Effect of seed rate and nitrogen on growth and yield attributes of wheat (*Triticum aestivum* L.)

Abstract

The field experiment entitled Effect of Seed Rate and Nitrogen on Growth and Yield Attributes of Wheat (*Triticum aestivum* L.) was conducted, in the experiment comprising a total 12 treatment combinations; such as three seed rates (100, 125 and 150 kg/ha) and four levels of nitrogen (75, 100, 125 and 150 kg/ha). Which was carried out in split plot design with three replications. Results revealed that the growth, yield and economics of wheat significantly differed with different seed rates and nitrogen levels. Results showed that crop sown using seed rate of 100 kg/ha recorded significantly higher plant height, spike length, number of grains per spike and test weight as compared to 125 and 150 kg/ha seed rates. Higher dry matter accumulation, number of tillers per meter row length and straw yield recorded with seed rate of 150 kg/ha over 100 and 125 kg/ha. However, significantly higher grain yield and biological yield, net returns and B: C ratio were recorded with the seed rate of 125 kg/ha as compared to seed rate of 150 and 100 kg/ha. Among nitrogen levels, significantly higher plant height, dry matter accumulation, number of tillers per meter row length, spike length, number of grains per spike and test weight, grain yield, straw yield and biological yield, net returns and B: C ratio recorded with the application of nitrogen @ 125 kg/ha as compared to application of nitrogen @ 75 and 100 kg/ha, but it was at par with the application of nitrogen @ 150 kg/ha as compared to 125 and 150 kg/ha seed rates.

Keywords: Nitrogen, Wheat, Growth, Yield Attributes, Yield.

Introduction

"Wheat (*Triticum aestivum* L.) is one of the most important cereal crops grown in the world. It is used as a staple food grain for urban and rural societies. It ranks first in the world among cereals both in respect of area and production so it is called the "king of cereals." It is an important crop worldwide and in India it is the second most important staple food after rice. It is a prime cereal crop that is considered as backbone of food security for a large number of countries in the world. Wheat is belongs to the family Poaceae having about six hundred genera and ten thousand species of grasses. *Triticum aestivum* L. (Common wheat), *Triticum durum* (Durum Wheat) and *Triticum dicoccon* (Emmer wheat) are the three important species of wheat and are mainly consumed to make bread, pasta and softer cakes, cookies, and pastries. Wheat also provides other valuable benefits to human beings as well. Wheat is also consumed in various other preparations such as, dalia, halwa, sweet meat etc. Besides, an allergy to wheat mostly from its gluten resultantly can cause coeliac disease which makes the sufferer have diarrhoea is also very dangerous to the human body. It is mainly grown in states like Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, Bihar, Gujarat and Maharashtra. The total area under wheat in the world during 2021-22 was 31125 (000 ha) with an annual production of 109590 (000 mt) and average productivity of 3.5mt /ha" (USDA, 2022). In Punjab, Wheat is a major cereal crop of Punjab. It was grown on an area of 35.20 lakh hectares during 2019-20 with the production of 176.2 lakh tonnes and average yield of 50.04 quintals per hectare (Anonymous 2022). "The climate and soil of Punjab are quite favorable for the cultivation of wheat. To get maximum yield, it is necessary to use quality seeding and improved agronomic techniques such as optimum seeding rate, time of seeding, irrigation, fertilizer application, weeding, water management, time of harvest etc. Higher wheat grain yield with better quality requires appropriate seeding rate for different cultivars"[28,29,30,31]. "Increase in seeding rate may only enhance production cost without any increase in grain yield" (Rafique *et al*. 2010). "There is a need to

increase the yield of wheat per unit area in Punjab to provide the ever-increasing food requirement of the country. Seeding rate plays a vital role for optimum plant densities which is a pre-requisite for increased seed yield. It influences the yield and yield attributes of wheat" (Singh and Singh, 1987). Nitrogen plays noticeable role in plant metabolism and all the vital physiological and metabolic processes in plant are associated with protein of which nitrogen is an essential constituent.

