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Response of Some Growth Traits of Safflower(*Carthamus tinctorius* L.) to Spray with Humic Acid Under Levels of Phosphorus Fertilizer

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Abstract. The research was carried out in Agriculture College farm / Basra University – Karmat Ali location, the winter season 2020- 2021, to study the response of Safflower variety Gilla to spray with four concentrations of humic acid (0,6,12,18g L-1) under four levels of Phosphorus fertilizer(0,60,120 kg P h-1). The experiment was carried out in a factorial arrangement with three replications using a randomized complete block design. The results showed that 120 kg P h-1 gave of the highest days until 50% flowering , plant height , the total number of main branches and leaves and a diameter of the stem (106.75 days ago, 183.01cm,12.44 branches plant-1, 588.71 leaves plant-1 ,1.466cm respectively). The maximum number of days to 50% flowering plant height , the number of main branches were superior with a humic acid concentration of 12 g L-1., (109.56 day,180.34cm and 12.70 branches plant-1respectively) ,while concentration 18 g L-1 gave the highest number of leaves. The interaction of 120 kg P h-1 with 12 g L 1- of humic acid gave the highest number of days from planting to 50% flowering, plant height , the number of main branches.

Keywords. Safflower, Humic acid, Diameter, Main branches.

1. Introduction

Safflower (*Carthamus tinctorius* L.) is an annual plant which belongs to the Composite family. It is widely cultivated in the world for its oil, which is 32-40%, also It was mostly produced for the flowers, which were used to make clothes and food colors. [1]. Safflower oil is recommended because it contains a higher proportion of poly unsaturated fatty acids [2]. The importance of the cultivation of this crop it one of the few oilseed crops which suitable for the winter season for the Iraqi environment, while, most of the oil crops in Iraq are summer crops. It is also needs few water as well as, its tolerance to salty and drought conditions[3].One of the most crucial factors in achieving high safflower output is nutrient control[4]. phosphorus is one of the main nutrients that the plant needs in large quantities that affect directly or indirectly in biological processes ,In addition, It is the main component of the metabolism and biological biosynthesis of cell membranes. Several studies have indicated that adding phosphorous to the soil improves plant growth and has a positive impact. When the level of Phosphorus increasing from 50 to 60 kg P h^{-1} to the highest of plant increased from 96.23 to 101.97 cm[5]. Increasing the level of Phosphorus fertilizer gave the highest height plant, number of branches and stem diameter for of safflower[6] .

Organic fertilizer use is being considered around the world due to its importance in food safety and environmental health., as it added to soil or spraying on plant in low concentrations, including humic acids which has been widely used in recent times to improve plant growth and production, [7,8, 9,10, 11] .Increased photosynthesis, cell membrane permeability, and NPK absorption are all benefits of humic acid [12]. [13] found when spraying safflower with four concentrations of humic acid (0, 300, 400, 500mg L^{-1}) the concentration of 300 mg L-1gave the highest plant height of 81.37cm, while the control gave the lowest 73.07 cm. The purpose of this study was to see how varied quantities of phosphorus fertilizer and humic acid concentrations affected on some growth traits of Safflower

2. Materials and Methods

The research was carried in Agriculture College farm / Basra University – Karmat Ali University of Basrah, Iraq, at the winter season 2020- 2021 to study the response of Safflower variety Gilla to spray with four concentrations of humic acid (0,6,12,18g L^{-1}) under four levels of phosphorus fertilizer (0,60,120 kg P h^{-1}). The soil texture was silty loam and its physical and chemical properties were analyzed (table 1). The plot size was 3*2m2, it contain four ridges ,the distance between hills was 20 cm with 50 cm apart ridges. Super calcium phosphorus was used as a phosphorus fertilizer (P_2O_5 45%) at the seeds sowing , 180 kg h-1 of nitrogen fertilizer were applied as urea (N46%) in three doses, the first after emergence, the second when the flower buds are formed, while the third when the flowers open on the main stem [14]. Safflower seeds, cultivar Gilla were sown on 1st November 2021[15]. Four concentrations of foliar application were prepared , sprayed twice on the leaves, the first after a month of sowing, while, the second spraying was done a month after the first spraying, A knapsack sprayer was used for the foliar spraying application. All foliar spraying was done in the early morning in order to avoid the high temperature. weeding and irrigation were carried out as needed. After the plants reached 50% flowering, the middle rows were was considered to measure the traits of the number of days to 50% flowering, the plant height ,stem diameter, number of main branches and leaves of the plant. The statistical analysis of the traits was carried out using the GenStat statistical program's .The LSD ($p \leq 0.05$) was used to compare the averages [16] .

Table 1. Physical and chemical properties of soil.

