Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.5, No.1, 2015

Effect of Sowing Dates and Seed Rates on the Agro-Physiological Traits of Wheat

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Abstract
Wheat yield in Pakistan is very low due to improper seed rate and not sowing the crop at proper time. Delay in sowing of wheat causes linear reduction in grain yield. To evaluate the effect of seed rates and sowing dates on agro-physiological traits of wheat an experiment was conducted at New Developmental Farm, The University of Agriculture Peshawar-Pakistan during winter 2012-13. Randomized complete block design (RCBD) with split plot arrangement having three replications was used. Sowing dates (29th October, 10th November, 24th November, 10th December, 26th December and 10th January) were kept in the main plots, whereas, seed rates (120,150,180 kg ha^{-1}) were allotted to sub plots. Wheat variety "SIRAN-2010" was sown in a plot size of 5m x 1.8m (9 m^2), having six rows with row to row distance of 30 cm and row length 5m. All the standard agronomic practices were uniformly adopted for the whole experiment. Results showed that maximum spikes m^{-2} (411), grains spike^{-1} (52), thousand grains weight (43 g), biological yield (12327 kg ha^{-1}) and grain yield (5587 kg ha^{-1}) were recorded in plots sown at 10th November. Seed rate of 150 kg ha^{-1} showed maximum number of grains spike^{-1} (44), spikes m^{-2} (307), thousand grains weight (37g), biological yield (9568 kg ha^{-1}) and grain yield (4296 kg ha^{-1}). It was concluded from the results that wheat should preferably be sown between 29th October and 24th November at 150 kg ha^{-1} seed rate to get higher grain yield in Peshawar valley.

Introduction

Wheat (*Triticum aestivum* L.) is a major source of food all over the world and is consumed as staple food especially in Pakistan. It meets the major dietary needs. Its straw is used as feed for livestock. In Pakistan the total production of wheat in 2011-12 was 23.47 million tones and the area occupied by wheat was about 8.64 million hectares. During 2011-12 wheat was cultivated on 0.73 million hectares in Khyber Pakhtunkhwa and was likely to produce 1.13 million tons. (MINFA, 2012) .

Relatively early planting ensures optimum emergence through sufficient tiller number per unit area. The proper sowing date for wheat in Khyber Pakhtunkhwa ranges from 25th October to 15th December and specifically for Peshawar valley it ranges from 1st November to 15th December and proper seed rate for wheat in Peshawar valley is 150 kg ha^{-1} (SUPARCO, 2011 and Said et al., 2012). Each week delay of wheat sowing reduces length of the crop vegetative and reproductive stages and causes yield reduction (Akmal et al., 2011). High seed rates increases plant population and yield, also more the seed rate more will be the number of plants per unit area thus suppress weeds and will give maximum economic returns (McKenzie et al., 2011). Malik et al. (2009) reported that delayed sowing decreased grain yield due to decrease in germination count m^{-2}, number of grains spike^{-1} and 1000-grain weight whereas increase in seed rate did not affect grain yield.

Seeding rate strongly influence the intra and inter plant competition for environmental resources i.e. light, water and nutrients during crop development. The interplant competition is decreased due to low seed rates during vegetative growth, but intra-plant competition is increased during grain filling duration because plant tends to produce more tillers and thus spikes bearing tillers. Ozturk *et al.* (2006) reported that the number of kernels spike^{-1} increased less than 10% when seed rate was decreased from 625 to 325 seeds m^{-2}. Baloch et al. (2010) concluded that higher number of tillers, spike length, plant height, 1000-grain weight and the grain yield were produced with seed rate of 150 kg ha^{-1}. McKenzie et al. (2011) reported that seeding rate had a smaller effect on crop yield and quality than sowing date, although lower yields were consistently obtained at the lowest seeding rates.

Materials and Methods

The experiment was conducted at New Developmental Farm, The University of Agriculture Peshawar-Pakistan during crop season 2012-13. Randomized complete block design with split plot arrangement having three replications were used. Sowing dates (29th October, 10th November, 24th November, 10th December, 26th December and 10th January) were kept in main plots, whereas seed rates (120, 150 and 180 kg ha^{-1}) were allotted to sub plots. Wheat variety "SIRAN-2010" was sown in a plot size of 5m x 1.8m (9 m^2) with row to row distance of 30 cm having six rows per subplot each row 5m long. All the standard agronomic practices were uniformly adopted for all the sub plots. Data was recorded using standard methods for days to emergence, emergence m^{-2}, days to anthesis, days to maturity, plant height, spikes m^{-2}, grains spike^{-1}, thousand grain weight, biological yield

and grain yield. Data thus collected were compiled and analyzed statistically using ANOVA appropriate for the split plot design and LSD values were calculated for the significant differences (Jan et al. 2009).