Materials and Methods

A field experiment was conducted the experimental area of the research farm of Guru Kashi University, Talwandi Sabo (Bathinda) during *Rabi* 2022-2023. The farm is located at $29^0$57'N latitude and $75^0$7'E longitude and an altitude of 213 meters above the sea level as per goggle map. Climate and weather conditions: The mean maximum and mean minimum temperature ranged 36.9ºC and 4.4ºC, respectively recorded from November, 2022 to April, 2023. The mean lowest temperature varied from 4.4ºC (January, 2022) - 18.4ºC (April 2023) and the mean highest temperature varied from 18.9ºC (January, 2023) - 36.9ºC (April, 2023). The mean monthly evaporation and mean monthly rainfall during November, 2022 to April, 2023 is presented in the mean evaporation range from 56.20 mm (Nov. 2022) to 329.70 mm (April 2023) during the period under study. The mean monthly rainfall varied from 2.7 mm (Feb. 2023) to 10.8 mm (Jan. 2023). The experiment comprised of 12 treatments combinations consisting three seed rate (S_1, S_2 and S_3) and four Nitrogen level (N_1, N_2, N_3 and N_4) respectively. Experimental Detail Season: *Rabi*, 2022-23; Crop-Wheat; Total no. of treatments-1; Replication 3; total plot 36; net plot size 3x2 meter square, Gross plot size; 3.4x2.2 meter square; Split Plot Design; HD- 3086 variety Analysis of all data as per materials and methods under thesis.

Results and Discussion

A field experiment-Effect of Seed Rate and Nitrogen on Growth and Yield Attributes of Wheat (*Triticum aestivum* L.) was conducted at the research farm of Guru Kashi University, Talwandi Sabo (Bathinda) during *Rabi* season 2022-23. The experimental findings about growth parameters, yield attributes and yields of wheat as influenced by different seed rates and nitrogen levels based on field experiments are presented in this chapter. The data recorded for important characters have also been depicted graphically for elucidation of the important trends, wherever necessary.

Plant height Effect of seed rates

It can be stated that data (Table 1) indicated that the plant height of wheat was influenced significantly due to seed rates. Crop sown using seed rate of 100 kg/ha recorded significantly maximum plant height of 20.06, 94.80 and 112.59 cm at 45, 90 DAS and at harvest. Percentage increases in plant height due to seed rate of 100 kg/ha to the tune of 12.44 and 42.78 per cent at 45 DAS, 13.15 and 46.75 percent at 90 DAS and 11.92 and 44.40 per cent at harvest as compared to seed rate of 125 and 150 kg/ha, respectively. These trends of plant heights may be due to competition for resources like light and space. These results corroborate the findings of Kumar *et al.* (2002) and Mahajan *et al.* (1991).

Effect of nitrogen levels

Data (Table 1) revealed that the plant height of wheat was significantly influenced by different nitrogen levels. There was a gradual increase in plant height with the increase in nitrogen levels. The maximum plant height (19.01, 89.47 cm and 107.25 at 45, 90 DAS and at harvest, respectively) was recorded with the application of nitrogen @150 kg/ha, it was at par with application of nitrogen @ 125 kg/ha as compared to nitrogen @ 75 and 100 kg/ha. The increases in plant height of wheat due to application nitrogen @ 125 kg/ha to the tune of 25.94 and 7.58 per cent at 45 DAS, 30.54and 9.36 percent at 90 DAS and 22.77 and 5.76 per cent at harvest as compared to nitrogen @ 75 and 100 kg/ha, respectively. The increase in plant height with an increase in

successive levels of nitrogen might be due to more supply of nitrogen to crop resulting in rapid synthesis of carbohydrates and consequently converted into protoplasm and thereby smaller portion available for cell wall formation. This has served consequences of increase in the size of cell which is expressed morphologically through increase in plant height. The results confirm with Ali *et al.* (2011), Patel *et al.* (2012).

Table 1: Effect of seed rates and nitrogen levels on plant height of wheat

Treatments	Plant height (cm)		
	45 DAS	90 DAS	At harvest
Seed rate			
100 kg/ha	20.06	94.80	112.59
125 kg/ha	17.84	83.78	100.60
150 kg/ha	14.05	64.60	80.17
SEm±	0.32	1.86	2.09
C.D. at 5 %	1.25	7.28	8.20
Nitrogen levels			
75 kg/ha	14.65	67.10	83.78
100 kg/ha	17.15	80.09	97.26
125 kg/ha	18.45	87.59	102.86
150 kg/ha	19.01	89.47	107.25
SEm±	0.40	1.43	1.56
C.D. at 5 %	1.19	4.25	4.63

Dry matter accumulation (gm)Effect of seed rates

It can be stated that data (Table 2) indicated that dry matter accumulation of wheat influenced significantly due to seed rates. Crop sown using seed rate of 150 kg/ha recorded significantly maximum dry matter accumulation (224.70 g/meter row length) as compared to seed rate of 100 and 125 kg/ha. Percentage increases in plant height due to seed rate of 150 kg/ha to the tune of 28.66 and 13.74 percent at harvest as compared to seed rate of 100 and 125 kg/ha, respectively. A higher level of seed rate recorded significantly higher dry matter at harvest is attributed to greater plant population per unit area, increased plant height and higher leaf area index. Nel and Dijkhuis (1990) and Kumar *et al.* (2002) also observed the similar results.

