches application of wheat straw and cow manure on some of sunflower properties.

Materials and methods: In order to evaluate the possibility of increasing the quantitative and qualitative yield of the product in saline soil conditions (At a depth of 0 to 60 cm, with an average electrical conductivity of 8.68 dS m^{-1}, pH of 7.85 and silty clay soil texture) a factorial experiment in a randomized complete block design with three replications was conducted on sunflower (Ghasem hybrid) in Agricultural and Natural Resources University of Khuzestan in 2016. Treatments was included, three mulches (no application, wheat stubble 15 t ha^{-1} and cow manure 30 t ha^{-1}), foliar spraying of selenium in the form of sodium selenite (no application, 17 and 34 mg l^{-1}) and boron foliar spraying in the form of boric acid (no application and 400 mg l^{-1}). Irrigation was done in a furrow. The traits that were studied included: seed yield, oil yield, seed protein percentage, selenium and boron content of seed, oil harvest index, seed harvest index, biological yield, number of seeds per capitulum and 1000-seed weight.

Results: The application of mulch, especially wheat mulch, in comparison with non-application of mulch, had a positive effect on most of the studied traits. The use of selenium significantly increased the content of selenium seed compared to its non-application so that the highest and lowest selenium seed content were observed in high (0.14 mg Kg^{-1}) and low (0.12 mg Kg^{-1}) levels of selenium foliar spraying treatments respectively. The main effect of boron foliar application were not significant on the studied traits, but its triple interaction with selenium foliar spraying and mulch on important traits such as seed yield, oil yield and harvest index were significant. Application of selenium significantly reduced the weight of 1000 seeds, so that the highest 1000-seed weight was obtained from the non-use of selenium (55.50 g) and by increasing the concentration of selenium foliar spraying solution, 1000 seed weight (50.55 g) decreased. The interaction effect of selenium and boron foliar spraying on seed number per capitulum was significant so that the lowest number of seeds per capitulum (1293) was obtained from non-use of selenium and boron which averaged more than 100 seeds less than other treatment compounds. The highest seed yield (6431 Kg ha^{-1}) and oil yield (2529 Kg ha^{-1}) showed in boron foliar spraying × wheat straw. Treatments had no significant effect on seed oil percentage (with mean of 35.78 %). The highest protein content (25.46 %) was obtained from treatment of wheat straw.

Conclusion: In saline soil conditions, among three treatments used in the experiment, the application of wheat straw soil had the highest positive effect on the quality and quantity of sunflower. Wheat straw on the surface of the soil provided better conditions for the growth and development of sunflower by creating a more suitable micro-silage, in comparison to non-use. Regarding the lower price of wheat straw than other existing raw materials in the market, as well as access to it in most parts of the country, by conducting further evaluation, application it in sunflower cultivation under saline condition could be recommended in the climate condition of Khuzestan plain.

Keywords: Oil harvest index, Oil plant, Plant nutrition, Wheat stubble mulch

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Effect of some Bacterial Isolates on Supplying Potassium to Maize

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Abstract

Background and objectives: There are large amount of K in soil but main of that are not in the available form for plants hence potassium deficiency can occur in this condition. Hence, dissolution of soil minerals with microorganisms is notable and it could be very important to use potassium releasing bacteria for supplying potassium to plants. Accordingly, this experiment was performed in order to determine the effect of different bacterial isolates on providing potassium in corn.

Materials and methods: This greenhouse experiment was performed using completely randomized block design with three replications and with application of disinfected seeds of corn (KSC 704). Experiment treatments were including 10 treatments with different bacterial isolates inoculation (including *Pseudomonas*, *Bacillus*, *Enterobacter* and *Azotobacter*), fertilizer treatments (K50 and K100; using 50% and 100% of K_2SO_4 based on fertilizer recommendation) and negative control (no bacterial inoculation and no fertilizer). The experiment prolonged to the beginning of reproductive phase and after harvesting and oven- drying of plant specimen, dry weight of shoot and root were weighed. Eventually, plant samples were digested and concentration of potassium, phosphorus and nitrogen were measured in extracts.