Properties	pH	EC (dS m^{-1})	Organic matter (g kg-1)	Available N	Available P (mg kg^{-1})	Available K
Value	7.37	8.62	1.60	30.50	11.90	110.43

3. Results and Discussion

3.1. Days to 50% is Flowering

According to the results there were significant variances in the levels of phosphorus fertilizer and the concentration of humic acid for days to 50% flowering (Table 2). The level of 120 kg P ha^{-1} achieved the highest number of day of planting to 50% flowering of 106.75 day with no significant differences with the level 60 kg P ha^{-1} which gave an average of 106.50 days, while the control gave the lowest (104.75 day), this reselt may be due to the fact that phosphorus encouraged the increase in the root total and thus increasing the time of vegetative growth, resulting in an increase in the number of days to 50% flowering . This result was in accordance with [17]. Results also revealed that Spraying humic acid with a concentration of 12 gm L^{-1} increased days from planting to 50% flowering (109.56 day), while the control (0) gave the lowest number (104.00 day) with no difference when spraying with 18 gm L^{-1}, this due to the role of humic acid which includes cyclic phenolic chemicals that have a plant hormone-like function. especially auxins, cytokinins and gibberellins [18] as a result, the rates of active plant cell division and elongation increased, thus, Growth rates and total vegetative time increased .The interaction had a significant effect, the level 120 kg P ha^{-1} and spray with 12 gm L^{-1} of humic gave the longest period of time to 50% flowering (113.00 day) ,while the interaction between the control treatments of record the lowest days (102.00 day).

3.2. Plant Height

The results showed that the addition of phosphorus fertilizer had a significant impact on the height of plant , Higher values were observed on the 120 kg ha^{-1} (183.01 cm), , The control treatment recorded the lowest result (168.90 cm), The reason for this is due to the effective phosphorus's function in most vital processes inside the plant which , in turn increases plant growth and plant height . Humic acid spraying also had a significant impact on plant height, The plant's height increased as humic concentration increased, the concentration 12 gm L^{-1} gave the highest(180.34 cm), while the control treatment gave the minimu height (172.42 cm) with no significant differences with concentration 6 gm L^{-1} which recorded 173.19 cm. This increase may be related to humic acid's role in developing physiological hormones like IAA, which leads to increased cell division and cell enlargement, which improves plant development [19]. In terms of interactions, the maximum phosphorus level 120 kg P ha^{-1} with a concentration of 12 gm L^{-1} gave the maximum value (186.33 cm), while the the control treatments of phosphorus and humic gave the lowest high of the plant (161.16 cm).

3.3. Number of Main Branches

On Number of main branches ,both factors and their interaction had a significant effect . Table 2 shows that phosphorus levels 120 kg P ha-1 gave the maximum number (12.44, 11.97 branches plant $^{-1}$) and there were no significant differences between them, while control treatment gave the lowest of 10.36 branches plant-1. This may be due to the high plant height which increased branches per plant. Humic acid concentration at 12 g L^{-1} gave the maximum number of main branches (12.70 branches $plant^{-1}$)with no significant differences with concentration 18 gm L^{-1} (12.18 branches $plant^{-1}$), while minimum branches was recorded at control (9.66 branches plant-1). This could be related to humic acid's effect of increasing photosynthetic efficiency, this reflected on growth of plant develop of branches [20]. These results agreed with[21,22], As for the interaction the combination of 120 kg P ha-1 with 12 g L-1 of humic acid gave the maximum number of branches (14.10 branches plant-1), Whereas, the interaction of control treatments of phosphorus fertilization and spraying recorded the minimum number of branches (9.33 branches plant-1) .

3.4. Number of Total Leaves

As indicated in the table (2), Phosphorus fertilizer has a significant effect on the number of leaves. The maximum number of leaves recorded 588.71 leaf plant-1 for the level of 120 kg P h^{-1} with an increased percentage 16.30% compared to the control which record the minimum number (506.18 leaf $plant^{-1}$), this may be due to the an increase in number of main branches as a result, the number of leaves increased.. This is consistent with [23]. The same table revealed significant differences between the the humic acid concentration in the number of leaves ,spraying humic acid with 18 g L^{-1} recorded the highest leaves number (589.05 leaf plant $^{-1}$) and did not differ significantly with 12 gm L^{-1} (589.05 leaf plant -1), while the control gave the lowest (443.00 leaf plant $^{-1}$), This may be due to Humic acid's contribution in promoting the vegetative growth of the plant, as it works on the abundance of nutrients by increasing the rates of absorption, transport and stimulation. all the physiological processes [24,25]which led to Increased spread and size of the vital mass of the vegetative parts[26]. In addiion, the number of leaves of plant showed a significant interaction between the factors, the level of 120 kg P h^{-1} a concentration of 18 g L^{-1} gave the maximum number (676.11 leaf plant $^{-1}$), while control treatments record the lowest number (378.61 leaf plant $^{-1}$).

