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The effect of seeding date and rate on growth and productivity of wheat under the rice-wheat successive system

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ABSTRACT

A field experiment was carried out in the fields of the rice research station in Al-Mishkhab - Najaf Governorate, belongs to the Agricultural Research Office, in the winter seasons 2014-2015 and 2016-2017 to study the effect of seeding date and rate on the growth and productivity of wheat grown under the rice-wheat successive system. The wheat variety Abaa 99 was planted in the fields of the Jasmine rice variety, and the plants were standing and not yet harvested, on two dates, 11/15 and 12/15, at four seeding rates of 120, 160, 200, and 240 kg/ha, according to a randomized complete block design in the order of factorial experiments, with three replications. The results showed that the early planting date of 11/15 outperformed the late date of 15/12 in all the studied traits, as it gave the highest grain yields of 2,635 and 3,690 tons/ha compared to the late date of 1,583 and 1,461 t/ha for the first and second seasons, respectively. The seed rate of 160 kg/ha gave the highest grain yield of 2.5 and 2.71 t/ha for the first and second seasons, respectively. Therefore, we recommend planting wheat in mid-November, at a seed rate of 160 kg/ha under the rice-wheat succession system, in the environment of the rice region of Iraq.

Keywords: Sowing date, Sowing rate, Rice-wheat succession system.

Introduction

Rice and wheat have been grown successively in South Asia and China for more than 1,000 years. In this system (RW System), these two crops are grown successively annually, and it was developed by introducing rice cultivation into areas planted with wheat, and vice versa (Paroda et al., 1994 and Tran and Marathee, 1994). This system is one of the largest global agricultural production systems and covers an area of 2.6 million hectares, which constitutes a third of the area with rice and wheat in South Asia, and produces more than 20% of the world's food. To provide food for India's expected population of 1.35 billion people by the year by 2025, agricultural production, especially rice and wheat, must achieve an additional increase of about 20% (Chauhan et al., 2012). The seed rate is one of the most important field factors that must be given high attention to achieve the maximum yield Plants depend on available resources, especially water, nutrients, and solar radiation, which results in poor quality and low yields. If the seed rate is low, the yield will decrease due to the production of a smaller number of plants per unit area (Hameed et al., 2002). Relatively, early planting ensures optimal emergence and a sufficient number of branches per unit area (Shazma et al., 2015). It was found that every week of delay in sowing wheat reduces the duration of vegetative growth and reproductive stages, causing a reduction in yield (Akmal et al., 2011). Mckenize et al. (2011) found that seeding rate had a lesser effect on yield and quality than seeding date, although the lowest yield was obtained at the lowest seeding rate. The rice-wheat succession system has prevailed in the Shalabi region of Iraq for decades, as wheat is grown on rice plants before

harvesting them to make the most of the moisture of the soil planted with rice. The farmer often increases the seed rate of wheat to unknown limits, believing that increasing the seed rate increases the yield by increasing the number of ears per unit area. Therefore, this research was proposed as a result of complaints and field problems about the appropriate seeding rate and date for wheat in the rice region.

Materials and Methods

A field experiment was carried out at the rice research station in Al-Mishkhab - Najaf Governorate, belongs to Agricultural Research Office, in the seasons 2014-2015 and 2016-2017 to study the effect of seeding date and rate on wheat grown under the rice-wheat successive system. Planting was done broadcasted in the rice fields, and the plants were still standing and had not yet been harvested. A randomized complete block design was used according to the arrangement of factorial experiments with three replications. Planting was done with two dates: 11/15 and 12/15 (the first factor) and four seed rates: 120, 160, 200, and 240 kg/ha (the second factor). Wheat variety Abaa 99 was grown in plots, the area of the plot is 15 m2 (5x3 m), and the plants of the jasmine rice variety are standing. All standard agricultural operations were carried out in accordance with recommendations, and some growth characteristics, yield and its components of wheat plants were studied. The data were analyzed statistically according to the Genestate program, and the averages of traits were compared on the basis of the least significant difference at the 5% level.

