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Nitrogen and Spacing Interaction in Wheat

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ABSTRACT

Modification of row spacing and nitrogen rate proposed as a possible strategy for increasing the wheat yield and profitability. Field experiments were carried out at LPU during *rabi* season to assess the wheat response to spacing and N levels. Combinations of spacings (15,20,25) with four N levels (0,90,120,150) effect on growth and yield of wheat. A Randomized Block Design with three replications were designated to experimental plot. Row spacing and N levels exhibited no notable interaction for all the parameters at the stage of crop development. Results of this experiment reveals that some of the parameters such as growth, yield and yield attributes were affected significantly by row spacing and N levels. However, 25 cm got the highest spike length and grain yield. Straw and biological yield were maximum at 15 cm. With respect to N levels, growth parameters such as chlorophyll, LAI, CGR, RGR and yield attributes such as spikelets per spike, spike length, grain, straw and biological yield were found highest with 150 kg/ha N.

Keywords Nitrogen, Spacing, Wheat.

INTRODUCTION

Wheat is one among those cereals that are feeding about one-fifth of the world population. Wheat belongs to the family Poaceae and its technical name is *Triticum aestivum*. It is the staple food that provides about 55% carbohydrates and 13% protein. Compared to other cereal crops as rice, wheat requires less amount of irrigation, which is the reason for increased area under wheat. Wheat is grown in larger area, which have more trade in the world than any other crop. Starch and gluten are the byproducts of wheat in addition to biscuits, bread and pastries. It is cultivated under a wide range of soils and climatic conditions. Inadequate and erratic rainfall, low soil fertility, use of low yielding varieties, use of low inputs and water logging are the reasons for low yield in wheat. In wheat production, nitrogen is the most limiting nutrient which improves grain yield by improving crop vigor.

Nitrogen plays a major role in chlorophyll synthesis in plants. Chlorophyll is the site at which photosynthesis take place. Nitrogen plays a vital role in the plant metabolic processes. It has a major role in the

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formation of living tissues. The biological processes that occur in wheat are governed by nitrogen and helps in growth and development of wheat (Kutman *et al.* 2011). So, nitrogen is one very important plant nutrient that affects the crop growth and increases the yield of the crop.

Row spacing influences crop yield as it determines optimum crop stand along with convenient inter-culture operations and application of herbicides for more effective weed control. Narrow spacing makes the plants crowded and suffer mutual, solar radiation falling in-between rows become unutilized in case of wider row spacing. Yield may reduces in narrow spacing as there is more competition for moisture and nutrients among plants (Das and Yaduraju 2011). Narrow spacing causes weed suppression as ground cover and light interception increases. Among all the cultural practices, row spacing and nutrient management have great significance in the crop productivity.

MATERIALS AND METHODS

A field experiment was conducted on wheat during *rabi* season (during 2020-21) at School of Agriculture, LPU, Jalandhar, Punjab, India. The experiment is located at a latitude of 31.147^0 N and longitude of 75.312^0 E. It was carried out in a sub-tropical monsoon with an average temperature of 37 degrees C that exceeds the maximum of 47 degrees C during summer, total annual precipitation of 500-750 mm. The field experiment was conducted to study the effect of row spacing and levels of nitrogen on wheat production. The experiment was conducted with 3 row to row spacing (15, 20 and 25 cm) and 4 levels of nitrogen (0, 90,120,150 kg N/ha) with three replications by following Factorial Randomized Block Design. Results of the soil analysis which was taken prior to planting and fertilization. The soil of experimental field was loamy sand in texture clay- 4.06%, silt- 11.16% and sand 83.6% having a pH (7.2), EC (1.32) ds/m, OC (0.63%), available N,P,K 282.8 kg/ha (medium), 8.53 kg/ha (medium) and 135.9 kg/ha (low) respectively.

RESULTS AND DISCUSSION

Nitrogen and spacing interaction on plant height (cm) in wheat

Results from the data analysis (Table 1) shows that at 30 DAS, there is no effect of spacing on plant height.

