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Growth Parameters and Productivity of Wheat as Influenced by Crop Establishment Methods and Different Seed Rate

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ABSTRACT

An experiment was conducted during rabi season 2014-15 and 2015-16 at farmer field of village Akalgarh, Yamunanagar, Haryana (India) in semi-arid subtropical climate. The experiment was conducted on loamy texture soil to study the growth and productivity of wheat as affected by crop establishment methods and different seed rate. The experiment was laid out in split plot design with three replications keeping four crop establishment methods viz. zero tillage with residue retention, zero tillage without residue, conventional methods of broadcasting and line sowing in main plots and three seed rate viz. 75, 100 and 125 kg/ha in sub plots. The results revealed that growth and productivity were recorded significantly higher under zero tillage wheat with rice residue retention as compared to conventional method of broadcasting but it was statistically at par with zero tillage without residue and conventional method of line sowing. Among seed rate, growth parameters and grain yield were produced significantly higher with 125 kg/ha seed rate than 75 kg/ha but it was statistically at par with 100 kg/ha seed rate.

Key words: *Growth, productivity, crop, establishment methods, seed rate*

INTRODUCTION

Wheat (*Triticum aestivum* L.) is a major cereal crop, which plays an important role in food and nutritional security. It shares upto 40 percent of total food grain production. In India, total area under wheat is 31.0 Mha, with production of 86.53 mt and the productivity of 2.8 t/ha[15]. In Haryana, area under wheat is 2.6 Mha with production of 10.35 mt and the productivity of 4.0 t/ha[3]. In India, major breakthrough in wheat production started in 1967-68 with the introduction of the dwarf Mexican wheat genotypes. The growth rate of production was highest during I960's which led green revolution. Currently, India stands first in area and second in production next to China in the world. There is hardly any scope for expansion of area under wheat. The main emphasis would be on increasing the productivity of wheat by adopting improved cultivation practices. If agronomic practices are fine tuned and weeds are managed properly, the wheat productivity can be enhanced further.

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Crop management practices like residue management, choice of crop establishment method and optimum seed rate have pronounced effect on crop-weed interference and wheat productivity. The future increases in the productivity of wheat will greatly depend upon improvements in soil environment by proper management of resources with utilization of crop residues and other agricultural wastes. There are currently few uses for rice straw because of its poor quality for forage, bioconversion, and engineering applications. Rice straw thus remains unutilized and is generally burnt in the field as the loose straw interferes with tillage and seeding operations for the subsequent wheat crop. Zero-till machines have been used to sow wheat into rice fields with retained residues, but loose straw clogs the tines, so that burning of loose residues is essential. Burning of residues will result in loss of soil organic matter and plant nutrients besides causing environmental pollution. To overcome the problems of burning residues or late sowing of wheat, a machine called 'Happy Seeder' has been developed that cuts and spreads rice residues on the soil surface while simultaneously sowing wheat with zero or strip tillage. When the crop residues are retained on soil surface in combination with no tillage, it initiates processes that lead to improved soil quality and overall resources enhancement. Further, the seed rate plays an important role in capture of the resources. The optimum seed rate can be useful to enhance the productivity by facilitating more number of tillers per unit area as well as reducing growth of weeds by smothering action. Seeding rate can have a great impact on wheat tillering and finally on grain yield of wheat. The optimum seed rate can be useful to enhance the productivity by facilitating more efficient utilization of available natural resources.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* season 2014-15 and 2015-16 at farmer field of village Akalgarh, Yamunanagar, Haryana (India) in loamy texture soil to study the growth and productivity of wheat under different crop establishment methods and seed rate. During the crop period 2014-15 and 2015-16, the 8^{th} and 1^{st} standard weeks recorded the highest (102.8 mm) and lowest (2.20 mm) rainfall while the 10^{th} and 45^{th} standard weeks recorded the highest (36.6 mm) and lowest (0.30 mm) rainfall, respectively. Irrigation was scheduled based on crop water requirement and gap in rainfall. To supplement the rainfall, three irrigations in zero tillage with residue retention while four irrigations in zero tillage without residue, conventional method of line sowing and broadcasting were applied during first year. Whereas, four irrigations in zero tillage with residue retention while five irrigations in zero tillage without residue, conventional method of line sowing and broadcasting were applied during second year. The soil of experimental field was slightly alkaline in nature with pH of 7.9. The organic carbon content was 0.67% in the upper layer of experimental field. Soil was low in available N (164.0 kg/ha), medium in available P (27.1 kg/ha) and available K (173.6 kg/ha). The experiment was laid out in split plot design with three replications consisting four crop establishment methods *viz*. zero tillage with residue retention, zero tillage without residue, conventional tillage of broadcasting and line sowing in main plots and three seed rate *viz*. 75, 100 and 125 kg/ha in sub plots. Fertilizer was applied as per CCS HAU, Hisar recommendation with uniform application of 150: 60: 60 kg/ha of N, P_2O_5 and K_2O. Full dose of P_2O_5 and K_2O were applied at the time of sowing of wheat. Nitrogen was applied in two equal splits as top dressing after first irrigation at CRI stage (20-25 DAS) and tillering stage (40-45 DAS) during both years. Spacing of 21 cm was kept under zero tillage with residue and without residue retention and conventional method of line sowing while random seeding was done in

