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Yield and Yield Components of Wheat as Affected by Different Planting Dates, Seed Rate and Nitrogen Levels

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Abstract: In order to study the yield and yield components of wheat as affected by different planting dates, seed rate and nitrogen levels, an experiment was carried out at Malakandhar Research Farms, NWFP Agricultural University Peshawar, Pakistan during 2000. Mean value of the data indicated that different sowing dates and nitrogen levels had a significant effect on productive tillers m^{-2} spike length, spiklets spike^{-1}, grain yield, biological yield and harvest index, while the effect of different seed rates on the above parameters was non significant. October 25th sowing (early) had maximum productive tillers m^{-2}, grain yield and biological yield. Plots fertilized with 160 kg N ha^{-1} recorded maximum productive tillers m^{-2}, spike length, spiklets spike^{-1}, grain yield and biological yield.

Key words: Yield, plating dates, seed rate, nitrogen levels, wheat

Introduction

The ultimate yield of wheat crop is controlled by a number of internal and external factors. An optimum level of single factor will not cause an appreciable increase in the yield itself, but a combination of factors contribute to the ultimate yield of wheat crop. It is well recognized that inputs like improved varieties, optimum sowing time, optimum seeding density, and balanced use of fertilizers; each has an effective role in increasing the yield of crop. Ayaz *et al.* (1997) concluded that biological yield increased with increase in seed rate. Sowing of wheat after 10th November reduced yield due to poor emergence, low plant population and lighter grains (Stoppler *et al.*, 1990). Sultan *et al.* (1991) reported that nitrogen application increased grain yield significantly over control. Rathi and Ramsingh (1973) reported that nitrogen application increased yield by increasing tillering, ear length, umber of grains ear^{-1} and 1000 grain weight. Increasing levels of irrigations and N acted synergistically in increasing grain yields N uptake and utilization of fertilizer N. (Sud *et al.*, 1990) concluded that increasing N rate increased number of tillers plants^{-1}, but number of grains ear^{-1} and 1000 grain weight were not changed. Late sowing and higher N rates reduced 1000 grain weight, high N rates increased lodging and diseases incidence but also increased protein yield, grain protein and dry gluten content (Mazurek and Kus, 1991).
Keeping on view the role of optimum sowing time, seed rate and balanced dose of fertilizer, particular N, the research was conducted to study the effect of different planting dates, seed rate and nitrogen levels on the yield and yield components of wheat.

Materials and Methods

An experiment entitled the yield and yield components of wheat as affected by different planting dates, seed rate and nitrogen levels, variety Fakhre-Sarhad was conducted at Malakndhar Research Farms of NWFP Agricultural University Peshawar, Pakistan during 1999-2000. The land was thoroughly prepared as required for wheat sowing. The experiment was laid out in randomized complete block design (RCB), with split plot arrangement. The experiment was replicated four times having sub plot size of 1.2x5 m^2. Planting dates were allotted to main plots, while combination of seed rates and fertilizer levels were kept in sub plot. The following treatments were used in the experiment.

Planting dates
D_1 = 25th October D_2 = 10th November D_3 = 25th November

Seed rate
S_1 = 75 kg ha^{-1} S_2 = 100 kg ha^{-1} S_3 = 125 kg ha^{-1}

Fertilizer levels
F_0 = Control F_1 = 120 kg N ha^{-1} F_2 = 140 kg N ha^{-1}
F_3 = 160 kg N ha^{-1}

Before sowing soil analysis revealed 0.12 % total nitrogen content. While after harvesting soil analysis revealed (F_0 = 0.07, F_1 = 0.08, F_2 = 0.08 and F_3 = 0.09 %) total nitrogen content. Standard agronomic practices were followed through out the growing season. The various data collected was productive tillers m^{-2}, spike length, grains spike^{-1}, spiklets spike^{-1}, grain yield, biological yield and harvest index.
The data collected during the experiment was analyzed according to RCB design and upon obtaining significant differences least significant differences (LSD) test was applied (Steel and Torrie, 1980).

