YIELD AND YIELD COMPONENTS OF WHEAT AS AFFECTED BY DIFFERENT SEED RATES AND NITROGEN LEVELS

WAJID ALI SHAH*, HIMAYAT ULLAH KHAN**, SHAZMA ANWAR**
and KHALID NAWAB***

* *Faculty of Agriculture, Gomal University, D.I. Khan – Pakistan.*
** *Department of Agronomy, Khyber Pakhtunkhwa Agricultural University, Peshawar – Pakistan..*
*** *Department of Agricultural Extension Education & Communication, Khyber Pakhtunkhwa Agricultural University, Peshawar – Pakistan.*

ABSTRACT

The present study was designed to find out the effect of different seed rates and nitrogen levels on wheat. The experiment was laid out in Split plot arrangement with 4 replications. The plot size of 4 x 1.8 m^2 was maintained. Prior to sowing Wheat variety Lakki- J03 was sown on a well prepared seed bed on 2nd week of Nov. in 2003. at Agriculture Research Station Serai Nourang, Bannu, Khyber Pakhtunkhwa - Pakistan. Adequate plant protection measures were made during the crop growing period. Keeping in view the soil condition and physical appearance of crop, five numbers of irrigations were applied to all the plots uniformly. Observations on number of tillers m^{-2}, spikes m^{-2}, number of grains $spike^{-1}$, 1000 grain weight (g), biological yield (kg ha^{-1}), grains yield (kg ha^{-1}) and economic analysis were recorded. Five seed rates (S_1 = 60 kg ha^{-1}, S_2 = 80 kg ha^{-1}, S_3 = 100 kg ha^{-1}, S_4 = 120 kg ha^{-1} and S_5 = 140 kg ha^{-1}) and five nitrogen doses (N_0 = Control, N_1 = 40 kg ha^{-1}, N_2 = 80 kg ha^{-1}, N_3 = 120 kg ha^{-1} and N_5 = 140 kg ha^{-1}) were applied during experiment. Analysis of the data recorded from the irrigation treatments showed that maximum (334.85) tillers m^{-2}, spikes m^{-2} (326.00), grains $spike^{-1}$ (60.80), 1000-grain weight (41.91 g), grain yield (3957.64 kg ha^{-1}), biological yield (10172.40 kg ha^{-1}), net income (Rs. 50225.00), BCR (4.28 %) and MRR % (428.27) was noted from the plots which were seeded with 120 kg ha^{-1}. Statistical analysis of the data also revealed that maximum (348.00) tillers m^{-2}, spikes m^{-2} (332.95), grains $spike^{-1}$ (63.90), 1000-grain weight (42.19 g), grain yield (4145.14 kg ha^{-1}), biological yield (10579.75 kg ha^{-1}), net income (Rs. 52831.00), BCR (4.46 %) and MRR % (446.21) was noted from the plots fertilized with 120 kg N ha^{-1}. In case of interaction between seed rate and nitrogen, it was observed that maximum (380.75) tillers m^{-2}, spikes m^{-2} (372.25), grains $spike^{-1}$ (68.25), 1000-grain weight (44.20 g), grain yield (4663.20 kg ha^{-1}), biological yield (11270.00 kg ha^{-1}), net income (Rs. 60179.00), BCR (4.88 %) and MRR % (488.25) was noted from the plots seeded with 120 kg ha^{-1} seed rate and fertilized with 120 kg N ha^{-1}.. From the above results, it is concluded that to get more yield and economic profit, for wheat crop use 120 kg ha^{-1} seed rate and fertilized with 120 kg N ha^{-1}.

Key Words: **Seed rates, nitrogen levels, yield, yield components**

Citation: Shah, W.A., H.U. Khan, S. Anwar and K. Nawab. 2011. Yield and yield components of wheat as affected by different seed rates and nitrogen levels. Sarhad J. Agric. 27(1): 17-25

INTRODUCTION

Wheat requirement in Pakistan are growing at an exorbitant rate. Wheat being the staple food of general populace plays a vital role in socio-economic system of Pakistan. During last 60 years every government has given top priority to increase wheat production. Wheat occupies 1st position by covering about 68 % of the annual food crop area in the country. But the yield average is too low when compared to that of advanced countries of the world.

