

## Impact of Bio-Fertilizer on Growth and Yield of Two Sunflower (*Helianthus annuus* L.) Hybrids at Shambat, Sudan

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**Abstract:** The study was conducted at the Demonstration Farm, Sudan University of Science and Technology, College of Agricultural Studies, Shambat, during two successive summer and winter growing seasons of 2012 to study the effect of bio-fertilizer (Effective Microorganisms, EM) on growth and yield of two irrigated sunflower (*Helianthus annuus* L.) hybrids. The experiment was arranged in split-plot based on a randomized complete block design with four replications. The main plots were allotted for the two sunflower hybrids, Hysun 33 (V1) and Shambat (V2). While the subplots for bio-fertilizer treatments. The liquid bio-fertilizer levels were (Zero, 06.25, 12.5, 18.75 and 25.00 L/Ha) corresponding to F1, F2, F3, F4 and F5 treatments. The result showed that, leaf area index (LAI) and stem diameter were higher in Hysun-33 than Shambat while reverse trend was observed in case of number of seeds per head. Also, stem diameter, LAI, number of seeds per head, seeds oil content were affected by bio-fertilizer application. The highest, LAI, stem diameter was recorded in F3x V1 treatment while the highest seeds oil content was higher in hysun-33 than Shambat hybrid particularly under F3 and F4 bio-fertilizer levels.

**Keywords:** Sunflower, Hybrids, Bio-Fertilizer, Seed yield, oil content

### INTRODUCTION

Sunflower (*Helianthus annuus* L.) is an oil crop grown successfully when it is seeded as spring-sown crop under irrigated and rain-fed conditions; it is adapted to wide types of soils and climatic conditions and produces its optimum yield when accompanied with sound management practices [1]. Sunflower is a native to North America and was grown by Indians as a food source. Russia, Argentina and USA are the leading producer countries of sunflower, it is a potential source of high quality edible oil, ranges third to soybean and rapeseed as an oil crop in the world [2]. Sunflower is considered to be a good source of both oil and proteins. Oil content of sunflower ranges from 39-49%. Sunflower oil is generally considered a premium oil because of its light color, high level of unsaturated fatty acids and lack of linolenic acid, bland flavor and high smoke points [2]. The primary fatty acids in the oil are oleic and linoleic (typically 90% unsaturated fatty acids), with the remainder consisting of palmitic and stearic saturated fatty acids. Due to its edible oil content it is very important food supplement. Protein percentage of sunflower meal ranges from 28% for non-dehulled seeds to 42% for completely dehulled seeds [3]. Sunflower is considered to be the most suitable for margarine production, for hydrogenation and as cooking

oil. The industrial uses of sunflower are the production of soaps, paints, varnishes and candles. The resulting meal is a rich source of protein utilized in the livestock and poultry feeds after oil extraction [4]. The total world sowing area, production and yield in 2012/013 and 2013/014 were 23,839,000 and 24,626,000ha producing 36,062,000 Tons and 42,867,000 Tons, respectively [5]. In the Sudan, the total area under sunflower in season 2003/2004 was 6300 ha out of this area 3360 ha were irrigated and 2940 ha were under rain fed, the total production was 385 thousand metric tons. The productivity was 952.4Kg/ha under irrigation and 238kg /ha under rain fed [6]. This low productivity is attributed mainly to the lack and/or weak application of cultural practices concerns with sunflower, e.g. suitable doses of fertilizers, methods of sowing, sowing dates, using of agricultural machines [4].

The Bio-fertilizer is defined as a substance or a mixture of effective living microorganisms (bacteria and fungi) which colonizes the rhizosphere or the interior parts of the plant and activates the growth promotion by increasing the supply or the availability of primary nutrient and/or growth stimulus in order to gain high yield. The application of the bio-fertilizer is conducted by adding the suitable doses of it to the seeds

before planting directly, spraying to plant shoot system and adding it to the soil before sowing or with watering intervals [7, 8]. The role of the effective living microorganisms (EM) of Bio-fertilizers (bacteria and fungi) is resulted in the increase of the yield of the crops by improving the chemical and biological characteristics of the soil, increase phosphate solutions and make it available to be absorbed by root system, accelerating the mineralization processes of soil organic matter and helping the release of soil nutrients [9, 10]. Therefore, bio-fertilizers can be considered as eco-friendly, non hazardous and nontoxic products [11,12].

