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Integrated Effect of Nitrogen Fertilizer and Vermicompost on Quantitative and Qualitative Traits of Sorghum (*Sorghum bicolor* L.) Under Water Stress Situation

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ABSTRACT

BACKGROUND: Management of water deficit is a great factor to sustainable crop production, especially in arid and semi-arid regions. Vermicompost is an organic compound that is microbial active and rich in nutrients that results from the interaction of earthworms and microorganisms with organic matter decomposition.

OBJECTIVES: This research was carried out to assess effect of different level of water deficit stress and combined effect of nitrogen fertilizer and vermicompost on Sorghum crop production and seed protein content.

METHODS: Current study was conducted according split plot experiment based on randomized complete blocks design with four replications along 2017 year. The main factor included water deficit stress at three level (A_1: 70, A_2: 100 and A_3: 130 mm Class A evaporation pan) and combined effect of nitrogen fertilizer and vermicompost at five level (B_1: 100% Nitrogen; 100% pure nitrogen equivalent to 200 kg per hectare, B_2: 75% Nitrogen+25% Vermicompost, B_3: 50% Nitrogen+50% Vermicompost, B_4: 25% Nitrogen+75% Vermicompost, B_5: 100% Vermicompost) belonged to sub plot.

RESULT: According result of analysis of variance effect of water deficit stress and combination nitrogen with vermicompost on all measured traits was significant but interaction effect of treatments only on seed and biologic yield was significant.

Mean comparison result of different level of water deficit stress indicated that maximum plant height, race length, number of raceme per race, number of seed per race, 1000-seed weight and protein yield was noted for 70 mm evaporation pan class A and minimum of those belonged to 130 mm evaporation pan class A.

Also as for Duncan classification made with respect to different level of combination nitrogen with vermicompost maximum and minimum amount of mentioned traits belonged to 75% nitrogen+25% vermicompost and 100% vermicompost treatment.

CONCLUSION: Finally in order to achieve maximum quantitative and qualitative yield, cultivation of sorghum with apply 75% nitrogen+25% vermicompost treatment under 70 mm evaporation pan class A it can be advised at studied areas.

KEYWORDS: *Biologic fertilizer, Forage, Nutrition, Protein, Seed yield.*

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1. BACKGROUND

Drought is one of the most important abiotic stresses that adversely affect agricultural productivity and causes significant crop loss. Sorghum, which is grown in Sistan and Baluchistan, are exposed with drought stress often occurring during the growth season (Fazeli Rostampour *et al*., 2013). In breeding of forage crops, increase of yield and forage quality are the main factors which play prominent role in the introduction of new varieties. Forages with good quality should have high dry matter yield, energy, digestibility and low fiber for optimal fermentation in the silo and storage. (Curran and Posch, 1999). Sorghum has potential uses such as: food (grain), feed (grain and biomass), fuel (ethanol production), fiber (paper), fermentation (methane production) and fertilizer (utilization of organic byproducts) (Roy *et al*., 2018). Sorghum production in the Iran has spanned almost 120 yr. The crop has served producers and end users well, as advancements in cultivar development have produced the high-performing, well adapted, premium quality cultivars. For example, screening of seven salinity tolerant and ten salinity sensitive sorghum genotypes was reported (Chuck and Donnelly, 2014). Grain sorghum as a staple food grain in several developing countries (Buah and Mwinkaara, 2009) is an important crop in arid and semiarid regions, because of its environmental adaptability. Nitrogen is an important nutrient for optimum crop growth and yield performance. Although its effect on the growth and yield of sorghum has been demonstrated to be dependent on the factors of climate, soil type and genotype which also vary across seasons and locations, the application nitrogen generally results in increase in the biomass and yield of sweet sorghum until an optimum rate is reached. This optimum rate varies from one location to another and from one season to another. However, from this, the optimum rate can be said to lie within the range of 60 and 120 kg N ha^{-1} depending on the location, the soil type and the native nitrogen of the soil determined through soil test (Olugbemi, 2017). Organic farming has emerged as an 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 the 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). Vermicompost is an organic compound that is microbial active and rich in nutrients that results from the interaction of earthworms and microorganisms with organic matter decomposition. It has been shown that these pitched and homogeneous materials have high porosity, adequate ventilation and drainage, and high water retention capacity, and contain nutrients found in the plant's absorbable form (Koozehgar kaleji and Ardakani, 2017). Vermicompost, along with chemical fertilizers, improves the usefulness of low-energy elements and their absorption in plants compared with the use of chemical fertilizers alone (Jabeen and Ahmad, 2017). Adesoji *et al*. (2018) reported application of 60 kg N ha^{-1} produced significantly longest panicle which was at par with application of 90 kg N ha^{-1}. In combined means, application of 30, 60 and 90 kg N ha^{-1} increased length of sorghum panicle by 2.0, 5.9 and 4.7% when compared with no zero N, respectively. Sebetha and Modisapudi (2019) reported nitrogen fertilizer source had significant effect ($p<0.001$) on sorghum stem diameter. Stem diameter of sorghum fertilized with ammonium sulphate, LAN and urea had significantly larger stem diameter of 1.07 cm than control. The interaction of nitrogen fertilizer source × cultivar × soil type had significant effect ($p<0.001$) sorghum stem diameter. Almodares *et al*. (2009) suggested to apply 200 $kg.ha^{-1}$ urea because the highest biomass and protein content and the lowest fiber content will be achieved with at this amount of nitrogen fertilizer. Although, this amount of nitrogen will decreased soluble carbohydrates content but it seems this reduction dose not effect on forage palatability and digestibility considerably.