3.5. Stem Diameter(cm)

Stem diameter was significantly influenced by the phosphorus fertilizer, spraying with humic acid ,and their interaction (Table 2). The addition of 120 kg P h^{-1} of phosphorus raised stem diameter by 13.95 % above the control treatment. This is due to the role of phosphorus in the stimulation of a number of important metabolic reactions in plants, as a result, the quantity of vascular packages has increased and thus the stem diameter increased . From the data in Table 2 we note the significant effect of humic acid spray in increasing stem diameter , 6 g L-1 was superior, the plants which sprayed by this concentration has higher stem diameter (1.48 cm) with no difference with 12 g L^{-1} (1.39 cm), while the control recorded the lowest (1.27 cm).The phosphorus fertilizer and humic acid also interacted in

their effect on stem diameter , the largest stem diameter 1.54cm for the interaction between the level 120 kg P ha-1 spraying with 6 g L-1,while interaction between the two control treatments of phosphorus and spraying gave the lowest stem diameter(1.15 cm).

Table 2. The effect of Phosphorus fertilizer , humic acid concentration and interaction on growth of Safflower .

Treatments		Days to 50% flowering	Plant height (cm)	Main branches per plant	Leaves per plant	Stem diameter (cm)
Phosphorus fertilizer levels Kg h^{-1}	0	104.75	168.90	10.30	506.18	1.29
	60	106.50	176.29	11.97	518.66	1.36
	120	106.75	183.01	12.44	588.71	1.47
LSD ($P \leq 0.05$)		1.060	1.748	0.540	41.89	0.072
Humic acid ($g\ L^{-1}$)	0	172.42	172.42	9.66	443.00	1.27
	6	173.20	173.20	11.75	533.63	1.48
	12	180.34	180.34	12.70	584.21	1.39
	18	178.31	178.31	12.18	589.05	1.34
LSD ($P \leq 0.05$)		1.218	2.018	0.623	48.37	0.083
0	0	102.00	161.16	9.33	378.61	1.15
	6	105.00	161.77	10.22	487.44	1.57
	12	106.67	177.77	11.55	588.23	1.20
	18	105.33	174.89	10.10	570.42	1.22
60	0	106.33	173.44	10.10	430.22	1.33
	6	107.33	175.04	12.33	543.61	1.34
	12	109.00	176.91	12.44	580.18	1.43
	18	103.33	179.77	12.99	520.63	1.35
120	0	103.67	182.66	9.66	520.17	1.33
	6	106.00	182.78	12.70	569.84	1.54
	12	113.00	186.33	14.10	566.2.4	1.53
	18	104.33	180.28	13.44	676.11	1.46
(LSD ($P \leq 0.05$		2.110	3.496	1.079	83.78	0.144

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References

[1] Gecgel, U., Demirci, M., Esendal, E. 2007 . Fatty Acid Composition of the Oil from Developing Seeds of Different Varieties of Safflower (Carthamus tinctorius L.). J.Amer. Oil Chem. Soc., 84, 47-54.
[2] Belgin, C., Bilal, G., Mustafa, K. 2007 : Oil content and fatty acid composition of some safflower (Carthamus tinctorius L.) varieties sown in spring and winter. – Inter. J. Nat. and Eng. Sci. 1(3): 11-15
[3] Hussain, M. I., Lyra, D. A., Farooq, M., Nikoloudakis, N., and Khalid, N. 2016 . Salt and drought stresses in safflower: a review. Agronomy for sustainable development, 36(1), 1-31.
[4] Mündel H. H., Morrison R. J., Blackshaw R. E., Roth B. Safflower production on the Canadian prairies: 2004 . Agricultural Research Stations. – Let bridge, Canada, 2004, 43 p.

