Kirkuk University Journal for Agricultural Sciences
ISSN:2958-6585
https://kujas.uokirkuk.edu.iq

RESEARCH ARTICLE

https://doi.org. 10.58928/ku24.15414

Response of Three Black Seed cultivars to Humic Acid Fertilizer in Sulaimani Region, Iraq.

Alaa M. Mohammad-Ameen[1] **Eman H. ALanbari[1]**

Biotechnology and Crop Sciences Department, College of Agricultural Engineering Sciences, University of Sulaimani, Sulaymaniyah, IRAQ.

*Corresponding Author: almas.muhammad@univsul.edu.iq.

Received: 07/07/2024 **Revised: 22/08/2024** **Accepted: 02/09/2024** **Published: 01/12/2024**

ABSTRACT

A field experiment was conducted in Qlyassan, Agricultural Research Station, College of Agricultural Engineering Sciences, University of Sulaimani. To study the role of humic acid in improving the yield component of black seed cultivates under rainfall conditions during the growing seasons of 2021-2022 and 2022-2023, under rainy conditions by using factorial complete randomized block design (CRBD) with three replications. The study consisted of two factors, the first factor includes three black seed (NARC-Pakistan, Raw Indian and Bengali) cultivates, and second factor included different concentrations {0 ml.L^{-1} (control), 5ml.L^{-1} and 10ml.L^{-1}} of humic acid fertilizer. The results showed that the productive season 2022-2023 exhibited better results in most studied traits includes; Capsules.m-^{2}, Capsules.plant^{-1}, Seeds.capsule^{-1}, seed weight kg. ha^{-1}, biological weight kg.h^{-1} and fixed oil %. Although there was a factor of cultivars, there were no significant differences for the studied traits except two traits that were Capsules.plant^{-1} and fixed oil%, and the reason is may be due to the fact that there was intense competition between the varieties. For foliar application, results showed that humic acid applications have shown better results as compared to control especially the concentrate of 10ml.L^{-1} for these traits; Capsules.m-^{2}, Capsules.plant^{-1}, Seeds.capsule^{-1}, seeds weight. plant^{-1}, 1000 seed weight (g) and total seed weight kg. ha^{-1} by 30.890%, 37.025%, 20.949%, 31.887%, 20.667%, 24.523% for first season, and 23.819%, 33.599%, 10.249%, 26.093%, 21.147%, 21.133% for second season respectively. For the oil content, which was one of the most important traits intended in the study, the high value obtained by the Pakistani variety with 27.402% between cultivars, while for humic acid application in the experiment and its effect on oil content, the dose with 10 ml/ L superior on control by 19.577% and 23.897% for the two years respectively, while between years, the second season superior first season by 9.434%..

***Keywords*:** Black seed, humic acid, growth, yield components and fixed oil content.

INTRODUCTION

The growing trend in the utilization of medicinal plants worldwide has sparked a surge in interest in their cultivation and production methods, because of their appropriateness with nature and more harmoniously for it [1]. In recent times, there has been a notable shift toward herbal remedies, with the resurgence of interest in medicinal plants that had previously waned with the introduction of pharmaceutical drugs, now experiencing a resurgence once again for various reasons. [1]. Among various medicinal plants, black seed is an annual herbaceous plant belonging to the Ranunculaceae family and it is one of the most important medicinal plants [2]. Numerous studies on black seeds have been referred to as having anti-oxidative, strengthening of the immune system, anti-inflammatory, anti-histamine and oil extract properties. In addition, considering the importance of black seeds in food and cosmetics industries, pharmaceutical, it is strongly needed to conduct comprehensive studies on the cultivation Including agricultural applications and development of the plant [3, 4]. The plant acquired its pharmacological activity and its medical value in great splendor and occupied a special place for medicinal plants in the Islamic civilization through the ideological belief in its treatment of multiple diseases the holy prophet, Mohammed (peace be upon him) that the plant is healing all sickness except death [5]. In addition, it is an integral part of the cuisine of south Asia and southeast Asia, used as a flavor for traditional breads [6]. One of the major factors that increase the productivity of medicinal plants is fertilization. Excessive use of chemical fertilizer in agricultural operations leads to various environmental problems, such as deteriorating soil fertility, increasing the cost of production, as well as its impact on the health of living organisms [7, 8]. To dispense with the use of chemical fertilizers and reduce their harmful, it is necessary to find a safe alternative way. Therefore, organic fertilizers are the best methods used to reduce the environment and improves soil health, water retention ability and high cation exchange capacity [9]. Also, contain a macro and micronutrients, vitamins, growth promoting factors indole 3-acetic acid (IAA) and gibberellic acid (GA) [10] and it is increases production in a similar method to inorganic fertilizers [11]. In recent years, there has been a significant amount of research conducted on the role of

