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Effect of sowing date and planting distance on growth and yield of Oat

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ABSTRACT

The experiment was carried out during at winter agricultural season 2019-2020 in Babylon Governorate/ Abi-Gharq district For the purpose of knowing the effect of sowing date and planting distance on growth and yield of oats*Avena sativa* L.The sowing date is 1st and 15th of November and 1st and 15th of December and planting distance are 20, 25 and 30 cm. The treats are distributed in a factorial experiment according to RCBD with three replicates. The results show that sowing at November 15 produced higher tillers number, content of chlorophyll dyes in flag leaf, panicle number, number of grains in panicle, weight of 1000 grains, biological and grain yield, with averages of 645.5 tillers.m^{-2}, 53.26 SPAD, 551.8 dalia.m^{2} and 54.16 grain.dalia^{-1}, 41.40 g, 29.25 ton.ha^{-1} and 12.59 ton.ha^{-1} respectively. The planting distance 20 cm produces higher tillers number, panicle number, biological and grain yields with averages of 620.8 tiller.m^{-2}, 587.8 panicle.m^{-2}, 27.13 ton.ha^{-1} and 10.21 ton.ha^{-1} respectively. The interaction treat November 15 with 20 cm distance is significantly higher on average in tillers number, biological and grain yield with averages of 778.7 tiller.m^{-2}, 33.85 ton.ha^{-1} and 15.38 ton.ha^{-1} respectively.

***Key words**: Growth, Oats, Sowing dates, Planting distance.*

Introduction

Oats are grown in many countries of the world as a cereal food, medicinal and fodder crop. The grain content of fiber, nutrients, vitamins, protein, etc. contributes to prevention and diet of people with chronic diseases, especially patients with high blood sugar, high cholesterol, cardiovascular disease, and obese patients (Anomymous, 2002). The choosing of sowing date is one of the most important administrative decisions in cereal production (Hossain *et al.*, 2003), as the late date leads to undesirable consequences for the quality and quantity of the grains produced (Al-Issa, 2001), several studies have proven that oats are very sensitive to high temperatures and the stages of its growth are affected by the delay in planting, especially the phase of filling the grain, which negatively affects its yield of grains (Shaker *et al.*, 2016), the losses in oats productivity caused by the delay in sowing are estimated at 35% (Kibite *et al.*, 2002). Also, determining the appropriate planting distance between the lines has a positive effect in reducing the competitions among the plants and their effect on the crop and its components. It is observed that some varieties of oats recorded high grain crops when the distance between lines is reduced and cultivated with high plant density (Marshall, 1987). Several studies indicated that spaces of planting affects grain chemical compound contents (Majid and Salim, 2018). Given that the climate of most regions of the world is affected by global warming, desertification, environmental pollu-

tion etc., the aim of the research is to determine the appropriate date and distance for cultivation to produce fodder and grains.

Materials and Methods

The experiment is performed during the winter agricultural season 2019-2020 in Babylon Governorate/Abi-Gharq sub-district in a soil and irrigation characteristics that are shown in Table 1.

After preparing the field, it was divided into plots, area of each plot is 6 m^2, phosphate fertilizer was added at form triple superphosphate (45% P_2O_5) mixed with the soil according to recommendation of 80 $kg.ha^{-1}$ (Jose *et al.,* 2016), added nitrogen fertilizer by using Urea (46% N) in three equal batches, first after emergence immediately, second at the start of branching phase, and third at 50% flowering phase at a level of 120 $kg.ha^{-1}$ (Neel Ratan *et al*., 2016). The seeds were sown according to the dates specified (N^{1st}, N^{15th}, D^{1st} and D^{15th}) by planting distances 20, 25 and 30 cm and the number of lines in the panels was 12, 10 and 8 lines respectively, with a length of 2 m per line. Harvesting took place after the plants reached the stage of full maturity according to the date of planting. The combinations are distributed among the workers in the factorial experiments according to the Randomized Complete Block Design (RCBD) with three replicates, each of which is divided into 12 experimental units. The distance between a replicate and another is m^2. To make the drives and corridors, separations are left between the experimental units within limits of 0.5 m to ensure that there is no overlap between the experiment parameters.

After collecting the data, the ready-made statistical program Gen Stat V. 20 is used according to the method used by (Al-Asady, 2019) to analyze the variance according to the ANOVA table at a probability level of 0.05, and the averages are compared according to Least Significant Difference Test (LSD) at a probability level of 0.05 (Al-Raoie and Khalaf Allah, 2000). The vegetative growth characteristics were measured when the plants bloomed at 100% at each date, and yield components properties were estimated at physiologically phase. Also, the temperature, duration of solar radiation and wind speed were recorded and monitored and recorded during the experiment as shown in chart 1.

