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Investigation Effect of Different Level of Vermicompost and Manure on Seed Yield and Its Components of Cowpea (*Vigna unguiculata* L.)

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RESEARCH ARTICLE

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ABSTRACT

BACKGROUND: Suitable and useful usage of different kind of fertilizers and biofertilizer is the main way for reformation and potential of soil fertility and increasing of crops yield.

OBJECTIVES: This research was carried out to evaluate effect of different level of vermicompost and several amount of cow manure on crop production of Cowpea.

METHODS: The current study was conducted according factorial experiment based on randomized complete blocks design with three replications along 2015 year. The first factor included three level of Vermicompost (V_1: nonuse of vermicompost or Control, V_2: 2 $t.ha^{-1}$, V_3: 4 $t.ha^{-1}$) and second factor consisted three level of cow manure (M_1: nonuse of cow manure or Control, M_2: 10 $t.ha^{-1}$, M_3: 15 $t.ha^{-1}$).

RESULT: Result of analysis of variance revealed effect of vermicompost, cow manure and interaction effect of treatments on all measured traits (instead harvest index at 5%) was significant at 1% probability level. Mean comparison result of different level of vermicompost indicated that maximum amount of all measured traits was noted for 4 $t.ha^{-1}$ vermicompost and minimum of those belonged to control treatment. Also as for Duncan classification made with respect to different level of cow manure maximum and minimum amount of all measured characteristics belonged to 15 $t.ha^{-1}$ and control. Evaluation mean comparison result of interaction effect of treatments indicated maximum amount of seed yield (415.36 $gr.m^{-2}$), biologic yield (865.6 $gr.m^{-2}$), number of pod per plant (13), number of seed per pod (14), 100-seed weight (25.3 gr) and harvest index (46.54%) was noted for 4 $t.ha^{-1}$ vermicompost and 15 $t.ha^{-1}$ cow manure and lowest ones belonged to control.

CONCLUSION: Finally according results of this study, treatments of 4 $t.ha^{-1}$ of vermicompost mixed with 15 $t.ha^{-1}$ of animal manure led to achieve highest amount of seed yield and its components, and can be advised to producers.

KEYWORDS: *Biofertilizer, Crop production, Harvest index, Organic manure, Pulse.*

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1. BACKGROUND

Grain legumes are a major source of protein in human and animal nutrition and play a key role in crop rotations in most parts of the world. When grown in rotation with other crops, under certain environmental conditions, they can improve soil fertility and reduce the incidence of weeds plant, diseases and pests (Albayrak *et al*., 2006). Vermicomposting technology involves the bioconversion of organic waste into vermicasts and vermiwash utilizing earthworms (Jadia and Fulekar, 2008). These earthworms feed on the waste and their gut act as the bioreactor where the vermicasts are produced (Ansari and Sukhraj, 2010). Worms Composting of organic wastes would increase the availability of nutrients within the organic wastes, will increases photosynthesis (chlorophyll and pigments) and plant biomass. In an experiment the application of vermicompost increased the amounts of anthocyanin and flavonoids in plants (Joshi *et al*., 2014). In several studies, the importance of organic wastes in the preparation of compost and vermicompost and the role of these organic fertilizers in sustainable agriculture and the growth, yield and macro- and micronutrient content of plants have been discussed (Hernandez *et al*., 2015). These vermicasts are also termed vermicompost and are rich in nitrogen, phosphorous, potassium and micronutrients (Palanichamy *et al.,* 2011). Effect of these vermicompost on plant growth is well reported but mostly it used as a main source of nitrogen. Increasing the vermicompost quantity also promoted plant growth as well as growth of the cob webs by increasing the zinc and phosphorous like nutrients. Zinc enhances plant growth regulation whilst phosphorous promotes plant growth (Abbasi *et al.,* 2009; Manyuchi *et al*., 2013a; Manyuchi *et al.,* 2013b). Increasing the level of phosphorous content in the soils also promoted plant growth, high resistance and quality of seed. Furthermore, it was well documented that increasing the application time of both the vermicompost and vermiwash also increased the soil copper, iron and phosphorous content (Manyuchi *et al*., 2013c; Nath and Singh, 2012). This increase in soil nutrient content promoted plant growth and chlorophyll production; hence boost the overall corn growth. In addition, microbial activities was also reported higher in the soil treated by vermicompost and this higher microbial activity also affected the production of plant growth regulators such as cytokinins as well as humic acid which promote plant growth (Gopal *et al.,* 2010; Manyuchi *et al.,* 2013d). Also considering to the environmental pollution caused by the indiscriminate use of the nitrogen fertilizers, development of biological strategies for safe and cost-effective option for management of nitrogen in order to reduce dangers indiscriminate use of it, is one of priority in sustainable agriculture (Sahoo *et al*., 2013). Organic farming has emerged as important priority area globally in view of the growing demand for safe and healthy food and long term sustainability and concerns on environmental pollution associated with indiscriminate use of agrochemicals. Though

use of chemical inputs in agriculture is inevitable to meet growing demand for food in world, there are opportunities in selected crops and niche areas where organic production can be encouraged to tape the domestic export market (Venkatash-Warlu, 2008). Organic manures including sheep, cattle and hen manure may be used for crop production as substitute of chemical fertilizers because importance of organic manures cannot be overlooked (Abbas *et al*., 2012). Manure plays important role in improving physical, chemical and biological properties of soil. Manures contain low concentration of plant nutrients and they have a slow acting nature, organic manure alone may fail to tend the high nutritional requirements of crops (Hossian *et al*., 2002). Continuous addition of manures to the soil increase its organic matter content year after year, improving physical and chemical soil properties (Bohme and Bohme, 2006). Alizadeh Dehkordi (2010) reported combination cow manure and urea fertilizer, even under drought stress, produce higher yield than to use urea fertilizer alone. Ghanbari *et al*. (2013) reported use 50% of manure + 50% of fertilizer treatment had the greatest effect on increasing forage yield, seed yield and barley yield components. Also that treatment had the highest accumulation of macro and micro elements in the seed. In other words, the integrated fertilizer and chemical fertilizer system as an effective solution to improve soil fertility and increase nutrient uptake has greatly improved the quality and quantity of barley.