humic acid (HA) in various fields such as fertility, soil chemistry, environmental sciences, and plant physiology. This is due to the numerous ways HA can effectively enhance plant growth and nutrient uptake. The findings from these studies have highlighted the importance of HA in promoting healthy and thriving plant development. [12]. [13] Conclude that providing nigella plants with foliar fertilizers during active vegetative growth increases yield significantly compared to soil applied fertilizers. Foliar sprays of Humic acid have shown significant benefits in improving plant growth, increasing yield, and enhancing quality across various plant species. This is achieved by boosting nutrient uptake, serving as a mineral nutrient source, and regulating nutrient release [14]. To assess the impact of foliar humic acid spray on the vegetative development, yield, yield component and oil content of black seed, the current study was conducted.

Materials and Methods

Field experiment was conducted at Qlyassan Agricultural Research Station-College of Agricultural Engineering Sciences, University of Sulaimani (Lat. 35º 34 307; N, Long. 45º 21 992; E, 765 m.a.s.l.), during the winter seasons of (2021-2022) and (2022-2023). The metrological data of Qlyassan shown in Table (1). The field was layout according to the factorial experiment within Completely Randomized Block Design, including three replicates, each block consisting of 15 experiment unit of 1 m^2 (1×1) with 0.5 m apart. The experiment was consisted of two factor; first factor was three cultivates of black seed (Pakistani, Indian and Bengali) and the second factor was the fertilization by using humic acid treatment with two levels (5 and 10 $ml.L^{-1}$) compared to control which applied as a foliar spray three times after six weeks after planting (tillering, elongation and blooming). The soil of experimental land was prepared for cultivation by irrigating it before plowing it by using mold broad plow and harrow. The field was weed by hand wherever needed, and all other agricultural practices were implemented uniformly for all plots as necessary. Some physical and chemical properties of the soil were measured in depth of (0.3 m) shown in Table (2). Plants were harvested at physiological maturity and the following parameters were taken the experiment.

Vegetative growth traits:

1. plants m^{-2}
2. Branches plants $^{-1}$: Three plants from each plot were taken randomly after flowering to calculate the average of No. of branch plants $^{-1}$.
3. Plant height (cm).
4. Days from sowing to 50 % flowering.
5. Days from sowing to 100 % flowering.

Yield and yield component traits:

1. Capsules. m^2.
2. Capsules $plant^{-1}$.
3. Seeds $capsules^{-1}$.
4. Seed $plant^{-1}$.
5. 1000 seeds weight (g).
6. Total seed yield (kg ha^{-1}): calculated as a yield of grains of unit area, converted to tons per hectare.
7. Biological yield (kg ha^{-1}).
8. Harvest Index (HI): It was calculated as a percentage of grain weight to biological yield [15].
9. Seed oil content: The oil content of the harvested seeds from each plot was determined through a digital soxhlet apparatus was utilized for the oil distillation process, employing hexane as the solvent, as described by [16], 1 g of the seed samples from each plot was powdered using an electric blender. The oil content was subsequently calculated based on the extracted oil yield:

$$\textbf{Oil}\ \% = \frac{[(\mathbf{W2}-\mathbf{W1})\times\mathbf{100}]}{\mathbf{S}}$$

W1 = empty flask Weight of the (g).
W2 = flask and the extracted oil Weight (g)
S = Sample weight

Statistical analysis

The data were analyzed by analysis of variance that was carried out as a general test of (3×2) factorial experiment with RCBD design. The means were compared using L.S.D at a significant 0.05 and 0.01 probability [17].