Among the several factors responsible for low yield in Pakistan, low plane popular, use of unbalanced rate of fertilizers and inappropriate seed rats are important and research on these limiting factors will surely lead to high yields. Optimum seed rate is most important for maximum yield of crop. If more seed rate is used, plant population will be more and there will be competition among plants for water, nutrients and sunlight resulting in low quality and low yield. If less seed rate is used yield will be less due to lesser number of plants unit $area^{-1}$. (Hamid *et al.*, 2002.) Khan *et al.*, (2002) concluded that maximum grain yield was obtained with the increase in seed rate while minimum grain yield was produced by low seed rate. Ram *et al.*, (1988) reported that when wheat was sown 140 or 160 kg seed ha^{-1} gave average yields of 4.02 and 4.05 t ha^{-1} compared with 3.83 and 3.69 t ha^{-1} with sowing rates of 120 and 140 kg ha^{-1}, respectively. Islam *et al.*, (2002) reported that percentage of effective tillers increased with highest sowing rate due to which grain yield also increased. Barriage *et al.*, (1980) seeded wheat at the rate of 100, 125, 150, 175 and 200 kg ha^{-1} and observed that grain yield increased with the increase in the seed rate. Cheema *et al.*, (2003) in an experiment compared different seedling rates and reported the highest grain yield with 100 kg seed ha^{-1}. Singh and Uttam (1994) reported that seeding rates of 100,125 and 150 kg seed ha^{-1}gave average grain yield. The number of kernels $head^{-1}$ and weight $kernal^{-1}$ showed slight decrease with increase in seed rate. Similarly nitrogen is very important for plant. It plays an important role in crop life. It is necessary for protein synthesis. In case of nitrogen deficiency, drying and firing of leaves occur, poor growth is achieved, grain poorly filled and yield

is severely affected. Excess nitrogen, in particular, is also not good for wheat crop; it causes an early exhaustion of soil moisture, induces lodging, reduces resistance to leaf diseases, and delay maturity.

Roy and Pradhan (1991) concluded that increasing N rate increased number of tillers plants^{-1} and ears number m^{-2} 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). Narang *et al*., (2000) found that grain yield increased with increasing in nitrogen application. Grain yield, spikes m^{-2} and lodging increased with increasing N rate. Shah (1997) investigated that split application of N fertilizer has been found effective in increasing crop yields compared with full application of N fertilizer. Grain and straw yield were increased with increase in nitrogen levels. (Sabir *et al*., 2002).

Among the different nutrients nitrogen is the key input for achieving higher production. Wheat requires nitrogen throughout its growing period. Considering the above facts, the present study has been undertaken to fulfil the following objectives:

i. To find out the optimum seed rate for healthy growth and higher yield of wheat.
ii. To determine the optimum dose of nitrogen for better growth and higher yield of wheat and
iii. To determine the interaction, if any, between seed rate and nitrogen for maximum yield of wheat.

MATERIALS AND METHODS

The present study was designed to find out the effect of different seed rates and nitrogen levels on wheat variety Lakki- J03.

The following treatments included in this study were.

A. Seed rates (kg ha^{-1})
S_1= 60 S_2= 80 S_3=100 S_4=120 S_5=140
B. Nitrogen levels (kg ha^{-1})
N_0= Control N_1= 40 N_2= 80 N_3= 120 N_4= 140

The experiment was laid out in Split plot arrangement with 4 replications. The plot size of 4 x 1.8 m^2 (row x row diastance was 30 cm) was maintained. Wheat variety Lakki- J03 was sown on a well prepared seed bed in 2nd week of Nov. in 2003. The fertilizer dose of phosphorus 90 kg ha^{-1} was used in the form of Single Super Phosphate and different nitrogen doses were applied in the form of Urea. All phosphorus fertilizer was used during sowing time. Different nitrogen doses were applied in two split doses i.e. 50 % N at sowing time and 50 % at tillering stage. Adequate plant protection measures were made during the crop growing period. Keeping in view the soil condition and physical appearance of crop, five numbers of irrigations were applied to all the plots uniformly so that the wheat. Hand weeding was done to keep the crop free of weeds. At maturity four rows of the plot were harvested and tied into small bundle for sun drying for about one week. The dried bundles were threshed for collection of grain yield. Prior to sowing, a composite soil sample from the experimental area upto 30 cm depth was collected and analyzed for physico-chemical characteristics given in Table I.