2. OBJECTIVES

This research was carried out to evaluate effect of different level of vermicompost and several amount of cow manure on crop production of Cowpea.

3. MATERIALS AND METHODS

3.1. Field and Treatments Information

The current study was conducted according factorial experiment based on randomized complete blocks design with three replications along 2015 year. Place of research was located in Ahvaz city at longitude 48°40'E and latitude 31°20'N in Khuzestan province (Southwest of Iran). The first factor included three level of Vermicompost (V_1: nonuse of vermicompost or Control, V_2: 2 $t.ha^{-1}$, V_3: 4 $t.ha^{-1}$) and second factor consisted three level of cow manure (M_1: nonuse of cow manure or Control, M_2: 10 $t.ha^{-1}$, M_3: 15 $t.ha^{-1}$). This experiment had 27 plots. The size of each plot was 6×5 m^2. For the experiment, the distance between rows to rows was 60 cm with six rows per treatment.

3.2. Farm Management

Base fertilizers were added to soil based on the soil tests and recommendations of Iranian Soil and Water Research Institute at planting stage. Light-disk harrow was used to mix soil and the fertilizer after soil fertilization. The furrower was used to make furrows at a distance of 50 cm. The zinc and manganese Nano-chelate were used in the furrows (with 4cm depth) before planting. The furrows were covered with soil. The seeds were planted 2 cm above the fertilizer. Physical and chemical properties of the soil are mentioned in table 1.

3.3. Measured Traits

After physiological ripening seed yield, biologic yield, number of pods per m^2, number of pods per plant, number seeds per pod and seed weight was determined. Harvest index (HI) was calculated according to formula of Gardener *et al.* (1985) as follows: **Equ.1.** HI= (Seed yield/Biologic yield) ×100.

3.4. Statistical Analysis

ANOVA and mean comparisons were done by MSTAT-C software and Duncan test at 5% probability level.

Table 1. Physical and chemical properties of studied field

Depth of soil (cm)	Nutrition			Clay (%)	Silt (%)	Sand (%)	Soil texture	pH	EC ($ds.m^{-1}$)
	K (ppm)	P (ppm)	N (ppm)						
0-30	145	4	6.02	41.5	47	11.5	Silty Clay	7.90	2.60

4. RESULT AND DISCUSSION

4.1. Seed yield

According result of analysis of variance effect of vermicompost, cow manure and interaction effect of treatments on seed yield was significant at 1% probability level (Table 2). Mean comparison result of different level of vermicompost indicated that maximum seed yield (366.3 $gr.m^{-2}$) was noted for 4 $t.ha^{-1}$ vermicompost and minimum of that (246.45 $gr.m^{-2}$) belonged to control treatment (Fig.1). Using vermicompost, the physical and chemical properties of the soil have improved, resulting in more root development, reducing water losses, and conditions for improved growth and photosynthesis, and thus the plant will be able to produce more biomass and biological yield (Sainz *et al.*, 1998).

Table 2. Result analysis of variance of measured traits

S.O.V	df	Seed yield	Biologic yield	No. pod per plant	No. seed per pod	100-seed weight	Harvest index
Vermicompost (V)	2	**	**	**	**	**	*
Cow Manure (M)	2	**	**	**	**	**	*
V × M	4	**	**	**	**	**	*
CV (%)	-	2.25	3.09	2.95	4.11	3.19	4.21

ns, * and **: no significant, significant at 5% and 1% of probability level, respectively.

Singh *et al.* (2009) reported that vermicompost increased chickpea yield. Seghatoleslami (2013) on cumin also reported that manure application increases cumin yield. As for Duncan classification made with respect to different level of cow manure maximum and minimum amount of seed yield belonged to 15 $t.ha^{-1}$ (350.66 $gr.m^{-2}$) and control (267.74 $gr.m^{-2}$) (Fig.2). Evaluation mean comparison of interaction effect of treatments indicated maximum seed yield (415.36 $gr.m^{-2}$) was noted for 4 $t.ha^{-1}$ vermicompost and 15 $t.ha^{-1}$ cow

manure and lowest one (217.1 gr.m^{-2}) for control (Fig.3). Fallah *et al.* (2007) reported that a combination of manure and inorganic fertilizers increased maize yield than to use of mineral fertilizer alone. A reason for role of livestock manure in improving soil structure and providing low-consumption elements as well as essential elements of the plant by mineral fertilizers.

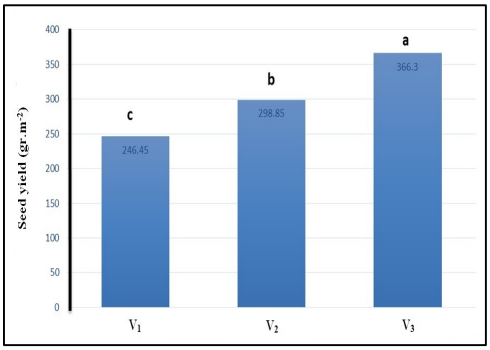

Fig.1. Effect of different level of Vermicompost on seed yield via Duncan test at 5% probability level. V_1: nonuse of vermicompost or Control, V_2: 2 t.ha^{-1}, V_3: 4 t.ha^{-1}.