2. OBJECTIVES

This research was carried out to assess effect of different level of water deficit stress and combined effect of nitrogen fertilizer and vermicompost on Sorghum crop production and seed protein content.

3. MATERIALS AND METHODS

3.1. Field and Treatments Information

Current study was conducted according split plot experiment based on randomized complete blocks design with four replications along 2017 year. Place of research was located in Hamideyeh city at longitude 48°10'E and latitude 31°33'N in Khuzestan province (Southwest of Iran). The main factor included water deficit stress at three level (A_1: 70, A_2: 100 and A_3: 130 mm Class A evaporation pan) and combined effect of nitrogen fertilizer and vermicompost at five level (B_1: 100% Nitrogen; 100% pure nitrogen equivalent to 200 kg per hectare, B_2: 75% Nitrogen+25% Vermicompost, B_3: 50% Nitrogen+50% Vermicompost, B_4: 25% Nitrogen+75% Vermicompost, B_5: 100% Vermicompost) belonged to sub plot. The amount of vermicompost used in the field in 100% vermicompost treatment was equal to 5 tons per hectare. This experiment had 60 plots. Each plot consisted of 6 lines with a distance of 75 cm and 5 meters length. Before performing experiment, sampling was done from farm soil and physical and chemical properties of the soil and vermicompost were determined (Tables 1 and 2).

Table 1. Some physical and chemical properties of field's soil

Depth of soil sampling (cm)	SP (%)	EC ($ds.m^{-1}$)	pH	OC (%)	N (ppm)	P (ppm)	K (ppm)	Soil texture
0-30	46	3.42	7.1	0.72	0.42	9.1	150	Clay loam
30-60	44	3.21	7	0.61	0.38	8.8	147	Clay loam

Table 2. Some physical and chemical properties of vermicompost

EC ($ds.m^{-1}$)	pH	Mn	Zn ($mg.kg^{-1}$)	Fe	Nitrogen	Potassium (%)	Phosphorus
2.9	6.9	21	33	44	4.96	3.19	0.61

3.2. Farm Management

The amount of fertilizer required in the field included 90 $kg.ha^{-1}$ of superphosphate triple and 100 $kg.ha^{-1}$ of potassium sulfate fertilizer. All vermicompost was applied to the soil in the mentioned treatments before planting. After fertilizing, the field soil was mixed with the soil by a light disk. Seed sowing was done manually on August 10, 2017 at a depth of four centimeters. The first irrigation was done immediately after planting. Up to the four-leaf stage of the conventional irrigation, and after the four-leaf stage, according to the experimental treatments based on the Class A evaporation pan placed near field and based on continuous evaporation from it, each of stress treatments of irrigation water shortage stress (Nadimpour and Mojaddam, 2015). Sorghum seedlings were thinning at four-leaf stage and weed controlled manually without chemical pesticides.

3.3. Measured Traits

In order to determine the yield and yield components, two side rows and a half meters from the beginning and end of the plot were removed as marginal effects. The final harvest was done on the 24th of October of 2017 in an area equivalent to two square meters in each plot. In order to calculate the weight of 1000 seeds, two groups of 500 seeds were separated and if their difference was less than six percent, their total weight was determined as the weight of 1000 seeds. To determine the biological yield, an area of two square meters was taken from each plot and a section of about 500 grams was separated and after transferring the samples to the laboratory, they were placed in a oven dryer at 75 °C for 48 hours. And after drying, their weight was calculated. To determine the percentage of grain protein, the percentage of grain nitrogen was first measured by Kjeldahl method, which includes digestion, distillation and titration. To measure amount of seed protein by multiplying percentage of seed nitrogen by a factor of 6.25, the amount of protein in seed was obtained. By multiplying the percentage of protein in each treatment by its seed yield, the protein yield for each treatment was calculated (Keeney and Nelson, 1982).

