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THE RESPONSE OF *CUCURBITA PEPO* PLANT TO PHOSPHATE FERTILIZATION AND FOLIAR SPRAYING WITH POTASSIUM HUMATE

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Abstract

This study was conducted during 2019 season in Fadak farm, Najaf province, Iraq to determine the effect of phosphate fertilization and foliar spraying with potassium humate on the growth and yield indicators of *Cucurbita pepo* L. plant (c.v Fadwa). Randomized complete blocks design (RCBD) was used in a factorial experiment with two main factors and three replicates. The first factor was adding phosphorous in a three different levels (0, 100 and 200kg P_2O_2.h^{-1}) and the second factor was sprayings potassium humate in a three different concentrations (0, 5 and 10 ml.L^{-1}). Means were compared using least significant difference test (L.S.D.) at 0.05. Results showed that treatment of 200kg of phosphate fertilization was exceled other treatments in vegetative and quantitative traits and recorded 139.89cm of plant length, leaves number (23.23 leave.plant^{-1}), leave area (572.00 cm^2.leave^{-1}), dry weight of total vegetative (139.88 g.plant^{-1}), fruit length (24.22cm), the number of fruits in each plant (13.37 friut.plant^{-1}), yield of each plant (3.250 kg.plant^{-1}) and total yield (24.557 ton.h^{-1}) compare to control treatment. Sprayings potassium humate at 10ml.L^{-1} concentration showed significant effect on studied traits and gave 136.17cm plant length, leaves number 21.29 leave.plant^{-1}, leave area 512.20 cm^2.leave^{-1}, dry weight of total vegetative 133.55 g.plant^{-1}, fruit length 22.69cm, the number of fruits in each plant 11.80 friut.plant^{-1}, yield of each plant 3.175 kg.plant^{-1} and total yield 23.436 ton.h^{-1} in comparison with control. The interaction between 200kg of phosphate fertilization (P_2O_2) treatment and spraying10 ml.L^{-1} of potassium humate gave higher values of examined traits compare to non-fertilizer x spraying water only (interaction control).

Key words: *Cucurbita pepo*, phosphorous, vegetative traits, potassium humate.

Introduction

Field pumpkin (*Cucurbita pepo* L.) is a vegetable plant that belongs to Cucurbitaceae and it is cultivated widely in some mountainous areas with an altitude of more than 3000m in Central and North America, specifically northern Mexico, south and west of United States (Borass *et al.,* 2006). Its fruits are preferred in Iraq due to its role in human diet as it considers a rich source of nutrients, vitamins as well as its medicinal uses (Borass *et al.,* 2011). The total area that grown by field pumpkin globally reached 2078450 h with a total productivity of 27449481 ton, while in Iraq, the cultivated area reached 2104 h and 19864 ton yield (FAO, 2019). Perhaps, the most important reason for the increasing of yield of this crop in Iraq is the failure to use modern technologies and scientific methods in crop management which can impact positively on plant growth, development and increased production. The increase in population in the world requires provision of food, however, the limitation in agricultural areas make it difficult to achieve and for that it is necessary to increase production per unit area, so farmers resort to the use of phosphorus as a main element for plants to increase vegetative and yield (Mfilingel *et al.,* 2014).

Al-Sahaf, (1989) and Verma (2007) mentioned that phosphorous involves in many biological compounds and reactions, as it involves in phospholipids which play an important role in building cell protoplasm as well as in building nucleotides which are the main component of building nucleic acids and transmitting genetic traits via DNA and RNA and forming energy compounds such as ADP and ATP. Foliar feeding is an appropriate and necessary feeding system to meet the needs of plant through leaves because its transport through roots requires more time compared to spray on leaves and its positive reflection on the physiological processes that affect growth and yield (Haytova, 2013; Stojanova *et*

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al., 2016). Humic acid has an important role in plant nutrition, as it increases the readiness of nutrients and leads to increased plant growth in quantity and quality (El-Hefny, 2010). Potassium is one of macro elements which can activate more than 60 enzymes which contribute in many vital activities and has an important role in photosynthesis process as well as in transfer of water and nutrients to other parts of plant (Naseem *et al.,* 2019). The objectives of this study were to use different level of phosphate fertilization and examine its effect on vegetative and quantitative traits of field pumpkin plant, determine the best concentration of potassium humate and its impact on yield and growth and study the interaction between the two factors to give best productivity.