Table I ***Soil physico-chemical properties***

Property	Unit	Value
Clay	%	52.30
Silt	%	35.60
Sand	%	12.00
Textural class	%	Clay
pH	%	8.35
EC	D Sm^{-1}	2.60
Organic matter	-	0.85
Total Nitrogen	-	0.036
Available P	Ppm	6.50
Available K	Ppm	91.00

(Source: Agric. Research Station Serai Nourang Bannu NWFP- Pakistan)

The following observations were recorded:

i. Number of tillers m^{-2} ii. Spikes m^{-2}
iii. Number of grains spike^{-1} iv. 1000 grain weight (g)
v. Biological yield (kg ha^{-1}) vi. Grains yield (kg ha^{-1})
vii. Economic analysis

Procedure for the Data Recording

The following procedures were adopted for recording the data on individual parameter of the crop. Number of tillers m^{-2} was recorded by counting the number of tillers m^{-2} in one meter length area of the three central rows in each subplot and their mean was then calculated. Spikes m^{-2} were counted in 1 meter row length at three different places in each sub plot and were converted into spikes m^{-2}. For calculating number of grain $spike^{-1}$, five spikes $treatment^{-1}$ were randomly selected in each sub plot and then their grains were counted and divided by 5 to get the average grains $spike^{-1}$. For 1000-grain weight, two samples of thousand grains were counted from threshed clean lot of each treatment, their weight was taken and average calculated. Four central rows were harvested, it was air dried and weighed to record biological yield which was calculated per hectare basis. Four rows were harvested for grain yield and threshed. After threshing the grains were cleaned, dried and weight to record the grain yield.

Economic Analysis

The profound analysis is termed as marginal rate of return (MRR), which were calculated that each incremental increase in cost was obtain a given increase in net benefit. For example, MRR = 95%, which indicate that for every Rs.1.00 invested, one can expect to recover the Rs.1.00 and obtain an additional Rs.0.95.

$$\text{MRR \%} = \frac{\text{Marginal increase in net benefit}}{\text{Marginal increase in net benefit}} \times 100$$

Marginal increase in cost

Benefit Cost Ratio	=	Output (Rs ha^{-1})/Input (Rs ha^{-1})
% Increase in benefit	=	Individual benefit/total benefit x 100
Net Income	=	Total output - Total input
% Increase in cost	=	Individual cost/total cost x 100

(With the increase in total cost, there is increase in net income. but when the total cost exceeds the net income or with the increase in total cost, there is decrease in net income, and then it is called dominated treatments).

Statistical Analysis

Statistical analysis of the two years data was done at 1 % level of probability using Duncan's Multiple Range Test (DMRT) to test the difference between the individual means. (Steel and Torrie, 1984)

RESULTS AND DISCUSSION

Tillers m^{-2}

Data presented in Table II indicated that seed rate had significant ($P \leq 0.01$) effect on tillers m-^{2}. It is evident from the data that maximum (334.85) tillers m^{-2} were noted when plots were seeded with 120 kg ha^{-1} (S_4), while minimum tillers m^{-2} (280.50) were recorded when 60 kg ha^{-1} seed rate was used (S_1). The tillering potential was much higher at higher seed rate, when compared to lower seed rate. It might be due to that the number of tillers m^{-2} decreased with increase in seeding rate, because, by increasing seed rate per unit area, the inter plant competition for space, nutrient, moisture and sun light increases which results in lower tillers m^{-2}. Similar results were also reported by Chatha *et al.*, (1986) and Ibrar (1999), who found maximum tillering at 120 kg ha^{-1} seed rates then at lower seed rates.

Table II ***Tillers m^{-2} of wheat as affected by different seed rate and nitrogen levels***

	Nitrogen levels (kg ha^{-1})					
Seed rate (kg ha^{-1})	**N_0**	**N_1**	**N_2**	**N_3**	**N_4**	**Mean**
S_1	207.00 M	224.50 M	218.25 M	265.25 L	261.50 L	280.50 D
S_2	262.50 L	280.25 KL	292.25 JK	315.00 HI	307.75 H-J	300.40 C
S_3	296.75 I-K	316.00 G-I	320.75 E-H	342.00 C-E	325.25 E-H	301.75 C
S_4	318.75 F-H	340.50 C-E	340.00 C-F	380.75 A	360.00 A-C	334.85 A
S_5	317.50 G-I	340.75 C-E	337.50 D-G	371.25 AB	357.50 B-D	322.40 B
Mean	235.30 D	291.55 C	320.15 B	348.00 A	344.90 A	

LSD ($P \leq 0.01$) for Seed rate: 12.32
LSD ($P \leq 0.01$) for Nitrogen levels: 11.14
LSD ($P \leq 0.01$) for interaction: 21.70

The data further showed that different nitrogen levels had significantly ($P \leq 0.01$) affected tillers m^{-2}. It is clear from the data that during 2003-04, maximum (348.00) tillers m^{-2} were noted when 120 kg N ha^{-1} was used

(N_3), followed by N_4 (140 kg N ha^{-1}) which was statistically similar to N_3, while minimum (235.30) tillers m^{-2} were recorded with no nitrogen fertilizer (N_0). This might be due to increased nitrogen rate, therefore, led to greater stimulation of vegetative growth. All fertilizer levels significantly affected vegetative and reproductive growth of the plant depending upon the availability of needed nutrition which leads to proportional increase in tillers m^{-2}. These results are also in conformity with Ayoub *et al.*, (1994), who reported that 120 kg N ha^{-1} gave significantly the highest tillers m^{-2}.