3.4. Statistical Analysis

Analysis of variance and mean comparisons were done via SAS (Ver.8) software and Duncan multiple range test at 5% probability level.

4. RESULT AND DISCUSSION

4.1. Plant height

According result of ANOVA effect of water deficit stress and combination nitrogen with vermicompost on plant height was significant at 5% probability level but interaction effect of treatments was not significant (Table 3).

Table 3. Result analysis of variance of studied traits

S.O.V.	df	Plant height	Race length	No. raceme per race	No. seed per race
Replication	3	0.32^{ns}	30. 84^{ns}	0. 24^{ns}	1816^{ns}
Water deficit stress (A)	2	453.2*	71.35*	123.37*	476350**
Error I	6	25.9	10.13	14.48	6770
Combination nitrogen with vermicompost (B)	4	380.1*	52.25*	173.92*	243622**
A × B	8	5.34^{ns}	2.67^{ns}	2.03^{ns}	137.74^{ns}
Error II	36	35.48	7.93	10.13	5025
CV (%)	-	5.23	12.58	6.63	5.39

$^{ns, *\ and\ **}$: no significant, significant at 5% and 1% of probability level, respectively.

Continue Table 3.

S.O.V.	df	1000-seed weight	Seed yield	Biologic yield	Protein yield
Replication	3	0.2^{ns}	378.24^{ns}	1248.54^{ns}	15.34^{ns}
Water deficit stress (A)	2	38.3*	651742*	102442**	324.81**
Error I	6	3.172	39547	457.10	11.41
Combination nitrogen and vermicompost (B)	4	20.6*	532638*	98631**	125.64**
A × B	8	0.22^{ns}	209366*	60467**	2.45^{ns}
Error II	36	2.27	3514.30	401	6.74
CV (%)	-	6.62	5.61	5.83	7.72

$^{ns, *\ and\ **}$: no significant, significant at 5% and 1% of probability level, respectively.

Mean comparison result of different level of water deficit stress indicated that maximum plant height (117.61 cm) was noted for 70 mm evaporation pan class A and minimum of that (109.23 cm) belonged to 130 mm evaporation pan class A (Table 4). In this study, increasing drought stress causes increased competition for water between plants, so the plant allocates more photosynthetic material to the roots, as a result, less photosynthetic material reaches the aerial part (including the stem) led to reduce the plant height. This finding was consistent with the results of other researchers (Al-Kaisi and Yin, 2003; Moghimi, 2011) who stated that the reduction in plant height is evidence that drought stress has reduced cell division and reduced plant growth. As for Duncan classification made with respect to different level of combination nitrogen with vermicompost maximum and minimum amount of plant height belonged to 75% nitrogen + 25% vermicompost (118.18 cm) and 100% vermicompost treatment (108.43 cm) (Table 5). In this study, vermicompost alone could not increase plant height and along with nitrogen chemical fertilizer had a greater effect on plant height. Application of nitrogen and vermicompost increases the organic matter and activity of soil microorganisms, which provides nutrients and nitrogen from organic to inorganic form and the availability of these elements during the growth period and increase in height.

Table 4. Mean comparison effect of different level of water deficit stress on studied traits

Treatments	Plant height (cm)	Race length (cm)	No. raceme per race	No. seed per race	1000-seed weight (gr)	Protein yield ($gr.m^{-2}$)
70 (mm)	117.61^{a*}	24.32^{a}	51.20^{a}	1464.47^{a}	24.86^{a}	35.66^{a}
100 (mm)	114.41^{b}	22.83^{b}	47.8^{b}	1303.00^{b}	22.69^{b}	33.51^{b}
130 (mm)	109.23^{c}	19.97^{c}	44.86^{c}	1174.67^{c}	20.70^{c}	31.62^{c}

*Means with similar letters in each column are not significantly different by Duncan's test at 5% probability level.

Torbatinejad *et al*. (2002) and Azarpoor *et al*. (2012) also pointed increase in plant height with the use of nitrogen fertilizer and vermicompost, which with the results of this study Matched.

