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Influence of Spraying Humic Acid and Number of Cutting on Forage Yield of Oat (*Avena sativa* L.)

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Abstract: The field experiment was carried out during the seasons 2017-2018 and 2018-2019, University of Basra to study the effect of spraying with four concentrations of humic acid (0, 3, 6, 9 g l^{-1}) and the number of cuts (1,2 and 3 cuts) on some growth characteristics, green and dry forage yield of Alguda oat variety. Experiment was applied in according to split plot design using randomized complete block design (with three replications. The spray concentrations were placed in the main plots, while the secondary plots included the number of cuts. The spraying with a concentration of 6 g l^{-1} achieved the highest dry forage yield of 5.877 and 4.370 ton ha^{-1} for the two seasons respectively and was, at a par with a concentration of 9 g l^{-1}. The 3rd cuts were superior in most of the characteristics, and resulted in the highest yield of green and dry forage of 19.941 and 4,860 ton ha^{-1} respectively for the first season, and 20.275 and 4.981 ton ha^{-1} respectively for the second season. The highest protein yield was 0.520 and 0. 545ton ha^{-1} for the two seasons respectively, while the number of cuts had no significant effect on the protein content of oat forage.

***Keywords*:** Cutting, Humic acid, Oat, Forage

Oat (*Avena sativa* L.) is a major winter crop, high yielding for fodder of to Poaceae family and, in the world oat it ranks the first within the fodder production, and the sixth in the global context of wheat, maize, rice, barley, and sorghum as a food crop (Siloriya et al 2014). It has been adapted to a wide range of soils and climatic condition due to its luxurious growth. Oat is an important winter season fodder. However, the low productivity of fodder, the shortage of feed resources for animals, increase in prices and the increase in demand are most important issue associated with this crop. Livestock in Iraq, on which the national economy is based, suffers from shortage of fodder crops. This shortage occurs especially during the winter season as a result of the slow growth of alfalfa and berseem due to the low temperatures it is necessary to search for fodder crops with high productivity and tolerance to low temperatures, including the oat crop. The oat crop is characterized by its ability to grow and branch after cutting while maintaining its good quality, which provides a number of cuts during the growing season. Mahale et al (2004) observed that the twice cutting of oat caused an increase in the yield of green and dry fodder. Singh and Dubey (2007) obtained the highest green fodder yield with two cuts oats after 55 and 75 days compared to one after 75 days of planting. In order to improve the productivity of the fodder crop for oat, it is necessary to use the recommended techniques, including fertilization, foliar spraying of organic fertilizers and the trace elements to meet the plant's need during the growing season. Humic acid is one of the types of organic fertilizers that play a major role in plant nutrition and soil fertility, and it contains many nutrients that increase plant growth and yield. Earlier r researchers observed the positive effect of humic acid on the growth and yield of crops (Alabdulla 2019, Hassan et al 2019), as it affects plant growth by stimulating enzymatic reactions, increasing the permeability of cell membranes and increasing cell division and elongation (Kaya et al 2005), and enhance the natural resistance against diseases and insects (Scheuerell and Mahaffee 2006). The aim of the study was to determine the growth and productivity of multicut forage oat with humic acid.

MATERIAL AND METHODS

A field experiment was carried out during winter seasons 2018-91 and 2019-20 at Basrah Agricultural University, Basrah, Iraq., (30° 57′ N lat., 47° 80′ long.) to study the effect of spraying with four concentrations of humic acid (0, 3, 6, and 9 g l^{-1}) and the number of cutting times (once, twice and three cuts) on some growth traits, yield and quality of forage of oat Alguda variety in silty loam soil. The physical and chemical properties were estimated according to Page et al (1982) and Black (1965) (Table 1). The experiment was laid out in a random complete block design which was arranged in split plot design with three replications, plot size of 2x3 m. The main plots included the concentrations of humic acid, while the sub-plots included the number of cuts. Oat seeds were sown on 15th and 12th November for the 2018 and 2019

seasons respectively with seed rate of 120 kg ha^{-1} (Ahmad et al 2011). Then the plots were fertilized with urea (46%) at 120 kg ha^{-1} in two equal doses, the first at 30 days after sowing and the second in the elongation stage. The phosphate fertilizer was added at sowing at 100 kg ha^{-1} in the form of DAP fertilizer (46%. P_2O_5). Humic acid was sprayed in two equal doses the first after two weeks of planting while the second after each cut to promote the growth of plant after cutting in e early morning. After 60 days of planting, the first cut was carried out and he second was done 30 days after the first cutting and the third as 30 days after the second cutting. The growth parameters for observations were plant height, the number of tillers, green and dry forage. The crude protein was measured by multiplying the nitrogen content (%) by 6.25 determined using the micro-kjeldal method (Salovaara et al 2004). GenStat Program was used for statistical analyses.