To overcome the adverse effects of chemical fertilizers the best available option lies in the complimentary use of biofertilizers as a mean of increasing yield by biological nitrogen fixation and other microbial activities [13]. Nowadays multi-strain biofertilizers i.e. gathered groups of soil microorganisms, having a definite beneficial role in supporting plant growth, developing sustainable soil fertility and in bio-controlling soil born diseases [14]. In recent years, biofertilizers have emerged as a promising component of integrating nutrient supply system in agriculture. Our whole system of agriculture depends on many important ways and microbial activities appear to be a tremendous potential for making use of microorganisms in increasing crop production [15, 16-17]. Recently many researchers [1, 6, 18-22] noticed significant differences among sunflower genotypes in growth and yield traits and also reported that sunflower hybrids surpassed local varieties or cultivars in yield and its components [23] reported that, in the Sudan, virtually 98% of oilseed sunflower production depends on hybrids, which has intensified the interest of farmers and other producers to grow the crop, Also, they reported that, the area under sunflower cultivation in the Sudan had shown an increasing manner in the last ten years. Meager studies have been conducted on the effects of biofertilizer on sunflower hybrids in Sudan. Therefore, the main objectives of this research were to study the effect of different levels (doses) of liquid bio-fertilizers on some growth and seed and oil yield of two sunflower (*Helianthus annuus*) hybrids and to select the suitable dose for improving sunflower hybrid production at Shambat area, Sudan.

## MATERIALS AND METHODS

The two field experiments were conducted at the Experimental Farm, Sudan University of Science and Technology, College of Agricultural Studies, Shambat (Lat. 15° 40' N, Long.32° 32' E and at of 380 meters above sea level) during two successive summer and winter seasons of 2011 (in the period from July 2011 to November 2011 for the summer season and in the period from November 2011 to February 2012 for the winter season). The experiments were designed to study the effect liquid bio-fertilizer (Effective Microorganisms {EM}) on the performance of two sunflower hybrids for some growth, yield and yield components.

The experiment was arranged in split-plot based on a randomized complete block design with four replications. The main plots were allotted for the two sunflower hybrids, Hysun33 (V1) and Shambat (V2). While the subplots for bio-fertilizer treatments. The liquid bio-fertilizer levels were (Zero, 06.25, 12.5, 18.75 and 25.00 L/Ha) corresponding to F1, F2, F3, F4 and F5 treatments. The two sunflower hybrids were released by Agricultural Research Corporation (ARC), Sudan. Each hybrid was planted in ridges, 5 meter-long, 70 cm between ridges and 20 cm between holes. Seeds rate was three seeds/hole, the seeds were sown manually and then thinned to two plants/hole three weeks after sowing. The five liquid bio-fertilizer (EM) levels were added to the experiment at sowing date and together with watering intervals which was conducted every 10-12 days. Weeding was done manually whenever needed. At harvest, seven growth, yield and quality characters were measured included: Stem diameter (cm), Leaf area index (LAI), Head diameter (cm), Number of seeds head<sup>-1</sup>, 100-seed weight (g) and Seeds yield (kg ha<sup>-1</sup>). The oil content of seeds of seeds was determined by sox let extraction method [24]. The collected data of the two seasons were statistically analyzed separately according to the analysis of variance (ANOVA) by using MSTAT-C computer software packages [25]. Mean comparisons were worked out by Duncan's Multiple Range Test (DMRT) at 5% level of probability according to [26].

## RESULTS AND DISCUSSION

Generally, Hysun-33 (V1) and application of bio-fertilizer levels (F3 and F4) and their interaction (V1xF3 and V1xF4) treatments significantly increased the mean leaf area index and stem diameter content compared to their respective treatments (Table 1). Results revealed that the above parameters were greater in bio-fertilizer at rate of (18.75 L/Ha) than other fertilization treatments particularly F1, F5 and control treatments. These results indicate that application of bio-fertilizer at rate of (18.75 L/Ha) had tremendous effects on plant growth and development compared to control and other levels of bio-fertilizer application in sunflower. Moreover, the increase in aforementioned growth characters might be due to the promotion of nitrogen, fixed by EM, in increasing of cell division and enlargement as well as its effect in metabolic processes in plant organs and consequently increased of leaf area per plant. These results had conformity with findings of [27,28]. Who reported that, this enhancement in growth characters may be due to increase in nitrogen uptaken by plant because bacteria directly affected the growth of the plants. On the other hand, the hysun-33 and Shambat hybrids differ significantly with each other in their growth parameters (stem diameter and LAI) as shown in Table 1. Differences in plant growth parameters between two hybrids were under genetic control as well as phenotypic difference as reported by [29].

**Table-1: Effects of bio-fertilizers levels and sunflower hybrids on mean of stem diameter and LAI**

		Summer		Winter	
		Stem diameter (cm)	LAI	stem diameter (cm)	LAI
V1		16.33	3.99	18.40	2.95
V2		10.07	2.88	17.34	3.02
LSD <sub>0.05</sub>		2.07	1.58	1.64	0.62
F1		10.53	2.48	19.25	2.87
F2		22.21	3.35	19.37	3.50
F3		24.57	4.02	19.37	3.45
F4		22.57	3.89	15.87	2.01
F5		17.25	3.46	16.48	3.09,,
LSD <sub>0.05</sub>		7.15	0.59	1.81	0.57
V1	F1	10.99	2.91	19.00	3.31
	F2	21.64	3.53	19.25	3.28
	F3	24.91	4.64	19.25	3.72
	F4	22.90	4.62	16.25	1.86
	F5	18.23	4.27	18.25	2.58
V2	F1	10.08	2.05	19.50	2.43
	F2	22.79	3.16	19.50	3.73
	F3	23.23	3.40	19.50	3.18
	F4	22.24	3.16	15.50	2.16
	F5	17.25	2.65	14.67	3.60
LSD <sub>0.05</sub>		4.62	1.31	3.67	1.39