4.2. Race length

Result of analysis of variance revealed effect of water deficit stress and combination nitrogen with vermicompost on race length was significant at 5% probability level, but interaction effect of treatments was not significant (Table 3). According result of mean comparison maximum of pod length (24.32 cm) was obtained for 70 mm evaporation pan class A and minimum of that (19.97 cm) was for 130 mm evaporation pan class A treatment (Table 4). In this study, the reduction in cluster length in drought stress treatments can be attributed to the reduction in the number and growth rate and elongation of cluster cells under limited moisture conditions (Brown *et al*., 1965). In this regard, Jabereldar *et al*. (2017) reported that water stress significantly reduces the race length compared to the optimal irrigation conditions in the sorghum plant. Evaluation mean comparison result indicated in different level of combination nitrogen with vermicompost the maximum race length (25.05 cm) was noted for 75% nitrogen + 25% vermicompost and minimum of that (18.56 cm) belonged to 100% vermicompost treatment (Table 5). In this research, nitrogen and vermicompost have increased the production of photosynthetic materials by providing suitable conditions for vegetation growth, and this has made it possible to produce taller and thicker panicles (Frutos *et al*., 2010).

4.3. Number of raceme per race

According result of ANOVA effect of water deficit stress and combination nitrogen with vermicompost on number of raceme per race was significant at 5% probability level but interaction effect of treatments was not significant (Table 3). Assesse mean comparison result showed in different level of water deficit stress maximum number of raceme per race (51.20) was noted for 70 mm evaporation pan class A and minimum of that (44.86) belonged to 130 mm evaporation pan class A (Table 4). It seems providing necessary amount of moisture to produce initial flower has caused more raceme to be produced in optimal irrigation. According to result of Saeed Abadi *et al*. (2014), providing sufficient moisture in conditions of high evaporation can increase number of raceme per race in sorghum, which is consistent with results of this study.

Table 5. Mean comparison effect of combination nitrogen with vermicompost on studied traits

Treatments	Plant height (cm)	Race length (cm)	No. raceme per race	No. seed per race	1000-seed weight (gr)	Protein yield ($gr.m^{-2}$)
100% Nitrogen	114.80[b]	23.11[b]	49.11[b]	1355.67[b]	114.80[b]	37.05[b]
75% Nitrogen+25% Vermicompost	118.18[a]	25.05[a]	53.55[a]	1459.78[a]	118.18[a]	44.49[a]
50% Nitrogen+50% Vermicompost	116.03[ab]	24.15[ab]	51.66[ab]	1416.60[ab]	116.03[ab]	39.48[b]
25% Nitrogen+75% Vermicompost	111.35[c]	21.01[c]	44.30[c]	1243.00[c]	111.35[c]	26.96[c]
100% Vermicompost	108.43[d]	18.56[d]	41.11[d]	1096.22[d]	108.43[d]	20.01[d]

*Means with similar letters in each column are not significantly different by Duncan's test at 5% probability level.

Also, according to the results of some researchers such as Jabereldar *et al.* (2017) water stress reduced the number of raceme in the race. Compare different level of combination nitrogen fertilizer with vermicompost showed that the maximum and the minimum amount of number of raceme per race belonged to the 75% nitrogen + 25% vermicompost (53.55) and 100% vermicompost (41.51) treatments (Table 5). It seems mentioned treatment due to the provision of suitable conditions for vegetation growth and production of more photosynthetic materials, the number of raceme in the race increased. That result was similar to the finding of some researchers such as Sarwar *et al.* (2009). In this regard, Biri *et al.* (2016) reported that the use of vermicompost and nitrogen fertilizers had a positive and significant effect on most of the evaluated traits, so that in some of the mentioned traits such as the number of raceme per race. These organic fertilizers even had an effect equal to the effect of half of the nitrogen fertilizer used, which was consistent with the results of current study.

4.4. Number of seed per race

Result of analysis of variance revealed effect of water deficit stress and combination nitrogen with vermicompost on number of seed per race was significant at 1% probability level, but interaction effect of treatments was not significant (Table 3). Evaluation mean comparison result showed in different level of water deficit stress the maximum number of seed per race (1464.47) was noted for 70 mm evaporation pan class A and minimum of that (1174.67) belonged to 130 mm evaporation pan class A treatment (Table 4). It seems, the presence of sufficient moisture in the 70 mm evaporation pan class A increased the fertility of the flowers and increased the number of seeds per race. Also the decrease in the number of seeds per race in the 130 mm evaporation pan class A is due to the increase in the percentage of non-inoculation of flowers. Mentioned result was similar to finding of Foliard *et al.* (2004). Water stress during meiosis division of pollen stem cell causes abnormal anther growth and ultimately reduces number of seeds per race (Sinaki *et al*., 2007).