Effect of nitrogen levels

Data (Table 2) revealed that the dry matter accumulation of wheat was significantly influenced by different nitrogen levels. There was a gradual increase in dry matter accumulation with the increase in nitrogen levels. The higher dry matter accumulation of 213.25 g/meter row length was recorded with the application of nitrogen @125 kg/ha, it was at par with application of nitrogen @ 150 kg/ha as compared to nitrogen @ 75 and 100 kg/ha.

Table 2: Effect of seed rates and nitrogen levels on dry matter accumulation ofwheat

Treatments	Dry matter accumulation (g/meter row length)
Seed rate	
100 kg/ha	174.64

125 kg/ha	197.55
150 kg/ha	224.70
SEm±	5.58
C.D. at 5 %	21.90
Nitrogen levels	
75 kg/ha	164.50
100 kg/ha	192.31
125 kg/ha	213.25
150 kg/ha	225.78
SEm±	5.30
C.D. at 5 %	15.75

The percentage increases in dry matter accumulation of wheat due to the application of nitrogen @ 125 kg/ha to the tune of 29.64 and 10.89 percent as compared to nitrogen @ 75 and 100 kg/ha, respectively. Dry matter production at higher levels of nitrogen (125 kg/ha) may be attributed to the fact that nitrogen is important constituent of nucleotides, chlorophyll and enzymes involved in various metabolic processes which have a direct impact on vegetative and reproductive phases of wheat. This was evident from the linear increase in dry matter production with increased nutrient uptake by the wheat. Beneficial effects of higher levels of nitrogen on dry matter production in wheat were also reported by Ram *et al.* (2005), Kumar et al. (2007) and Alam *et al.* (2013).

Yield attributes and yield

Number of tillers per meter row lengthEffect of seed rates

Critical examination of data presented in Table 3 indicated that the number of tillers per meter row length of wheat influenced significantly seed rates. A significantly higher number of tillers per meter row length was recorded with the crop sown using seed rate of 150 kg/ha as compared a seed rate of 100 and 125 kg/ha. Percentage increases in number of tillers per meter row length due to seed rate of 150 kg/ha to the tune of 28.01 and 11.00 percent as compared to seed rate of 100 and 125 kg/ha, respectively, Higher level of seed rate recorded significantly higher dry matter at harvest is attributed to greater plant population per unit area, increased plant height, and higher leaf area index. Nel and Dijkhuis (1990) and Kumar et al. (2002) also observed the similar results.

Effect of nitrogen levels

It is confirmed from the data given in table 3 that the number of tillers per meter row length of wheat was significantly influenced by different nitrogen levels. There was a gradual increase in number of tillers per meter row length with the increase in nitrogen levels. Application of nitrogen @125 kg/ha remained at par with application of nitrogen @ 150 kg/ha and recorded significantly higher number of tillers per meter row length as compared to nitrogen @ 75 and 100 kg/ha. Application of nitrogen @125 kg/ha increased a number of tillers per meter row length to the tune of 28.38 and 10.93 percent over nitrogen @ 75 and 100 kg/ha, respectively. The higher number of tillers per plant may be due to sufficient availability of nitrogen to the root of the crop. Higher availability of nitrogen may increase the nutrition to the active growing part of plant which can shoot with favorable conditions and that's why ultimately leads to higher shooting of the tillers to the base of the plant. The results confirm with Kumar *et al.* (2007), Ali *et al.* (2011) and Kaur *et al.* (2015).

Table 3: Effect of seed rates and nitrogen levels on the number of tillers of wheat

Treatments	Number of tillers per meter row length
Seed rate	
100 kg/ha	98.10
125 kg/ha	113.14
150 kg/ha	125.58
SEm±	3.16
C.D. at 5 %	12.39
Nitrogen levels	
75 kg/ha	94.17
100 kg/ha	108.99
125 kg/ha	120.90
150 kg/ha	125.03
SEm±	3.00
C.D. at 5 %	8.93

Spike length (cm) Effect of seed rates

Critical examination of data presented in table 4 indicated that spike length of wheat influenced significantly due to seed rates. Significantly higher spike length was recorded with the crop sown using seed rate of 100 kg/ha as compared to seedrate of 125 and 150 kg/ha. Percentage increases in spike length due to seed rate of 100 kg/ha to the tune of 8.39 and 16.75 per cent as compared to seed rate of 125 and 150 kg/ha, respectively.