Table 1. Nitrogen andspacing interaction on plant heightand chlorophyll at 30, 60, 90 DAS.

Treatments	Plant height (cm)			Chlorophyll- SPAD value		
	30 Days	60 Days	90 Days	30 Days	60 Days	90 Days
Spacing						
S1-15 cm	20.47	42.4	83.7	36.83	37.42	47
S2-20 cm	20.53	41.50	86.49	36.68	36.68	40.35
S3-25 cm	20.03	43.15	85.91	37.87	36.15	40.45
CD	NS	1.29	1.71	NS	NS	3.19
SE	0.16	0.44	0.58	0.42	0.58	1.08
Levels						
L1- 0 kg N/ha	19.47	39.34	82.12	36.18	34.9	37.8
L2- 90 kg N/ha	19.93	42.26	84.8	38.57	36.15	42.76
L3- 120 kg N/ha	20.80	44.12	86.52	37.4	38.44	42.14
L4- 150 kg N/ha	21.18	43.68	88.03	36.51	37.52	47.83
CD	0.55	1.49	1.98	1.45	1.99	3.68
SE	0.19	0.51	0.67	0.49	0.67	1.25
Interaction (S*L)						
CD	NS	NS	NS	NS	NS	6.38
SE	0.32	0.88	1.16	0.85	1.17	2.17
CV	2.80	3.61	2.37	3.99	5.54	8.70

At 60, 90 DAS, there is an effect of spacing on plant height of wheat. Regarding levels, there is a significant effect of N levels on plant height of wheat at 30, 60, 90 DAS. Interaction between the spacing and N levels on plant height was found to be non-significant at 30, 60, 90 DAS. Nitrogen affected the plant height to a great extent. With the increase of N level upto150 kg/ha N, plant height was increased in a significant manner. Similar conclusions have also been given by Dawadi and Sah (2012), Kadbe *et al.* 2016.

Nitrogen and spacing interaction on no. of tillers per plant in wheat

From the Fig.1 it is shown that, at 30, 60, 90 DAS, there is a significant effect on tillers among spacing. Among levels, there is an effect of N levels on tillers of wheat at 30, 60, 90 DAS. Interaction between spacing and N levels on tillers was found to be significant at 30 DAS. At 60 and 90 DAS, interaction between spacing and N levels on tillers was not significant. At