According to result of Assefa *et al*. (2010) drought stress reduced the number of seeds per race, which was consistent with the finding of current study. Between different levels of combination nitrogen with vermicompost the maximum number of seed per race (1459.78) was observed in 75% nitrogen+25% vermicompost and the lowest one (1096.22) was found in 100% vermicompost treatment (Table 5). It seems in this study, the presence of vermicompost organic matter provides optimal conditions for photosynthesis and as a result, more plant growth. So with the decomposition of vermicompost, root and shoot growth and development increases and mentioned factors have a direct effect on increasing the number of seeds in the race (Amyanpoori *et al*., 2015). It can also be said that the presence of nitrogen fertilizer and vermicompost caused the availability of cultivated materials for the cluster and due to the reduction of grain competition for nutrients, the number of seeds per cluster increased. Mentioned result consisted with finding of Nadimpour and Mojaddam (2015).

4.5. 1000-seed weight

According result of analysis of variance effect of water deficit stress and combination nitrogen with vermicompost on 1000-seed weight was significant at 5% probability level but interaction effect of treatments was not significant (Table 3). Mean comparison result of different level of water deficit stress indicated the maximum and the minimum amount of 1000-seed weight belonged to 70 mm evaporation pan class A (24.86 gr) and 130 mm evaporation pan class A treatment (20.70 gr) (Table 4). It seems that due to the fact that sorghum plant has a high resistance to drought and absorbs and uses water with high efficiency, it has been able to increase the amount of photosynthetic material transfer to seeds in moderate drought conditions and grain weight. Keeps it acceptable, but that trend decreases with increasing water stress. According to research by Foliard *et al*. (2004), drought stress, especially in the reproductive growth stage, has severely reduced seed yield in sorghum. This decrease in yield could be due to a decrease in the number of seeds per plant and also a decrease in the weight of 100 seeds due to disturbances in pollination practice and finally a decrease in the number of inoculated seeds, which was consistent with the results of this study. Among different level of combination nitrogen with vermicompost maximum 1000-seed weight (118.18 gr) was obtained for 75% nitrogen+25% vermicompost and minimum of that (108.43 gr) was for 100% vermicompost treatment (Table 5). It seems that in this study, low levels of vermicompost and nitrogen fertilizers could not provide the nitrogen requirement of sorghum. Therefore, sorghum seeds were not well fed in the absence of vermicompost and chemical fertilizers at low levels, and as a result, the weight of 1000 seeds was lower compared to higher levels of fertilizer. It seems in the treatment 75% nitrogen + 25% vermicompost due to the presence of worm-shaped droplets, vermicompost has a lower apparent specific gravity, which increases porosity, ventilation and permeability of water in soil, and by providing plant with the necessary nutrients such as nitrogen. Phosphorus, potassium improve seed weight per plant (Nadimpour and Mojaddam, 2015). Biari *et al*. (2008) and Biri *et al*. (2016) reported similar result.

4.6. Seed yield

Result of analysis of variance showed effect of water deficit stress, combination nitrogen with vermicompost and interaction effect of treatments on seed yield was significant at 5% probability level (Table 3). Evaluation mean comparison result of interaction effect of treatments indicated maximum seed yield (4720.64 $kg.ha^{-1}$) was noted for the 70 mm evaporation pan class A and 75% Nitrogen + 25% Vermicompost and the lowest one (1640.90 $kg.ha^{-1}$) belonged to the 130 mm evaporation pan class A and 100% Vermicompost treatment (Table 6). Riahinia *et al*. (2013) reported sorghum crop the highest seed yield was obtained in the full irrigation treatment and application of 60 $kg.ha^{-1}$ nitrogen fertilizer, which was consistent with the results of current study.