Results and Discussion

Analysis of the data (Table 1) revealed that productive tillers m^{-2} were significantly ($P \leq 0.05$) affected by different dates of sowing, seed rate, nitrogen levels and D x S x F interaction, while the remaining interactions had a non significant effect. Mean values of the data (Table 1) revealed that 25th October sown crop produced maximum productive tillers m^{-2} due to lengthy growing period and depending to absorb maximum nutrients from the soil and light for the sun resulting in maximum photosynthesis. Khan and Saleem (1980) reported that wheat sown earlier is more profitable when compared with late sown because of more productive tillers m^{-2}. It is also clear from the data that plots which were seeded at the rate of 125 kg ha^{-1} gave more productive tillers m^{-2}. Greater productive tillers m^{-2} was recorded when wheat was seeded at higher seed rate (Nazir *et al.*, 1987). When the effect of fertilizer was taken into an account, it was observed that plots treated with 160 kg N ha^{-1} produced maximum productive tillers m^{-2}, whereas control plots i.e. 0 kg N ha^{-1} recorded minimum productive tillers m^{-2} by different nitrogen levels may be due to proper vegetative and reproductive growth, which ultimately resulted in an increase productive tillers m^{-2}. Similar results are also reported by Rajput *et al.* (1989)
Mean value of the data (Table 2) inferred that 25th October sown crop produced longer spike than the other sowing dates. This may be due to the longer time available for maximum reproductive growth as vegetative growth was terminate at proper time and the crop utilize the soil nutrients efficiently for reproductive growth. These results are in agreement with those of Wariach *et al.* (1982), who reported that delayed sowing decreased the heading and spike length of the crop. In case of fertilizer maximum spike length was produced in the plots which received N at the rate of 160 kg N ha^{-1}, while minimum spike length was noted at control. This increase in spike length by higher due to N may be

Table 1: Tillers m^{-2} of wheat variety Fakhre-Sarhad as affected by sowing dates (D), seed rates (S) and fertilizer levels (F)

Seed rate (Kg ha^{-1})	Fertilizer levels (Kg N ha^{-1})	Sowing dates: 25th October	10th November	25th November	Means
		D x S x F			D x S x F
75	0	4145.80l-n	386.50l-n	330.80n	377.70
	120	581.30f-k	537.50g-k	612.50c-k	577.10
	140	585.30e-k	574.50f-k	526.30l-k	562.00
	160	645.80b-h	632.30b-l	544.30l-k	607.40
100	0	407.00l-n	421.00lm	333.00mn	387.00
	120	698.00a-c	654.50b-g	548.01k	633.50
	140	625.30c-j	716.00ab	558.30h-k	633.20
	160	671.50a-e	615.30c-k	646.00b-h	644.30
125	0	428.80l	498.00l	458.00l-n	402.90
	120	607.00d-k	624.80c-j	603.50d-k	61.80
	140	747.80a	676.30a-d	569.50g-k	664.50
	160	658.80a-f	571.30f-k	626.80c-l	618.90
		D x F			D x F
	0	415.20	411.80	340.60	389.20b
	120	628.80	605.60	588.00	607.40a
	140	652.80	655.60	551.30	619.90a
	160	658.70	606.30	605.70	623.50a
		D x S			D x S
75		557.00	532.70	503.40	531.00b
100		600.40	601.70	521.30	574.50a
125		609.10	575.10	539.40	574.50a
Mean (D)		588.80a	569.80a	521.40b	

Mean followed by different letters are significantly different from one another at $P \leq 0.05$

Table 2: Spike length (cm) of wheat variety Fakhre-Sarhad as affected by sowing dates (D), seed rates (S) and fertilizer levels (F)

Seed rate (Kg ha^{-1})	Fertilizer levels (Kg N ha^{-1})	Sowing dates: 25th October	10th November	25th November	Means
		D x S x F			D x S x F
75	0	11.00h-l	10.80j-l	10.70kl	10.80e
	120	12.10a-f	11.90c-g	10.90l-l	11.60bc
	140	12.40a-d	12.10a-f	10.80j-l	11.80bc
	160	12.00b-g	12.00b-g	11.90c-g	11.90abc
100	0	11.90c-g	11.70d-h	11.00h-l	11.50cd
	120	12.20a-f	12.80a	10.50l	11.80bc
	140	12.60a-c	11.90c-g	11.00h-l	11.80bc
	160	12.30a-e	11.30g-k	11.60e-l	11.70bc
125	0	11.60e-l	11.30g-k	10.40l	11.10de
	120	12.40a-d	11.70d-h	10.50l	11.50cd
	140	11.70d-h	12.50a-c	11.70d-h	12.00ab
	160	12.70ab	12.80a	11.50f-j	12.30a
		D x F			D x F
	0	11.50c	11.20c	10.70d	11.10c
	120	12.20a	12.10a	10.60d	11.70b
	140	12.20a	12.20a	11.20c	11.80ab
	160	12.30a	12.00b	11.60bc	12.00a
		D x S			D x S
75		11.90	11.70	11.10	11.50
100		12.20	11.90	11.10	11.70
125		12.10	12.10	11.00	11.70
Mean (D)		12.10a	11.80a	11.00b	

Mean followed by different letters are significantly different from one another at $P \leq 0.05$

due to the available for nitrogen in significant quantity to upkeep the plant health, which ultimately resulted proportional increase in spike length corresponding to the amount of fertilizer used when compared o the control plots. Rathi and Ramsingh (1973) reported that nitrogen application increase spike length when compared with control plots. Spikelets spike^{-1} contributes much towards final yield of the crop.