Materials and Methods

An experiment was carried out in a 40m × 9m greenhouse in Fadak farm, Rehamia, Najaf province in 2019 autumn season. Field pumpkin seed were obtained from Baghdad Agriculture Directorate. Ten samples of greenhouse soil were taken randomly from 0-30cm depth before planting then samples were mixed very well and left under sun light for 24 h after that grinded and sifted with a 2mm hole sieve. Samples of irrigation water and soil were analysed to measure chemical and physical characteristics of these samples table 1.

Greenhouse soil was prepared by tilling and levelling then the area was divided into three lines, each line was 35m length and the distance between them was 1.5m. Three seeds were sawn directly in soil in 27/9/2019 on both side of line and 0.5m left between each plant then after the emergence, plants were thinned to one plant and all agricultural services were applied as needed (Matlop *et al.,* 1989). Maximum and minimum temperatures were recorded from Metrological Organization and Seismology in Najaf as listed in table 2.

Treatments were distributed in a factorial experiment using RCBD design with three replicates and total of 27 experimental units and two factors, the first factor was adding phosphorous fertilization (P_2O_2) in a three different levels 0 (A_0), 100 (A_1) and 200 (A_2) kg $P_2O_2.h^{-1}$(Matlop *et al.,* 1989) and the second factor was sprayings potassium humate (Germany) which consisting of 20% organic material, 1.5% organic nitrogen, 5% potassium oxide and 15% humic and folic acids in a three different concentrations 0, 5 and 10 $ml.L^{-1}$ (Al-Hamady, 2018) on leaves in early morning using 16 L hand sprayer with adding washing liquid as a diffuser to increase efficiency to absorb potassium humate (Al-Sahaf, 1989), the number of sprayings was three (F_1, F_2, F_3), the first spray was applied at 2-3 leaves of plant age and the other sprayings after one week between each spray.

Table 2: The monthly evarage of maximum and minimum temperatures in Najaf for 2019 season.

Temperatures		Month
Minimum	Maximum	
24.2	40.3	September
18.6	33.4	18.6
11.8	24.2	November
6.5	17.9	December
5.2	16.0	January

The area of experimental unit was 3.75m^2 (2.5m length × 1.5m width) with 9 plants then data were analysed using Genstat. Means were compared using the least significant difference (L.S.D.) at 5% level of significance (P>0.05) (Al- Rawi and Khalf, 2000).

Vegetative traits

Vegetative traits were measured by taken 5 plants randomly from each experimental unit then the following traits were studied:

1- Plant length ($cm.plant^{-1}$) was measured using measuring tape from soil surface until the top of plant.

2- The number of total leaves ($leave.plant^{-1}$) was calculated in the main stem and branches.

3- Leave area ($cm^2.plant^{-1}$) three leaves were taken from each plant in the experimental unit then measured using a ruler (Sadik *et al.,* 2011; Al-Zaidy, 2016).

4- Dry weight of total vegetative ($gm.plant^{-1}$) estimated after drying in electric oven at 70^{0}C for 48h then samples were weighted in sensitive scale as follows:

$$\frac{Dry\ weight}{X} = \frac{100g\ of\ weight}{fresh\ weight\ of\ total\ vegetative}$$

$$X = \frac{Dry\ weight \times fresh\ weight\ of\ total\ vegetative}{weight\ of\ 100g}$$

Yield traits

1- Fruit length (cm) 10 fruits of each treatment were

Table 1: Chemical and physical characteristics of greenhouse soil and irrigation water samples.

pH of soil	Electric conductivityE.C.($dS.m^{-1}$)	Organic material (%)	sand	silt	clay	Soil Texture
			($g.kg^{-1}$)			
7.4	4.0	1.2	760	140	100	loamy sand

taken and measured by ruler then means were recorded.

2- The number of each plant (fruit.plant^{-1}) the number of total fruits of each experimental unit was divided on the number of plants then means were taken.

3- The yield of each plant (kg.plant^{-1}) was calculated from first pickup until the end of the season then means were taken as follows:

The yield of each plant (kg.plant^{-1}) =

$$\frac{Yield\ of\ \mathrm{exp}erimental\ unit\ (kg)}{Plant\ number\ of\ \mathrm{exp}erimental\ unit}$$

4- Total yield (ton.h^{-1}) was calculated during the season from 18/11/2019 to 16/1/2020.

