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Effect of Different Crop Establishment Methods and Nitrogen Levels on Growth Attributes, Dry Matter Partitioning and Radiation Characteristics of Wheat (*Triticum aestivum* L.)

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ABSTRACT

Crop establishment methods and nitrogen levels influences wheat production. We evaluated the effects of five crop establishment methods and four nitrogen levels on performance and profitability of wheat in 2013-14 at research farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana (India) in split plot design with three replications by using "F" test. Remarkable effects were noted under drill sowing at 18 and 20 cm and bed planting with three rows which were better in terms of growth and yield. Dry matter accumulation, number of tillers/m^2, leaf area index and light interception were significantly higher with drill sowing at 18 cm row spacing. However, spike length were highest with bed planting (2 rows). The highest grain yield (50.94 q/ha)) was obtained with 18 cm row spacing. The successive application of N from 100 per cent RDN, 112.5 per cent RDN and 125 per cent RDN, enhanced significantly various growth parameters including fertile tiller resulting in higher grain and straw yield of wheat.

Key words: *Crop Establishment Methods, Nitrogen levels, Growth attributes, Radiation characteristics and Wheat*

INTRODUCTION

Inefficient utilization of available resources by plants, particularly solar radiation under a wider row spacing, and severe inter-row competition among plants in narrow rows have compelled researchers to optimize row spacing for attaining better production of different crops and even varieties within the same species. Optimal row spacing is one of several important agronomic approaches that can be used to enhance wheat yield by optimizing tillering capacity and the efficient utilization of other available resources[4]. Cultural practices like method of sowing, crop density and geometry have pronounced effect on crop-weed interference.

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The narrow spacing can prove to be a useful practice to further enhance the productivity. Row spacing in wheat is an important agronomic practice to maximize the yield and quality of wheat crop. Under FIRBS (furrow irrigated raised bed system) method, wheat crop can be sown on the top (40 cm) of the beds, either with 2 rows per bed or 3 rows per bed. Sowing of wheat under FIRBS with 2 and 3 rows per bed was found to produce more yield compared to flat sowing[1]. Moreover, the cost of cultivation was lower and net benefit cost ratio was higher in bed planting as compared to conventional method of wheat plantation.

Among essential plant nutrients nitrogen is the one of most important nutrient for cereal crops and its availability is limited in soils. Nitrogen fertilization is one of the key factors in determining the yield of wheat. Its application in large quantities is very essential, particularly in high yielding varieties of wheat for optimum growth and higher yields. Nitrogen plays the key role in enhancing the photosynthetic activity of wheat crop which results in higher dry matter production and consequently higher productivity. The use of optimum dose of fertilizer and their suitable method of application are essential for improving the productivity level and finally the net income[9].

Bed planting holds immense potential for improving productivity potential of wheat based cropping system by making them less-resource-intensive and more sustainable. Information on the response of wheat for its suitability under FIRBS in respect to grain yield and quality, water use efficiency and economics of cultivation is lacking for agro-climatic conditions of Haryana. Further, row spacing for sowing of wheat under FIRBS planting method and flat sowing along with its response to varying nitrogen levels are also to be quantified. Keeping the above mentioned points in view, the present experiment was planned to evaluated the effects of five crop establishment methods and four nitrogen levels on wheat crop.

MATERIALS AND METHODS

Experimental details and site description

The experiment was conducted during *rabi* season of 2013-14 at research farm of Department of Agronomy, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana (India) situated at 29°10' N latitude and 75° 46' E longitude at an elevation of 215.2 m above mean sea level. The climate of this region is subtropical and semi-arid and climate characterized with summers and extremely cold winters. The mean maximum temperature of this region is about 45^0C to 48^0C is not uncommon during summer while very low temperature (4-10^0C) accompanied by frost may be experienced in December-January. About 80 to 90% of rainfall received during July to September and few showers are also a common feature during the month of December to January and in late spring season.