Results and Discussion

The planting date had a significant effect on the number of days from planting to 50% flowering in both seasons, as the early planting date gave the highest number of days, reaching 114.58 and 128.42 days, which is 3.85 and 15.25% higher compared to the second date (12/15), and 1.88. And 7.08% compared to the general average for the first and second seasons, respectively.

The seed rate had a significant effect on the number of days from planting until 50% flowering, as the seed rate of 120 kg/ha gave the highest number of days, 120.67 days, which is 0.63% higher compared to the general rate in the second season.

The planting date had a significant effect on the number of days from planting until physiological maturity for both seasons, as the early date (11/15) gave the highest number of days, 165 and 168.17 days, which is 15.15 and 9.91% higher compared to the second date, and 7.19 and 4.66% compared to the average of the year for the first and second seasons, respectively. The planting date had a significant effect on plant height for both seasons, as the highest value was 88.67 and 93.25 cm in the early date, which is 11.94 and 9.48% higher compared to the second date, and 5.63 and 4.52% higher than the general average for the first and second seasons, respectively.

The seed rate had a significant effect on plant height for the second season, as the highest value of plant height was achieved at the seed rate of 160 kg/ha, reaching 90.5 cm, which is 3.22% higher compared to the seed rate of 240 kg/ha, and 1.44% compared to the general average. The highest value of spike length was recorded in the early season for both seasons, reaching 12.4 and 10.42 cm, with an increase of 11.71 and 8.88% compared to the second season, and 5.53 and 4.3% compared to the general average for the first and second seasons, respectively. The seed rate had a significant effect on spike length in the second season. The highest value was reached at the seed rate of 160 kg/ha, which is 13.8% higher compared to the seed rate of 240 kg/ha (the highest seed rate) and 4.80% higher than the general average.Planting dates significantly affected the infertility percentage The early date had the lowest value of infertility in both seasons, amounting to 2.24 and 0.38%, with a decrease rate of 148.66 and 626.31% compared to the second season, and 74.55 and 75.79% compared to the general average for the first and second seasons, respectively.

Table (1): The effect of planting dates and seeding rates on no. of days from sowing to 50% anthesis under rice-wheat succession system.

	First season			Second season		
	15/11	15/12	Mean	15/11	15/12	Mean
120	115	110	112.5	129.33	112	120.67
160	114.33	110	112.17	128.67	111.33	120
200	115	110.67	112.83	127	111.33	119.17
240	114	110.67	112.33	128.67	111	119.83
$LSD_{0.05}$	N.S.		N.S.	N.S.		0.961

Mean	114.58	110.33	112.46	128.42	111.42	119.92
$LSD_{0.05}$	1.342			6.484		

Table (2): The effect of planting dates and seeding rates on number of days from sowing to physiological maturity under rice-wheat succession system.

	First season			Second season		
	15/11	15/12	Mean	15/11	15/12	Mean
120	165.67	142.67	154.17	160.67	153	160.83
160	164.67	142.67	153.67	167.67	153	160.33
200	165	143	154	167.67	153.33	160.5
240	164.67	143	153.83	168.67	152.67	160.67
$LSD_{0.05}$	N.S.		N.S.	N.S.		N.S.
Mean	165	142.83	153.92	168.17	153	160.68
$LSD_{0.05}$	2.181			0.949		

Table (3): The effect of planting dates and seeding rates on in length of spike (cm) under rice-wheat succession system.