Effect of nitrogen levels

It is confirmed from the data given in table 4 that the spike length of wheat was significantly influenced by different nitrogen levels. There was a gradual increase in spike length with the increase in nitrogen levels. Application of nitrogen @125 kg/ha remained at par with application of nitrogen @ 150 kg/ha and recorded a significantly higher spike length of 11.27 cm as compared to nitrogen @ 75 and 100 kg/ha. Application of nitrogen @125 kg/ha increased spike length to the tune 18.26 and 7.54 percent over nitrogen @ 75 and 100 kg/ha, respectively. It might be due to the application of higher dose of RDN which make higher availability of nutrients for photosynthetic activity. So increasing application of nitrogen which increases the length of spike. The results confirm with those of Ali *et al.* (2011), Patel *et al.* (2012), Singh *et al.* (2013).

Table 4: Effect of seed rates and nitrogen levels on spike length of wheat

Treatments	Spike length (cm)
Seed rate	
100 kg/ha	11.50
125 kg/ha	10.61
150 kg/ha	9.85
SEm±	0.21
C.D. at 5 %	0.83
Nitrogen levels	
75 kg/ha	9.53

100 kg/ha	10.48
125 kg/ha	11.27
150 kg/ha	11.34
SEm±	0.23
C.D. at 5 %	0.69

Number of grains per spikeEffect of seed rates

It is confirmed from the data given in table 5 indicated that number of grains per spike of wheat influenced significantly due to seed rates. Significantly higher number of grains per spike was recorded with the crop sown using seed rate of 100 kg/ha as compared to seed rate of 125 and 150 kg/ha. Percentage increases in number of grains per spike due to seed rate of 100 kg/ha to the tune of 8.39 and 16.75 per cent as compared to seed rate of 125 and 150 kg/ha, respectively. The decreasing trend of grains per spike at increasing seed rates was probably due to increased competition and shortage in input supply under higher population densities as also revealed by Jat and Dhakar (2002).

Effect of nitrogen levels

It is confirmed from the data given in Table 5 that the number of grains per spike of wheat was significantly influenced by different nitrogen levels. Application of nitrogen @125 kg/ha recorded a significantly higher number of grains per spike of 45.03 as compared to nitrogen @ 75 and 100 kg/ha, but it remained at par with the application of nitrogen @ 150 kg/ha. However, lower number of grains per spike of 38.68 was recorded with the application of nitrogen @75 kg/ha. Application of nitrogen @125 kg/ha increased spike length to the tune 16.42 and 7.06 percent over nitrogen @ 75 and 100 kg/ha, respectively. Due to higher dose of nitrogen make higher availability of nutrients for photosynthetic activity. So increased application of nitrogen which increased number of seeds per spike. These results are in close conformity with those reported by Ali *et al.* (2011), Patel *et al.* (2012) and Pandey *et al.* (2014).

Table 5: Effect of seed rates and nitrogen levels on number of grains

Treatments	**Number of grains per spike**
Seed rate	
100 kg/ha	46.36
125 kg/ha	43.37
150 kg/ha	39.52
SEm±	0.63
C.D. at 5 %	2.46
Nitrogen levels	
75 kg/ha	38.68
100 kg/ha	42.06
125 kg/ha	45.03
150 kg/ha	46.56
SEm±	0.57
C.D. at 5 %	1.69

Test weight (gm)Effect of seed rates

Critical examination of data presented in Table 6 indicated that test weight of wheat

influenced significantly due to seed rates. Higher test weight was recorded with the crop sown using seed rate of 100 kg/ha as compared to seed rate of 125and 150 kg/ha. Increases in test weight due to seed rate of 100 kg/ha to the tune of 8.31 and 16.67 per cent as compared to seed rate of 125 and 150 kg/ha, respectively.

Effect of nitrogen levels

It is confirmed from the data given in Table 6 that the test weight of wheat was significantly influenced by different nitrogen levels. Application of nitrogen @125 kg/ha recorded significantly higher test weight as compared to nitrogen @ 75 and 100 kg/ha, but it was remained at par with application of nitrogen @ 150 kg/ha. However, lower test weight was recorded with the application of nitrogen @75 kg/ha. Application of nitrogen @125 kg/ha increased test weight to the tune 18.05 and 7.61 per cent over nitrogen @ 75 and 100 kg/ha, respectively. The increased test weight with the application of nitrogen @125 kg/ha seems to be on account of increased photosynthetic efficiency which leads heavier grain leading higher test weight. The finding are close conformity with those reported by Samra and Dhillon (2002), Pandey *et al.* (2004), Patel *et al.* (2004), Kumar and Yadav (2005) and Ali *et al.* (2011).