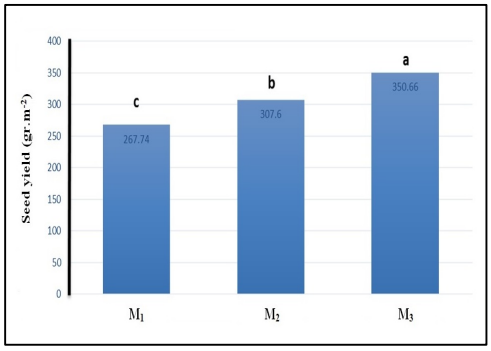

Fig.2. Effect of different level of Cow manure on seed yield via Duncan test at 5% probability level.
M_1: nonuse of cow manure or Control, M_2: 10 t.ha^{-1} cow manure, M_3: 15 t.ha^{-1} cow manure.

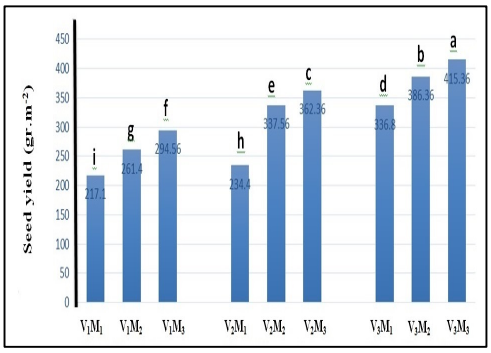

Fig.3. Interaction effect of treatments on seed yield via Duncan test at 5% probability level.
V_1: nonuse of vermicompost or Control, V_2: 2 t.ha^{-1}, V_3: 4 t.ha^{-1}
M_1: nonuse of cow manure or Control, M_2: 10 t.ha^{-1}, M_3: 15 t.ha^{-1}

4.2. Biologic yield

Result of analysis of variance revealed effect of vermicompost, cow manure and interaction effect of treatments on biologic yield was significant at 1% probability level (Table 2). According result of mean comparison maximum of biologic yield (724.76 gr.m^{-2}) was obtained for 4 t.ha^{-1} vermicompost and minimum of that (561.76 gr.m^{-2}) was for control (Fig.4). Manure application improves soil structure and moisture content, provides plant with essential elements, increases growth, number of umbrella per plant and biological yield and finally led to increase seed yield (Ahmadian *et al.*, 2011). Several studies have investigated positive effect of vermicompost on increasing the quantitative and qualitative performance of crops and medicinal plants, including the effect of vermicompost on biological yield, basil, chamomile, forage corn, forage forage, forage sorghum, artemisia and Joe

pointed out (Haj Seyed Hadi *et al.*, 2010).

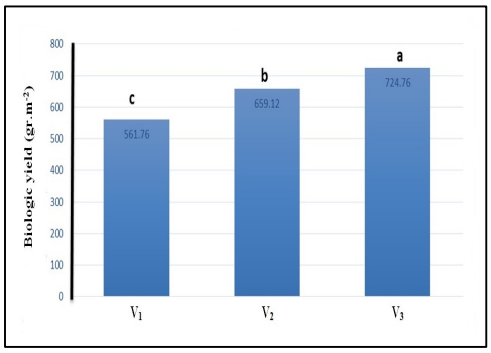

Fig.4. Effect of different level of Vermicompost on biologic yield via Duncan test at 5% probability level.
V_1: nonuse of vermicompost or Control, V_2: 2 t.ha^{-1}, V_3: 4 t.ha^{-1}.

In a study on Effects of vermicompost on growth and nutrients uptake by lettuce in a calcareous soil, Biological fertilizers significantly increased shoot dry matter and some nutrients uptake (Durak *et al.*, 2017). In an experiment by vermicompost application the Lettuce yield were increased 34% more than control (Hernandez-Rodríguez *et al.*, 2017). The vermicompost impacts positively on the nutrient available for uptake by the lettuce due to the presence of living organisms in the vermicompost thereby stimulating growth (Alidadi *et al.*, 2017). Vermicompost has considerable potential for improving plant growth when used as amendment to soil. Application of vermicompost on wheat increased the content of nutrients in the leaf and resulted in improved photosynthesis and biological yield (Anwar *et al.*, 2005). Evaluation mean comparison result indicated in different level of cow manure the maximum biologic yield (740.64 gr.m^{-2}) was noted for 15 t.ha^{-1} cow manure and minimum of that (546.33 gr.m^{-2}) belonged to control treatment (Fig.5). Cheraghi *et al.* (2016) studied the effect of organic manure and phosphorus fertilizer on yield and yield components of bread wheat and reported that the combined application of organic manure or vermicompost with chemical fertilizer has a better effect on yield and yield components of common wheat rather than single application. On the other hand combined application of organic and chemical fertilizers had more efficiency due to some positive interaction between their microorganisms in the soil that led to a synergistic effect and therefore lead to an increase in seed yield. Assessment mean comparison result of interaction effect of treatments showed maximum biological yield (865.6 gr.m^{-2}) was noted for 4 t.ha^{-1} vermicompost and 15 t.ha^{-1} cow manure and lowest one (525 gr.m^{-2}) belonged to control treatment (Fig.6).