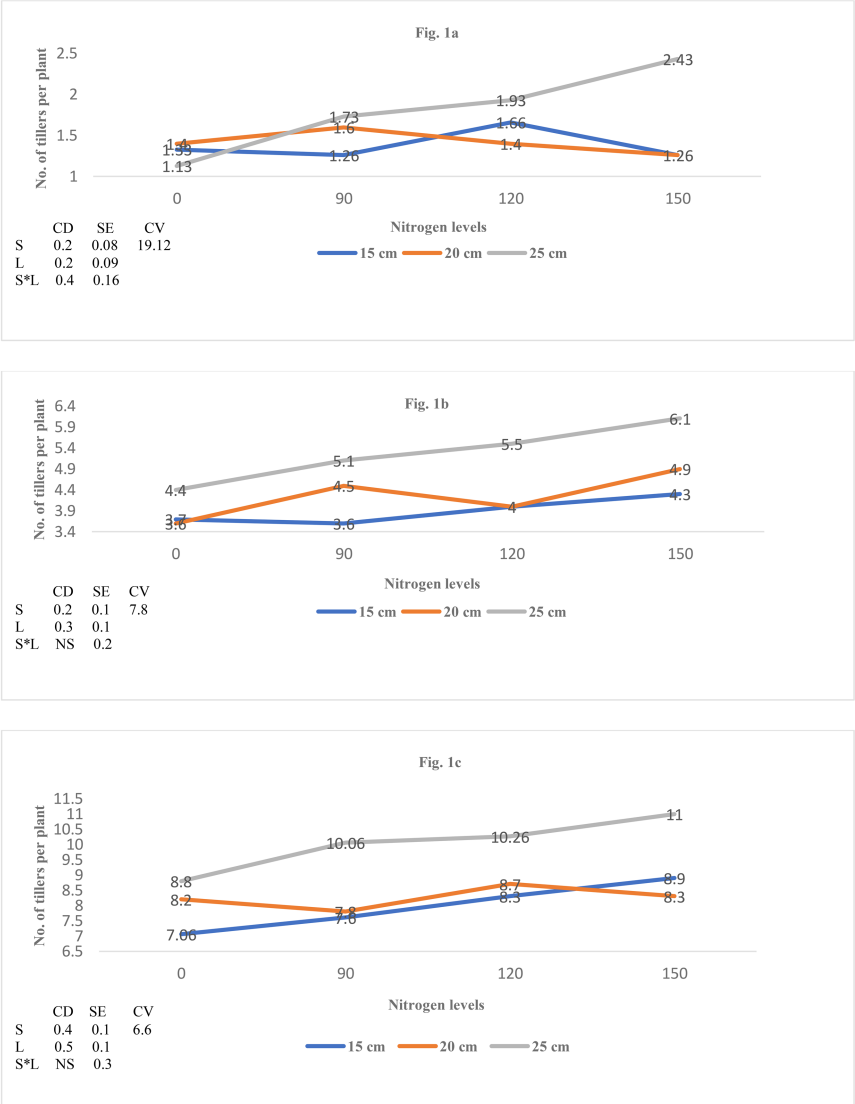
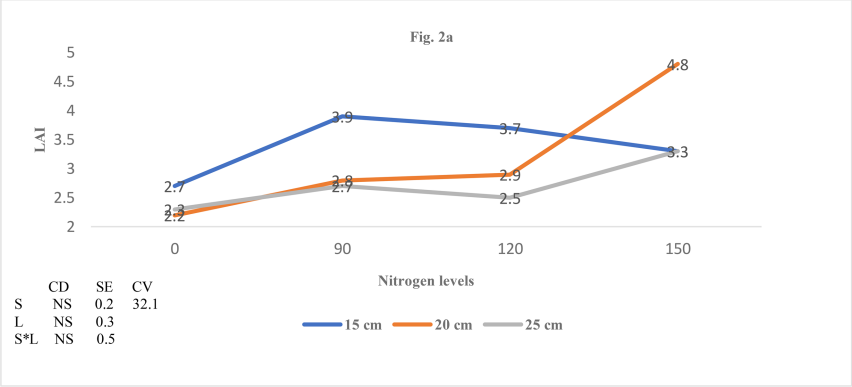
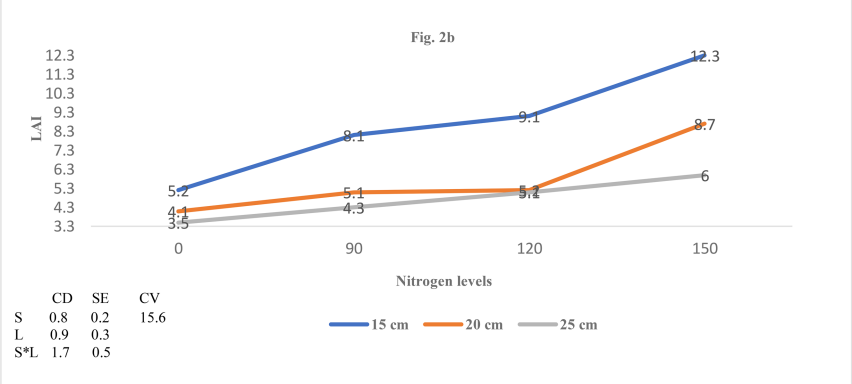


Fig. 1. Nitrogen and spacing interaction on no. of tillers at 30 (1a), 60 (1b), 90 (1c).