Results and Discussion

First: Indicators of vegetative growth

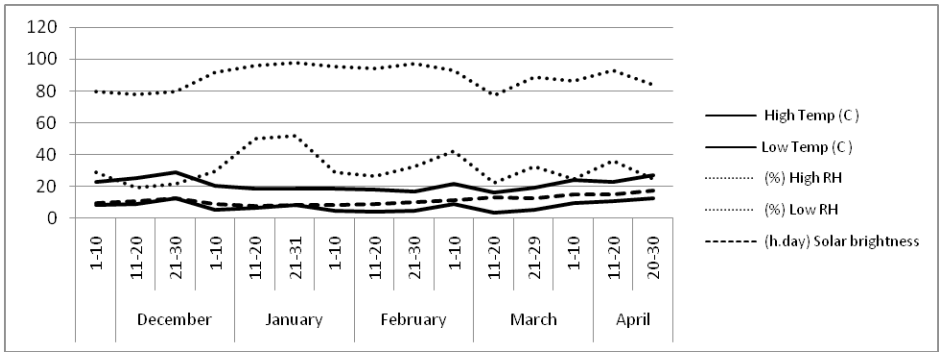
Table 2 shows the presence of a significant effect of the sowing date on plant height, leaves number, area of flag leaf, tillers number and content of chlorophyll dyes in flag leaf. November 1 has higher plants heights at 95.29 in comparison to December 15 whose plant heights are 80.98 on average. Likewise, the date November 1 outperforms the December 15 in the total number of leaves of the plant. Their averages are 4.86 leaf-1 and 3.73 leaf-1 respectively. In terms of flag sheet, November 1 has a bigger the flag sheet area by an average of 35.86 than the December 15 whose averages is 23.02 cm^2. Moreover, November 15 plants has a higher the number of tillers with an average of 645.5 tiller/m^{-2} when compared to the December 15 whose average is the lowest at 383.4 tiller/m^{-2}. In the November 15 plants, the chlorophyll dyes in the science paper is 53.26 (SPAD) on average compared to that of December 15 with the lowest averages of 34.83 (SPAD). The increases in the features of the plants of November 1 may be due to the positive effect of the early planting date, which provided the plants with suitable weather conditions in terms of temperatures, relative humidity and the duration of solar radiation, as in Graph 1. This suitability enhances of the construction of auxins that affected the elongation of cells (Hassan *et al*., 2009). Also, the number of leaves increase in November 1 because of the plant height increasing the number of nodes as seen in Table 2. The area of flag paper increases in November 1 and November 15 possibly because these plants have a longer period with suitable growth

Table 1. Some physical and chemical characteristics of soil and water

	pH	EC (ds/m)	Elements (mg/kg^{-1}) N	P	K	OM %	Soil Components Clay	Silt	sand	Soil Texture Sandy clay loam
Soil	7.6	1.8	34.16	9.76	369	1.4	23	14	63	
Water	7.7	0.71	15.4	6.2	8.1	-	-	-	-	-

conditions, as noted in Graph 1, which results in an increase in the area of the flag paper (Warrington *et al.*, 1977).

The plant outperformance in November 15 in the number of tillers may be attributed to the superiority in the chlorophyll dyes in flag leaf in Table 2. These dyes increase in the outputs of photosynthesis process and accumulation of dry matter, which produces more shells per plant (Mostafa *et al*., 2010). Chlorophyll dyes rises in November 15 and December 1 because in these two dates plants form good root groups that have high efficiency in absorbing the nutrients, especially nitrogen, which is a part of Porphyrins, which are most important compounds in building molecules of chlorophyll dyes (Ashraf and Bhatti, 1998). The same Table also shows that planting distances have a significant effect and is significantly higher than the 30 cm distance in terms of leaves number with an average of 4.61 leave.plant^{-1} when compared to 20 cm distance whose lowest average is 3.83 leave.plant^{-1}. Also, 25 cm planting distance has a significantly bigger area of flag leaf by an average of 34.86 cm^2 compared to planting distance of 20 cm whose average is the



Graph 1. Weather conditions for the experiment field at agricultural season 2019-2020