Table. 6: Effect of seed rates and nitrogen levels on test weight of wheat

Treatments	Test weight (1000 grain weight) (gm)
Seed rate	
100 kg/ha	41.57
125 kg/ha	38.38
150 kg/ha	35.63
SEm±	0.78
C.D. at 5 %	3.07
Nitrogen levels	
75 kg/ha	34.51
100 kg/ha	37.86
125 kg/ha	40.74
150 kg/ha	40.99
SEm±	0.85
C.D. at 5 %	2.54

Grain yield (q/ha)

Effect of seed rates

It can be stated that data (Table 7) indicated that grain yield of wheatinfluenced significantly due to seed rates. Crop sown using seed rate of 125 kg/harecorded significantly maximum grain yield (58.61 q/ha)) as compared to seed rate of 150kg/ha, but it was at par with seed rate of 100 kg/ha. Crop sown using seed rate of 125 kg/ha increased grain yield to the tune of 9.27 per cent as compared to seed rate of 150 kg/ha.

Effect of nitrogen levels

Further reference to data given in (Table 7) revealed that the grain yield of wheat was significantly influenced by different nitrogen levels. There was a gradual increase in grain yield with the increase in nitrogen levels. Maximum grain yield (69.83 q/ha) was recorded with the application of nitrogen @150 kg/ha and it was at par with application of nitrogen @ 125kg/ha as compared to nitrogen @ 75 and 100 kg/ha. The percentage increases in grain yield of wheat due to application nitrogen @ 125 kg/ha to the tune of 76.12 and 26.84 per cent as compared to nitrogen @

75 and 100 kg/ha, respectively. This may be mainly attributed to improved growth and yield parametersviz., plant height, length of spike, number of seeds per spike, grain weight per spike and the beneficial effects of nitrogen on cell division and elongation, formation of nucleotides and co-enzymes which resulted in increased meristematic activity and photosyntheticarea and hence more production and accumulation of photosynthates, yielding higher grain yield. The results are in close conformity with those reported by Ali *et al.* (2011), Patel *et al.* (2012), Rahimi (2012), Pradhan *et al.* (2013), Singh *et al.* (2013), Shirazi *et al.* (2014), Pandey *et al.* (2014), Kaur *et al.* (2015) and Satyanarayana *et al.* (2017).

Table 7: Effect of seed rates and nitrogen levels on grain yield of wheat

Treatments	**Grain yield (q/ha)**
Seed rate	
100 kg/ha	57.71
125 kg/ha	58.61
150 kg/ha	53.64
SEm±	1.07
C.D. at 5 %	4.22
Nitrogen levels	
75 kg/ha	37.78
100 kg/ha	52.46
125 kg/ha	66.54
150 kg/ha	69.83
SEm±	1.23
C.D. at 5 %	3.66

Straw yield (q/ha)Effect of seed rates

It can be stated that data (Table 8) indicated that straw yield of wheatinfluenced significantly due to seed rates. Crop sown using seed rate of 150 kg/harecorded significantly maximum straw yield (102.13 q/ha)) as compared to seed rate of 100 ad 125 kg/ha. Crop sown using seed rate of 150kg/ha increased straw yield to thetune of 28.66 and 13.73 per cent as compared to seed rate of 100 and 125 kg/ha. The similar response of decrease in yield and yield attributes with decreasing seed rates have been reported by Naik *et al.* (1991), Parihar and Singh (1995) and Samra and Dhillon (1993).

Effect of nitrogen levels

Experimental data presented in (Table 8) revealed that the straw yield of wheat was significantly influenced by different nitrogen levels. There was a gradual increase in straw yield with the increase in nitrogen levels. Maximum straw yield (102.63 q/ha) was recorded with the application of nitrogen @150 kg/ha (96.93 q/ha) and it was at par with application of nitrogen @

125 kg/ha as compared to nitrogen @ 75 and 100 kg/ha. The percentage increases in straw yield of wheat due to application nitrogen @ 125 kg/ha to the tune of 29.64 and 10.88 per cent as compared to nitrogen @ 75 and 100 kg/ha, respectively. The increased straw yield per plant with the application of nitrogen @125 kg/ha seems to be on account of increased photosynthetic efficiency and greater development of vegetative structure. It might be due to nitrogen apply in form of urea which contain N readily available form which leads better root and shoot development while nitrogen leads improve the supply of nutrients increased photosynthetic area and thereby ultimately resulted into higher values of yield and yield attributing characters. The results are in close proximity with finding of conformity with Patel *et al.* (2012), Rahimi (2012), Singh *et al.* (2013), Shirazi *et al.* (2014) and Pandey *et al.* (2014).