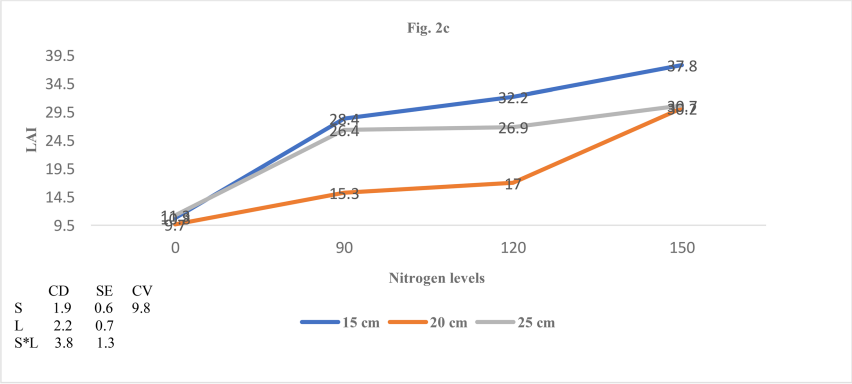


Fig. 2. Nitrogen and spacing interaction on leaf area index at 30 (2a), 60 (2b), 90 (2c).

30 DAS, 25 cm spacing with 120 N level gave the maximum number of tillers, which is at par with 150 N level. But at 60 and 90 DAS, 25 cm with 150 N level recorded the highest number of tillers. Lowest tiller number was obtained at 15 cm with zero N level at 30, 60 and 90 DAS. Results revealed that, tiller number gradually raised as the increase in spacing and N level. Related results were also noticed by Naser *et al.*(2011), Yordonas (2013).