Table 1: Metrological data at Qlyassan environments during the growing season 2021-2022 and 2022-2023.

Months	2021-2022			2022-2023		
	Temperature Cº		Rain-fall	Temperature Cº		Rainfall
	Maximum	Minimum.	mm	Maximum	Minimum	mm
Oct.	24.8	23.0	0.0	37.0	11.2	15.8

Nov.	16.3	14.9	36.8	22.5	7.4	80.8
Dec.	10.6	9.3	29.1	18.5	1.0	46
Jan.	5.4	4.3	141.0	14.5	- 0.4	94
Feb.	11.2	9.8	54.3	21.7	- 2.0	85.8
Mar.	11.9	10.6	22.7	24.4	2.4	240.2
Apr.	21.1	19.3	15.7	27.1	4.6	113.4
May	24.6	22.9	10.9	33.6	11.6	39.0
Total			310.5			715

Table 2: Soils physical and chemical properties at Qlyassan location

Soil properties	*Qlyassan*
% Sand	10.64
% Silt	45.15
% Clay	44.21
Texture	Clay
EC d S m^{-1} at 25°C	0.7
PH	7.85
N %	0.19
Organic matter %	1.25

Results and discussion

1- Vegetative Growth traits

A- Effect of cultivars on vegetative growth traits

Results of means analysis showed that the effect of varieties was significantly deference at a significance level of probability 0.01 (Table 3) for the two trails, No. of plants.m^2 and No. of branches. $plant^{-1}$ in first and second season. The maximum values for No. of plants.m^2 was recorded to Bengali cultivar which were (129.333 and 210) for the both years respectively, while the minimum value were recorded to Indian cultivar in both seasons which were (80.222 and 129.333) respectively. But for the rest of the traits, there were no significant differences between cultivars, this may be because they are new in the study and there is strong competition between them, so the values were very close between them.

Table 3: Effect of black seed cultivars on vegetative growth characters during 2021-2022 and 2022-2023 seasons.

Black Seed cultivars	No. of plants.m^2	No. of branches.$plant^{-1}$	plant height cm	days from sowing to 50% flowering	days from sowing to 100% flowering
		2021-2022			
Pakistani	81.111	4.333	39.259	148.444	159.778
Indian	80.222	4.370	39.963	150.333	161.444
Bengali	129.333	3.296	39.037	149.333	162.222
LSD (p≤0.05)	12.835	0.639	*n.s*	*n.s*	*n.s*
LSD (p≤0.01)	17.684	0.880	*n.s*	*n.s*	*n.s*
		2022-2023			
Pakistani	140.444	14.000	36.185	162.667	175.000
Indian	129.889	11.185	36.926	164.444	176.556
Bengali	210.111	10.629	35.259	160.000	174.333
LSD (p≤0.05)	39.124	*n.s*	*n.s*	2.061	*n.s*
LSD (p≤0.01)	53.905	*n.s*	*n.s*	2.840	*n.s*

B- Effect of humic acid on vegetative growth traits.

Results in Table (4) show there are non-significant differences according to humic level concentrations for these traits in

both seasons; except for the two traits which are No. of plants.m^2 and No. of branches. $plant^{-1}$ at probability 0.01 and 0.05, the high value was recorded at 10 $ml.L^{-1}$ of humic acid which was 169.833 and 7.166 for both traits respectively. In contrast, the lower value was 115 and 5.333 recorded to control treated respectively for the season 2021-2022. Although there is a difference between values in second season for these two traits they are not significant.

Table 4: Effect of humic acid on vegetative growth characters of black seed during 2021-2022 and 2022-2023 seasons