Table 8: Effect of seed rates and nitrogen levels on straw yield of wheat

Treatments	**Straw yield (q/ha)**
Seed rate	
100 kg/ha	79.38
125 kg/ha	89.80
150 kg/ha	102.13
SEm±	2.54
C.D. at 5 %	9.96
Nitrogen levels	
75 kg/ha	74.77
100 kg/ha	87.42
125 kg/ha	96.93
150 kg/ha	102.63
SEm±	2.41
C.D. at 5 %	7.16

Biological yield (q/ha)Effect of seed rates

It is apparent from the data given in (Table 9) indicated that biological yield of wheat influenced significantly due to seed rates. Crop sown using seed rate of 150 kg/ha recorded significantly maximum biological yield (155.77 q/ha) as compared to seed rate of 100 kg/ha, but it was at par with 125 kg/ha. Crop sown using seed rate of 150 kg/ha increased biological yield to the tune of 13.63 per cent as compared to seed rate of 100 kg/ha.

Effect of nitrogen levels

Data in Table 9 revealed that the biological yield of wheat was significantly influenced by different nitrogen levels. There was a gradual increase in biological yield with the increase in nitrogen levels. Maximum biological yield (172.46 q/ha) was recorded with the application of nitrogen @150 kg/ha (96.93 q/ha) and it was at par with application of nitrogen @ 125 kg/ha as

compared to nitrogen @ 75 and 100 kg/ha. The percentage increases in biological yield of wheat due to application nitrogen @ 125 kg/ha to the tune of 45.24 and 16.88 per cent as compared to nitrogen @ 75 and 100 kg/ha, respectively.

Table 9: Effect of seed rates and nitrogen levels on biological yield of wheat

Treatments	**Biological yield (q/ha)**
Seed rate	
100 kg/ha	137.09
125 kg/ha	148.40
150 kg/ha	155.77
SEm±	3.07
C.D. at 5 %	12.04
Nitrogen levels	
75 kg/ha	112.56
100 kg/ha	139.87
125 kg/ha	163.48
150 kg/ha	172.46
SEm±	3.45
C.D. at 5 %	10.25

Harvest indexEffect of seed rates

It can be stated that data in table 10 indicated that harvest index of wheat influenced significantly due to seed rates. Crop sown using seed rate of 100 kg/harecorded significantly higher harvest index as compared to seed rate of 125 and 150 kg/ha.

Effect of nitrogen levels

It is evident from the data in table 10 showed that the harvest index of wheat was significantly influenced by different nitrogen levels. Higher harvest index was recorded with the application of nitrogen @100 kg/ha and it was at par with applicationof nitrogen @ 150 kg/ha as compared to nitrogen @ 75 and 100 kg/ha.

Table 10: Effect of seed rates and nitrogen levels on harvest index of wheat

Treatments	Harvest index (%)
Seed rate	
100 kg/ha	41.65
125 kg/ha	38.80
150 kg/ha	34.22
SEm±	0.66
C.D. at 5 %	2.59
Nitrogen levels	
75 kg/ha	33.76
100 kg/ha	37.75

125 kg/ha	40.85
150 kg/ha	40.54
SEm±	0.38
C.D. at 5 %	1.14

Economics

Net returns Effect of seed rates

Economic analysis in table 11 indicated that net returns of wheat influenced significantly due to seed rates. Crop sown using seed rate of 125 kg/ha recorded significantly higher net returns of 116636 /ha as compared to seed rate of 100 kg/ha, but it was at par with 150 kg/ha.

Effect of nitrogen levels

Economic analysis in table 11 showed that the net returns of wheat were significantly influenced by different nitrogen levels. Higher net returns of 136032/ha was recorded with the application of nitrogen @125 kg/ and it was at par with application of nitrogen @ 150 kg/ha as compared to nitrogen @ 75 and 100 kg/ha.

B: C ratio Effect of seed rates

It can be stated that data in table 11 indicated that B: C ratio of wheat influenced significantly due to seed rates. Crop sown using seed rate of 125 kg/ha recorded significantly higher B: C ratio 2.51 as compared to seed rate of 100 kg/ha, but it was at par with 150 kg/ha.