Significant ($P \leq 0.05$) effect for all factors except seed rate was observed on spikelets spike^{-1} (Table 3). Analysis of the data indicated that spikelets spike^{-1} was generally decreased as sowing dates were delayed. In case of 25th October sown crop, growth period was longer with due reason more assimilates were utilized in reproductive units like spikelets spike^{-1} . In case of nitrogen levels, spikelets spike$_{-1}$ decreased in those plots, where no nitrogen was applied (i.e. control plots). This decrease in number of spikelets spike^{-1} at control plots may be due to unavailability of required amount on N needed for vegetative growth and reproductive growth of the plant. These results are supported by Whing and Kemp (1980) who investigated that spikelets number increased with increasing in nitrogen due to increased rates of spikelets primordial production. In case of D x S interaction, 25th October sown crop seeded at 75 kg ha^{-1} increased spikelets spike^{-1}. Stoppler *et al.* (1990) revealed that decrease sowing rates compensated for early sowing.

Grains spike^{-1} being an important yield component was significantly affected by time of sowing. Favorable climatic conditions at early sowing lead to maximum grains spike^{-1} (Table 4). These results are in line with those reported by Ansary

Table 3: Spikelets spike^{-1} of wheat variety Fakhre-Sarhad as affected by sowing dates (D), seed rates (S) and fertilizer levels (F)

Seed rate (Kg ha^{-1})	Fertilizer levels (Kg N ha^{-1})	Sowing dates: 25th October	10th November	25th November	Means
		D x S x F			D x S x F
75	0	21.80c-f	20.40h-l	18.80n	20.30de
	120	23.30a	19.70k-n	20.20h-m	21.10bc
	140	23.00a-c	21.40e-h	19.40n	21.30b
	160	20.70f-k	20.30h-l	21.40e-h	20.80b-d
100	0	21.30f-l	21.00e-j	19.30l-n	20.50c-e
	120	22.00b-e	22.00b-e	19.40l-n	21.10bc
	140	21.10e-l	21.40e-h	20.40h-l	21.00bc
	160	21.70d-g	21.30e-l	20.11l-m	21.00bc
125	0	20.50g-l	20.20h-m	19.00mn	19.90e
	120	22.80a-d	23.30h-l	19.80j-n	21.00bc
	140	21.00e-j	21.40e-h	21.30e-l	21.20b
	160	23.10ab	21.70d-g	21.80c-f	22.20a
		D x F			D x F
	0	21.20b-d	20.50ef	19.00h	20.20b
	120	22.70a	20.60d-f	19.80g	21.10a
	140	21.70bc	21.40bc	20.30fg	21.10a
	160	21.80b	21.10c-e	21.10c-e	21.30
		D x S			D x S
75		22.20a	20.40d-f	19.90ef	20.80
100		21.50bc	21.40bc	19.80f	20.90
125		21.90ab	20.90cd	20.50de	21.10
Mean (D)		21.90a	20.90b	20.10c	

Mean followed by different letters are significantly different from one another at P ≤ 0.05

Table 4: Grains spike^{-1} of wheat variety Fakhre-Sarhad as affected by sowing dates (D), seed rates (S) and fertilizer levels (F)

Seed rate (Kg ha^{-1})	Fertilizer levels (Kg N ha^{-1})	Sowing dates: 25th October	10th November	25th November	Means
		D x S x F			D x S x F
75	0	57.40c-l	58.30b-h	60.90b-d	58.90c-e
	120	60.90cb-d	51.80ij	52.30ij	55.00g
	140	60.00b-f	62.30a-c	55.90d-j	59.40c-e
	160	62.50a-c	63.10ab	63.80ab	63.10ab
100	0	60.40b-e	55.60d-j	52.60ij	52.20e-g
	120	59.20b-f	63.50ab	62.20a-c	61.60a-c
	140	60.50b-e	59.70b-f	54.70f-j	58.30d-f
	160	58.50b-g	53.00g-j	54.40f-j	55.30fg
125	0	52.70h-j	62.20a-c	50.70j	55.20fg
	120	59.40b-f	54.90e-j	55.70d-j	56.60e-g
	140	55.80ab	63.50ab	62.00bc	60.40b-d
	160	63.20ab	67.70a	60.70b-d	63.80a
		D x F			D x F
	0	56.80	58.70	54.70	56.70c
	120	59.80	56.70	56.70	57.70bc
	140	58.80	61.80	57.50	59.40ab
	160	61.40	61.30	59.60	60.80a
		D x S			D x S
75		60.20ab	58.90bc	58.20b-d	59.10
100		59.60a-c	57.90b-d	55.90d	57.80
125		57.80b-d	62.00a	57.30cd	59.00
Mean (D)		59.20a	59.60a	57.10b	