The data also indicated that interaction between seed rate and nitrogen levels was significantly ($P \leq 0.01$) affected. Data showed that maximum (380.75) tillers m^{-2} were noted when 120 kg ha^{-1} seed rate and 120 kg N ha^{-1} was used (S_4N_3), while less (207.00) tillers m^{-2} were noted from plots in which seed rate was used 60 kg ha^{-1} in control plots (S_1N_0).

Spikes m^{-2}

Analysis of the data presented in Table III indicated that spikes m^{-2} were significantly ($P \leq 0.01$) affected by different seed rate Maximum (326.00) spikes m^{-2} were noted for plots seeded with 120 kg ha^{-1} (S_4), while minimum (254.10) spikes m^{-2} were recorded from plots seeded with 60 kg ha^{-1} (S_1). These results are in conformity with the findings of Marwat *et al.*, (1989).

Table III ***Spikes m^{-2} of wheat as affected by different seed rate and nitrogen levels***

Seed rate (kg ha^{-1})	Nitrogen levels (kg ha^{-1})					Mean
	N_0	N_1	N_2	N_3	N_4	
S_1	166.00 N	187.50 M	195.00 M	244.25 KL	234.50 L	254.10 E
S_2	248.25 K	268.25 J	280.25 HI	307.75 DE	288.25 GH	271.65 D
S_3	276.00 IJ	289.25 GH	314.75 D	334.75 C	316.50 D	290.55 C
S_4	285.25 G-I	303.25 EF	328.25 C	372.25 A	359.50 B	326.00 A
S_5	295.00 FG	310.00 DE	334.50 C	371.00 A	354.25 B	310.60 B
Mean	205.45 D	278.55 C	306.25 B	332.95 A	329.70 A	

LSD ($P \leq 0.01$) for Seed rate: 6.15
LSD ($P \leq 0.01$) for Nitrogen levels: 5.55
LSD ($P \leq 0.01$) for interaction: 5.55

Data further revealed that spikes m^{-2} were significantly ($P \leq 0.01$) affected by different nitrogen levels. It is clear from the data that maximum (332.95) spikes m^{-2} were noted for plots treated with 120 kg N ha^{-1} (N_3), followed by plots in which 140 kg N ha^{-1} (N_4) was applied which was statistically similar to N_3 (329.70 spikes m^{-2}), while minimum (205.45) spikes m^{-2} were recorded from control plots (N_0). Similar results were also reported by Hussain *et al.*, (1984) who reported that number of fertile shoots m^{-2} increased with increasing N rate.

The data also indicated that interaction between seed rate and nitrogen levels was significantly ($P \leq 0.01$) affected. Data showed that maximum (372.25) spikes m^{-2} were noted when 120 kg ha^{-1} seed rate and 120 kg N ha^{-1} was used (S_4N_3), which was statistically similar to S_4N_4, while less (166.00) spikes m^{-2} were noted from plots in which seed rate was used 60 kg ha^{-1} in control plots (S_1N_0).

Grains Spike^{-1}

The potential of wheat spike is determined by the grains spike^{-1} which is an important yield component of grain yield. The data on grains spike^{-1} of wheat is influenced by different seed rate. Data presented in table IV indicated that seed rate had significant ($P \leq 0.01$) effect on number of grains spike^{-1}. It is evident from the data that maximum (60.80) grains spike^{-1} were noted when plots were seeded with 120 kg ha^{-1} (S_4), while minimum (51.25) number of grains spike^{-1} were recorded when 60 kg ha^{-1} seed rate was used (S_1). Similar results were also reported by Marwat *et al*., (1989), who reported that higher seed rates produced significant decrease in the number of grains spike^{-1}.