Nitrogen and spacing interaction on chlorophyll in wheat

Results revealed that from the Table 1 states that,

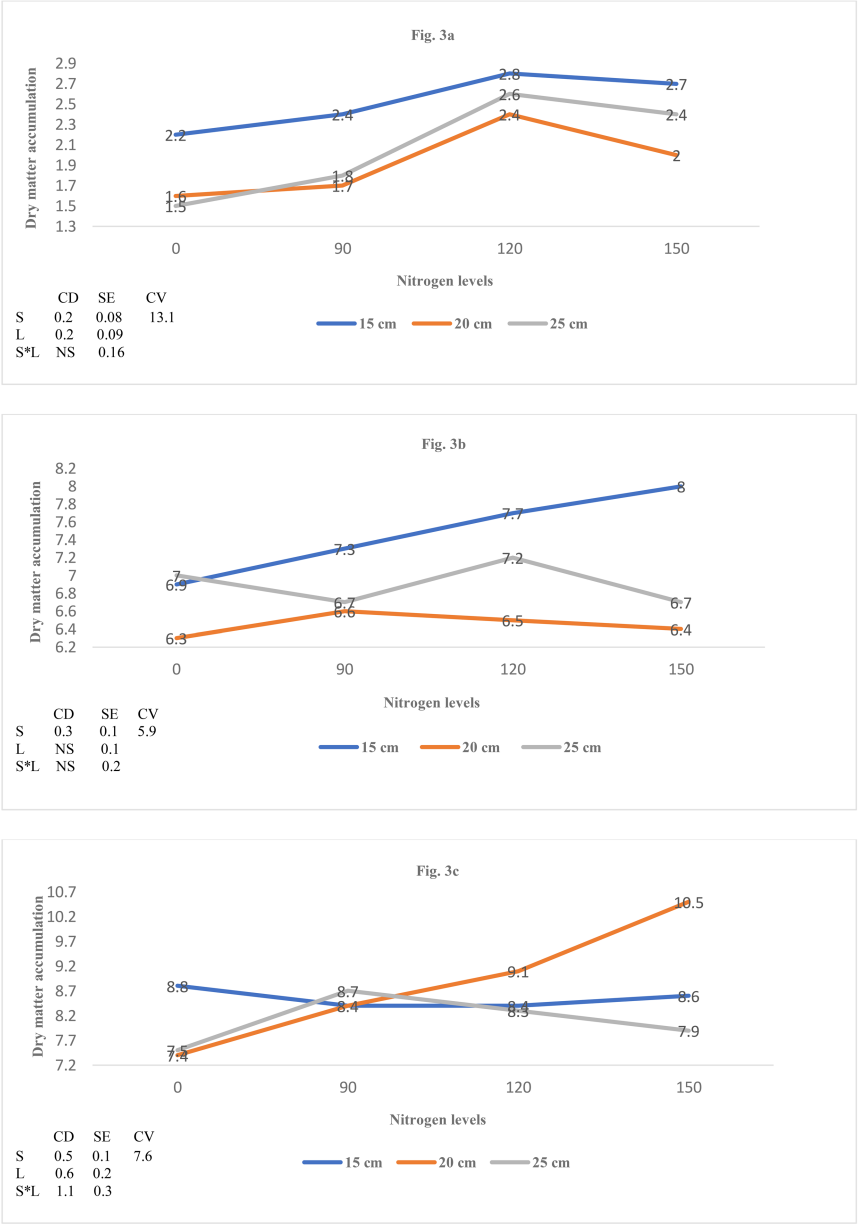


Fig. 3. Nitrogen and spacing interaction on dry matter accumulation at 30 (3a), 60 (3b), 9 (3c).

at 30 and 60 DAS, there is no significant effect of spacing on chlorophyll, but there is a significant effect of spacing on chlorophyll at 90 DAS. At 30, 60, 90 DAS there is an effect of N levels on chlorophyll. Interaction between spacing and N levels on chlorophyll was not significant at 30, 60 DAS. At 90 DAS, there is an interaction of spacing and levels on chlorophyll in wheat. Both 30, 60 have got the same results, at 90 DAS it is different. Regarding N levels, chlorophyll significantly increased as N level increases. Gradually increasing of chlorophyll content by increase in levels of N from 0 to 150 kg/ha. These