Mean followed by different letters are significantly different from one another at P ≤ 0.05

et al. (1989) who concluded that delay in sowing suppressed the yield by reduced in grains spike^{-1} when compared with other treatments. Maximum spike length in these treatments, which gave rise to more spikelets and more grains spike^{-1} indicated better partitioning of assimilates during the period of vegetative phase treated with 160 kg N ha^{-1} produced maximum grains spike^{-1}, while minimum grains spike^{-1} were recorded from control plots.

Yield is an important criterion in evaluating the adoptability of a crop to an environmental variation. Mean values of the data indicated that grain yield was significant (P ≤ 0.05) affected by different sowing dates and fertilizer levels (Table 5). Analysis of the data revealed that early sowing dates favored the maximum partitioning of photosynthates when compared to the late sowing and gave maximum grain yield. Furthermore, there was sufficient time available for the plant growth and development at early sowing. Similar results have also been reported by Razzaq *et al*. (1986), Zeb *et al*. (1987) and Iftikhar *et al*. (1992), they concluded that grain yield decreased progressively with delay in sowing time. It can also be seen from the mean values of the data that the response of grain yield to seed rates was non significant. All N levels increased grain yield when compared to control plots. The highest grain yield of wheat crop with maximum level of N could be attributed to availability of plant nutrients in abundant amount resulting in more tillers, longer spikes and more grains spike^{-1} which ultimately led to maximum grain yield. These results are

Table 5: Grain yield (kg ha^{-1}) of wheat variety Fakhre-Sarhad as affected by sowing dates (D), seed rates (S) and fertilizer levels (F)

		Sowing dates			
		25th October	10th November	25th November	Means
Seed rate (Kg ha^{-1})	Fertilizer levels (Kg N ha^{-1})	D x S x F			D x S x F
75	0	5546.00	5313.00	4427.00	5095.00
	120	8583.00	6167.00	5750.00	6833.00
	140	8042.00	6375.00	5208.00	6542.00
	160	8667.00	6583.00	5333.00	6861.00
100	0	4979.00	5052.00	4531.00	4854.00
	120	8542.00	6709.00	5417.00	6889.00
	140	7875.00	7292.00	5625.00	6931.00
	160	7667.00	6583.00	5250.00	6500.00
125	0	4760.00	4583.00	3958.00	4434.00
	120	7459.00	7425.00	5959.00	6947.00
	140	8584.00	6750.00	5708.00	7014.00
	160	7625.00	7000.00	6292.00	6972.00
		D x F			D x F
	0	5095.00cd	4983.00d	4306.00e	4794.00b
	120	8195.00a	6767.00b	5709.00c	6890.00a
	140	8167.00a	6806.00b	5514.00cd	6829.00a
	160	7986.00a	6722.00b	5625.00cd	6778.00a
		D x S			D x S
75		7709.00	6109.00	5180.00	6333.00
100		7266.00	6409.00	5206.00	6293.00
125		7107.00	6440.00	5479.00	6342.00
Mean (D)		7361.00a	6319.00ab	5288.00b	

Mean followed by different letters are significantly different from one another at $P \leq 0.05$

Table 6: Biological yield (kg ha^{-1}) of wheat variety Fakhre-Sarhad as affected by sowing dates (D), seed rates (S) and fertilizer levels (F)