Results and Discussion

Vegetative traits

Results of table 3 showed that there were significant differences between treatments of phosphorous fertilization on vegetative traits (plant height, the number of leaves, leave area and dry weight of total vegetative). 200kg.h treatment gave the highest value of plant length which recorded 139.89cm and leaves number (23.23 leave.plant^{-1}), leave area (572.00cm^2.leave^{-1}) and dry weight of total vegetative (139.88g.plant^{-1}) compare to control treatment which gave the lowest value of these traits and recorded 120.78cm, 12.78 leave.plant^{-1}, 415.40cm^2.leave^{-1} and 116.95g.plant^{-1} respectively. The reason for this increasing of plant growth is the role of phosphorus as a macro element which is required in plants to make increasing in metabolism and rapid cell division (Ndakidemi and Dokora, 2007). In addition, phosphorous play significant role in activation of cell division and make it bigger which led to increase plant height and leaves number then reflect positively on leave area and total vegetative. Moreover, phosphorous has vital role in raising the efficiency of photosynthesis process through the formation of ATP enzymes, transfer energy in plant (Humbel and Raschke, 1971) and increase the amount of nutrients inside plant. Results also showed significant effect when sprayings field pumpkin plant with potassium humate as the spraying by 10ml.L^{-1} concentration gave higher values of vegetative growth and recorded 136.17cm plant length , leaves number 21.29 leave.plant^{-1}, leave area 512.20cm^2.leave^{-1}, dry weight of total vegetative 133.55g.plant^{-1} in comparison with122.81cm, 15.74eave.plant^{-1}, 480.07cm^2.leave^{-1} and 122.36g.plant^{-1} respectively in control treatment (spraying with water only). The reason of this increasing may because that humic fertilizers are rich of nitrogen and phosphorous which enhance the production of auxins, synthesize nucleic acids DNA and RNA, proteins and protoplasm that contribute to increase cell division, plant length and chlorophyll which led to increasing vegetative growth (Al-Sahaf, 1989; Taiz and Zeiger, 2006). Potassium enhances

Table 3. The effect of phosphate fertilization and foliar spraying with potassium humate and their interaction on vegetative traits of *Cucurbita pepo* plant.

Treatments			Plant length (cm)	Total number of leaves (leave.plant^{-1})	Leave area (cm^2.leave^{-1})	Dry weight of total vegetative (g.plant^{-1})
Phosphate fertilization kg.h^{-1}	Without adding fertilizer		120.78	12.78	415.40	116.95
	100		125.78	19.23	498.20	124.80
	200		139.89	23.23	572.00	139.88
L.S.D. 0.05			4.208	1.890	43.60	2.934
Spraying of potassium humate concentrations ml.L^{-1}		0	122.81	15.74	480.07	122.36
		5	127.47	18.20	493.34	125.73
		10	136.17	21.29	512.20	133.55
L.S.D. 0.05			4.208	1.890	n.s.	2.934
Phosphate fertilization X Spraying of potassium humate concentrations	Without adding fertilizer	0	117.54	10.00	400.5	112.54
		5	121.33	11.51	412.4	118.35
		10	123.46	16.83	433.3	119.94
	100	0	120.50	18.00	483.3	122.57
		5	126.79	19.00	498.0	124.10
		10	130.05	20.67	513.4	127.73
	200	0	130.39	19.22	556.4	131.95
		5	134.27	24.09	569.6	134.72
		10	155.00	26.36	589.9	152.97
L.S.D. 0.05			7.289	3.274	75.52	5.083

many enzymes that contribute in the processes of respiration and photosynthesis (Ordog and Molnar, 2011) in addition to its vital role in building protoplasm and many biological processes inside plant such as cell division and increase its size. The increasing in dry weight of total vegetative occurred as a result of positive affect of potassium humate in improving plant height, the number of leaves and leave area and this is consistent with the finding of Al-Noamy (2013), Omidire *et al.,* (2015) and Al-Hamady, (2018) on cucumber. The effect of foliar spraying of potassium during different stages of plant growth reflected significantly on total vegetative and this is consistent with the finding of Abdalkareem (1994) on tomato. In the other hand, foliar nutrition by potassium has an important role to increase vegetative growth and the decreasing of potassium content in leaves led to decrease plant size which confirmed previously by Pankov (1974) on tomato plants. The interaction between treatments of 200kg.h^{-1} phosphate fertilization and the sprayings of 10ml.L^{-1} concentration of potassium humate had significant effect on vegetative growth when it gave the highest values of plant length 155.00m, number of leaves 26.36 leave.plant^{-1} , leave area 589.90cm2.leave-1 and total dry weight of vegetative 152.97 g.plant-1 compare to control treatment.