Humic Acid	No. of plant.m^{-2}	No. of branches.$plant^{-1}$	plant height.cm	days from sowing to 50% flowering	days from sowing to 100% flowering
		2021-2022			
Control	115.000	5.333	58.777	225.500	244.167
5 $ml.L^{-1}$	151.167	5.500	58.111	221.667	238.667
10 $ml.L^{-1}$	169.833	7.166	60.500	225.000	242.333
LSD ($p \leq 0.05$)	12.835	0.639	*n.s*	*n.s*	*n.s*
LSD ($p \leq 0.01$)	17.684	0.880	*n.s*	*n.s*	*n.s*
		2022-2023			
Control	229.500	15.722	54.333	243.667	264.500
5 $ml.L^{-1}$	257.833	19.722	53.500	243.833	262.000
10 $ml.L^{-1}$	233.333	18.278	54.722	243.167	262.333
LSD ($p \leq 0.05$)	*n.s*	*n.s*	*n.s*	*n.s*	*n.s*
LSD ($p \leq 0.01$)	*n.s*	*n.s*	*n.s*	*n.s*	*n.s*

C- Effect of seasons on vegetative growth

In Table (4) showed significant differences were detected between the two seasons on black seed cultivars. Vegetative growth such as No. of plants.m^2, No. of branches. $plant^{-1}$, days from sowing to 50% flowering and days from sowing to 100% flowering in season 2022-2023 recorded 160.148, 11.938, 162.370 and 175.296 respectively for all cultivars. Thus, the growing season 2022-2023 recorded good values for those parameters, this is due to the amount of rainfall in that season, in addition to its regular distribution, especially during the flowering period and the filling of the capsules, this results are agreeing with [18] which he mentioned that sufficient humidity or enough and regular raining have an impact on yield.

Table 5: Effect of seasons 2021-2022 and 2022-2023 on vegetative growth.

Seasons	No. of plant.m^{-2}	No. of branches.$plant^{-1}$	plant height cm	days from sowing to 50% flowering	days from sowing to 100% flowering
2021-2022	96.889	4.000	39.419	149.370	161.148
2022-2023	160.148	11.938	36.123	162.370	175.296
LSD ($p \leq 0.05$)	175.636	22.040	*n.s*	36.094	39.282
LSD ($p \leq 0.01$)	291.252	36.549	*n.s*	59.853	65.139

2-Yield and yield component traits.

A- Effect of varieties on yield and yield component traits and oil percentage

Results shown in Table (6), that there are significant deferent between cultivars for a few traits in both seasons; in season 2021-2022, the maximum No. of capsules. m^2 was recorded by Bengali 553.22, while the minimum value was recorded by Pakistan 522.222, while high value for No. of capsules. $plant^{-1}$ was recorded by Indian which was 4.926, but low value was recorded to Bangali, this reason is because the number of plants. m^2 of the Bangali was high than other cultivars which is indicated in Table (3). In contrast, the high value for fixed oil was

Table 6: Effect of cultivars on yield and yield component and oil percentage.

Black Seed cultivars	No. of Capsules .m-2	No. of capsules. Plant-1	No. of Seeds. Capsule-1	weight of seeds. plant-1	1000 seed weight (g)	total seed weight kg.ha-1	Biological weight kg.ha-1	Harvest index	Fixed oil %
				2021-2022					
Pakistani	522.222	4.888	55.733	1.840	3.600	542.633	2027.778	0.270	27.402
Indian	526.556	4.926	56.111	1.620	3.752	526.511	1983.333	0.273	20.833
Bengali	553.222	3.852	54.311	1.765	3.779	536.733	1686.667	0.325	22.240
LSD (p≤0.05)	23.476	0.646	*n.s*	*n.s*	*n.s*	*n.s*	*n.s*	*n.s*	2.488
LSD (p≤0.01)	*n.s*	0.890	*n.s*	*n.s*	*n.s*	*n.s*	*n.s*	*n.s*	3.428
				2022-2023					
Pakistani	574.889	6.589	63.044	1.956	3.762	586.667	2338.356	0.250	26.117
India	593.889	6.592	68.867	1.694	3.717	578.789	2357.833	0.246	25.959
Bangali	710.556	5.666	63.956	1.949	3.995	640.044	2232.000	0.287	25.378
LSD (p≤0.05)	87.470	*n.s*	*n.s*	0.163	*n.s*	36.752	*n.s*	0.024	*n.s*
LSD (p≤0.01)	120.516	*n.s*	*n.s*	0.224	*n.s*	50.636	*n.s*	0.034	*n.s*