broadcasting method a common farmer practice widely adopted in western IGP. The wheat variety HD 2967 was sown manually in broadcasting method while seed drill was used under conventional methods of line sowing. Whereas, Happy seeder was used to establish crop under zero tillage method with residue and without residue retained situation. All rice residues were removed in case of broadcasting and line sowing but about 30% stubbles portion were retained in case of zero tillage without residue situation but all rice residues were retained on soil surface under zero tillage sowing with Happy seeder before sowing of wheat crop.

RESULTS AND DISCUSSION

Growth studies:

Emergence count and number of tillers

Proper plant population is prerequisite for obtaining higher productivity. The emergence count is the key indicator of predicting crop productivity. The emergence counts at 15 DAS did not differ significantly among crop establishment methods. This was due to equal seed rate that leads to uniform plant population. However, improvement in plant population was reported by Singh *et al*[21]., and Majid *et al*[10]., under zero tillage as compared to conventional tillage in wheat. But results confirmed the outcomes of Kumar[6] who observed non-significant effects of zero tillage and conventional tillage on emergence count. Singh *et al*[18]., also reported uniform plant density in mulched and non mulched condition of wheat crop. Further, seed rate of 125 kg/ha had recorded significantly more emergence than 75 kg/ha but it was statistically at par with 100 kg/ha seed rate during both years (Table 1). Sharma and Singh[16] also observed increased plant population per unit area with higher seed rates. Tillering is another important parameter for assessing growth in wheat. As tillering stage of wheat generally approach at 40-45 DAS, so number of tillers continued to increase from 30 to 60 DAS under all treatments but decreased at maturity due to mortality as a result of competition between tillers for photosynthates (Table 1). At 30, 60 DAS and at maturity significantly higher number of tillers were recorded in zero tillage sown wheat with residue retention as compared to conventional method of broadcasting in both the years. It might be due to better utilization of resources that leads to more number of tillers under zero tillage with residue retention. Further, this could be owing to suitable placement of seed in narrow slit through Happy seeder, early emergence of wheat seedling and availability of more moisture. Saini and Walia[13] reported no marked effect on growth when compared zero tillage wheat with residue and without residue retention situation. Among different seed rate, 125 kg/ha was significantly superior with respect to number of tillers than 75 kg/ha seed rate but it was statistically at par with 100 kg/ha during both the years of research study. This might be due to more plant population per m^2 resulted from higher seed rate. Singh *et al*[19]., observed that number of tillers per m^2 were maximum with seed rate of 80 kg/ha, which was superior over lower seed rates of 60 kg/ha and 40 kg/ha. While, Kabir *et al*[4]., reported highest total tillers per plant from the seed rate of 140 kg/ha compared to higher and lower seed rates.

Plant height

Plant height is an important attribute of development that provides an idea of predictable biomass and so on crop productivity. The rate of increase in plant height was maximum during 60 to 90 DAS and thereafter it slowed down (Table 2). This was generally due to maximum growth of plant attained during this period. Among the tested crop establishment methods, zero tillage with residue retention recorded maximum plant height, which was significantly higher than conventional method of broadcasting at all the crop growth period in both the years. This was possibly due to enhanced soil health and micro-environment by implementation of conservation based management practices[8]. In contrast, Sardana *et al*[14]., and Singh *et al*[21]., observed non-significant difference in plant height when compared zero tillage with

conventional methods. Meena[11] observed significantly higher plant under zero tillage than farmer's practice and conventional tillage. Kharub and Chander[5] confirmed similar plant height with zero and rotary tillage. However, Yadav *et al*[24]., reported marginally higher growth parameters of wheat crop under ZT than CT. Plant height of wheat measured at all growth periods was significantly higher with 125 kg/ha seed rate than 75 kg/ha but it was statistically at par with 100 kg/ha seed rate during both the years. This increase was primarily due to more competition for light resulted from increased number of tillers with higher seed rate, forced the plants to grow higher to intercept the sunlight[7]. Singh *et al*[20]., reported taller plants with 80 kg/ha seed rate which was significantly superior over lower seed rates of 60 kg/ha and 40 kg/ha. While, highest plant height was reported by Kabir *et al*[4]., at seed rate of 140 kg/ha than lower and higher seed rate. While, Singh[22] observed non-significant difference in plant height due to different seeding density.