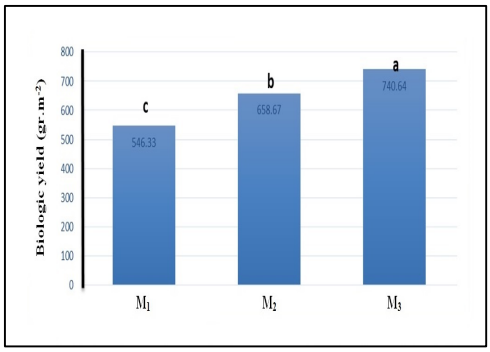

Fig.5. Effect of different level of Cow manure on biologic yield via Duncan test at 5% probability level.
M_1: nonuse of cow manure or Control, M_2: 10 t.ha^{-1}, M_3: 15 t.ha^{-1}

4.3. Number of pod per plant

According result of analysis of variance effect of vermicompost, cow manure and interaction effect of treatments on number of pod per plant was significant at 1% probability level (Table 2). Assesse mean comparison result indicated in different level of vermicompost the maximum number of pod per plant (11.3) was noted for 4 t.ha^{-1} vermicompost and minimum of that (7.7) belonged to control treatment (Fig.7).

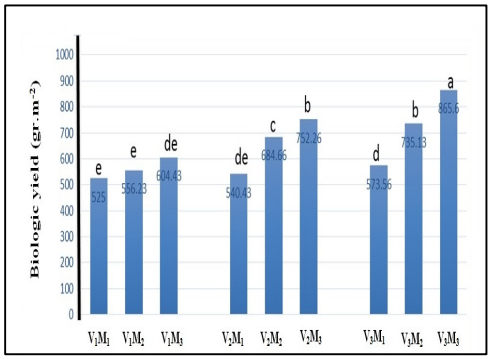

Fig.6. Interaction effect of treatments on biologic yield via Duncan test at 5% probability level.

V_1: nonuse of vermicompost or Control, V_2: 2 t.ha^{-1}, V_3: 4 t.ha^{-1}

M_1: nonuse of cow manure or Control, M_2: 10 t.ha^{-1}, M_3: 15 t.ha^{-1}

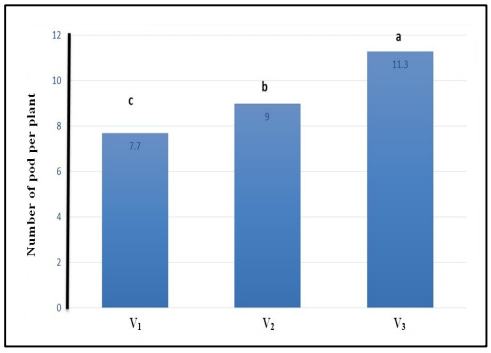

Fig.7. Effect of different level of Vermicompost on number of pod per plant via Duncan test at 5% probability level.

V_1: nonuse of vermicompost or Control, V_2: 2 t.ha^{-1}, V_3: 4 t.ha^{-1}.

With using carrot vermicompost, leaf number increased 30% with respect to date compost. In a study Asghari *et al.* (2016) showed that the effect of urban waste compost and vermicompost on the number of lemon leaves was significant. Application of vermicompost did not have a significant effect on the number of leaves per plant (Huerta *et al.*, 2018). Vermicompost caused an increase Number of Leave per plant 49% more than control (Weerasinghe and De Silva, 2017). Compare different level of cow manure showed that the maximum and the minimum amount of number of pod per plant belonged to 15 t.ha^{-1} cow manure (10) and control (8.6) treatments (Fig.8). Evaluation mean comparison result of interaction effect of treatments indicated maximum number of pod per plant (13) was noted for 4 t.ha^{-1} vermicompost and 15 t.ha^{-1} cow manure and lowest one (7.4) belonged to control treatment (Fig.9).

4.4. Number of seed per pod

Result of analysis of variance revealed effect of vermicompost, cow manure and interaction effect of treatments on number of seed per pod was significant at 1% probability level (Table 2). Evaluation mean comparison result revealed in different level of vermicompost the maximum number of seed per pod (12.35) was noted for 4 t.ha^{-1} vermicompost and minimum of that (8.17) belonged to control treatment (Fig.10). Some researchers such as Sujatha *et al.* (2008) confirmed mentioned result, because they showed that the application of vermicompost by improving the physical properties of the soil to in-

crease absorption elements, improve the production led to increase the number of seeds per row and number of rows per ear trait.

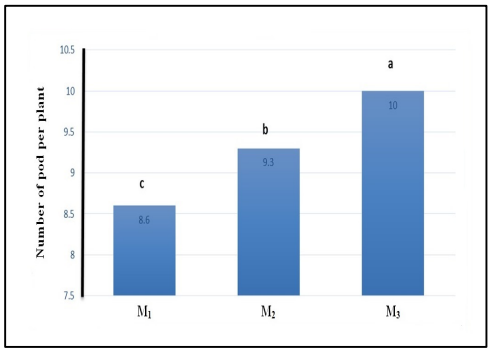

Fig.8. Effect of different level of Cow manure on number of pod per plant via Duncan test at 5% probability level.
M_1: nonuse of cow manure or Control, M_2: 10 t.ha^{-1}, M_3: 15 t.ha^{-1}.