	First season			Second season		
	15/11	15/12	Mean	15/11	15/12	Mean
120	12.5	11.27	11.88	10.73	9.63	10.18
160	12.73	11	11.87	11.43	9.50	10.47
200	12.47	11.1	11.78	10.46	9.76	10.12
240	11.9	11.03	11.47	9.03	9.36	9.2
$LSD_{0.05}$	N.S.		N.S.	N.S.		0.289
Mean	12.4	11.1	11.75	10.42	9.57	9.99
$LSD_{0.05}$	0.700			0.328		

Table (4): The effect of planting dates and seeding rates on in plant height (cm) under rice-wheat succession system.

	First season			Second season		
	15/11	15/12	Mean	15/11	15/12	Mean
120	88	80.67	84.33	94.67	83.33	89
160	89.33	78.5	83.92	94.67	86.33	90.5
200	88.67	80	84.33	93.33	86	89.67
240	88.67	77.67	83.17	90.33	85	87.67
$LSD_{0.05}$	N.S.		N.S.	N.S.		1.863
Mean	88.67	79.21	83.94	93.25	85.17	89.21
$LSD_{0.05}$	2.885			0.359		

Table (5): The effect of planting dates and seeding rates on in infertility percentage under rice-wheat succession system.

	First season			Second season		
	15/11	15/12	Mean	15/11	15/12	Mean
120	1.82	5.08	3.45	0.76	1.78	1.27
160	2.12	5.9	4.01	0.50	3.32	1.91
200	2.19	6.26	4.23	0.12	3.53	1.83
240	2.85	5.05	3.95	0.15	2.43	1.29
$LSD_{0.05}$	N.S.		N.S.	N.S.		N.S.
Mean	2.24	5.57	3.91	0.38	2.76	1.57
$LSD_{0.05}$	1.694			1.284		

Planting dates significantly affected the number of spikes/m^2, as the early date had the highest number of ears for both seasons, amounting to 203.4 and 342.6 ears/m^2, which is 36.6 and 169.33% higher compared to the second date and 15.5 and 45.84% higher than the general average for the first and second seasons. respectively.

The seed rate had a significant effect on the number of ears/m2. The highest value reached 193.5 and 257 ears/m2 at the seed rate of 240 kg/ha, which is 20.9 and 23.76% higher compared to the seed rate of 160 kg/ha. And 9.88 and 9.40% compared to the general average for the first and second seasons, respectively.

The planting date had a significant effect on the number of filled grains/spike for both seasons. The early date had the highest number of filled grains, reaching 71.9 and 54.6 grains/spike for the first and second seasons, respectively, which were 14.5 and 6.10% higher compared to the late date, 6.25 and 2.91%. Compared to the general average for the first and second seasons, respectively.

The seed rate had a significant effect on the number of filled grains/spike, as the seed rate of 160 kg/ha gave the highest grain number of 70.4 and 57.87, which is 13.73% higher compared to the seed rate of 200 kg/ha in the first season, 22.26% compared to the seed rate of 240 kg/ha. e in the second season, 4.45 and 8.56% compared to the general average for the first and second seasons, respectively.

The effect of planting date on seed weight, as the early date had the highest seed weight of 37.51 and 32.56 gram for the first and second seasons, respectively, which was 21.2 and 16.3% higher compared to the late date, and 9.6 and 7.5% compared to the general average for the first and second seasons, respectively.

The seed rate had a significant effect on the weight of 1000 seeds, as it achieved 35 and 30.72 at the seed rate of 160 kg/ha, which is 3.95 and 2.71% higher compared to the seed rate of 120 kg/ha and 2.25 and 1.45% compared to the general average for the first and second seasons, respectively.

The planting date had a significant effect on grain yield. The highest grain yield was achieved at the early date, reaching 2,635 and 3,690 tons/ha, which is 66.45 and 152.56% higher compared to the late date, and 24.94 and 43.24% compared to the general average for the first and second dates, respectively.

The seeding rate had a significant effect on grain yield. The highest grain yield reached 2.5 and 2.710 tons/ha at the seeding rate of 160 kg/ha, which is 28.33% higher compared to the seeding rate of 240 kg/ha in the first season and 12.35% higher compared to the seeding rate of 200 kg. /e in the second season, with an increase rate of 18.53 and 5.20% compared to the general average for the first and second seasons, respectively.