The texture of the surface soil of the experimental field was well drained sandy loam, containing 61.4 per cent sand, 17.8 per cent silt and 20.8 per cent clay. The basic infiltration rate was 4.4 mm/hr. Soil contained 20.2 and 7.5 per cent moisture, on weight basis, at -0.03 and -1.5 MPa, respectively. It was slightly alkaline (pH 8.2) in nature. The organic carbon content was 0.41 per cent. Soil was low in available N (181 kg/ha), medium in available P (19 kg/ha) and high in available K (281 kg/ha). The treatments consists of five row spacing [T_1- Sowing with drill at 20 cm, T_2- Sowing with drill at 18 cm, T_3- Sowing with drill at 16 cm, T_4- Bed planting (3 rows) and T_5- Bed planting (2 rows)] and four fertility level [F_1- 100 % Recommended N level (150 kg N/ha), F_2- 112.5 % Recommended N level (168.75 kg N/ha), F_3- 125 % Recommended N level (187.5 kg N/ha) and F_4- Control (No Nitrogen)].The study was made in split plot design with three replications. Half dose of N and full dose of P and K through urea, DAP and muriatic of potash, respectively, were applied at sowing and remaining half N was applied at first irrigation. Wheat (WH-711) with the spacing (rows) of 20 cm was grown with recommended agronomic package of practices in 20 m^{-2} plot size. The seeds were placed manually in the furrows with a seed rate of 125 kg ha^{-1} sown on 06-12-2013 (late) and harvested on 24-04-2014.

Data collection

Observations on various growth parameters viz. plant height; Number of tillers and dry matter accumulation were recorded at 90 DAS and at harvest of crops, whereas LAI was measured at 60 and 90 DAS. Moreover, Light interception was measured by using Lux meter, taking the difference of incident light on crop canopy and transmitted, reflected light from crop canopy at 60 and 90 DAS.

Statistical analysis

All experimental data were statistically analyzed by the method of analysis of variance (ANOVA). The significance of treatment effects was tested with the help of "F" (variance ratio) test. Appropriate standard errors along with critical differences (CD at 5%) were worked out for differentiating the treatment effects from those of change effects.

RESULTS AND DISCUSSION

Growth attributes

Data presented in Table 1 revealed that drill sowing at 20 and 18 cm row spacing of wheat could not significantly influence the plant height at 90 DAS and harvest stage. However, at every stage, significantly shorter plants were recorded under Bed planting (2 rows) and tallest plants (67.9 and 81.1 cm) at 90 DAS and harvest stage, respectively under drill sowing at 16 cm row spacing. Whereas, drill sowing of wheat at 18 cm recorded significantly higher dry matter accumulation (713.1 and 1,329.0 g/m^2) and tillers/m^2 (514 and 412 at 90 DAS and harvest stage, respectively than drill sowing at 16 cm and bed planting with two rows of wheat. Lowest dry matter accumulation and tillers/m^2 was recorded under drill sowing at 16 cm row spacing at both crop growth stages. This indicates that narrow spacing of 16 cm might have led to more mutual competition among the plants. Higher dry matter and tillers/m^2 under 18 cm row spacing was obtained by Mali and Chaudhary[3] and Kumar *et al*[1].

The linear increase in growth attributes *viz.*, plant height, dry matter accumulation and tillers/m^2 was recorded with increase in nitrogen levels which was also significant between two successive increases up to 125 per cent RDN at 90 and harvest stage. The highest plant height (69.1 and 84.7 cm), dry matter accumulation (727.4 and 1,361.8 g/m^2) and tillers/m^2 (513 and 420) was recorded with application of 125 per cent RDN at 90 DAS and harvest stage, respectively. Moreover, lowest values of growth attributes were noticed under control plot at both crop growth stages. These results are in line with the findings of Pandey *et al*[5].