Table IV ***Grains spike^{-1} of wheat as affected by different seed rate and nitrogen levels***

Seed rate (kg ha^{-1})	Nitrogen levels (kg ha^{-1})					Mean
	N_0	N_1	N_2	N_3	N_4	
S_1	44.75 K	47.75JK	50.75 IJ	52.75 HI	51.25 IJ	51.25 D
S_2	50.50 IJ	53.50 HI	54.25 G-I	56.25F-H	56.50 E-H	55.85 C
S_3	50.75 IJ	54.75 G-I	59.75 C-F	60.75 C-E	58.50 D-G	58.55 B
S_4	56.25 F-H	63.00 BC	65.50 AB	68.25 A	66.50 AB	60.80 A
S_5	54.00 HI	60.25 C-F	62.50 B-D	66.00 AB	64.00 A-C	59.35 B
Mean	49.45 E	54.20 D	56.90 C	63.90 A	61.35 B	

LSD ($P \leq 0.01$) for Seed rate: 1.35
LSD ($P \leq 0.01$) for Nitrogen levels: 2.18
LSD ($P \leq 0.01$) for interaction: 4.26

The increase in number of grains spike^{-1} with decrease in seed rate might be due to the plant nutrients present in the soil were enough for the vegetative growth and grain formation when there were less number of plants per unit area. They were less competitive for all essential elements as compared to the greater number of plants per unit area.

The data further showed that different nitrogen levels had significantly ($P \leq 0.01$) affected grains spike^{-1}. It is clear from the data that maximum (63.90) number of grains spike^{-1} were noted when 120 kg N ha^{-1} was used (N_3), while minimum (49.45) number of grains spike^{-1} were recorded with no nitrogen fertilizer (N_0). These results are in agreement with Ibrar. (1999), who reported that grains spike^{-1} increased at 120 kg N ha^{-1}. These results are in agreement with Geleto *et al.*, (1995), who reported that grains spike^{-1} increased at 120 kg N ha^{-1}.

The data also indicated that interaction between seed rate and nitrogen levels was significantly ($P \leq 0.01$) affected. Data showed that maximum (68.25) number of grains spike^{-1} were noted when 120 kg ha^{-1} seed rate and 120 kg N ha^{-1} was used (S_4N_3), while less (44.75) grains spike^{-1} were noted from plots in which seed rate was used 60 kg ha^{-1} in control plots (S_1N_0).. These findings are in conformity with the results of Ijaz *et al.*, (2002)

1000-grains weight (g):

The potential of wheat spike is determined by the number of grains spike^{-1} which is an important yield component of grain yield. Data presented in table V indicated that seed rate had significant ($P \leq 0.01$) effect on 1000-grains weight. It is evident from the data that maximum 1000-grains weight (41.91 g) were noted when plots were seeded with 120 kg ha^{-1} (S_4), while minimum 1000-grains weight (38.30 g) were recorded when 60 kg ha^{-1} seed rate was used (S_1). These results are in conformity with Marwat *et al.*, (1989), who also reported that 1000 grain weight decreased with increasing in seeding densities.

Table V ***1000-grain weight (g) of wheat as affected by different seed rate and nitrogen levels***

	Nitrogen levels (kg ha^{-1})					
Seed rate (kg ha^{-1})	**N0**	**N1**	**N2**	**N3**	**N4**	**Mean**
S1	35.35 K	38.20 IJ	37.40 J	39.13 HI	36.80 JK	38.30 D
S2	38.23 IJ	40.90 D-F	40.83 D-F	42.18 B-D	40.00 F-H	41.23 AB
S3	38.03 IJ	41.93 B-E	41.28 C-F	42.73 A-C	40.53 E-H	40.90 BC
S4	39.20 G-I	42.98 AB	42.45 BC	44.20 A	42.13 B-D	41.91 A
S5	40.70 D-G	42.15 B-D	42.53 BC	41.34 C-F	42.53 BC	40.40 C
Mean	37.38 C	40.43 B	40.90 B	42.19 A	41.85 A	

LSD ($P \leq 0.01$) for Seed rate: 0.79
LSD ($P \leq 0.01$) for Nitrogen levels: 0.79
LSD ($P \leq 0.01$) for interaction: 1.54

The reduced grain weight with higher seed rate might be due to greater competition among plants in plots seeded at the highest rate as compared to plants in plots where less seed rate was used.

The data further showed that different nitrogen levels had significantly ($P \leq 0.01$) affected tillers m^{-2}. It is clear from the data that heaviest (42.19 g) 1000-grains weight was noted when 120 kg N ha^{-1} was used (N_3), while lighter (37.38 g) 1000-grains weight was recorded with no nitrogen fertilizer (N_0). These results are in agreement with those of Memon *et al.*, (1989).

The variations in 1000 grain weight is mainly due to variations in spikes m^{-2}, as spikes population increases, then the inter and intra plant competition increases therefore higher doses of nitrogen leads to higher vegetative growth but decreases the grain weight.