Results: Results showed expect root dry weight, phosphorus transfer factor and shoot phosphorus concentration, all the parameters were significantly affected by treatments. The highest total potassium content were obtained in *Pseudomonas* sp. Az-8 and 100% fertilizer recommendation, respectively equal to 1582 and 1570 mg plant[-1]. Among bacterial isolates, the highest total content of phosphorus and nitrogen belonged to Az-8 that was equal to 50.59 and 264.5 mg plant[-1], respectively. But the highest shoot potassium concentration and content were in 100% fertilizer treatment, 2.55% and 1077.289 mg per shoot weight, respectively. But in regard to bacterial isolates, this parameter was measured in *A. chroococcum* 14SP2-1 with an increasing of 24% and 16% as compared with control. The highest root potassium concentration and content (2.4% and 605.1 mg per root weight, respectively) were observed in *Pseudomonas* Az-8. This isolate has the highest efficiency of potassium nutrition by 104.5%. The maximum shoot dry weight was observed in 50% and 100% fertilizer treatments (44.42 and 44.06 g).

Conclusion: In general results of experiment showed, some bacterial inoculations were better than chemical fertilizers in some parameters and it could be related to biological effects of bacteria in soil. Overall, it could be suggested to use selected bacteria such as *Pseudomonas* Az-8, *A. chroococcum* 14SP2-1 and *Enterobacter* S16-3 for ongoing and future experiments.

Keywords: Bacterial inoculation, Corn, Isolate, Potassium releasing bacteria

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Interaction of *Rhizobium* inoculation and nitrogen levels on some morphophysiological and yield characteristics of soybean (*Glycine max* L.) varieties in Kermanshah climate conditions

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Abstract

Background and objectives: The soybean plant [(*Glycine max* (L.) Merr.] has the ability to air nitrogen fixation through the bacteria of the *Rhizobium japonicum*. Nitrogen fixation, although not providing the plant's needs for maximum yield, but in the right conditions, it may be up to about 80% of the total nitrogen required for the plant to stabilize. Use of the nitrogen fixation mechanism of nitrogen will reduce production costs, mitigating environmental pollution and maintain soil construction. In soybean, amount of nitrogen fixation depend on the usage and condition of inoculation, the type of soil, the reaction of the variety and the weather conditions of the region. With attention to importance of soybean, this study fulfilled with the aim of evaluation the effect of inoculation of *Rhizobium* and different levels of nitrogen on some morphophysiological characteristics and yield of soybean cultivars.

Materials and methods: This experiment was conducted as split-split plot based on a randomized complete block design with three replications at the Research Farm of Campus of Agricultural and Natural Resources, Razi University, Kermanshah during 2009.The main factor was nitrogen fertilizer (0, 50, 100, 150 and 200 kg ha^{-1}) from urea source, sub-factor of soybean varieties (Williamz and Hobbit) and sub-sub-plot of inoculation of *Rhizobium japonicum* (no-inoculation and inoculation).In this experiment traits were investigated such as leaf area index, plant height, quantum yield, photosynthesis efficiency index, canopy temperature, stomatal conductance and chlorophyll index at early-flowering stage and biomass, grain yield, harvest index, number of pods per plant, number of seeds per Pods, 1000-seed weight, number of branches per plant and seed oil percent.

Results: The results showed that in the early-flowering stage by increasing nitrogen levels leaf area index versus stomata conductance were enhanced, but the highest efficiency of photosynthesis was obtained at 50 and 100 Kg ha^{-1} nitrogen. The highest quantum yield was obtained for inoculation conditions and consumption of 100 Kg ha^{-1} for Williamz variety. Plant height for Hobbit variety increased compared to Williams by more than 100 Kg ha^{-1} nitrogen. In the ripening stage, the effect of nitrogen fertilizer, soybean cultivars and seed inoculation were significant on biomass yield, seed yield, harvest index and 1000-seed weight. The response of biomass was different in two varieties from nitrogen and inoculation. The highest amount was for Williamz (50 kg ha^{-1}) and Hobbit (150 and 200 Kg ha^{-1}). *Rhizobium* inoculation increased seed yield by 570 Kg ha^{-1}.The highest grain yield was obtained amount of 5400 Kg ha^{-1} with 50 Kg ha^{-1} nitrogen fertilizer and inoculation at Williamz variety.

Conclusion: In Kermanshah climatic conditions, Williams and Hobbit varieties produced maximum seed yield by 50 and 100 Kg ha^{-1} nitrogen with *Rhizobium* inoculation. Williamz had the highest yield to Hobbit.