Dry matter partitioning

During 90 DAS and at harvest the relative contribution of leaf, stem and spike dry matter towards total dry matter was more pronounced under FIRBS compared to other planting techniques (Fig 1 & 2). The relative per cent contribution of leaf: stem: spike was 29:60:11 at 90 DAS and 18:39:43 at maturity under FIRBS with 3 rows. The respective values under FIRBS with 2 rows were 29:59:12 at 90 DAS. Furthermore, among the nitrogen level treatments, the contribution of leaves and spikes towards total dry matter increases with increasing fertility level while contribution of stems towards total dry matter decreases with increasing fertility level during 90 DAS and at harvest. Adequate supply of the nutrient to crop, helped in the synthesis of carbohydrates and protein in plants. The role of nitrogen in synthesizing protoplasm and body building materials of plants are well documented[8].

Leaf area index

The data indicated that the increase in LAI was more remarkable from 30 to 60 DAS period as compared to 60 to 90 DAS (Table 1). The maximum LAI was attained under drill sowing with 18cm row spacing followed by drill sowing with 20 cm row spacing and bed planting with three of wheat at 60 to 90 DAS. However, the LAI under drill sowing at 20 cm was found to at par with LAI under bed planting with three rows during both growth stages. The significantly lower LAI was recorded under bed planting with two rows (3.24 and 5.30) as compared to all other planting techniques. Moreover, the LAI manifested a huge improvement numerically with increasing levels of nitrogenous fertilizer. The application of N up to 125 per cent RDN increased LAI significantly over lower N rates. During 60 and 90 DAS, increased fertility levels showed significant increments in LAI. The highest value of LAI was recorded with application of 125 per cent RDN, while lowest under control treatment at all the growth stages. Overall improvement in LAI due to N application has been reported by Sharma *et al*[7].. They reported that the photosynthetic potential (LAI) manifested a huge improvement numerically with increasing levels of nitrogenous fertilizer.

Radiation characteristics in wheat crop

Transmission and reflection coefficient (Table 2) were observed minimum under drill sowing at 18 cm row spacing due to optimum growth and higher LAI. Absorption coefficient was maximum under drill sowing at 18 cm row spacing. The values of transmission coefficient, reflection and absorption at 60 and 90 under various planting techniques ranged from 0.106 to 0.126 and 0.075 to 0.088, 0.077 to 0.097 and 0.081 to 0.093, and 0.777 to 0.812, 0.813 to 0.846, respectively. Furthermore, enhanced application of nitrogenous fertilizer resulted in higher leaf area index which enhanced the absorption coefficient of light. Absorption value of light by crop canopy increased with increasing fertility level during 60 and 90 DAS. Among the fertility levels highest value of absorption coefficient was recorded with application of 125 per cent RDN and lowest under control during 60 and 90 DAS. Transmission value and reflection value of light by crop canopy decreased with increased nitrogen levels while value of light absorption increased with increasing fertility levels. Higher absorption and lower transmittance value under enhanced nitrogen level was due to increased leaf area index.

Phenological studies

Different row spacing failed to produce any significant variation in days taken to emergence, flag leaf and anthesis while, flag leaf and anthesis was delayed with increased fertility levels. This could be due to enhanced succulency of the plants which requires more days for completion of phonological events. Nitrogen application had significant influence on the days taken to flag leaf and anthesis (Table 2). All nitrogen levels significantly delayed flag leaf and anthesis. Among nitrogen levels, 125 per cent RDN took maximum time to flag leaf (75.1) and anthesis (86.9) as compared to control. Similar response of delayed booting was also reported by Mahla *et al*[2]., in rice. Nitrogen application increased the vegetative growth as nitrogen application increased the photosynthetic activity and the leaves remained functional for a longer period which improved plant height and dry matter accumulation which ultimately delayed the anthesis in wheat. Increase in nitrogen application resulted in increase in photosynthetic efficiency of the plant which ultimately delayed the maturity of the crop. Rehman *et al*[6]., also reported similar influence of nitrogenous fertilizer on days to maturity in wheat.