Results and Discussion

Days to emergence

Data regarding days to emergence are shown in Table 1. Analysis of the data revealed that only sowing dates (SD) significantly affected days to emergence. Delay in sowing date constantly increased days to emergence. In sowing dates highest days to emergence (17) were recorded in plots sown on 10th January. Similarly lowest days to emergence (5) were recorded in plots sown on 29th October followed by days to emergence (6) recorded in plots sown on 10th November. Jan *et al.* (2000) reported that higher number of seedlings were emerged in plots sown in November than plots sown in late December.

Emergence m^{-2}

Data pertaining to emergence m^{-2} are given in Table 2. Emergence m^{-2} was significantly affected by sowing dates. In sowing dates maximum emergence m^{-2} (144) was recorded in plot sown on 29th October which is at par with 10th November. Minimum emergence m^{-2} (16) was recorded in plot sown on 10th January. Emergence per unit area decreased when wheat planting was delayed in season from Oct. 24 onwards for all varieties but with a different magnitude (Akmal *et al.* 2011). McKenzie *et al.* (2011) reported that plant establishment tended to decline slightly as sowing date was delayed.

Days to anthesis

Table. 3 shows that days to anthesis decreases with delay in sowing. More days to anthesis (146) were recorded in plot sown on 29th October while fewer days to anthesis (109) were recorded in plot sown on 10th January. Seed rate had an inconsistent effect on days to anthesis. Days to anthesis were higher (129) in plot sown at seed rate of 150 kg ha^{-1} compared to less days to anthesis (126) with 120 kg ha^{-1} seed rate. Early planted wheat had more time for heading started after 76-78 days in November planted wheat, whereas, this period reduced to 70-69 days in mid December sowing reported by Khokhar *et al.* (2010).

Plant height (cm)

Data concerning plant height are reported in Table 5. Plant height drastically decreased from sowing date 10th December to 10th January. Maximum plant height recorded in Oct. 29th, Nov. 10th and Nov. 24th . Minimum plant height (49cm) was observed in plots sown on 10th January. Maximum plant height (85cm) was obtained from plots sown with seed rate of 150 kg ha^{-1} as compared with rest. Early sowing of wheat produces tallest plants (Baloch *et al*. 2010). Iqbal *et al*. (2012) reported that increasing seeding rate at 150 kg ha^{-1} decreases plant height.

Spikes m^{-2}

Analysis of data shows that sowing date and seed rate significantly affected spikes m^{-2} with non significant SD×SR interaction. Regarding sowing dates maximum spikes m^{-2} (411) were recorded in plot sown on 10th November while fewer spikes m^{-2} (50) were recorded in plot sown on 10th January. Seed rate had an inconsistent effect on spikes m^{-2}. Spikes m^{-2} (307) were higher in plots sown at seed rate of 150 kg ha^{-1} compared to lower spikes m^{-2} (287) recorded in plots sown at seed rate of 120 kg ha^{-1} (Table 6). Higher grain yield of early sowing over late sowing may be attributed to its higher number of ear m^{-2}. These results are in line with Wajid *et al.* (2004). Sun *et al*. (2012) demonstrated that the delayed sowing causes reduction in biomass and yield production which could be compensated by increase in seed rates.

Grains spike^{-1}

Table 7 shows linear decrease in grains spike^{-1} with delay in sowing dates from 10th December to 10th January. Improved grains spike^{-1} (52) were produced in plots sown on 10th November however, grains spike^{-1} produced in Oct. 29th, Nov. 10th and Nov. 24th were statistically at par with each other. Minimum grains spike^{-1} (16) were produced by plots sown on 10th January. Seed rate had an unpredictable effect on grains spike^{-1}. More grains per spike (44) were produced in plots with seed rate of 150 kg ha^{-1} while less grains spike (40) were produced in plots sown with 120 kg ha^{-1}seed rate. Early sowing date produced significantly more number of grains per spike (Yajam *et al*. 2013). Fewer grain spike^{-1} was found with increasing seed rate reported by Soomro *et al*. (2009).

Thousand grain weight

Data regarding thousand grain weight are presented in Table 8. Thousand grains weight significantly decreased with delay in sowing date from 10th December to 10th January. Heavier weight (43g) was produced in plots sown on 10th November however, thousand grain weight produced in Oct. 29th, Nov. 10th and Nov. 24th were statistically at par with each other. Minimum yield (20g) was given when wheat was sown on 10th January.

Higher thousand grains weight (37g) recorded when wheat was sown at 150 kg ha^{-1} seed rate while minimum (34g) thousand grains weight was noted when wheat was sown at the rate of 120 kg ha^{-1}. Malik *et al.* (2009) reported that the highest 1000 wheat grain weight was noted in November as compared to December sowing. Similarly, the heaviest 1000-grain weight was recorded, when 125 kg ha^{-1} of seed rate was used, where as the lightest 1000-grain weight was observed when 175 kg ha^{-1} seed rate was used.