obtaining from Pakistani cultivar which was 27.402, but low value was obtained from India variety that was 20.833. While in the second year 2022-2023, there were more significant differences between the traits of the studied cultivars as compared to the first season; the studied characters, No. of capsules.m^2, total seed weight kg.ha^{-1} and harvest index, the maximum values were 710.556, 640.044 and 0.287 respectively, recorded to the Bengali cultivar, while the minimum value of No. of capsules.m^2 was 574.889 for Pakistani, and weight of seeds.$plant^{-1}$, total seed weight kg.ha^{-1} and harvest index were 1.694, 578.789 and 0.246 respectively. But for fixed oil, in season 2021-2022, the maximum value recorded for Pakistani cultivar was 27.402, and minimum was for Indian cultivar, while for next season there were no significant differences between the cultivars.

B- Effect of Humic Acid on yield and yield component traits and oil percentage

The results obtained through variance analysis indicated that the effect of humic acid fertilizer treatment on these traits was significant at 0.05% and 0.01% (Table 7). According to means value of trials the maximum values for capsules. m^2, capsules. $plant^{-1}$, seeds. $capsules^{-1}$, weight of seeds. $plant^{-1}$, 1000 seeds weight (g), total seed weight kg. ha^{-1}, biological yield kg. ha^{-1} and harvest index were 893.833, 7.999, 87.367, 3.047, 5.990, 902.217, 2933.333 and 0.469 respectively, these recorded values were obtained from treatments who sprayed with 10 $ml.L^{-1}$ of humic acid then followed by application of 5 $ml.L^{-1}$. The increase in trials values is due to the addition of humic acid which stimulates the plant to grow and increases biological yield, which is ultimately reflected in the crop productivity of the black seed plant [19], and this also agree with [20] who found the same results in his study of the effect of humic acid on the black seed plant. This means that application of humic acid significantly enhanced the seed yield components of black seed as compared to the untreated plants. For the fixed oil percentages (Table 6), foliar fertilizer had a significant impact, it is clear that the highest values f fixed oil percentage 38.124 % and 42.640 % for both years was obtained from plants that were sprayed with 10ml/ L for both locations then followed by 5$ml.L^{-1}$ [14]. The reinforcement of humic acid fertilizers to the oil content might be due to its simulative influence on fresh mass, as well as the activation of enzymes involved in the metabolism of oil formation [21].

Table 7: Effect of Humic Acid on yield and yield component traits and oil percentage

Humic Acid	Capsules.m-2	Capsules. plant-1	Seeds. capsule-1	weight of seeds.plant-1	1000 seed weight g	total seed weight kg.ha-1	Biological weight kg.ha-1	Harvest index	Fixed oil %
First				2021-2022					

Season									
Control	654.67	5.50	70.800	2.209	4.868	705.133	2738.333	0.396	31.326
5 ml.L^{-1}	854.500	7.000	81.233	2.582	5.840	801.467	2875.000	0.435	36.263
10 ml.L^{-1}	893.833	7.999	87.367	3.047	5.990	902.217	2933.333	0.469	38.124
LSD (p≤0.05)	23.476	0.646	4.949	0.404	0.323	23.180	*n.s*	*n.s*	2.488
LSD (p≤0.01)	32.345	0.890	6.819	*n.s*	0.445	31.937	*n.s*	*n.s*	3.428
Second Season				2022-2023					
Control	813.000	7.555	78.533	2.366	5.121	802.950	3406.167	0.353	33.538
5 ml.L^{-1}	973.167	10.111	83.333	2.957	5.758	912.617	3537.850	0.390	40.003
10 ml.L^{-1}	1032.833	10.606	87.017	3.076	6.332	992.683	3448.267	0.431	42.640
LSD (p≤0.05)	87.470	0.941	5.764	0.163	0.294	36.752	*n.s*	0.024	1.604
LSD (p≤0.01)	120.516	1.296	7.941	0.224	0.405	50.636	*n.s*	0.034	2.211

C- Effect of seasons on yield and yield component and oil content.