Table 1: Effects of crop establishment methods and nitrogen levels on growth attributes and LAI

Treatments	Plant height (cm)		Dry matter accumulation (g/m^2)		Tillers/m^2		Leaf area index (LAI)	
	90 DAS	At harvest	90 DAS	At harvest	90 DAS	At harvest	60 DAS	90 DAS
Row spacing								
Drill sowing at 20 cm	66.1	81.0	697.7	1,297.0	491	402	4.07	5.81
Drill sowing at 18 cm	66.2	81.1	713.1	1,329.0	514	412	4.18	5.93
Drill sowing at 16 cm	67.9	83.1	630.7	1166.5	472	393	3.65	5.45
Bed planting (3 rows)	63.5	77.9	698.1	1,295.0	490	403	4.05	5.80
Bed planting (2 rows)	63.0	77.2	652.8	1,262.4	452	358	3.24	5.30
SEm±	0.31	0.37	5.10	18.64	1.5	1.7	0.02	0.04
CD at 5%	1.02	1.24	16.91	61.75	4.9	6.3	0.04	0.16
Fertility level								
100 % RDN (150 kg/ha)	66.2	81.1	677.7	1,266.8	484	393	3.99	5.65
112.5 % RDN (168.7 kg/ha)	68.1	83.4	716.8	1,342.1	506	416	4.24	5.93
125 % RDN (187.5kg/ha)	69.1	84.7	727.4	1,361.8	513	420	4.33	6.10
Control	58.0	71.1	594.3	1,109.2	463	338	2.81	5.04
SEm±	0.20	0.24	4.11	7.84	1.2	1.3	0.02	0.03
CD at 5%	0.59	0.35	11.93	24.05	3.6	3.0	0.03	0.08

Table 2: Effects of crop establishment methods and nitrogen levels on radiation characteristic and phenology

Treatments	Transmission coefficient		Reflection coefficient		Absorption coefficient		Days taken to		
	60 DAS	90 DAS	60 DAS	90 DAS	60 DAS	90 DAS	Emergence	Flag leaf	Anthesis
Row spacing									
Drill sowing at 20 cm	0.114	0.080	0.087	0.085	0.799	0.835	8.6	74.7	85.5
Drill sowing at 18 cm	0.111	0.075	0.077	0.081	0.812	0.846	8.7	74.2	85.5
Drill sowing at 16 cm	0.106	0.085	0.083	0.091	0.811	0.827	8.7	74.2	85.5
Bed planting (3 rows)	0.111	0.079	0.089	0.084	0.810	0.835	8.8	74.5	85.4
Bed planting (2 rows)	0.126	0.088	0.097	0.093	0.777	0.813	8.8	74.4	85.4
SEm±							0.04	0.31	0.15
CD at 5%							NS	NS	NS
Fertility level									
100 % RDN (150 kg/ha)	0.115	0.088	0.081	0.082	0.805	0.831	8.7	74.3	85.1
112.5 % RDN (168.7 kg/ha)	0.109	0.082	0.080	0.081	0.809	0.836	8.6	74.8	86.2
125 % RDN (187.5kg/ha)	0.100	0.081	0.079	0.078	0.821	0.841	8.8	75.1	86.9
Control	0.124	0.089	0.089	0.087	0.787	0.824	8.8	70.5	80.1
SEm±							0.11	0.26	0.19
CD at 5%							NS	0.78	0.55