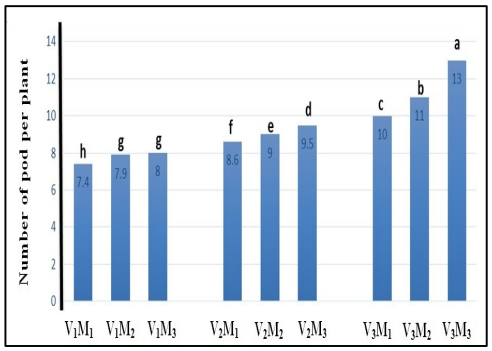

Fig.9. Interaction effect of treatments on number of pod per plant via Duncan test at 5% probability level.
V_1: nonuse of vermicompost or Control, V_2: 2 t.ha^{-1}, V_3: 4 t.ha^{-1}
M_1: nonuse of cow manure or Control, M_2: 10 t.ha^{-1}, M_3: 15 t.ha^{-1}

Sinha *et al*. (2010) reported the application of vermicompost increased the length and diameter of the ear, increased the number of seeds per ear and number of rows per ear in corn. Other researchers also reported that the application of vermicompost on rice led to an increase in seed yield and rice cluster (Eftekhari *et al*., 2006). Between different levels of manganese Nano-chelate the maximum number of seed per pod (11.2) was observed in 15 t.ha^{-1} cow manure and the lowest one (9) was found in control treatment (Fig.11). Assessment mean comparison result of interaction effect of treatments showed maximum number of seed per pod (14) was noted for 4 t.ha^{-1} vermicompost and 15 t.ha^{-1} cow manure and lowest one (8) belonged to control treatment (Fig.12).

4.5. 100-seed weight

According result of ANOVA effect of vermicompost, cow manure and interaction effect of treatments on 100-seed weight was significant at 1% probability level (Table 2). Mean comparison result of different level of vermicompost indicated the maximum and minimum 100-seed weight belonged to 4 t.ha^{-1} vermicompost (24.86 gr) and control (21.14 gr) (Fig.13). 1000-seed weight as a result of use vermicompost fertilizer showed the positive effect of vermicompost on seed yield.

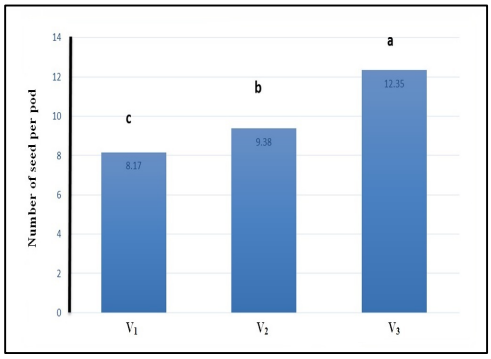

Fig.10. Effect of different level of Vermicompost on number of seed per pod via Duncan test at 5% probability level.
V_1: nonuse of vermicompost or Control, V_2: 2 t.ha^{-1}, V_3: 4 t.ha^{-1}.

So resulting in an increase in the amount of photosynthesis stored, resulting in an increase in the weight of one thousand seeds, and the application of vermicompost fertilizer led to increased yield and seed weight of sesame (Ghosh and Mohiuddin, 2000). In a research on wheat, it was determined that the application of vermicompost fertilizer would increase the seed weight of wheat (Bar-Tal *et al.*, 2004).

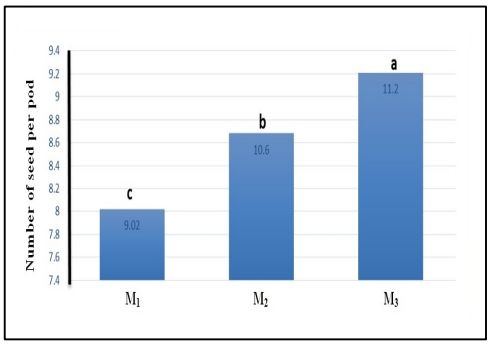

Fig.11. Effect of different level of Cow manure on number of seed per pod via Duncan test at 5% probability level.
M_1: nonuse of cow manure or Control, M_2: 10 t.ha^{-1}, M_3: 15 t.ha^{-1}.

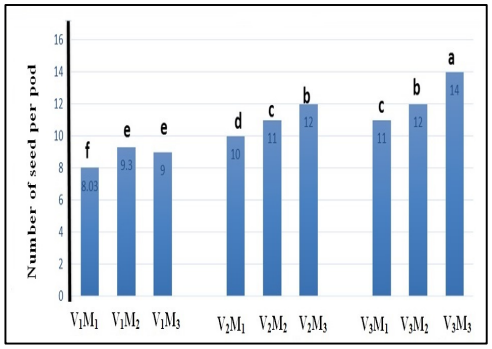

Fig.12. Interaction effect of treatments on number of seed per pod via Duncan test at 5% probability level.
V_1: nonuse of vermicompost or Control, V_2: 2 t.ha^{-1}, V_3: 4 t.ha^{-1}
M_1: nonuse of cow manure or Control, M_2: 10 t.ha^{-1}, M_3: 15 t.ha^{-1}.

Some researchers reported that increase in amount of 1000-seed weight trait due to the application of iron Nano fertilizer due to the optimal combination of the micronutrient elements and main nutrient elements in the reproductive stages of the plant. Also the available main elemental led to improve the trend of accumulation of assimilates in the seeds (sink) and also produce the heavier seeds (Bybordi and Mamedov, 2010).

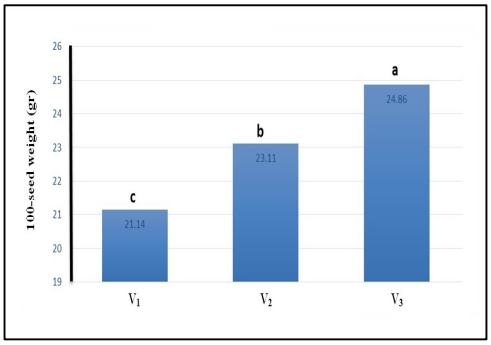

Fig.13. Effect of different level of Vermicompost on 100-seed weight via Duncan test at 5% probability level.
V_1: nonuse of vermicompost or Control, V_2: 2 t.ha^{-1}, V_3: 4 t.ha^{-1}.