The data also indicated that interaction between seed rate and nitrogen levels was significantly ($P \leq 0.01$) affected. Data showed that maximum (44.20 g) 1000-grains weight was noted when 120 kg ha^{-1} seed rate and 120 kg N ha^{-1} was used (S_4N_3), while minimum (35.35 g) 1000-grains weight was noted from plots in which seed rate was used 60 kg ha^{-1} in control plots (S_1N_0). Similar trend was observed in 2004-05. These results are in conformity with Marwat *et al.*, (1989),

Grain Yield (kg ha^{-1})

Analysis of the data presented in Table VI indicated that grain yield was significantly ($P \leq 0.01$) affected by different seed rate. It is evident from the data that maximum (3957.64 kg ha^{-1}) grain yield was noted for plots seeded with 120 kg ha^{-1} (S_4), while minimum (2784.03 kg ha^{-1}) grain yield was recorded from plots seeded with 60 kg ha^{-1} (S_1). Similar trend was observed in 2004-05. These results are in agreement with Chatta *et al.*, (1986), Ibrar (1999),

Hameed *et al*., (2003) and Ijaz *et al*., (2003), who reported that grain yield increased as seed rate increased and the highest grain yield was noted in plots seeded at the rate of 120 kg ha^{-1}.

Table VI ***Grain yield (kg ha^{-1}) of wheat as affected by different seed rate and nitrogen levels***

Seed rate (kg ha-1)	Nitrogen levels (kg ha-1)					Mean
	N0	N1	N2	N3	N4	
S1	2152.78 I	2291.67 HI	2465.28 G-I	2847.22 D-I	2638.89 F-I	2784.03 C
S2	2361.11 G-I	3194.45 B-I	3618.05 A-G	3958.33 A-E	2916.67 C-I	3169.43 BC
S3	2878.47 C-I	3437.50 A-H	4062.50 A-D	4569.45 A	3555.56 A-H	3608.33 AB
S4	3750.00 A-F	3798.61 A-F	4458.34 AB	4663.20 A	4055.55 A-D	3957.64 A
S5	2777.78 E-I	3124.95 C-I	3437.50 A-H	3750.00 A-F	4131.94 A-C	3459.72 A-C
Mean	2479.17 C	3209.72 B	3700.69 AB	4145.14 A	3444.43 B	

LSD ($P \leq 0.01$) for Seed rate: 677.60
LSD ($P \leq 0.01$) for Nitrogen levels: 571.00
LSD ($P \leq 0.01$) for interaction: 1277.00

Data further revealed that grain yield was significantly ($P \leq 0.01$) affected by different nitrogen levels. It is clear from the data that maximum (4145.14 kg ha^{-1}) grain yield was noted for plots treated with 120 kg N ha^{-1} (N_3), while minimum (2479.17) grain yield was recorded from control plots (N_0). This might be due to adequate supply of nutrients during grain filling duration. Similar results were reported by Khan *et al.*, (2000), who stated that N at 120 kg ha^{-1} resulted in higher yield and yield components than at 80 and 100 kg N ha^{-1}.

The data also indicated that interaction between seed rate and nitrogen levels was significantly ($P \leq 0.01$) affected Data showed that maximum (372.25) spikes m^{-2} were noted when 120 kg ha^{-1} seed rate and 120 kg N ha^{-1} was used (S_4N_3), which was statistically similar to S_4N_4, while less (166.00) spikes m^{-2} were noted from plots in which seed rate was used 60 kg ha^{-1} in control plots (S_1N_0). These results are in agreement with the findings of Farooq *et al*., (1989) and Hussain *et al*., (1984).

Biological Yield (kg ha^{-1})

Biological yield is an important factor because farmers are also interested in straw in addition to grain. It can be inferred from the data showed in table VII indicated that biological yield was significantly ($P \leq 0.01$) affected by various seed rate. It is evident from the data that maximum (10172.40 kg ha^{-1}) biological yield was noted when plots were seeded with 120 kg ha^{-1} (S_4), followed by plots seeded with 80 and 140 kg ha^{-1} (10006.15 and 10094.05 kg ha^{-1}), which were statistically similar to S_4, while minimum biological yield (8738.45 kg ha^{-1}) was recorded when 60 kg ha^{-1} seed rate was used (S_1). These results are in agreement with Marwat *et al*., (1989), Ghaffar and Shahidullah (1987) stated that the increase in biological yield with higher seed rate might be due to more number of plants per unit area, though with reduced tillers.