Biological yield

Data pertaining biological yield are reported in Table 9. Biological yield was found maximum in early sown plots. Maximum biological yield (12327 kg ha^{-1}) was produced in early sown plots on 10th November whereas minimum biological yield (2839 kg ha^{-1}) was produced in late sown plots on 10th January. Higher biological yield (9568 kg ha^{-1}) was obtained from 150 kg ha^{-1} as compared to other seed rates.

Grain yield

Data concerning grain yield of wheat are shown in Table 10. Analysis of the data indicated that sowing dates and seed rates significantly affected grain yield. The interaction of sowing dates and seed rates for grain yield was found non significant. Delay in sowing significantly affected grain yield. Maximum grain yield (5587 kg ha^{-1}) was produced in plots sown on 10th November whereas minimum grain yield (1287 kg ha^{-1}) was produced in late sown plots on 10th January. Grain yield was greater (4296 kg ha^{-1}) at seed rate of 150 kg ha^{-1} and lower (3953 kg ha^{-1}) at 120 kg ha^{-1} seed rate. Hussain *et al*. (2010) reported that grain yield increased as seed rate was increased from 50 kg to 150 kg ha^{-1}.

Conclusion and Recommendations

It is concluded from the results that in order to get optimum grain yield and yield components of wheat, it should be grown between 29th October to 10th November using seed rate of 150 kg ha^{-1} .Therefore, sowing of wheat variety "SIRAN" from 29th October to 10th November with 150 kg ha^{-1} seed rate is recommended for higher yield.

Acknowledgements

We are thankful to the Directorate of Science and Technology (DoST) Government of Khyber Pakhtunkhwa for the financial assistance of Grant No. Dirtt: S & T/ KP/ PRS/ FINANCIAL ASSISTANCE 2011-12, Dated 27-6-2012 for this research.

Table 1. Days to emergence of wheat as affected by sowing dates and seed rates

Seed rate (kg ha^{-1})	Sowing Dates (SD)						
	Oct.29	Nov.10	Nov.24	Dec.10	Dec.26	Jan.10	Mean
120	5	6	7	9	13	16	10
150	5	7	8	9	11	18	10
180	6	6	8	10	11	18	10
Mean	5 e	6 e	8 d	9 c	12 b	17 a	

Means in the same category followed by different letters are significantly different from each others at P level SD $\leq$ 0.05.
LSD value for SD $\leq$ 0.05 = 1.0715
LSD value for SR $\leq$ 0.05 = ns
LSD value for SD x SR $\leq$ 0.05 = ns

Table 2. Emergence m^{-2} of wheat as affected by sowing dates and seed rates

Seed rate ($kg\ ha^{-1}$)	Sowing Dates (SD)						
	Oct.29	Nov.10	Nov.24	Dec.10	Dec.26	Jan.10	Mean
120	132	130	108	98	59	18	91
150	151	140	115	100	66	13	97
180	148	143	116	102	73	16	100
Mean	144 a	138 a	113 b	100 c	66 d	16 e	

Means in the same category followed by different letters are significantly different from each others at P level SD $\leq$ 0.05.
LSD value for SD $\leq$ 0.05 = 7.8801
LSD value for SR $\leq$ 0.05 = ns
LSD value for SD x SR $\leq$ 0.05 = 12.273

Table 3. Days to anthesis of wheat as affected by sowing dates and seed rates

Seed rate ($kg\ ha^{-1}$)	Sowing Dates (SD)						
	Oct.29	Nov.10	Nov.24	Dec.10	Dec.26	Jan.10	Mean
120	145	137	127	121	117	109	126 b
150	148	143	131	123	118	108	129 a
180	146	138	129	122	118	110	127 ab
Mean	146 a	139 b	129 c	122 d	118 e	109 f	

Means in the same category followed by different letters are significantly different from each others at P level SD $\leq$ 0.05.
LSD value for SD $\leq$ 0.05 = 2.3530
LSD value for SR $\leq$ 0.05 = 1.5052
LSD value for SD x SR $\leq$ 0.05 = ns

Table 4. Days to maturity of wheat as affected by sowing dates and seed rates

Seed rate ($kg\ ha^{-1}$)	Sowing Dates (SD)						
	Oct.29	Nov.10	Nov.24	Dec.10	Dec.26	Jan.10	Mean
120	188	176	162	152	145	130	159 b
150	192	179	166	155	148	130	162 a
180	189	179	165	152	147	130	160 ab
Mean	190 a	178 b	164 c	153 d	147 e	130 f	

Means in the same category followed by different letters are significantly different from each others at P level SD $\leq$ 0.05.
LSD value for SD $\leq$ 0.05 = 3.6058
LSD value for SR $\leq$ 0.05 = 2.0112
LSD value for SD x SR $\leq$ 0.05 = ns