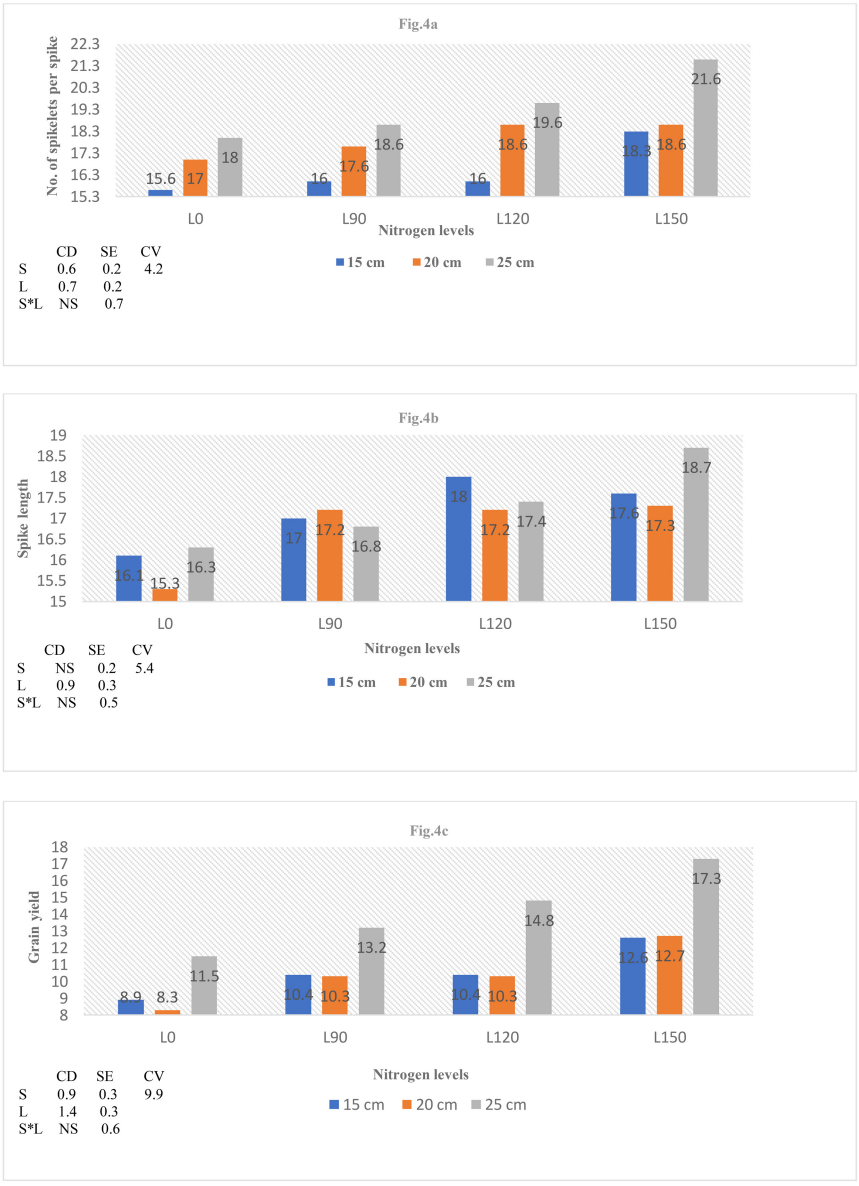


Fig. 4. Nitrogen and spacing interaction on no. of spikelets per spike (4a), spike length (4b), grain yield (4c).

results were in conformity with findings of Pramanik and Bera (2013).

Nitrogen and spacing interaction on leaf area index in wheat

Fig. 2 shows that, at 30 DAS, there is no effect of spacing on LAI, but at 60, 90 DAS there is a significant effect of spacing on LAI. There is no effect of N levels on LAI at 30 DAS, but at 60 and 90 DAS, there is an effect of N levels on LAI of wheat.There is no interaction of spacing and N levels on LAI of wheat at 30 DAS. At 60, 90 DAS, there is an interaction of spacing and N levels on LAI of wheat. Utmost LAI

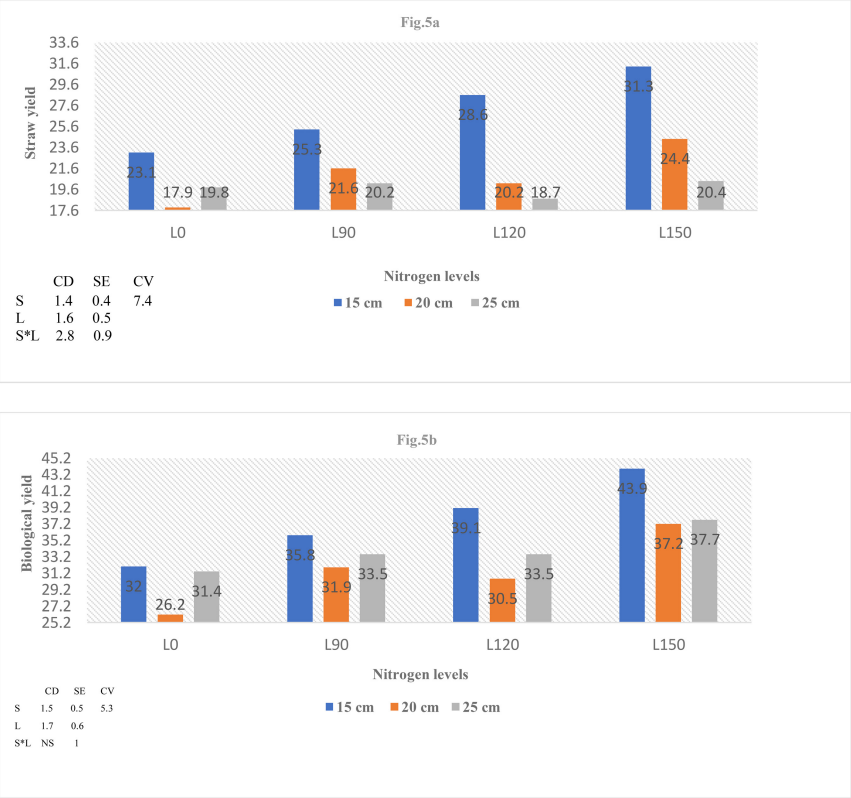


Fig. 5. Nitrogen and spacing interaction on straw yield (5a), biological yield (5b).