		Sowing dates			
		25th October	10th November	25th November	Means
Seed rate (Kg ha^{-1})	Fertilizer levels (Kg N ha^{-1})	D x S x F			D x S x F
75	0	14740.00	11042.00	8177.00	11319.00
	120	24334.00	16875.00	17667.00	19625.00
	140	23750.00	19667.00	18250.00	20556.00
	160	24708.00	17125.00	16917.00	19583.00
100	0	14500.00	11094.00	7760.00	11118.00
	120	24458.00	19458.00	15292.00	19736.00
	140	24042.00	20375.00	16667.00	20361.00
	160	22959.00	18083.00	16542.00	19195.00
125	0	16125.00	11302.00	9844.00	12424.00
	120	22834.00	19875.00	18042.00	20250.00
	140	223667.00	19709.00	19167.00	20847.00
	160	24333.00	19708.00	20875.00	21639.00
		D x F			D x F
	0	15122.00	11146.00	8594.00	11620.00b
	120	23875.00	18736.00	17000.00	19870.00a
	140	23820.00	19917.00	18208.00	20588.00a
	160	24000.00	18306.00	18111.00	20139.00a
		D x S			D x S
75		21883.00	16177.00	15253.00	17771.00b
100		21490.00	17253.00	14065.00	17602.00b
125		21740.00	17648.00	16982.00	18790.00a
Mean (D)	21704.00 a	17206.00b	15433.00b		

Mean followed by different letters are significantly different from one another at $P \leq 0.05$

confirmed by Rathi and Ramsingh (1973) and Ahmad *et al.* (1994), who concluded that grain yield increased with increase in fertilizer rates.

Biological yield is an important factor because farmers are also interested in straw in addition to grain. Mean values of the data indicated (Table 6) that variation in biological yield was significant ($P \leq 0.05$) due to different sowing rates and fertilizer levels while their interaction had a non significant effect. Biological yield was maximum at early sowing time due to long growing season during which efficient photosynthetic activities were conducted and thus increased total dry matter production of the crop. Dry matter production decreased when sowing was delayed (Beutler and Foote, 1963). Higher seed rate due to more seed sown unit area^{-1} resulted in higher emergence unit area^{-1} and have produced maximum biological yield. Ghaffar and Shahidullah (1987) reported that straw yield increases with increase in seed rate. When the effect of different n levels was taken into an account, it was revealed that increasing levels of N increased biological yield. This may be due to vigorous vegetative growth when N level was increased. These results are in agreement with those of Ahmad *et al.* (1994) and Shah (1984), who reported that dry matter production increased with increased level of N.

Significant ($P \leq 0.05$) differences in harvest index were noted due to seed rates and N levels, while the effect of sowing dates was non significant (Table 7). Data revealed that lower seed rates increased harvest index when compared with higher biological

Table 7: Harvest index (%) of wheat variety Fakhre- Sarhad as affected by sowing dates (D), seed rates (S) and fertilizer levels (F)

Seed rate(Kg ha^{-1})	Fertilizer levels (Kg N ha^{-1})	Sowing dates 25th October	10th November	25th November	Means
		D x S x F			D x S x F
75	0	38.00	49.00	54.70	47.20a
	120	36.60	36.80	33.40	35.60b
	140	34.00	33.90	28.70	32.20b
	160	35.40	38.30	33.00	35.20b
100	0	34.60	46.00	61.00	47.20a
	120	35.90	34.80	35.70	35.40b
	140	34.20	36.20	35.20	35.20
	160	34.10	36.20	31.80	34.00b
125	0	29.60	40.90	40.20	36.90b
	120	32.50	38.00	35.10	35.20b
	140	36.70	35.10	30.20	34.00b
	160	32.80	35.80	30.10	32.90b
		D x F			D x F
	0	45.30b	45.30b	51.90a	43.80a
	120	36.50c	36.50c	34.70cd	35.40b
	140	35.10cd	35.10cd	31.30d	33.80b
	160	36.70c	36.70c	31.60d	34.10b
		D x S			D x S
75		36.00	39.50	37.40	37.60a
100		34.70	38.30	40.90	38.00a
125		32.90	37.40	33.90	34.70b
Mean (D)		34.50	38.40	37.40	

Mean followed by different letters are significantly different from one another at $P \leq 0.05$

yield at higher seed rates. It might be due to higher biological yield at higher seed rate and had thus decreased harvest index. Mean values of the data also indicated that 25th November sown crop applied with no N gave maximum harvest index in case of D x F interaction. In case of S x F interaction, lower seed rates (75 or 100 kg ha^{-1}) applied with no nitrogen increased harvest index.

These results lead to the conclusion that wheat Cv. Fakhre- Sarhad performs better if it is sown either in last week of October or in last week of November. The seed rate effect was non significant but it should not be used less than 100 kg ha^{-1}. In case of fer tilizer treatments, control plots had poor yield and 160 kg N ha^{-1} seems to be an optimum level due to more tillers and grains spike^{-1}.

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