Table 6. Mean comparison interaction effect of treatment on seed and biologic yield

Water deficit stress × combination nitrogen and vermicompost	Seed yield ($kg.ha^{-1}$)	Biological yield ($gr.m^{-2}$)
70 (mm evaporation from class A evaporation)× 100% Nitrogen	4230.92^{b}*	1067.87^{b}
70 (mm evaporation from class A evaporation)× 75% Nitrogen+25% Vermicompost	4720.64^{a}	1265.06^{a}
70 (mm evaporation from class A evaporation)×50%Nitrogen+50% Vermicompost	4660.31^{ab}	1251.44^{ab}
70 (mm evaporation from class A evaporation)× 25% Nitrogen+75% Vermicompost	3420.31^{d}	1118.26^{c}
70 (mm evaporation from class A evaporation)× 100%Vermicompost	3160.54^{ef}	1069.99^{d}
100 (mm evaporation from class A evaporation)× 100% Nitrogen	3430.15^{d}	1103.45^{c}
100 (mm evaporation from class A evaporation)× 75% Nitrogen+25% Vermicompost	4600.85^{a}	1199.29^{ab}
100 (mm evaporation from class A evaporation)×50%Nitrogen+50% Vermicompost	3580.33^{cd}	1126.45^{c}
100 (mm evaporation from class A evaporation)× 25% Nitrogen+75% Vermicompost	2500.3^{g}	1041.22^{d}
100 (mm evaporation from class A evaporation)× 100%Vermicompost	2470.14^{g}	1024.63^{d}
130 (mm evaporation from class A evaporation)× 100% Nitrogen	3000.18^{f}	1067.97^{d}
130 (mm evaporation from class A evaporation)× 75% Nitrogen+25% Vermicompost	3250.17^{e}	1101.76^{c}
130 (mm evaporation from class A evaporation)×50%Nitrogen+50% Vermicompost	3030.23^{ef}	1090.96^{d}
130 (mm evaporation from class A evaporation)× 25% Nitrogen+75% Vermicompost	2350.86^{g}	923.68^{e}
130 (mm evaporation from class A evaporation)× 100%Vermicompost	1640.90^{h}	790.58^{f}

*Means with similar letters in each column are not significantly different by Duncan's test at 5% probability

Zare *et al*. (2016) reported that application of vermicompost under dehydration at 60 and 80% of field capacity, increase seed yield compared to control treatment. Research results of other researchers such as Amyanpoori *et al*. (2015); Assefa *et al*. (2010) confirm the results of this study.

4.7. Biologic yield

According result of analysis of variance effect of water deficit stress, combination nitrogen with vermicompost and interaction effect of treatments on biologic yield was significant at 1% probability level (Table 3). Assessment mean comparison result of interaction effect of treatments indicated maximum seed yield (1265.06 $gr.m^{-2}$) was noted for 70 mm evaporation pan class A and 75% Nitrogen+25% Vermicompost and lowest one (790.58 $gr.m^{-2}$) belonged to 130 mm evaporation pan class A and 100% Vermicompost treatment (Table 6). Rashtbari and Alikhani (2012) reported that the application of vermicompost under drought stress conditions increased plant biological yield.

4.8. Protein yield

Result of analysis of variance showed effect of water deficit stress and combination nitrogen with vermicompost on protein yield was significant at 1% probability level, but interaction effect of treatments was not significant (Table 3). Assessment mean comparison result indicated in different level of water deficit stress the maximum protein yield (35.66 $gr.m^{-2}$) was noted for 70 mm evaporation pan class A and minimum of that (31.62 $gr.m^{-2}$) belonged to 130 mm evaporation pan class A treatment (Table 4). Compare different level of combination nitrogen with vermicompost showed that the maximum and the minimum amount of protein yield belonged to 75% nitrogen+25% vermicompost (44.49 $gr.m^{-2}$) and 100% vermicompost (20.01 $gr.m^{-2}$) treatments (Table 5). It seems in 75% nitrogen+25% vermicompost treatment that due to the gradual release of nutrients and their greater absorption by the plant, due to increased seed yield as well as higher nitrogen content, had a higher protein yield. Biri *et al*. (2016) reported that the application of vermicompost fertilizers had a positive and significant effect on most of the evaluated traits such as protein yield.

5. CONCLUSION

In this study, due to the fact that the use of vermicompost in the soil alone can not provide nitrogen, it is necessary to add nitrogen fertilizers to vermicompost. Therefore, the use of vermicompost fertilizer along with chemical nitrogen fertilizer, in addition to producing sufficient product, can reduce the consumption of nitrogen chemical fertilizer, which contributes significantly to the health of the environment and an important strategy to The move towards agriculture is sustainable. Also, application of vermicompost reduced the adverse effect of water stress on growth and yield of sorghum. Therefore, adding vermicompost in agricultural areas facing water shortage problems can be a good solution. Finally in order to achieve maximum quantitative and qualitative yield, cultivation of sorghum with apply 75% nitrogen+25% vermicompost treatment under 70 mm evaporation pan class A it can be advised at studied areas.

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FOOTNOTES

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