Data illustrated in Table (8), showed there are variations in values for the studied traits based on the two years of cultivation at the concentration probability of 0.01% and 0.05%. The season 2022-2023 recorded high values; 626.444, 6.283, 65.289, 601.833,2309.396 and 25.818 for traits including capsules.m^2, capsules. Plant^{-1}, seeds. capsules^{-1}, total seed weight, biological yield and oil percentage. The reason may be attributed to the climatic conditions of both seasons or the rate of rainfall and its distribution according to the stages of growth of plants, which has a significant influence on vegetative growth and thus its impact on the yield components of the crop.

Table 8: Effect of seasons on yield and yield component and oil content.

Seasons	Capsules.m^{-2}	Capsules. Plant^{-1}	Seeds.capsule^{-1}	weight of seeds.plant^{-1}	1000 seed weight g	total seed weight kg.ha^{-1}	Biological weight kg.ha^{-1}	Harvest index	Fixed oil %
2021-2022	534.000	4.555	55.385	1.742	3.710	535.293	1899.259	0.289	23.492
2022-2023	626.444	6.283	65.289	1.866	3.825	601.833	2309.396	0.261	25.818
LSD (p≤0.05)	256.667	4.796	27.497	*n.s*	*n.s*	184.747	1138.723	*n.s*	6.458
LSD (p≤0.01)	425.623	7.953	45.598	*n.s*	*n.s*	306.360	1888.310	*n.s*	*n.s*

The final results of the analysis data variance showed in table (9) it becomes clear that the results of the traits studied in this research have influenced by cultivars, which was significant at 0.05% for capsules.m^2, harvest index, and high significant obtain in fixed oil %, while non-significant in seeds. capsule^{-1}, weight of seeds. plant^{-1}, 1000 seed weight (g), seed weight kg. ha^{-1} and biological weight kg.h^{-1} in the first season. In the second season the impact of cultivars was significant at 0.05% for harvest index and highly significant for capsules.m^2, weight of seeds. plant^{-1} and seed weight kg. ha^{-1}, but non-significant obtain in Capsules. plant^{-1}, Seeds.capsule^{-1}, 1000 seed weight (g), Biological weight kg. ha^{-1} and fixed oil%. While results of variance analysis showed that the effect of humic acid applications in experiment in both season was high significant at 0.01% for these traits; Capsules.m^2, Capsules. plant^{-1} Seeds.capsule^{-1}, weight of seeds. plant^{-1}, 1000 seed weight (g) and seed weight kg. ha^{-1}, and non-significant for Biological weight kg. ha^{-1} in both season and harvest index in first season. For the interaction between the two factors, there were non-significant Differences at 0.05% and 0.01% for all traits, except seed weight kg. ha^{-1} which was significant at 0.05% in both seasons and recorded the higher

Table 9: Mean squares of the variance analysis of the studied characters in both seasons

S.O.V	d.f	Capsules.m^{-2}	Capsules. plant^{-1}	Seeds.capsule^{-1}	weight of seeds.plant^{-1}	1000 seed weight (g)	total seed weight kg.ha^{-1}	Biological weight kg.ha^{-1}	Harvest index	Fixed oil %
2021-2022										
Replicates	2	9.333	0.087	2.117	0.311	0.09	188.579	128848	0.003	9.471
A	2	2536.333 *	3.345 **	8.108^{ns}	0.113^{ns}	0.084^{ns}	598.845^{ns}	309514.815 ns	0.009*	107.666**
B	2	65787.444 **	6.332 **	547.655 **	0.705*	1.482**	38848.343 **	40070.37 ns	0.005^{ns}	49.373**
AB	4	947.778 ns	0.642^{ns}	56.397^{ns}	0.224^{ns}	0.056^{ns}	1806.579 *	230403.704 ns	0.004^{ns}	9.431^{ns}
Exp. Error	16	551.861	0.418	24.53	0.163	0.105	538.042	131907	0.002	6.197
2022-2023										
Replicates	2	1904.111	0.864	13.671	0.064	0.03	69.634	11605	0	0.3
A	2	48566.333 **	2.564^{ns}	2.958^{ns}	0.201**	0.199^{ns}	9995.234 **	41287.374 ns	0.005*	1.364^{ns}
B	2	51693.444 **	10.724 **	126.749 **	0.578 **	1.466 **	36290.791 **	18092.056 ns	0.006*	87.743**
AB	4	18975.278 ns	0.4^{ns}	2.713^{ns}	0.005^{ns}	0.252^{ns}	4309.541*	37149.634 ns	0.002^{ns}	7.128^{ns}
Exp. Error	16	7661.306	0.887	12.309	0.026	0.086	1352.501	22183.2	0.001	2.578

value in second season.