Keywords: Yield and yield components, Quantum efficiency, Stomatal conductance, Photosynthetic efficiency

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Investigating the Interaction of Inoculation of Biological Fertilizers and Application of Chemical Fertilizer on Soybean Characteristics under Weed Free and Weedy Check Conditions

Abstract

Background and objectives: Inoculation of crops with mycorrhiza fungi and growth-promoting bacteria increase the growth due to the high benefits including increased root area and nitrogen fixation. Also, nitrogen increases the seed yield in crops by playing an important role in crop growth and development. On the other hand, an increase of competition between crop-weeds and reducing the access of crops to resources reduces seed yield. Therefore, this experiment was conducted aimed to investigate the interaction of mycorrhiza, rhizobium inoculation and nitrogen fertilizer on soybean characteristics under weedy check and weed-free conditions.

Materials and methods: This experiment was conducted in Ali Abad Katoul County in 2016. Treatments were included 1- Weed management at two levels of weed free and weedy check, 2- inoculation of biological fertilizer at four levels of non-application (control), inoculation of seeds with *Bradyrhizobium japonicum*, inoculation of seeds with mycorrhizal fungus *Glomus mosseae* and co-inoculation with Mycorrhiza and Rhizobium and 3- Application of nitrogen fertilizer (pure) from the source of urea fertilizer at three levels of zero (control), 25 and 50 Kg ha^{-1}.

Results: The results of this experiment showed that the effect of biological fertilizers and the interaction of weed and chemical fertilizer on maximum soybean leaf area index was significant. Also, the results of this experiment showed that the effect of biological fertilizer, nitrogen fertilizer and weed management on yield components and seed yield was significant. So, with increasing application of nitrogen fertilizer, inoculation with biological fertilizer and weed control, number of pods per plant, 100 seed weight and number of seeds per plant increased. According to the results of this experiment, the highest number of pods in soybean (67.29 pods per plant) was observed during weedy check, use of mycorrhiza fungus and 50 Kg N ha^{-1} in hectare. Seed yield with weed control increased 22.2% and by using 50 kg of pure nitrogen, 16.3% was added to seed yield compared to control. Inoculation with mycorrhizal fungi and rhizobium also increased 8.6% and 13.2% of seed yield, respectively, as compared to the control.

Conclusion: According to the results of this experiment, in utilization of biological fertilizer treatment, co-inoculation of mycorrhiza and rhizobium and inoculation with rhizobium and in chemical fertilizer treatment, 50 Kg N ha^{-1} had the highest seed yield. Also, in both weed free and weedy check conditions, co-inoculation with mycorrhiza and rhizobium increased the amount of final dry matter of soybean. Therefore, it can be concluded that the improvement of growth conditions for soybean (weed free and utilization of nitrogen and biological fertilizer) causes the leaf area and dry matter accumulation increase during the growing season. Enhancement of leaf area and dry matter accumulation increased soybean yield components and ultimately increased seed yield. So, with regard to the cost of biological fertilizers, the usage of rhizobium is more cost-effective than mycorrhiza, and it's been suggested that research be conducted on a solution to coating seeds with biological fertilizers, especially rhizobium.

Keywords: Soybean, Weed control, Urea fertilizer, Seed yield components, Leaf area

Keywords: Cultivation suitability, Golestan province, AHP

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Evaluation of advanced mutant lines of Tarom Mahalli rice (*Oryza sativa* L.) using path and factor analysis

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Abstract

Background and objective: According to importance of food rice, and also increase of population, the development of new rice lines, and following that selection for improvement of grain yield is essential. Identification of direct and indirect effects of traits affecting grain yield facilitate successful selection. This research was done according to the importance of hidden factors in the formation of traits and their effects on grain yield, the need to determine the paths of the interaction between yield components on grain yield to improve in breeding programs, understanding the inter-relationships between traits and determining the most important traits related to grain yield for selecting the advanced mutant lines of Tarom Mahalli.

Material and methods: Twelve advanced mutant lines derived from Tarom mahalli together with Tarom Hashemi, Neda and Tarom mahalli were evaluated in a randomized complete block design with three replications at two locations of Sari and Tonekabon in 2016. The measured traits include: days to 50% flowering (DF), days to full maturity (DM), plant height (PH), no. of fertile tiller (FT), panicle length (PL), no. of filled and unfilled seeds per panicle (FUS), 1000 grain weight (1000 GW), grain length and width (GL&W), grain length / width ratio (GL/W), flag leaf length and weight (FLW), flag leaf length / width ratio (FL/W) and grain yield. Through stepwise regression, independent variables that had little effect on the function variable were eliminated, and fit the best model. Path analysis was calculated to determine the direct and indirect effects of traits on grain yield and also factor analysis was used in order to better justify and interpret the inter-relationships between traits and better understanding of hidden factors.