was recorded maximum at 15 cm with 150 N level, while the minimum was at 25 cm with 0 N level at 30 and 60 DAS. But at 90 DAS, 20 cm with 0 level has got the lowest value. It was observed that, with the decreasing in spacing and increase in N level LAI was maximum. Corroborative results have also been recorded by Chen *et al*. (2010), Aulakh (2013), Nsanzabganwa (2014), Thimmappa (2014), Kebede (2019).

Nitrogen and spacing interaction on dry matter accumulation (tonnes/ha) in wheat

The data represented in graph Fig. 3 indicates that there is an effect of spacing on dry matter accumulation at 30, 60, 90 DAS. There is an effect of N levels at 30, 90 DAS, but no significant effect of N levels on dry matter accumulation at 60 days. Interaction between spacing and N levels on dry matter accumulation was not significant at 30, 60 DAS, but at 90 days, it is shown as significant. Dry matter accumulation was high at 15 cm with 120 N level at 30, 60 DAS, while at 90 DAS, it was shown highest at 20 cm with 150 N level. Least was recorded at 20 cm with 0 N level at 30, 60 DAS. At 90 DAS, 25 cm spacing with 0 N level got the least value. In this case, similar results were noticed. These results concur with Chen *et al*. (2010), Nsanzabaganwa *et al.* (2014), Om *et al*. (2014).

Nitrogen and spacing interaction on CGR ($g/m^2/day^{-1}$) and RGR ($g/g^{-1}/day^{-1}$) in wheat

An appraisal of data Table 2 indicates that there is no significant effect of spacing on CGR at 30-60 days, but there is an effect of spacing on CGR at 60-90 days. Among N levels, at 30-60 and 60-90 DAS, there is an effect of N levels on CGR. Interaction between

Table 2. Nitrogen and spacing interaction on CGR and RGR at 30-60 and 60-90 DAS.

Treatments	CGR ($g/m^2/day^{-1}$) 30-60 days	CGR ($g/m^2/day^{-1}$) 60-90 days	RGR ($g/g/day^{-1}$) 30-60 days	RGR ($g/g/day^{-1}$) 60-90 days
Spacing				
15 cm	7.63	12.98	0.01	0.03
20 cm	7.61	14.06	0.01	0.03
25 cm	7.62	14.35	0.01	0.04
CD	NS	0.29	NS	0.006
SE	0.07	0.10	0.0019	0.002
Levels				
L1- 0 kg N/ha	7.05	12.88	0.01	0.02
L2- 90 kg N/ha	7.45	13.31	0.01	0.03
L3-120 kg N/ha	7.97	13.88	0.01	0.03
L4-150 kg N/ha	8.01	15.12	0.01	0.03
CD	0.24	0.34	NS	0.007
SE	0.08	0.11	0.002	0.002
Interaction (S*L)				
CD	NS	NS	NS	NS
SE	0.14	0.20	0.003	0.004
CV	3.31	2.55	39.03	23.55

spacing and N levels was found to be non-significant. At 30-60 DAS, 15 cm with 150 N level showed highest CGR, while it was least at 20 cm with 0 N level. Highest CGR was obtained at a spacing of 25 cm with 150 N level, while the minimum was at 15 cm with 0 N level. Application of 150 N level recorded the highest at 30-60 and 60-90 DAS.