Table 5. Plant height (cm) of wheat as affected by sowing dates and seed rates

Seed rate (kg ha^{-1})	Sowing Dates (SD)						
	Oct.29	Nov.10	Nov.24	Dec.10	Dec.26	Jan.10	Mean
120	101	101	102	86	63	50	84 b
150	103	102	102	89	64	51	85 a
180	102	101	101	87	61	47	83 b
Mean	102 a	101 a	102 a	87 b	62 c	49 d	

Means in the same category followed by different letters are significantly different from each others at P level SD $\leq$ 0.05.
LSD value for SD $\leq$ 0.05 = 4.6153
LSD value for SR $\leq$ 0.05 = 1.1117
LSD value for SD x SR $\leq$ 0.05 = ns

Table 6. Spikes m^{-2} of wheat as affected by owing dates and seed rates

Seed rate (kg ha^{-1})	Sowing Dates (SD)						
	Oct.29	Nov.10	Nov.24	Dec.10	Dec.26	Jan.10	Mean
120	375	399	382	313	197	55	287 c
150	409	425	396	345	222	46	307 a
180	393	408	386	326	211	48	295 b
Mean	392 b	411 a	388 b	328 c	210 d	50 e	

Means in the same category followed by different letters are significantly different from each others at P level SD $\leq$ 0.05.
LSD value for SD $\leq$ 0.05 = 17.218
LSD value for SR $\leq$ 0.05 = 7.6749
LSD value for SD x SR $\leq$ 0.05 = ns

Table 7. Grains spike^{-1} of wheat as affected by owing dates and seed rates

Seed rate (kg ha^{-1})	Sowing Dates (SD)						
	Oct.29	Nov.10	Nov.24	Dec.10	Dec.26	Jan.10	Mean
120	48	49	48	44	34	16	40 c
150	52	54	53	49	39	16	44 a
180	49	52	49	46	37	15	41 b
Mean	50 a	52 a	50 a	46 b	37 c	16 d	

Means in the same category followed by different letters are significantly different from each others at P level SD $\leq$ 0.05.
LSD value for SD $\leq$ 0.05 = 2.9688
LSD value for SR $\leq$ 0.05 = 0.8782
LSD value for SD x SR $\leq$ 0.05 = ns

Table 8. Thousand grain weight (g) of wheat as affected by sowing dates and seed rates

Seed rate (kg ha^{-1})	Sowing Dates (SD)						
	Oct.29	Nov.10	Nov.24	Dec.10	Dec.26	Jan.10	Mean
120	40	42	42	33	29	20	34 c
150	43	44	43	36	32	21	37 a
180	41	43	41	34	31	20	35 b
Mean	41 a	43 a	42 a	35 b	30 c	20 d	

Means in the same category followed by different letters are significantly different from each others at P level SD $\leq$ 0.05.
LSD value for SD $\leq$ 0.05 = 2.4897
LSD value for SR $\leq$ 0.05 = 0.4728
LSD value for SD x SR $\leq$ 0.05 = ns

Table 9. Biological yield (kg ha^{-1}) of wheat as affected by sowing dates and seed rates

Seed rate (kg ha^{-1})	Sowing Dates (SD)						
	Oct.29	Nov.10	Nov.24	Dec.10	Dec.26	Jan.10	Mean
120	11539	11772	11189	10045	6189	2611	8891 b
150	12645	13006	11933	9982	6833	3010	9568 a
180	11995	12204	11171	8959	6868	2895	9015 b
Mean	12060 ab	12327 a	11431 b	9662 c	6630 d	2839 e	

Means in the same category followed by different letters are significantly different from each others at P level SD $\leq$ 0.05.
LSD value for SD $\leq$ 0.05 = 879.33
LSD value for SR $\leq$ 0.05 = 308.33
LSD value for SD x SR $\leq$ 0.05 = ns

Table 10. Grain yield (kg ha^{-1}) of wheat as affected by owing dates and seed rates

Seed rate (kg ha^{-1})	Sowing Dates (SD)						
	Oct.29	Nov.10	Nov.24	Dec.10	Dec.26	Jan.10	Mean
120	4901	5300	5123	4387	2831	1173	3953 c
150	5452	5870	5465	4373	3195	1422	4296 a
180	5250	5591	5274	4103	3277	1266	4127 b
Mean	5201 b	5587 a	5287 ab	4288 c	3101 d	1287 e	

Means in the same category followed by different letters are significantly different from each others at P level SD $\leq$ 0.05.
LSD value for SD $\leq$ 0.05 = 309.42
LSD value for SR $\leq$ 0.05 = 139.33
LSD value for SD x SR $\leq$ 0.05 = ns

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