Among different level of cow manure maximum 100-seed weight (23.63 gr) was obtained for 15 t.ha^{-1} cow manure and minimum of that (22.46 gr) was for control treatment (Fig.14). Evaluation mean comparison result of interaction effect of treatments indicated maximum 100-seed weight (25.3 gr) was noted for 4 t.ha^{-1} vermicompost and 15 t.ha^{-1} cow manure and lowest one (20 gr) belonged to control treatment (Fig.15).

4.6. Harvest index

Result of analysis of variance revealed effect of vermicompost, cow manure and interaction effect of treatments on harvest index was significant at 5%

probability level (Table 2). Mean comparison result of different level of vermicompost indicated the maximum harvest index (46.52%) was obtained for 4 t.ha^{-1} vermicompost and minimum of that (39.81%) was for control treatment (Fig.16). The experimental results showed that the use of vermicompost in corn increased the harvest index. (Mojab Qasr al-Dashti *et al.*, 2011).

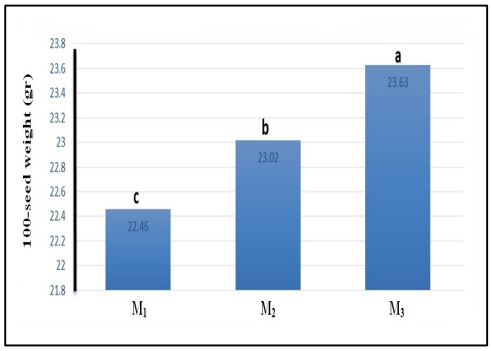

Fig.14. Effect of different level of Cow manure on 100-seed weight via Duncan test at 5% probability level.
M_1: nonuse of cow manure or Control, M_2: 10 t.ha^{-1}, M_3: 15 t.ha^{-1}.

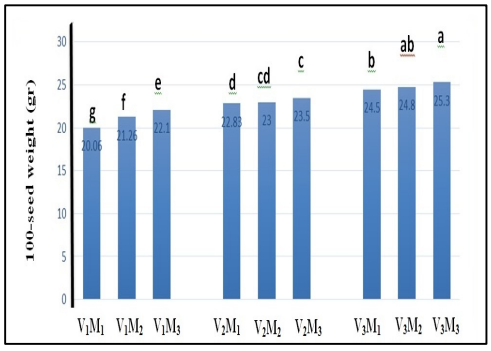

Fig.15. Interaction effect of treatments on 100-seed weight via Duncan test at 5% probability level.
V_1: nonuse of vermicompost or Control, V_2: 2 t.ha^{-1}, V_3: 4 t.ha^{-1}
M_1: nonuse of cow manure or Control, M_2: 10 t.ha^{-1}, M_3: 15 t.ha^{-1}

Harvest index indicates the rate of photosynthetic distribution between the reproductive and vegetative organs, and indicating the transfer of dry matter to a part of the plant that is harvested. The application of vermicompost fertilizer led to an increase in amount of harvest index in sorghum crop because of vermicompost has the positive effect on soil micro flora and increased the soil Mycorrhiza activity (Cavender *et al.*, 2003).

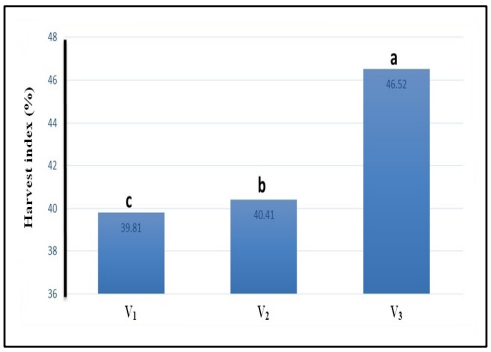

Fig.16. Effect of different level of Vermicompost on harvest index via Duncan test at 5% probability level.
V_1: nonuse of vermicompost or Control, V_2: 2 t.ha^{-1}, V_3: 4 t.ha^{-1}.
Compare different level of cow manure showed that the maximum and the minimum amount of harvest index belonged to 15 t.ha^{-1} cow manure (44%) and control (41%) treatments (Fig.17). Assessment mean comparison result of interaction effect of treatments showed maximum harvest index (46.54%) was noted for 4 t.ha^{-1} vermicompost and 15 t.ha^{-1} cow manure and lowest one (37.44%) belonged to control treatment (Fig.18).

5. CONCLUSION

Finally according results of current research the treatments of 4 t.ha^{-1} of vermicompost mixed with 15 t.ha^{-1} of animal manure led to achieve the highest amount of seed yield trait and its

components, and can be advised to producers.

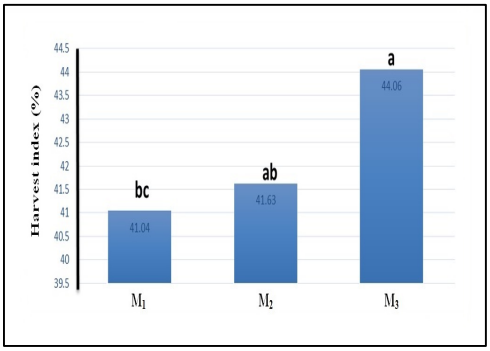

Fig.17. Effect of different level of Cow manure on harvest index via Duncan test at 5% probability level.

M_1: nonuse of cow manure or Control, M_2: 10 t.ha^{-1}, M_3: 15 t.ha^{-1}.