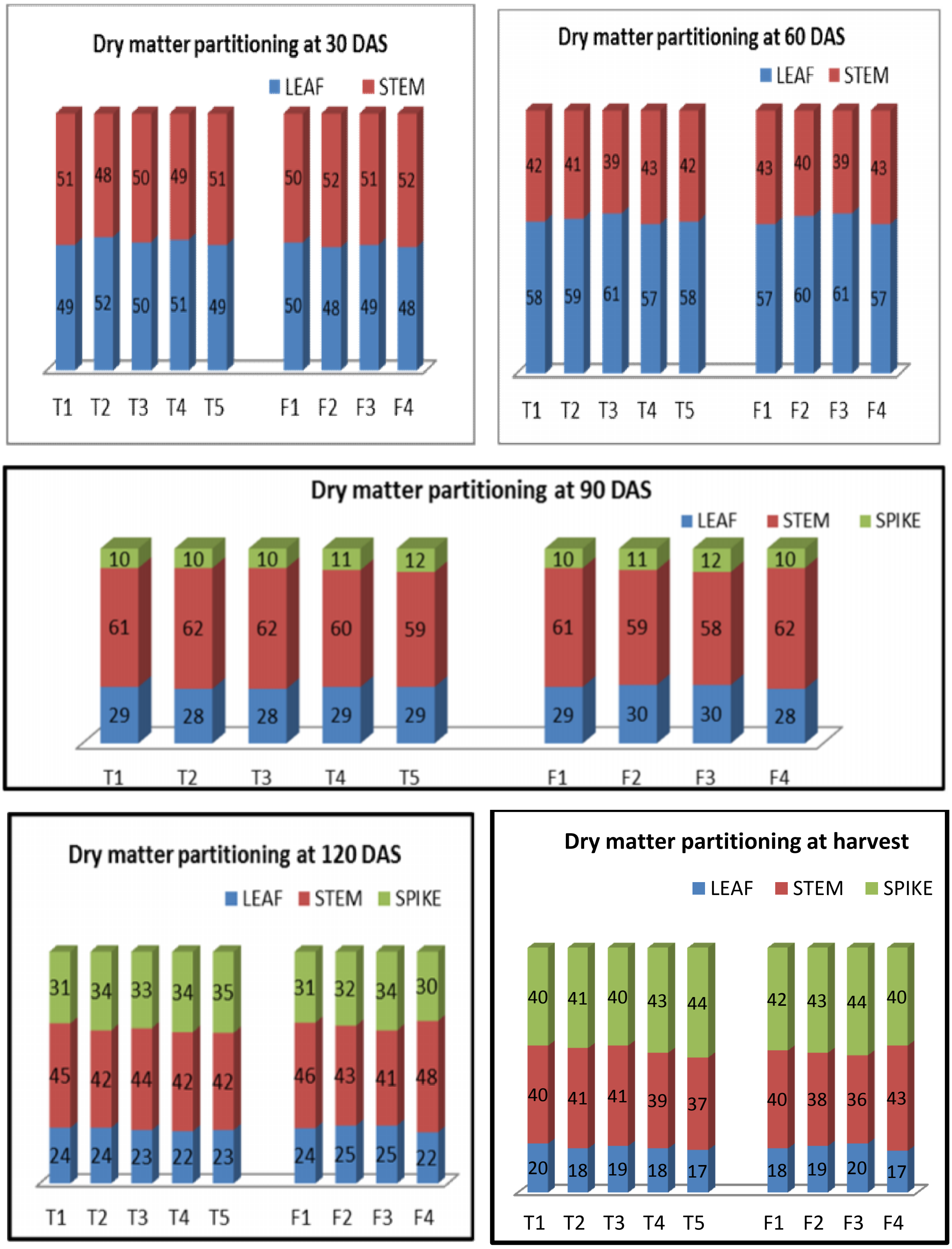

Fig. 1:

CONCLUSION

On the basis of experimental findings, it can be concluded that drill sowing at 18 cm proved to be better when fertilized with 125 per cent RDN. Besides, they also obtained Dry matter accumulation, number of tillers/m2, leaf area index and light interception were significantly higher with drill sowing at 18 cm row spacing. The successive application of N from 100 per cent RDN, 112.5 per cent RDN and 125 per cent RDN, enhanced significantly various growth parameters including fertile tiller resulting in higher grain and straw yield of wheat. Further, at least one more year research is needed to develop the site specific nitrogen management module for wheat.

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