Table 2. Indicators of vegetative growth of oats

Treatments		Plant height cm	Leaf number leaf.plant^{-1}	Flag leaf area cm^2	Tiller number m^{-2}	Chlorophyll SPAD
Sowing Dates	N^{1st}	95.29	4.86	35.86	487.0	39.33
	N^{15th}	91.78	4.40	35.36	645.5	53.26
	D^{1st}	82.83	3.91	28.47	552.4	52.76
	D^{15th}	80.98	3.73	23.02	383.4	34.83
L.S.D (0.05)	3.87	0.41	5.42	40.78	2.78	
Planting Distance	20	86.48	3.83	28.03	620.8	42.71
	25	87.38	4.23	34.86	510.3	44.67
	30	89.30	4.61	29.14	420.2	47.76
L.S.D (0.05)	n.s	0.35	4.69	35.32	2.41	
N^{1st}	20	90.10	4.58	30.84	606.0	35.98
	25	98.78	4.38	42.59	471.3	40.27
	30	97.00	5.63	34.15	383.7	41.73
N^{15th}	20	93.70	4.11	38.59	778.7	51.29
	25	90.62	4.25	34.53	628.2	51.63
	30	91.02	4.85	32.97	529.7	56.86
D^{1st}	20	80.97	3.48	22.87	673.3	49.08
	25	83.66	4.13	33.77	546.0	53.29
	30	83.85	4.11	28.78	438.0	55.91
D^{15th}	20	81.17	3.16	19.83	425.2	34.47
	25	76.43	4.16	28.57	395.7	33.47
	30	85.33	3.86	20.67	329.5	36.55
L.S.D (0.05)	6.70	n.s	n.s	70.64	n.s	

lowest at 28.03 cm^2. The latter does not differ significantly from the distance of 30 cm, with an average of 29.14 cm^2. However, the distance of 20 cm significantly exceeds the planting distance of 30 cm in number of tillers, with an average of 620.8 tiller.m^{-2} compared with the planting distance of 30 cm the lowest average of 420.2. In contrast, the 30 cm includes significantly higher chlorophyll dyes in flag leafwith an average of 47.76 SPAD, while the planting distance of 20 cm is 42.71 SPAD on average which is the lowest. This means there is not significant difference from the planting distance of 25 cm, with an average of 44.67 SPAD. The reason for the distance exceeding 30 cm inleaves number may be due to the lack of competition between plants for food, water and light, which led to an increase in rates of photosynthesis and thus an increase in leaves number by increasing the distance between plants (Majid and Salim, 2018). The reason for the greater area of the flag leaf in 25 cm in the may be due to the availability of appropriate space between the lines of cultivation giving a greater opportunity to receive the largest amount of light, water and nutrients. In 20 cm space, the number of tillers could decrease causing an increase in plant density within the unit area and creating more shading percentage and particularly reducing ratio of red to infrared radiation in light. This helps to produce more auxins and gibberellins stimulating filament production and increase the plant competition for light and other growing requirements. However, the wide distances reduce competition and shading and thus light deconstructs growth hormones in plants and this in turn recues tillers in plants (Alrijabo *et al*, 2014).

The increase and regularity of light to plant at the wider distance between the lines could help the plants obtain a greater amount of water and nutrients such as nitrogen which is part of Porphyrins and porphyrins is one of the main components in the metabolism of chlorophyll pigment molecules. This helps to produce more chlorophyll dyes. The table above shows a significant effect of the interlink between distance and time on the plant height and the number of tillers, as interaction treat November 1 with 25 cm distance is significantly higher in terms of plant height with an average of 98.78 cm compared with treat December with 25 cm is lower with an average of 76.43 cm. Also November 15 with 20 cm is higher with an average of 778.7 tiller.m^{-2} than the treat December 15 with 30 cm whose average is 329.5 tiller.m^{-2} Second: Yield and its components

Table 3 shows the presence of a significant effect of the planting date at November 15 is higher in panicle number, grain number, weight of 1000 grains, biological and grain yield with the highest average of 551.8 dalia.m^{-2}, 54.16 grain.$dalia^{-1}$, 41.40 g, 29.25 and 12.59 ton.ha^{-1}, while December 15 produces the lowest average of 419.3 dalia.m^{-2}, 36.83 grain.$dalia^{-1}$, 30.24 g, 16.54 and 5.05 ton.ha^{-1}respectively. In November 15 panicles number increases may be due to its increase in tillers number. Table (2) shows the reason for superiority of November 15 in terms of grains number in panicle is due to the suitability of weather conditions, as explained in graph (1), during the pollination and fertilization processes. This suitability enhances success of the number of fertilized florets in panicle and this in turn is reflected positively in number of pills in panicle (Batten and Khan, 1987). In addition, at November 15, the weight of 1000 grains is higher than the other dates due to the increase in area of the flag leaf (Table 2). This area increase contributes to supplication of the pills by 45% of Carbohydrates needed to fill grain by virtue of its location directly below the deltoid, thus increasing efficiency of light interception. Therefore, photosynthetic products represented by glucose sugar is converted to a greater extent and this conversion is transformed by polymerization process into starch and then stored temporarily in plastids and finally moves to the grain (Baloch *et al.,* 2010). The biological yield increase of November 15 may be caused by increase in tillernumber Table 2, which is the main part of straw components, in addition to increase of grain yield as explained in Table 3. The November 15 increase in grain production may due to increase in dalia number, grains number and weight of 1000 grains as in Table 3. These elements are the components of grain yield.