Yield traits and its contents

Table 4 showed that there was significant effect of phosphate fertilization treatments on fruit length, fruits number, yield for each plant and total yield when 200kg.h^{-1} of P_2O_2 treatment exceled other treatments and gave 24.22cm, 13,37fruit.plant^{-1}, 3.250kg.plant^{-1} and 24.557 ton.h^{-1} respectively compare to 15.44cm, 8.00fruit.plant^{-1}, 2.828kg.plant^{-1} and 13.168 ton.h^{-1} in control. There was also significant increasing in yield traits which may occurred due to the contribution of phosphorous in raising the efficiency of photosynthesis process through the formation and activation of ATP enzymes, transfer energy in plant (Naseem *et al.,* 2019). It can be noticed in Table 4 that spraying leaves of field pumpkin with potassium humate had significant effect on yield traits when spraying 10ml.L^{-1} concentration which gave highest values of studied traits and recorded 22.69cm, 11.80fruit.plant^{-1}, 3.175 kg.plant^{-1} and 23.436 ton.h^{-1} respectively in comparison with 14.54cm, 8.91fruit.plant^{-1}, 2.782 kg.plant^{-1} and 13.751 ton.h^{-1}. This improvement in yield traits may occur due to the readiness of necessary nutrients such as nitrogen and phosphorous from the organic material in potassium humate and its role in increasing protoplasm mass and cell division, in addition to the role of potassium in transferring nutrients from leaves and store it in fruits (Iqbal *et al.,* 2011; Glala *et al.,* 2013). The organic fertilizer is supplied plant by nutrients in all growth stages which enhances total vegetative and the efficiency of photosynthesis process and therefore increase yield in addition to improve chemical and physical characteristics of soil (Al-Sahaf and Aaty, 2007; Kandil and Gad, 2009;

Table 4. The effect of phosphate fertilization and foliar spraying with potassium humate and their interaction on yield traits and its contents of *Cucurbita pepo* plant.

Treatments			Fruit length (cm)	The Total number of fruits in each (fruit.plant^{-1})	Yield of each plant (kg.plant^{-1})	Total Yield (ton.h^{-1})
Phosphate fertilization kg.h^{-1}	Without adding fertilizer		15.44	8.00	2.828	13.168
	100		16.67	9.33	2.896	18.308
	200		24.22	13.37	3.250	24.557
L.S.D. 0.05			1.957	1.154	0.3004	3.910
Spraying of potassium humate concentrations ml.L^{-1}		0	14.54	8.91	2.782	13.751
		5	19.10	9.98	3.019	18.846
		10	22.69	11.80	3.175	23.436
L.S.D. 0.05			1.957	1.154	0.3004	3.910
Phosphate fertilization X Spraying of potassium humate concentrations	Without adding fertilizer	0	13.30	7.33	2.639	8.316
		5	15.67	7.67	2.860	12.978
		10	17.36	9.00	2.986	18.211
	100	0	14.00	8.41	2.755	13.405
		5	16.00	9.00	2.925	18.852
		10	20.00	10.59	3.012	22.667
	200	0	16.33	11.00	2.952	19.534
		5	25.64	13.28	3.271	24.709
		10	30.70	15.82	3.528	29.430
L.S.D. 0.05			3.389	1.999	0.5203	6.773

Al-Amery and Matlop, 2012; Thuy *et al.,* 2017). The interaction between treatments of 200kg.h^{-1} phosphate fertilization and the sprayings of 10ml.L^{-1} concentration of potassium humate had significant effect on yield traits and gave the highest values 30.70cm, 15,82fruit.plant^{-1}, 3.528kg.plant^{-1} and 29.430 ton.h^{-1} respectively compare to control treatment (without adding fertilizer X spraying water only).

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