Conclusions

According to the results of this experiment, it can be inferred that using humic acid as a fertilizer promoted vegetative growth and increased yield and its component as well as fixed oil of black seed cultivars. Application of humic acid concentrations of 5 and 10 ml.L^{-1} showed higher yield than control, especially the intensifying of vegetative growth. Therefore, based on the results of current study, it seems like that humic acid can reduce the use of chemical fertilizers and environmental pollution. They also play an important role in achieving the goals of sustainable agriculture.

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استجابة ثلاثة أصناف من الحبة السوداء لسماد حامض الهيوميك في منطقة السليمانية، العراق.

الماس جلال **محمد رشيد**

قسم تكنولوجيا الحيوية وعلوم المحاصيل، كلية علوم الهندسة الزراعية، جامعة السليمانية، السليمانية.

الخلاصة

نفذت هذه تجربة الحقلية في محطة البحوث الزراعية بقليسان التابعة لكلية علوم الهندسة الزراعية– جامعة السليمانية. لدراسة دور حامض الهيوميك في تحسين بعض الصفات من الحاصل و مكون حاصل الحبة السوداء تحت ظروف تساقط الأمطار خلال موسمي 2021–2022 و2022–2023، باستخدام تصميم القطاعات العشوائية الكاملة–العاملية (***CRBD***) وبثلاثة مكررات. تتكون الدراسة من عاملين، العامل الأول يتظمن ثلاثة أصناف من الحبة السوداء (***NARC***– باكستان، الهند الخام، البنغالية)، والعامل الثاني يتظمن ثلاث تراكيز مختلفة من سماد حامض الهيوميك {صفر مل/لتر (كونترول) ، 5 مل.لتر$^{-1}$ و 10 مل.لتر$^{-1}$}. أظهرت النتائج تفوق الموسم الزراعي 2022–2023 في معظم الصفات المدروسة والتي تشمل تجارب المكونات الخضرية والمحصولية. وعلى الرغم من وجود عامل الأصناف إلا أنه لم تكن هناك فروق معنوية للصفات المدروسة باستثناء صفتين أو ثلاث صفات، وقد يعود السبب إلى وجود منافسة شديدة بين الأصناف. أما بالنسبة للرش الورقي فقد اظهرت النتائج بان اضافة حامض هيوميد كتسميد الورقي تفوقت نتائجه على معاملة الكونترول اي بدون تسميد وخصوصا جرعة 10 مل.لتر$^{-1}$لهذا الصفات: عدد الكبسولة.م2، عدد الكبسولة.نبات$^{-1}$، عدد البذور .الكبسول$^{-1}$، الوزن البذور .النبات$^{-1}$، وزن الف حبة (غم) و إنتاجية البذوركغم.هكتار$^{-1}$ وبنسبة الثوية كالاتي 30.890%، 37.025%، 20.949%، 31.887%، 20.667%، 24.523% هذه بالنسبة للموسم الاول، و 23.819%، 33.599%، 10.249%، 26,093%، 21,147%، 21,133% بالنسبة للموسم الثاني للكل على التوالي. اما بالنسبة لمحتوى الزيت والذي كان من أهم الصفات المقصودة في الدراسة، فإن القيمة العالية التي حصل عليها الصنف الباكستاني بلغت 27.402% بين الأصناف، أما بالنسبة لتطبيق حامض الهيوميك في التجربة وتاثيرها على محتواه الزيتي فقد تفوقت الجرعة 10 مل.لتر$^{-1}$ على السيطرة (بدون التسميد) بنسبة 19.577% و23.897% كنسبة للسنتين على التوالي، واما بالنسبة للمواسم، فقد تفوقت الموسم الثاني على الموسم الأولى بنسبة 9.434%.

الكلمات المفتاحية: حبة السوداء، حامض الهيوميك، النمو، مكونات الحاصل و محتواه الزيت.