The same Table also shows that planting distance has a significant effect, and distance of 20 cm is significantly higher inpaniclenumber, biological and grain yieldswith the highest average of 587.8 panicle.m^{-2}, 27.13 and 10.21 ton.ha^{-1}respectively, comparison with the distance of 30 cm, which has the lowest average of 395.5 panicle.m^{-2}, 20.89 and 7.72 ton.ha^{-1}respectively.and distance of 30 cm is significantly higher in number grain $pancle^{-1}$with the highest average of 50.01 grain. $Panicle^{-1}$, comparison with the distance of 20 cm,which has the lowest average of 43.68 grain. $Panicle^{-1}$. The number

Table 3. Yield indicators and its components of oats

Treatments		Panicle number Panicle.m^{-2} Panicle^{-1}	Grain number Grain.	Wight 1000 Grains (g)	Biological yields (ton/ha^{-1})	Grain yields (ton/ha^{-1})
Sowing Dates	N^{1st}	479.0	43.21	35.24	26.44	7.59
	N^{15th}	551.8	54.16	41.40	29.25	12.59
	D^{1st}	542.9	50.75	39.04	23.32	10.67
	D^{15th}	419.3	36.83	30.24	16.54	5.05
	L.S.D (0.05)	23.46	4.47	1.07	1.09	1.10
Planting Distance	20	587.8	43.68	35.96	27.13	10.21
	25	511.4	45.02	36.49	23.65	8.99
	30	395.5	50.01	37.00	20.89	7.72
	L.S.D (0.05)	20.32	3.87	n.s	0.95	0.95
N^{1st}	20	566.8	37.26	34.73	30.53	7.77
	25	499.2	42.66	35.23	25.34	7.93
	30	371.0	49.73	35.77	23.45	7.06
N^{15th}	20	644.7	55.20	40.86	33.85	15.38
	25	560.2	52.97	41.46	28.34	12.32
	30	450.7	54.33	41.89	25.57	10.06
D^{1st}	20	636.3	52.20	38.50	26.00	12.70
	25	546.8	49.97	39.06	23.72	10.70
	30	445.5	50.08	39.57	20.25	8.61
D^{15th}	20	503.3	30.06	29.74	18.13	4.99
	25	439.5	34.49	30.19	17.19	4.99
	30	315.0	45.93	30.77	14.29	5.17
	L.S.D (0.05)	n.s	7.74	n.s	1.90	1.91

of panicle.m^{-2} increases in 20 cm distances possibly because of the This high number of tillers in the 20 cm distances (Suyin *et al*., 2010). The number of grain in panicle increases in 30 cm distances possibly because of the large exposure of light that stimulates the increase in the rates of photosynthesis sufficient to meet the requirements of plant during two stages: developing apex and growth of panicle.This light also contributes to formation of a greater amount of grains in panicle (Yoshida, 1972). Also, in 20 cm area, the increase in the biological yield could be attributed to increase in tillernumber, which are one of the main components of straw and in grain yield as seen in Tables 2 and 3. This tiller increases positively influence biological yield, which mainly consists of these two components (Ali *et al.*, 2010). In addition, 20 cm grain yield increasesbecause of increase inpanicle number, which is one of the basic yield components as Table 3 shows. It could also bedue to cultivation at narrow distances that makes a better distribution of plants and thus the optimum utilization of production factors when compared with the wide distances of lines (Freeman *et al.*, 2005). The same table also reveals that there is a significant effect of the treat interferences, and November 15 at 20 cm is significantly higher in grains number, biological and grain yields the highest average of 55.20 grain.dalia^{-1}, 33.85 and 15.38 ton.ha^{-1} respectively, than December 15 at 20 cm, the lowest means of 30.06 grain.dalia^{-1}, December 15 with 30 cm in the biological yields.the lowest means of 14.29 and while December 15 with 20 cm and December 15 with 25 cm in the grain yields. The lowest means of 4.99 ton.ha^{-1}.

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