Effect of nitrogen levels

Data in table 11 showed that the B: C ratio of wheat was significantly influenced by different nitrogen levels. Higher B: C ratio of 2.92 was recorded with the application of nitrogen @125 kg/ and it was at par with application of nitrogen @ 150 kg/ha as compared to nitrogen @ 75 and 100 kg/ha.

Table 11: Effect of seed rates and nitrogen levels on economics of wheat

Treatments	Net returns (₹/ha)	B:C ratio
Seed rate		
100 kg/ha	109951	2.38
125 kg/ha	116636	2.51
150 kg/ha	112469	2.41
Nitrogen levels		
75 kg/ha	67654	1.47
100 kg/ha	103214	2.23
125 kg/ha	136032	2.92
150 kg/ha	145174	3.10

CONCLUSION

Keeping in view the objectives framed for undertaking study and the results obtained after

experimental period, under mentioned conclusions may be drawn.

1. Crop sown using seed rate of 125 kg/ha recorded significantly higher yield attributes, seed, straw and biological yield as well as net returns and B:C ratio.
2. The higher growth parameters, yield attributes, seed, straw and biological yield as well as net returns and B: C ratio was obtained with application of nitrogen @ 125 kg/ha.

Based on the finding of the present investigation, it is recommended that crop sown using seed rate of 125 kg/ha along with application of nitrogen @ 125 kg/ha. However, these results are only indicative and required further experimentation to arrive at some more consistent and final conclusion.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc have been used during writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.
2.
3.

REFERENCES

1. Alam, M. S. (2013). Effect of sowing patterns and nitrogen rate on quality traits and yield of wheat. *Journal of Environment Science & Natural Resources*. 5(1): 267-272
2. Ali, A., Ahmad, A., Syed, W. H., Khaliq, T, Asif, M., Aziz, M. and Mubeen, M. (2011). Effects of nitrogen on growth and yield components of wheat. *Science International (Lahore).* 23 (4): 331-332.
3. Ames, N. P., Clarke, J. M., Dexler, J.E. and Woods S. M. (2023) Effects of Nitrogen Fertilizer on Protein Quantity and Gluten Strength Parameters in Durum Wheat (*Triticum turgidum* L. var. durum) Cultivars of Variable Gluten Strength. https://www.cerealsgrains.org/publications/cc/2003/March/Pages/80_2_203.aspx
4. Anonymous (2022) *Package of Practices for Rabi Crops.* Pp 1-21. Punjab Agricultural University Ludhiana.
5. Jat, BL and Dhakar, LL (2002). Yield attributes and yield of wheat (*Triticum aestivum* L.) varieties under sowing dates and seed rates. *Environment and Ecology.* 20(2): 439-442

6. Kaur, G., Asthir, B. and Bains, N. S. (2015) Nitrogen levels effect on wheat nitrogen use efficiency and yield under field conditions. *African Journal of Agricultural Research.*10(23): 2372-2377.
7. Kaur, G., Asthir, B. and Bains, N. S. (2015) Nitrogen levels effect on wheat nitrogen use efficiency and yield under field conditions. *African Journal of Agricultural Research.*10(23): 2372-2377.
8. Kumar, R. and Yadav, D. S. (2005). Effect of zero and minimum tillage in conjuction with nitrogen management in wheat (*Triticum aestivum*) after rice (*Oryza sativa*). *Indian Journal of Agronomy.*50(1): 54-57.
9. Kumar, R., Agarwal, S.K. and Nanwal, R.K. (2002). Biomas study in bread wheat under different planting systems, seed rates and nitrogen levels in sandy loams soils. *Haryana Agric. Univ. J. Res.,*32 (2): 73-76.
10. Naik , P. L., Patel, B. A. and Kalaria, K. K. (1991). Response of wheat (Triticum aestivumL.) Varieties to sowing date and seed rate. *Indian Journal of Agronomy.* (Suppl.). 36: 225-226.
11. Nel, A. A. and Dijkhuis, F.J. (1990).The effect of seeding rate, timing of nitrogen application and frequency of irrigation on wheat growth, yield and water use. *South African Journal Plant and Soil*. 7:163-166.
12. Nel, A.A. and Dijkhuis, F.J. (1990).The effect of seeding rate ,timing of nitrogen application and frequency of irrigation on wheat growth, yield and water use. *South Africa Journal of plant and soil*. 7:163-166.
13. Pandey, A. K.; Kureel, R. S.;Shukla, U. N.; Singh, S.;Mishra, M. L. and Kumar, J. (2014). Effect of nitrogen doses and scheduling on yield, quality and uptake of NPKunder late sown wheat. *Bioinfole.*11 (2A): 284-288
14. Parihar, G. N. and Singh, Rajendra (1995). Response of wheat (Triticum aestivumL.) genotypes to seed rate and sowing method under western Rajasthan condition. *Indian Journal of Agronomy.*40(1): 97-98
15. Patel, R.M. and Upadhyay, P.N. (1995). Response of wheat (*Triticum aestivum*L.) to irrigation under varying levels of nitrogen and phosphorous. *Indian Journal of Agronomy,*35(1): 113-15.
16. Pradhan, S.; Chopra, U. K.; Bandyopadhyay, K. K.; Singh, R.; Jain, A. K. and Chand,