[5] Sreekanth, N.,Vikram S.; Dhananjay T., and Shruti G. 2021. Effect of nitrogen and phosphorus levels on growth and yield of safflower (Carthamus tinctorius L.) The Pharma Innovation Journal; 10(10): 2271-2273.
[6] Silva, E. M., Paludo, J. T. S., Sousa, J. V. R., de Freitas Sousa, H. H., & da Silva, T. J. A. 2015. Development of safflower subjected to nitrogen rates in cerrado soil. American Journal of Plant Sciences, 6(13), 2136.
[7] Abbadi, J., and Gerendas, J. 2011. Effects of phosphorus supply on growth, yield, and yield components safflower and sunflower. Journal of Plant Nutrition 34: 1769-1787.
[8] Abdel Nabi, H. A.and Obaid A. K. 2019. Effect of HumicAcid on Some growth Characteristics and Green Yield of Two Hybrids of Broad bean (Vicia faba L.). Basrah J. Agric. Sci., 32 (Spec. Issue 2):256-261.
[9] Alabdulla,S.M. 2019 . Effect of foliar application of humic acid on fodder and grain yield of oat (Avena sativa L.). Res. on Crops 20 (4) : 880-885.
[10] Hassan H. H., Huthily, K. H. and Mohsen, K. H. 2019.Effect of humic acid and silicon on some growth characteristics of maize (Zea mays L). Basrah J.Agric.Sci 32(2):23-32
[11] Noaema, A. H. ; Alabdulla S. A. and Alhasany. A. R. 2020 . Impact of foliar application of seaweed extract and nano humic acid on growth and yield of Wheat varieties. Int. J. Agricult. Stat. Sci. Vol. 16, Supplement 1, pp. 1169-1174
[12] Pizzeghello, D., Francioso, O., Ertani, A., Muscolo, A. and Nardi, S. 2013 . Isopentenyl adenosine and cytokinin-like activity of different humic substances. J. Geochem. Ex., 129, 70-75.
[13] Hivare, V. S., Deotale, R. D., Dhongade, A. P., Pise, S. E., & Blesseena, D. A. R. A. 2019. Morpho-Physiological Traits and Yield in Safflower as Influenced by Foliar Application of Humic Acid and NAA. J. Soils and Crops, 29(2), 348-353.
[14] Abbas, A.l J. ; Al-Naqib ,M. A. 2003. Study of some physiological traits and seed yield of cultivars of safflower. Iraqi Journal of Agricultural Sciences. 34(1): 83-88.
[15] Al-Dougji, K.A.J. 2007. Effect of planting dates and distances on growth and yield of safflower genotypes at different nitrogen levels. PhD thesis - College of Agriculture - University of Baghdad.
[16] Al-Rawi, K.M. & Khalaf Allah, A.M. 2000. Design and Analysis of gricultural Experiments. Min. High. Educ. Sci. Res. Univ. Baghdad: 360pp. (In Arabic).
[17] Amanullah and Khan, M. W. 2010 . Interactive Effects of Potassium and Phosphorus on Phenology and Grain Yield of Sunflower in Northwest Pakistan . Journal of Pakistan. Pedosphere . 20(5): 674-680.
[18] Serenella, N., D. Pizzeghelloa, A. Muscolob, and A. Vianello 2002 . Physiological Effects of Humic Substances on Higher Plants. Soil Biology and Biochemistry, 34,1527-1536.
[19] Canellas, L. P., Olivares, F. L., Aguiar, N. O., Jones, D. L., Nebbioso, A., Mazzei, P., & Piccolo, A.2015. Humic and fulvic acids as biostimulants in horticulture. Scientia horticulturae, 196, 15-27.
[20] Nardi, S., Pizzeghello, D., Schiavon, M., and Ertani, A. (2016). Plant biostimulants: physiological responses induced by protein hydrolyzed-based products and humic substances in plant metabolism. Scientia Agricola, 73, 18-23.
[21] Ekin, Z. 2020 . Co-application of humic acid and Bacillus strains enhances seed and oil yields by mediating nutrient acquisition of safflower (Carthamus tinctorius l.) plants in a semi-arid region. Appl Ecol Environ Res, 18, 1883-1900.
[22] Karimi, E., & Tadayyon, A. 2018 . Effect of humic acid spraying on yield and some morphological characteristic of safflower (Carthamus tinctorius L.) under drought stress conditions. Field Crops Res, 31(1), 19-38
[23] Al-Baaj, R. 2022 . Effect of regular planting distances and fertilizer combinations of NPK on growth and yield of safflower. PhD thesis - College of Agriculture - University of Al-Muthanna
[24] Ahmad, S., I.; Daur, S. G., Al-Solaimani, S; Mahmood. 2016. Plant growth promoting rhizobacteria and humic acid improve growth and yield of organically grown canola. Int. J. of Engineering Research and Techn, 5(5): 424-428.
[25] Puglisi, E., Pascazio, S., Suciu, N., Cattani, I., Fait, G., Spaccini, R., and Trevisan, M. 2013 . Rhizosphere microbial diversity as influenced by humic substance amendments and chemical composition of rhizodeposits. Journal of Geochemical Exploration, 129, 82-94.
[26] Sainjua, U. M. ; Allen, B. L. ; Lenssen, A. W., and Ghimire, R. P. 2017 . Root biomass, root/shoot ratio, and soil water content under perennial grasses with different nitrogen rates. Field Crops Research, 210, 183-191.