Results from data Table 2 shown that there is no effect of spacing on RGR at 30-60 DAS, but there is an effect of spacing on RGR at 60-90 DAS. Among levels, at 30-60 days, it was non-significant and at 60-90 days, it was observed as significant. Interaction between spacing and N levels on RGR of wheat was recorded as non-significant. Highest RGR was at 20 cm, while the lowest was at 15 cm. At 25 cm, 150 N level, RGR was obtained maximum at 60-90 DAS,

Nitrogen and spacing interaction on no. of spikelets per spike in wheat

From the data Fig. 4a, it is shown that there is a significant effect of spacing on no. of spikelets per spike. Also, there is an effect of N levels on no. of spikelets per spike. Interaction between the spacing and levels on no. of spikelets per spike was found to be non-significant. At 25 cm with 150 N level, it was observed as highest, while it was lowest at 15 cm with 0 N level. It was observed that reducing the spacing from 25 to 15 cm and increase in N level from 0 to 150 recorded the maximum no. of spikelets/spike.

Nitrogen and spacing interaction on spike length (cm) in wheat

Fig. 4b shows that there is no significant effect of spacing on spike length, but there is an effect of N levels among the levels. Interaction between spacing and levels was observed as non-significant. Spike length is one attribute that contributes towards the grain yield. Crop which having the better spike length that could have the highest grain yield. The longer spikes recorded in row spacing of 25 cm with 150 level. Lowest was attained from the treatment 20 cm and 0 N level. The spike length increased progressively till the application of 150 N level. It produced highest spike length and it was significantly higher than what acquired at lowest N level. Results from the similar studies have also been revealed by Alam *et al*. (2014), Jabesa and Abraham (2017), Dargie *et al*. (2020).

Nitrogen and spacing interaction on grain yield (tonnes/ha) in wheat

Results from Fig. 4c indicated that there is a significant effect of spacing on grain yield. Also, there is an effect of N levels on grain yield. But there is no interaction between spacing and levels on grain yield. Maximum was recorded at 25 cm with 150 kg N/ha. Lowest was observed at 20 cm with 0 level N. It was noticed that increase in yield by increasing rate of nitrogen applied upto 150 N level, that was statistically increased than other levels. Similar results were also in accordance with Haileselassie *et al*. (2014), Amare and Adane (2015), Mishra *et al.* (2017).

Nitrogen and spacing interaction on straw yield (tonnes/ha) in wheat

The results from (Fig. 5a) confessed that there is an effect of spacing on straw yield, also there is a significant effect of N levels on straw yield. Interaction between spacing and levels on straw yield was

found to be significant. It is evident from data that straw yield was attained maximal at 15 cm with 150 N level. Minimum was obtained at 25 cm with 0 N level. While other treatments recorded the lowest straw yield. It was found that decrease in spacing and increase in N level results in better straw yield. The results are in observance with Mali and Choudhary (2013), Kalpana (2014).

Nitrogen and spacing interaction on biological yield (tonnes/ha) in wheat

From the data (Fig. 5b) it is exhibited that, there is a significant effect of spacing on biological yield and among N levels, biological yield was significant. Interaction between spacing and levels on biological yield was found to be non-significant. From the data, it is exhibited that biological yield was maximum from 15 cm with 150 N level. At 20 cm with 0 N level, it was observed as lowest. The results shows that, decrease in spacing results in better yield. This indicates that as N level increases, biological yield increases. Similar results were also supported by Rao and Padmaja (2014), Hussain *et al.*(2016), Jabesa and Abraham (2017).

CONCLUSION

Wheat shows positive response to spacing and nitrogen levels. So, modifying these parameters had a beneficial impact on yield also the yield attributes of wheat. Based on the result attained in the experiment, 150 N level achieved maximum grain yield which was sown at a spacing of 25 cm. Moreover, this experiment manifested an additive trend of the grain yield by increasing N level and increasing row spacing. Thus, further variation of N rates and row spacing upwards might increase in the grain yield. Above all, grain yield was significant and positively related with spike length, spikelets per spike. Recommended row spacing of 22.5 cm with 125 kg N/ha is not sufficient for wheat cultivation. Therefore, wider row spacing (25 cm) with 150 kg/ha N is suitable for higher yield of wheat.

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