(2013). Effect of water and nitrogen management on water productivity and nitrogen use efficiency of wheat in a semi-arid environment. *The International Journal of Agriculture Food Science & Technology.* 4(7): 727-732.

17. Rafique, S. M., Rashid, M., Akram, M. M., Ahmad, J., Hussain, R., Razzaq, A. (2010) Optimum seed rate of wheat in available soil moisture under rainfed conditions. *Journal of Agricultural Research.,* 47(2).
18. Rahimi, A. (2012). Effect of potassium and nitrogen on yield and yield components of dry land wheat in Boyerahmad region of Iran. *Annals of biological research.* 3(7): 3274-3277
19. Ram, T.; Yadav, S.K. and Sheoran, R.S. (2005) Growth analysis of wheat (Triticum aestivuml.) under varying fertility levels and Azotobacterstrains. *Indian Journal of Agricultural Research.* 39(4): 295-298.
20. Samra, J. S. and Dillon, S.S. (1993). Effect of seed rate and nitrogen level on new genotypes (PBW 154 and PBW 222) of wheat (*Triticum aestivum* L.). *Indian Journal of Agronomy.* 38(1): 111-112
21. Satyanarayana, M.; Reddy, A. P.; Bhatt, P. S.; Reddy, S.N. and Padmaja, J. (2017). Response of different wheat varieties to graded levels of nitrogen. *International Journal of Agricultural Science and Research.* 7(4): 373-382.
22. Satyanarayana, M.; Reddy, A. P.; Bhatt, P. S.; Reddy, S.N. and Padmaja, J. (2017). Response of different wheat varieties to graded levels of nitrogen. *International Journal of Agricultural Science and Research.* 7(4): 373-382.
23. Sharma, S. K. and Singh, H. (2001). Effect of seed rate and fertilizer doses on growth, yield and quality of pea (*Pisum sativum* L.), *Seed Tech News.,* 32 (1): 44.
24. Sharma, S.K. and Singh, H. (2001). Effect of seed rate and fertilizer doses on growth, yield and quality of pea (*Pisum sativum* L.), *Seed Tech News.,* 32 (1): 44.
25. Shirazi, S. M.; Yusop, Z.; Zardari, N. H. and Ismail, Z. (2014). Effect of irrigation regimes and nitrogen levels on growth and yield of wheat. *Journal of EnvironmentalProtection and Ecology.* 15(3): 973-982
26. Singh, D., Singh, T., Singh, H. and Faroda, A. S. (1987). Effect of seed rates and nitrogen levels on concentration and uptake of nitrogenin wheat. *Indian Journal of Agronomy.*32 (4): 458-459.
27. Singh, N. K.; Chaudhary, F. K. and Patel, B. T. (2013). Effectiveness of Azotobacterbio-

inoculant for wheat grown under dryland condition. *Journal of Environmental Biology*. 34: 927-932.

28. Amani A, Behzad MA. Effect of Split Application of Nitrogen on Growth and Yield of Wheat (Triticum aestivum L.). J. Exp. Agric. Int. [Internet]. 2020 Jul. 13 [cited 2024 Jun. 8];42(6):44-8. Available from: https://journaljeai.com/index.php/JEAI/article/view/1676
29. Patel V, Kumar A, Dwarka, Singh R. Effects of Nitrogen Sources on Soil Properties and Wheat (Triticum aestivum L.) Production. Int. J. Plant Soil Sci. [Internet]. 2023 Oct. 12 [cited 2024 Jun. 8];35(21):1-5. Available from: https://journalijpss.com/index.php/IJPSS/article/view/3939
30. Kong L, Xie Y, Hu L, Feng B, Li S. Remobilization of vegetative nitrogen to developing grain in wheat (Triticum aestivum L.). Field Crops Research. 2016 Sep 1;196:134-44.
31. Evans JR. Nitrogen and photosynthesis in the flag leaf of wheat (Triticum aestivum L.). Plant physiology. 1983 Jun 1;72(2):297-302.