The planting date had a significant impact on the biological yield, as the highest biological yield was 5.455 and 7.689 tons/ha, which is 52.71 and 161.88% higher compared to the late date, and 20.84 and 44.74% higher than the general average for the first and second seasons, respectively.

The seed rate had a significant effect on the biological yield. Its highest value reached 5.17 tons/ha at the seed rate of 160 kg/ha in the first season, which is 23.83% higher compared to the seed rate of 120 kg/ha and 14.53% compared to the general average.

The seed rate in the second season had a significant impact on the harvest index. Its highest value reached 51.3 at the seed rate of 120 kg/ha, which is 9.92% higher compared to its lowest value of 46.67 at the seed rate of 240 kg/ha, and 4.58% compared to the general average.

Table (6): The effect of planting dates and seeding rates on in number of spikes/ m^2 under rice-wheat succession system.

	First season			Second season		
	15/11	15/12	Mean	15/11	15/12	Mean
120	195.5	129.5	160	320	95.5	207.8
160	214	149.5	181.8	338	151	244.5
200	191.5	147	169.2	333	128	230.5
240	217.5	169.5	193.5	379.5	134.5	257
$LSD_{0.05}$	N.S.		15.43	N.S.		20.32
Mean	203.4	148.9	176.1	342.6	127.2	234.9
$LSD_{0.05}$	21.59			18.61		

Table (7): The effect of planting dates and seeding rates on in number of grains/spike under rice-wheat succession system.

	First season			Second season		
	15/11	15/12	Mean	15/11	15/12	Mean
120	76.1	62.1	69.1	60.4	52	56.2
160	74.6	66.2	70.4	60.4	55.33	57.87
200	67.4	56.5	61.9	53.73	47.55	50.64
240	69.5	66.8	68.2	43.87	50.8	47.33
$LSD_{0.05}$	N.S.		6.18	N.S.		1.274
Mean	71.9	62.9	67.4	54.6	51.42	53.01
$LSD_{0.05}$	7.68			1.274		

Table (8): The effect of planting dates and seeding rates on in weight of 1000 graine (gm) under rice-wheat succession system.

	First season			Second season		
	15/11	15/12	Mean	15/11	15/12	Mean
120	37.1	30.25	33.67	31.9	27.92	29.91
160	38.4	31.6	35	33.1	28.35	30.72
200	37.05	31.67	34.36	32.25	27.95	30.1
240	37.48	30.27	33.88	33	27.8	30.40
$LSD_{0.05}$	N.S.		1.631	N.S.		0.828
Mean	37.51	30.95	34.23	32.56	28	30.28
$LSD_{0.05}$	2.365			1.462		

Table (9): The effect of planting dates and seeding rates on in paddy yield (ton/ha.) under rice-wheat succession system.

	First season			Second season		
	15/11	15/12	Mean	15/11	15/12	Mean
120	2.795	1.205	2	3.622	1.42	29.91
160	2.85	2.15	2.5	3.775	1.645	30.72
200	2.45	1.525	1.987	3.555	1.27	30.1
240	2.447	1.45	1.948	3.809	1.51	30.40
$LSD_{0.05}$	N.S.		0.2731	N.S.		0.1491
Mean	2.635	1.583	2.109	3.69	1.461	2.576
$LSD_{0.05}$	0.5515			0.3798		

Table (10): The effect of planting dates and seeding rates on in biological yield (t/ha.) under rice-wheat succession system.