Table VII ***Biological yield (kg ha^{-1}) of wheat as affected by different seed rate and nitrogen levels***

Seed rate (kg ha^{-1})	Nitrogen levels (kg ha^{-1})					Mean
	N0	N1	N2	N3	N4	
S1	6741.25 I	7579.25 H	7791.75 H	8163.50 H	7803.75 H	8738.45 C
S2	8834.00 G	9708.75 EF	10214.50 C-E	10216.25 C-E	10332.50 B-D	9417.65 B
S3	9046.25 G	9846.25 DE	10351.75 B-D	10704.75 A-C	10283.00 B-E	10006.15 A
S4	9926.75 DE	10010.00 DE	10882.50 AB	11270.00 A	10568.00 AB	10172.40 A
S5	9144.00 FG	9944.00 DE	10790.25 A-C	10809.50 A-C	10781.00 A-C	10094.05 A
Mean	7615.90 C	9861.20 B	10046.40 B	10579.75 A	10225.45 AB	

LSD ($P \leq 0.01$) for Seed rate: 382.60
LSD ($P \leq 0.01$) for Nitrogen levels: 273.90
LSD ($P \leq 0.01$) for interaction: 612.50

Seed Rate (kg ha^{-1})
S_1= 60 S_2= 80 S_3= 100 S_4= 120 S_5= 140
Nitrogen Levels (kg ha^{-1})
N_0= Control N_1= 40 N_2= 80 N_3= 120 N_4= 140

Seed Rate (kg ha^{-1})
S_1= 60 S_2= 80 S_3= 100 S_4= 120 S_5= 140
Nitrogen Levels (kg ha^{-1})
N_0= Control N_1= 40 N_2= 80 N_3= 120 N_4= 140

As biological yield is a product of number of tillers m^{-2} and tillers weight including spike weight and grain weight, so the differences in biological yield could be variation in tillers m^{-2} and tiller weight. Both of these have been differentially affected by the soil and environmental conditions.

The data further showed that different nitrogen levels had significantly ($P \leq 0.01$) affected biological yield. It is clear from the data that maximum (10579.75 kg ha^{-1}) biological yield were noted when 120 kg N ha^{-1} was used (N_3), while minimum biological yield (7615.90 kg ha^{-1}) were recorded from control plots (N_0). The increase in biological yield with increase in nitrogen levels may be due to the effect of nitrogen on vegetative growth of wheat as well as increase in tillers number with higher rates of nitrogen. These results are in conformity with Geleto *et al*., (1995), who stated that biological yield and most grain yield components increased with 120 kg N ha^{-1}.

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The data also indicated that interaction between seed rate and nitrogen levels was significantly ($P \leq 0.01$) affected. Data showed that maximum (11270.00 kg ha^{-1}) biological yield were noted when 120 kg ha^{-1} seed rate and 120 kg N ha^{-1} was used (S_4N_3), while minimum biological yield (6741.25 kg ha^{-1}) were noted from plots in which seed rate was used 60 kg ha^{-1} in control plots (S_1N_0).

Economic Analysis

Data presented in Table VIII indicate the economic analysis of wheat as affected by various seed rates and different N levels. It is clear from the data that when plots were seeded with 120 kg ha^{-1} produced maximum (Rs. 50225.00) net income, while plots in which seed rate was used @ 60 kg ha^{-1} noted minimum (Rs. 34120.00) net profit. When the nitrogen trials were studied, it was noted that plots fertilized with 120 kg N ha^{-1}, recorded highest net profit (Rs. 52831.00). Lowest net income was noted from control plots (Rs. 28556.00). In case of interaction between seed rate and nitrogen levels, maximum (Rs. 60179.00) net profit was noted in the combination of 120 kg ha^{-1} seed rate and 120 kg N ha^{-1}, while minimum (Rs. 23593.00) was noted from plots seeded with 120 kg ha^{-1} and no nitrogen fertilizer was applied.

The data also revealed that BCR (benefit cost ratio) was higher when seed rate was applied @ 120 kg ha^{-1} gave (4.28) BCR, while when plots were seeded with 60 kg ha^{-1} noted minimum (3.34) BCR. In nitrogen fertilizer treatment, maximum (4.46) BCR was obtained when plots were fertilized with 120 kg N ha^{-1}. Minimum (2.97) BCR was recorded from the control plots. When the interaction studied, it was observed that when plots seeded with 120 kg ha^{-1} and fertilized with 120 kg N ha^{-1} produced maximum (4.88) BCR, while minimum (2.68) BCR was noted when plots were seeded with 60 kg ha^{-1} in control plots.