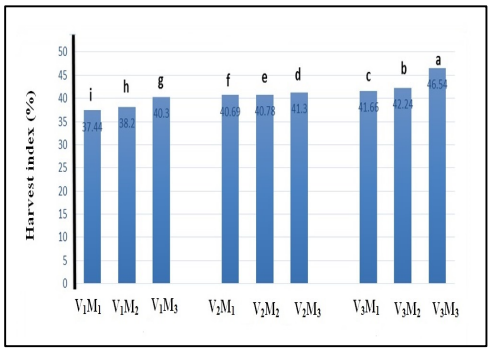

Fig.18. Interaction effect of treatments on harvest index via Duncan test at 5% probability level. V_1: nonuse of vermicompost or Control, V_2: 2 t.ha^{-1}, V_3: 4 t.ha^{-1}. M_1: nonuse of cow manure or Control, M_2: 10 t.ha^{-1}, M_3: 15 t.ha^{-1}.

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FOOTNOTES

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REFRENCES

Abbasi, T., S. Gajalakshmi. and S. A. Abbasi. 2009. Towards modeling and design of vermin composting systems: Mechanisms of composting vermin composting and their implications. Intl. J. Bio-Tech. 8: 177-182.

Abbas, G., J. Z. K. Khattak, A. Mir, M. Ishaque, M. Hussain, H. M. Wahedi, M. S. Ahmed. and A. Ullah. 2012. Effect of organic manures with recommended of NPK on the performance of wheat (*Triticum aestivum* L.). J. Animal Plant Sci. 22(3): 683-687.

Ahmadian, A., A. Ghanbari, M. Siahsar Haydari, M. Ramroodi. and S. M. Mousavinik. 2011. Study of chamomile's yield and its components under drought stress and organic and inorganic fertilizer using and their residue. J. Microbiol. Anti Micro. 3(2): 23-28.

Albayrak, S., C. S. Sevimay. and O. Tongel. 2006. Effect of inoculation with *Rhizobium* on seed yield and yield components of common vetch (*Vicia sativa* L.). Turkish J. Agri. Forestry. 30: 31-37.

Alidadi, H., A. Saffari, D. Ketabi, R. Peiravi. and A. Hosseinzadeh. 2017. Comparison of vermicompost and cow manure efficiency on the growth and yield of tomato plant. Turkish J. Agri. Food Sci. Tech. 5(11): 1360-1364.

Alizadeh Dehkordi, P. 2010. Effect of livestock and urea fertilizers on net soil mineralization, growth and yield of maize under cut irrigation at flowering. M.Sc. Thesis. Faculty Agriculture and

Natural Resources. Shahrekord University. 101 pages. (Abstract in English)

Ansari, A. A. and K. Sukhraj. 2010. Effect of vermiwash and vermicompost on soil parameters and productivity of okra (*Abelmoschus esculentus*) in Guyana. P. J. Agri Reso. 23: 137-142.

Anwar, M., D. Patra, S. Chand, K. Alpesh, A. Naqvi. and S. Khanuja. 2005. Effect of organic manures and inorganic fertilizer on growth, herb and oil yield, nutrient accumulation, and oil quality of French basil. Comm. Soil Sci. Plant Anal. 36: 1737-1746.

Asghari, M., M. Yousefi Rad. and A. Masoumi Zavarian. 2016. Organic fertilizers compost and vermicompost effects on quantitative and qualitative traits *Lippi citriodora*. J. Medicinal Plants. 58: 63-71. (Abstract in English)

Bar-Tal, A., U. Yermiyahu, J. Beraud, M. Keinan, R. Rosenberg, D. Zohar, V. Rosen. and P. Fine. 2004. Nitrogen, phosphorus, and potassium uptake by wheat and their distribution in soil following successive, annual compost applications. J. Environ. Quality. 33: 1855-1865.

Bohme, L. and F. Bohme. 2006. Soil microbiological and biochemical properties affected by plant growth and different long-term fertilization. Europe. J. Soil Biol. 42: 1-12.

Bybordi, A. and G. Mamedov. 2010. Evaluation of application methods efficiency of zinc and iron for canola (*Brassica napus* L.). Notulae Scientia Biologicale. 2(1): 94-103.

Cavender, N., R. Atiyeh. and M. Knee. 2003. Vermicompost stimulates mycorrhizal colonization of roots of sorghum bicolor at the expense of plant growth. Pedobiologia. J. 47: 85-89.

Cheraghi, Y., F. A. Mohyedi. and M. Kalhor. 2016. Effects of organic and chemical fertilizers on yield components of common wheat (*T. aestivum* L.). Inst Integrative Omics App. Biotech. J. 7(8): 82-86.

Durak, A., Ö. Altuntaş, İ. Kutalmış Kutsal, R. Işık. and F. Ege Karaa. 2017. The effects of vermicompost on yield and some growth parameters of lettuce. Turkish J. Agri. Food Sci. Tech. 5(12): 1566-1570.

Fallah, S., A. Ghalavand. and M. R. Khajehpour. 2007. Effects of Animal Manure Incorporation Methods and its Integration with Chemical Fertilizer on Yield and Yield Components of Maize (*Z. mays* L.) in Khorramabad, Lorestan. J. Water Soil Sci. 11(40): 233-243. (Abstract in English)

Gardner, F. P., R. B. Pearce. and R. L. Mitchell. 1985. Physiology of crop plants. Ames, IA: Iowa State Univ. Press. USA. 121 pp.

Ghanbari, A., Y. Ismaili. and M. Babaeans. 2013. Effect of animal and chemical fertilizers on forage yield, grain and some nutrient concentrations in elemental barley grain (*H. vulgare* L.). Iranian Journal of Plant Ecophysiology. 8(3): 23-36. (Abstract in English)

Gopal, M., A. Gupta, C. Palaniswami, R. Dhanapal. and G. V. Thomas. 2010. Coconut leaf vermiwash: a bioliquid from coconut leaf vermicompost for improving the crop production capacities. Current Sci. J. 98: 1202-1210.