	First season			Second season		
	15/11	15/12	Mean	15/11	15/12	Mean
120	5.69	2.66	4.175	7.435	2.83	5.133
160	5.875	4.465	5.17	7.75	3.265	5.508
200	5.2	3.424	4.312	7.515	2.583	5.049
240	5.057	3.74	4.398	8.055	3.065	5.56
$LSD_{0.05}$	N.S.		0.453	N.S.		N.S.
Mean	5.455	3.572	4.514	7.689	2.936	5.312
$LSD_{0.05}$	0.984			1.099		

Table (11): The effect of planting dates and seeding rates on in harvest index under rice-wheat succession system.

	First season			Second season		
	15/11	15/12	Mean	15/11	15/12	Mean
120	49.57	44.8	47.18	51.67	50.93	51.3
160	49.63	45.63	47.63	48.37	51.6	49.98
200	48.67	42.23	45.58	46.77	49.7	48.23
240	48.3	45.77	47.03	45.93	47.4	46.67
$LSD_{0.05}$	N.S.		N.S.	N.S.		2.181
Mean	49.04	44.61	46.86	48.18	49.91	49.05
$LSD_{0.05}$	N.S.			N.S.		

It is noted from the results that the early date increased the values of all the studied traits, from the number of days from planting to 50% flowering, the number of days from planting to physiological maturity, spike length, plant height, number of ears/m2, number of filled grains/spike, grain weight, grain yield and the biological outcome. This clearly indicates that early planting by broadcasting wheat grains and rice plants are still standing and have not yet been harvested. It appears that this date is the ideal sowing date for wheat under the rice-wheat succession system. The ideal temperature for the growth, development and production of wheat is 20-25 degrees Celsius, and the maximum temperature is It is 35°C, and if the temperature exceeds 35°C during the reproductive period, this leads to accelerated ripening and a loss in yield (Mohsen et al., 2013). The ideal temperature for wheat at flowering and grain filling ranges from 12 to 22 degrees Celsius, and exposure to a temperature higher than that can lead to a significant reduction in grain yield (Tewolde et al., 2006 and Fisher, 2007), as well as heat stress before flowering. Pre-anthesis in wheat leads to some physiological changes, which ultimately results in a reduction in grain weight, due to shortening the period of grain filling and starch assimilation (Hasan and Ahmed, 2005).

Early planting ensures a high emergence rate and a sufficient number of branches per unit area (Shazma et al., 2015). It was found that each week of delay in sowing wheat reduces the length of the vegetative growth period and reproductive stages, causing a reduction in yield (Akmal et al., 2011).

It is noted that increasing the seed rate has increased most of the characteristics of growth and yield, from the number of days to physiological maturity, spike length, plant height, number of spikes/m2, number of filled grains, grain weight, grain yield, biological yield, and harvest index. The highest seed rate is noted (240 kg/ ha) The highest number of ears/m2 was achieved, and the seed rate of 160 kg/ha increased the number of filled grains/ear, grain weight, grain yield, biological yield, and harvest index.

The seed rate is one of the most important field factors, which must be given great attention to achieve the maximum yield. The high seeding rate increases competition between plants for available resources, especially water, nutrients and solar radiation, which results in poor quality and low yields. If the seed rate is low, the yield will decrease due to the small number of plants per unit area (Hameed et al., 2002).

The seed rate strongly affected the competition between parts of a single plant (intra) and adjacent plants (inter plant competition) for light, water, and nutrients during the stages of crop development. It is worth noting that competition between parts of a single plant intensifies during the seed-filling period, by the plant to produce more branches bearing spikes in the early stages of plant development (Shazma et al., 2015). Baloch et al. (2010) found that the highest values for the number of branches, spike length, plant height, grain weight, and grain yield were achieved at a seeding rate of 150 kg/ha. Mckenize et al. (2011) found that the seeding rate had a lesser effect on yield and quality compared to the seeding date. Seeds, although the lowest yield was obtained at the lowest seed rate.

Conclusions

It is concluded from the research that early planting of wheat in mid-November and increasing the seed rate to 160 kg/ha increased the yield of wheat grown in rice fields, under the rice-wheat successive system.

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