Results: Results showed that grain yield had positive significant correlation with 1000 grain weight (0.354[*] and 0.304[*] at Sari and Tonekabon location respectively) and fertile tiller (0.627[**] and 0.442[**]), and negative significant correlation with plant height (-0.300[*] and -0.501[**]). It expressed that the shorter cultivars having more fertile tillers and heavier 1000 grain weight illustrating more performance. Based on results of path analysis revealed that the most direct effect related to no. of fertile tiller (0.613) and days to maturity (0.242) respectively, so later maturity genotypes with more no. of fertile tiller produced more grain yield. At Tonekabon location, plant height (-0.452) in the opposite direction and days to full maturity (-0.431) in the positive direction had the *greatest impact on yield* and shorter and late maturity genotypes exhibited higher performance. According to factor analysis at Sari location, five factors were selected so that totally more than 77% of yield variance was identified by the first factor was called as *morpho-phenology*. The second, third, fourth and fifth factors were called as panicle and its components, grain production, seed size and flag leaf size, respectively. At Tonekabon location four factors were known which are able to identify more than 70% of yield variance. The first factor was called as grain characteristic and phenology, the second together with the fourth factor, were defined as morphology and grain production component and the third factor was defined as grain production and late maturity.

Conclusion: Path analysis showed that days to full maturity, increase of number of fertile tiller and decrease of plant height have greater efficiency and can use as a selection index in breeding programs. Based on results obtained of the factor analysis found that selection for increased of grain yield, increased of the period of vegetative growth and increased of number of fertile tiller in investigated mutant lines is possible simultaneously.

Keywords: Mutant, Correlation, Path and factor analysis

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The effect of application of Vermicompost levels and Nitrogen on some of Agro-morphological traits, Photosynthetic Pigments and Essential oil content of Hyssop (*Hyssopus oficinalis* L.)

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Abstract

Background and objectives: Hyssop is herbaceous perennial plants belong to Lamiaceae family that it has small blue flowers borne on the upper part of the branches with up to 60 cm tall. The essential oils of hyssop are widely used in cosmetics, sanitary and food industries.
Distilled aqueous extract of aerial part of the plant has antioxidant and antimicrobial activities also it has high antivirus activity against AIDS. The indiscriminate use of chemical fertilizers in intensive agriculture has increased crop performance, but the undesirable results of this action is the pollution of water resources, reducing the quality of agricultural products and destroying ecosystems.
   Application of organic fertilizers such as vermicompost, beside of reducing the use of chemical fertilizers, improves the physical and microbial conditions of soil by supplying the nutrients required of plant. In this research considering the importance of hyssop in different industries, the effect of vermicompost and nitrogen fertilizer were studied on quantitative and qualitative traits of Hyssop.

Materials and methods: In order to study the effect of vermicompost on some traits of hyssop, a field experiment was carried out based on a randomized complete block design with three replicates during 2015/2016. Treatments consisted of 0, 5, 10, 15 t ha^{-1} vermicompost and 75 Kg N ha^{-1}. In this study plant height, stem diameter, number of lateral branches, total dry weight, essential oil content, chlorophyll a, chlorophyll b, total chlorophyll, total anthocyanins and total flavonoids were measured.

Results: The results indicated that percentage of essential oil varied from 0.48 to 0.62 in flowering branches of Hyssop plant. The greatest plant high, stem diameter, number of lateral and flowering branches as well as total dry weight was gained by application of vermicompost in high level at full flowering stage. The greatest amount of vermicompost (15 t ha^{-1}) had significantly affected on chlorophyll, carotenoid, total flavonoids and anthocyanins. Vermicompost levels had a promoting influence on most of growth traits and it increased significantly on essential oil accumulation at 1% of probability level. With enhancing levels of vermicompost the essential oil content was increased and use of 15 ton ha^{-1} vermicompost produced the maximum (2.46 g m^{-2}) essential oil yield.

Conclusion: In this study application of vermicompost with decreased harmful chemical inputs improved the most measured traits. Overall, utilization of 15 t ha^{-1} compared to other levels of treatments had suitable effect on content of essential oil, photosynthetic pigments and agro-morphological characteristics in Hyssop.

***Keywords*:** Chlorophyll, Fertilizer, Flavonoid, Medicinal plants, Secondary metabolite

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