RESULTS AND DISCUSSION

Effect of humic acid: The spraying with different concentrations of humic acid significantly affected all the growth parameters during both seasons. Plant height is one of the components of yield that contributes to the yield of green fodder and dry matter. The spray with 6 g l^{-1} gave the maximum plant height of 82.56 and 80.60 cm for two seasons respectively. The spray with a concentration of 9 g l^{-1} produced the highest number of tillers by giving 789.39 and 781.71 tiller m^{-2} for the two seasons respectively. At a concentration of 9 g l^{-1} , the spray recorded the highest green forage yield of 22,160 ton ha^{-1} in the first season, while spraying at a concentration of 6 g l^{-1} in the second season produced 21,891 tons ha^{-1} and in the second season at a par with of 9 g l^{-1} (21.412 ton ha^{-1}) .The spraying with of 6 g l^{-1} achieved the highest dry forage yield of 5,877 and 4,370 ton h^{-1} for the two seasons respectively and did not differ significantly from the concentration of 9 g l^{-1}, which gave a dry forage yield of 5,613 and 4,368 ton ha^{-1}. The increasing the spray concentration to 9 g l^{-1} led to an increase in the percentage and protein yield of the oat forage by 13.92% and 0.781 ton h^{-1} for the first season and 13.93% and 0.609 ton h^{-1} for the second season, which did not differ significantly from the concentration of 9 g l^{-} (12.03% and 0.526 ton ha^{-1}). Humic acid has a hormonal effect that affects the protoplasm of cells and the cell wall, which leads to rapid cell division and thus increased growth. It also has a role similar to the role of auxins in cell division, which encourages plant growth. The humic acid enters the plant as a supplement to polyphenols, which acts as a respiratory chemical mediator that increases the plant's biological activity, as the enzyme system becomes more effective and thus cell division increases (Kadam and Wadje 2011). Alabdulla (2019) revealed that foliar application with humic acid increased growth and forage yield of oat may be due to the containing of organic humic acid of nitrogen and phosphorous elements, which are included in the synthesis of DNA and RNA, proteins, and co- enzymes, this influences the process of absorption of nutrients and increases the division of cells and the formation and activation of essential plant activities .Similar results were obtained by Al-Taey and Majid (2018), Majid and Salim (2018), Hassan et al (2019) and Al-Taey et al (2019) . These chemicals have been commonly used by farmers instead of other substances due to the beneficial impact of humic substances on the growth of plants.

There was a significant effect for cutting frequency in most of the characteristics of the study and three cuts was significantly superior in most of the characteristics, except for the plant height, as the treatment of one cut gave the highest height of 98.21 and 86.13 cm for the two seasons consecutively (Table 2, 3). The treatment of three cuts recorded the highest number of tillers, which was 651.07 and 643. 54 tiller m^{-2}. The highest number of tillers at the third cut was due to the increased the activity of the lateral shoots of the plant after repeated cutting. The increase in the number of tillers associated with the decrease of plants heights this due to the increasing the competition between plants for growth requirements (water and nutrients), which negatively affected the efficiency of photosynthesis, this reduced the ability of stem cells to divide and elongate and thus decreased the plant's ability to elongate and increase plant height**.** The forage yield in the three cuts recorded the highest green and dry forage yield of 19.941 and 4.860-ton ha^{-1} respectively for the first season and 20.275 and 4.981 ton ha^{-1} for the second season, respectively. The highest yield of green forage was due to the role of humic acid in increasing

Table 1. Soil physic-chemical properties during both the seasons

Properties	pH	E. C. (dc m^{-1})	Organic matter (g kg^{-1})	Available (mg kg^{-1})		
				N	P	K
2017-18	7.7	4.31	2.11	33.5	16.48	120.43
2018-19	7.8	4.70	2.56	30.11	14.63	118.19

Table 2. Effect humic acid and numbers of cuts on growth, forage yield and protein of oat during winter season (2017-18)