Ghosh, D. and M. Mohiuddin. 2000. Response of summer sesame (*Sesamum*

indicum L.) to biofertilizer and growth regulator. Agri. Sci. 20(2): 90-92.

Haj Seyed Hadi, M., M. T. Darzi. and Z. Ghandahari Al-Wajah. 2010. Effect of spraying with amino acids and application of different amounts of vermicompost on morphological and chamomile flowers. New Agric. Findings. J. 5(2): 158-147.

Hernandez, O. L., A. Calderín, R. Huelva, D. Martínez-Balmori. and F. Guridi. 2015. Humic substances from vermicompost enhance urban lettuce production. Agron. Sust. Develop. Springer Verlag/EDP Sci./INRA. 35(1): 225-232.

Hossian, S. M. A., A. M. A. Kamal, M. R. Islam. and M. A. Mannan. 2002. Effect of different levels of chemical and organic fertilizers on growth, yield and protein content of wheat. J. Biol. Sci. 2(5): 304-306.

Huerta, E., O. Vidal, A. Jarquin, V. Geissen. and R. Gomez. 2018. Effect of vermicompost on the growth and production of Amashito pepper plant, interactions with earthworms and Rhizobacteria. J. Compost Sci. Utilization. 18(4): 282-288.

Jadia, D. C. and M. H. Fulekar. 2008. Vermicomposting of vegetable waste: A biophysico-chemical process based on hydro-operating bioreactor. Afri. J. Bio-Tech. 7: 3723-3730.

Joshi, R., S. Jaswinder. and A. Pal Vig. 2014. Vermicompost as an effective organic fertilizer and bio control agent: effect on growth, yield and quality of plants. Rev. Environ. Sci. Biotechnol. pp. 1-23.
DOI:10.1007/s11157-014-9347-1.

Manyuchi. M. M., T. Chitambwe, A. Phiri P. Muredzi. and Q. Kanhukamwe. 2013a. Effect of vermicompost, vermiwash and application time on soil physicochemical properties. Intl. J. Environ. Eng. 4: 216-220.

Manyuchi, M. M., L. Kadzungura, A. Phiri. and P. Muredzi. 2013b. Effect of Vermicompost, vermiwash and application time on *Zea mays* growth. Intl. J. Sci Eng. Tech. 2: 638-641.

Manyuchi. M. M., T. Chitambwe, P. Muredzi. and Q. Kanhukamwe. 2013c. Continuous flow-through vermin reactor for medium scale vermin composting. Asian J. Eng. Tech. 1:5-9.

Manyuchi, M. M., A. Phiri, P. Muredzi. and T. Chitambwe. 2013d. Comparison of vermicompost and vermiwash Bio fertilizers from vermin composting waste corn pulp. World Academy Sci. Eng. Tech. J. 7: 360-371.

Mojab Qasr al-Dashti, A., H. Baluchi. and A. Yadavi. 2011. Effect of urban waste and nitrogen compost on seed yield, forage production and some morphological traits of sweet corn. J. Crop. Prod. 1: 130-115.

Nath. G. and K. Singh. 2012. Effect of vermiwash of different vermin composts on the kharif crops. J. Central Europ. Agri. 13: 379-402.

Palanichamy, V., B. Mitra, N. Reddy, M. Katiyar, R. B. Rajkumari, C. Ramalingam. and A. Aranganthan. 2011. Utilizing food waste by vermicomposting, extracting Vermiwash, Castings and increasing relative growth of plants. Intl. J. Chem. Analytical Sci. 2(11): 1241-1246.

Sainz, M. J., M. T. Taboada-Castro. and A. Vilarino. 1998. Growth, miner-

al nutrition and mycorrhizal colonization of red clover and cucumber plants grown in a soil amended with composted urban wastes. Plant Soil. J. 205: 85-92.

Sahoo, R. K., D. Bhardwaj. and N. Tuteja. 2013. Bio-fertilizers: A Sustainable eco-friendly agricultural approach to crop improvement. *In:* Plant Acclimation to Environmental Stress. pp: 403-432.

Seghatoleslami, M. 2013. Effect of water stress, bio-fertilizer and manure on seed and essential oil yield and some morphological traits of cumin. Bulgarian. J. Agri. Sci. 19(6): 1268-1274.

Singh, N. I. and J. S. Chauhan. 2009. Response of French bean (*Phaseolus vulgaris* L.) to organic manures and inorganic fertilizer on growth and yield parameters under irrigated condition. Nature Sci. J. 7: 52-54.

Sinha, R., V. Dalsukh, C. Krunal. and A. Sunita. 2010. Embarking on second green revolution for sustainable agriculture by vermin culture biotechnology using earthworms: Reviving the dreams of sir charles darwin. J. Agri. Biotech. Sust. 2(7): 113-128.

Sujatha, M., B. Lingaraju, Y. Palled. and K. Ashalatha. 2008. Importance of integrated nutrient management practices in maize under rain fed condition. Karnataka J. Agri. Sci. 21: 334-338.

Venkatash-Warlu, B. 2008. Role of bio-fertilizers in organic farming: Organic farming in rain fed agriculture: Central institute for dry land agriculture. Hyderabad. Pak. pp: 85-95.

Weerasinghe, T. K. and I. H. W. K. De Silva. 2017. Effect of applying different ratios of compost made of municipal solid waste on growth of *Z.mays* L.. J. Soil Sci. Environ. Manage. 8(3): 52-60.