Highest (428.27) marginal rate of return was noted from plots seeded with 120 kg ha^{-1}, while lowest (334.02) marginal rate of return was obtained from those pots in which seed rate was used @ 60 kg ha^{-1}. In case of nitrogen trials, maximum (4.46) marginal rate of return was recorded from the plots in which 120 kg N ha^{-1} was applied. Minimum (2.97) marginal rate of return was noted control plots. The data further revealed that interaction showed a significant variation among seed rate and nitrogen treatments. Maximum (488.25) marginal rate of return was noted from the combination of 120 kg N ha^{-1} and 120 kg ha^{-1} seed rate, while minimum (268.04) marginal rate of return was noted from the control plots seeded with 60 kg ha^{-1}.

Table VIII *Economic analysis of wheat as affected by various seed rates and different N levels*

Treatments	Wheat Yield (kg ha^{-1})		Income (Rs. ha^{-1})		Gross Income (Rs. ha^{-1})	Total Expen. (Rs. ha^{-1})	Net Income (Rs. ha^{-1})	BCR	MRR %
	Grain	Straw	Grain	Straw					
A: Seed Rate (kg ha^{-1})									
S_1 (60)	2784	8738	33408	15292	48700	14580	34120	3.34	334.02
S_2 (80)	3170	9499	38040	16623	54663	14820	39843	3.69	368.85
S_3 (100)	3608	9925	43296	17369	60665	15060	45605	4.03	402.82
S_4 (120)	3957	10309	47484	18041	65525	15300	50225	4.28	428.27
S_5 (140)	3460	9958	41520	17427	58947	15540	43407	3.79	379.32
B: Nitrogen Levels (kg ha^{-1})									
N_0 (Control)	2479	7616	29748	13328	43076	14520	28556	2.97	296.67
N_1 (40)	3210	9807	38520	17162	55682	14980	40702	3.72	371.71
N_2 (80)	3701	10040	44412	17570	61982	15120	46862	4.10	409.93
N_3 (120)	4145	10486	49740	18351	68091	15260	52831	4.46	446.21
N_4 (140)	3444	10480	41328	18340	59668	15420	44248	3.87	386.95
C: Interaction (A x B)									
S_1N_0	2153	6741	25836	11797	37633	14040	23593	2.68	268.04
S_1N_1	2361	8834	28332	15460	43792	14500	29292	3.02	302.01
S_1N_2	2878	9046	34536	15831	50367	14640	35727	3.44	344.04
S_1N_3	3750	9144	45000	16002	61002	14780	46222	4.13	412.73
S_2N_4	2778	9927	33336	17372	50708	14940	35768	3.39	339.41
S_2N_0	2292	7579	27504	13263	40767	14280	26487	2.85	285.48
S_2N_1	3194	9709	38328	16991	55319	14740	40579	3.75	375.30
S_2N_2	3438	9846	41256	17231	58487	14880	43607	3.93	393.06
S_2N_3	3799	10352	45588	18116	63704	15020	48684	4.24	424.13
S_2N_4	3125	10010	37500	17518	55018	15180	39838	3.62	362.44
S_3N_0	2465	7792	29580	13636	43216	14520	28696	2.98	297.63
S_3N_1	3618	9944	43416	17402	60818	14980	45838	4.06	405.99
S_3N_2	4062	10215	48744	17876	66620	15120	51500	4.41	440.61
S_3N_3	4458	10883	53496	19045	72541	15260	57281	4.75	475.37
S_3N_4	3437	10790	41244	18883	60127	15420	44707	3.90	389.93
S_4N_0	2847	8164	34164	14287	48451	14760	33691	3.28	328.26
S_4N_1	3958	10333	47496	18083	65579	15220	50359	4.31	430.87
S_4N_2	4569	10810	54828	18918	73746	15360	58386	4.80	480.12
S_3N_3	4663	11270	55956	19723	75679	15500	60179	4.88	488.25
S_4N_4	3750	10968	45000	19194	64194	15660	48534	4.10	409.92
S_5N_0	2639	7804	31668	13657	45325	15000	30325	3.02	302.17
S_5N_1	2917	10216	35004	17878	52882	15460	37422	3.42	342.06
S_5N_2	3556	10283	42672	17995	60667	15600	45067	3.89	388.89
S_5N_3	4056	10781	48672	18867	67539	15740	51799	4.29	429.09
S_5N_4	4132	10705	49584	23774	73358	15900	57458	4.61	461.37

Grain Price = Rs. 12/- kg Straw = Rs. 1.75/- kg
BCR = (Benefit Cost Ratio) MRR % = Marginal Rate of Return

CONCLUSION AND RECOMMENDATIONS

From the above results, it is concluded to get more yield and economic profit, use 120 kg ha^{-1} seed rate and fertilized with 120 kg N ha^{-1}.

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