Treatments		Plant height (cm)	Number of tillers (m^{-2})	Green forage yield (ton ha^{-1})	Dry forage yield (ton ha^{-1})	Protein in grains (%)	Protein yield (ton ha^{-1})
Humic acid (g l^{-1})							
0		66.76	417.00	14.770	3.339	6.56	0.220
3		80.30	489.88	17.976	4.496	8.51	0.383
6		82.56	668.41	21.350	5.877	12.13	0.713
9		76.28	789.39	22.160	5.613	13.92	0.781
LSD (P ≤ 0.05)		1.46	4.103	0.722	0.422	2.34	0.170
Cutting treatments							
Single cut		89.21	520.59	18.146	3.803	9.09	0.346
Two cuts		72.41	601.85	19.110	4.630	10.19	0.472
Three cuts		67.82	651.07	19.941	4.860	10.69	0.520
LSD (P ≤ 0.05)		1.90	9.10	0.143	0.064	N.S	0.199
Single cut	0	76.27	409.85	14.737	3.276	6.25	0,205
	3	95.08	423.88	17.994	4.552	7.71	0,348
	6	95.26	551.94	20.032	5.804	11.69	0,678
	9	90.20	696.67	19.821	5.607	13.21	0,736
Two cuts	0	65.67	428.62	14.761	3.359	6.64	0,223
	3	78.22	507.50	17.887	4.479	9.04	0,401
	6	75.89	653.90	20.009	5.877	12.14	0,714
	9	69.84	816.36	19.784	5.631	13.98	0,790
Three cuts	0	58.35	411.51	14.814	3.382	6.88	0,233
	3	67.61	538.25	18.047	4.528	8.79	0,398
	6	76.52	799.40	20.018	5.949	12.54	0,746
	9	68.80	855.14	19.888	5.581	14.56	0,812
LSD (P ≤ 0.05)		3.79	1.95	0.291	0.128	1.955	0,200

Table 3. Effect humic acid and numbers of cuts on growth, forage yield and protein of oat during winter season (2018-2019)

Treatments		Plant height (cm)	Number of tillers m^{-2}	Green forage yield (ton ha^{-1})	Dry forage yield (ton ha^{-1})	%Protein in grains	Protein yield (ton ha^{-1})
Humic acid (g l^{-1})							
0		63.79	458.34	15.591	3.271	6.44	0.211
3		76.88	528.42	18.668	3.840	8.34	0.320
6		80.60	617.11	21.891	4.370	12.03	0.526
9		73.52	781.71	21.743	4.368	13.93	0.609
LSD (P≤ 0.05)		1.07	3.734	1.450	0.388	2.57	0.120
Cutting treatments							
Single cut		86.13	553.94	18.700	3.946	9.63	0.380
Two cuts		70.07	591.70	19.296	4.572	10.30	0.471
Three cuts		64.88	643.54	20.275	4.981	10.94	0.545
LSD (P≤ 0.05)		1.42	9.30	0.153	0.078	N.S	0.193
Single cut	0	73.83	441.62	14.932	3.264	6.14	0.200
	3	91.70	477.25	18.074	3.870	7.61	0.295
	6	91.67	569.50	20.990	4.392	11.54	0.507
	9	87.33	727.41	20.811	4.256	13.21	0.563
Two cuts	0	62.91	446.14	15.973	3.300	6.44	0.213
	3	74.20	513.54	18.670	3.781	8.81	0.333
	6	75.12	621.57	21.79	4.373	11.98	0.524
	9	68.04	785.55	20.761	4.401	13.96	0.614
Three cuts	0	54.63	487.25	15.861	3.254	6.75	0.220
	3	64.72	595.46	19.653	3.872	8.61	0.333
	6	75.00	660.27	22.891	4.350	12.56	0.546
	9	65.18	832.17	22.656	4.450	14.61	0.650
LSD (P≤0.05)		2.84	1.86	0.551	0.160	1.896	0.220

the number of tillers at each cut which positively affected the yield of dry forage. The highest protein yield was 0.520 and 0.545 ton ha^{-1} for the two seasons respectively, while the number of cuts had no significant effect on the protein content of oat forage. The interaction between the concentrations of humic and the number of cuts was observed and spraying with a concentration of 9 g l^{-1} was superior to the number of tillers (855.14 and 832.17 tiller m^{-2}) and the protein content (14.56 and 14.61 %) and protein yield (0.812 and 0.650 ton ha^{-1}) for both seasons, and this interaction gave the highest dry forage yield for the second season only, reaching 4.450 ton ha^{-1}. The humic concentration of 6 g l^{-1} achieved the highest yield of green forage yield at the third cut for both seasons (20.018 and 22.890 ton ha^{-1}) and the highest dry forage yield for the first season only (5.949 ton ha^{-1}).

CONCLUSIONS

The foliar application of humic has a significant effect on growth and forage yield of Oat. The spraying at 6 g L-1 achieved the highest dry feed yield for the two seasons respectively and did not differ significantly. The 3rd cuts was superior in most of the characteristics, and it recorded the highest yield of green and dry forage and the highest protein yield was for the two seasons respectively, while the number of cuts had no significant effect on the protein content of oat forage.

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