**Table-2: Effects of bio-fertilizers levels and sunflower hybrids on mean of yield components and oil content.**

		Summer					Winter				
		Head diameter	No. seeds head <sup>-1</sup>	100-seed weight	Yield (kg/ha)	Oil content	Head diameter	No. seeds head <sup>-1</sup>	100-seed weight	Yield (kg/ha)	Oil content
V1		13.94	1047.3	5.60	3.15	36.18	17.59	532.2	11.11	3.25	36.45
V2		13.52	1093.9	7.24	3.30	35.58	19.08	571.2	10.29	3.54	37.18
LSD <sub>0.05</sub>		NS	NS	NS	NS	1.13	NS	NS	NS	NS	2.11
F1		11.79	1002.2	5.61	4.64	36.21	18.6	497.5	11.03	3.63	34.87
F2		14.11	952.4	8.20	2.73	36.08	18.5	291.7	10.40	3.38	35.27
F3		14.44	1252.2	6.86	2.77	36.14	18.77	547.7	9.59	3.7	37.08
F4		14.69	1071.6	7.24	2.96	33.00	17.17	549	12.03	1.48	36.64
F5		13.66	1074.7	7.88	3.09	32.12	18.57	643.5	10.47	3.28	33.45
LSD <sub>0.05</sub>		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
V1	F1	11.28	1075.0	5.64	36.51	35.62	16.75	500.0	11.32	3.66	36.82
	F2	14.63	997.0	6.96	2.62	36.21	17.90	510.0	8.56	3.19	36.40
	F3	14.78	1155.5	6.69	3.16	35.23	18.00	468.7	11.31	3.76	37.51
	F4	14.80	1048.2	7.35	3.04	37.62	16.75	518.00	13.15	2.83	36.85
	F5	14.23	961.0	8.75	3.06	37.59	18.55	665.0	11.25	2.81	35.59
V2	F1	12.30	929.5	5.59	5.37	34.65	20.55	495.0	10.74	3.61	34.75
	F2	13.58	907.0	9.45	2.85	34.81	19.10	532.5	12.25	3.57	34.75
	F3	14.10	1349.5	7.02	2.38	35.13	19.55	626.7	7.88	3.68	35.11
	F4	14.58	1095.0	7.13	2.88	36.64	17.60	580.00	10.91	3.09	34.68
	F5	13.08	1188.5	7.01	3.12	36.59	18.60	622.00	9.69	3.76	36.70
LSD <sub>0.05</sub>		NS	280.60	NS	NS	NS	NS	NS	NS	NS	NS

In this study, table 2 showed the results of yield components and seeds oil content. These results revealed different ranges of significant and non-significant effects due to bio-fertilizers, hybrids and their interactions. However, it appears that the effect of the bio-fertilizer application on the two sunflower hybrids was clear for growth characters more than yield

characters. The effect was more pronounce (although non-significant) in combined application of bio-fertilizer F3 on the hysun-33 hybrid than other applications. The highest values of LAI and stem diameter were recorded in F3x V1 treatment followed by the treatment of F3x V2. Further, the positive attributes of bio-fertilizer (EM) application enhanced

growth and yield of sunflower is most likely due to promotion of root growth by the decreased ethylene levels attributed to ACC-deaminase activity as described by [30]. Moreover, yield parameters especially number of seeds per head was influenced by bio-fertilizer application particularly in hysun-33 (Table 2). The increase in the above mentioned yield component might be resulted in increased availability of nitrogen which increased LA and consequently increased number of seeds per head. The obtained results were agreement with findings of [31] who attributed the increase in number of seeds /head to that bio fertilizer increased plant growth and therefore make significant increase in number of seed per head. ). Also, [1, 21] reported that sunflower hybrids surpassed local varieties or cultivars in yield and its components. Application of F3 dose of bio- fertilizer showed major influencing factor in the most of yield attributes in both seasons. However, seeds oil yield was higher in hysun-33 than shambat hybrid in the first season while reverse trend was observed in case of second season (Table 2). Differences in seed oil content between two hybrids were under genetic control as reported by [29] (Arnon and Aslam, 1991). The highest seeds oil yield (by using bio-fertilizer F3, F4 levels) can be related to the longer growth period and higher active leaf. The similar results and observations were also reported by [31] who showed that application of bio fertilizer to sunflower resulted in higher seed oil content.

## CONCLUSION

According to this study using bio-fertilizers has been increased LAI and seed oil content of sunflower particularly hysun-33 hybrid. Application of F3 showed major influencing factor in the most of yield attributes in both seasons. In other words, presence of these (EM) sunflower hybrids (hysun-33 and shambat) growth factors has been increased under the local shambat condition.

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