Dry matter accumulation

Biomass accumulation is directly proportional to number of tillers and plant height. Among the crop establishment methods, zero tillage wheat with residue retention accumulated highest dry matter at 30 DAS till maturity which was significantly higher than that accumulated in conventional method of broadcasting (Table 3). The highest dry matter accumulation in zero tillage with residue retention might be due to moderated soil temperature, favourable soil moisture and improved soil biota by constant supply of nutrients through mineralization of rice residues[2,8]. Ram *et al*[12]., reported better light interception resulted more dry matter production in zero tillage wheat with residue retention situation than without residue application under ZT as well as CT practices. While, in contrast Saini and Walia[13] reported no marked effect on dry matter accumulation under different planting methods. Seed rate of 125 kg/ha had accumulated significantly higher dry matter than 75 kg/ha but it was statistically at par with 100 kg/ha seed rate at all intervals during both the years. This might be due to more exposure of soil under lower seed rate leading to higher evaporation and dryness[20].

Productivity or Grain yield

The grain yield of a crop is the net resultant of various factors which contribute to certain extent in determining the productivity of any system. It is valid criterion for comparing the efficiency of different treatments. Among crop establishment methods, grain yield of wheat was significantly higher in zero tillage wheat with residue retention than conventional method of broadcasting (Table 3). But there was no marked variation in grain yield of wheat when compared it with zero tillage without residue and conventional line sowing. The possible reason for higher yield under zero tillage with residue retention related to increased soil water availability due to reduced soil evaporation and less competition for nutrients and water with reducing weed population. The yield was probably an advantage of the straw retained or incorporation leads to maximize crop nutrient removal and minimize the risk of nutrient loss. Sidhu *et al*[17]., Bohra and Kumar[1] and Kumar *et al*[9]., also reported higher yields trends with conservation based crop establishment methods. Further, grain yield of wheat was significantly affected by seed rate, 125 kg/ha seed rate had recorded significantly higher grain yield than 75 kg/ha but it was statistically at par with 100 kg/ha during both the years of experimentation. Selection of appropriate plant density for higher productivity depends mainly on tillering and lodging. High plant density beyond optimum leads to mutual competition among plants due to which it fails to exploit the inputs fully. Tripathi *et al*[23]., and Sharma and Singh[16] also observed increasing trend in grain yield of wheat with increasing seed rates.

Table 1: Emergence count at 15 DAS and tillers of wheat at different growth period as affected by crop establishment methods and seed rate

Treatments	2014-15				2015-16			
	Emergence count (per m^2)	Numbers of tillers (per m^2)			Emergence count (per m^2)	Numbers of tillers (per m^2)		
		30 DAS	60 DAS	At maturity		30 DAS	60 DAS	At maturity
Crop establishment methods								
Zero tillage (with residue)	140.7	218.7	406.3	372.7	142.6	244.7	438.1	408.7
Zero tillage (without residue)	152.6	205.4	388.8	359.8	149.2	214.7	417.3	391.3
Broadcasting (CT)	143.4	182.9	342.7	313.3	143.6	169.3	373.1	340.2
Line sowing (CT)	145.3	202.8	387.1	356.0	144.1	213.4	413.1	384.7
SEm ±	10.7	5.3	8.6	9.9	10.5	11.3	9.8	12.0
CD (0.05)	NS	18.7	30.2	34.9	NS	39.9	34.7	42.4
Seed rate								
75 kg/ha	119.8	180.2	345.7	320.0	120.6	172.3	376.2	347.0
100 kg/ha	146.1	203.9	385.0	355.8	148.9	218.1	416.3	389.3
125 kg/ha	170.6	223.3	413.0	375.5	165.1	241.2	438.8	407.3
SEm ±	8.8	7.6	13.0	8.4	6.5	9.9	12.5	12.0
CD (0.05)	26.6	22.9	39.2	25.5	19.7	30.0	37.8	36.2

Table 2: Plant height of wheat as affected by crop establishment methods and seed rate

Treatments	Plant height (cm)									
	2014-15					2015-16				
	30 DAS	60 DAS	90 DAS	120 DAS	At maturity	30 DAS	60 DAS	90 DAS	120 DAS	At maturity
Crop establishment methods										
Zero tillage (with residue)	21.6	34.7	71.2	93.4	97.2	23.7	36.4	73.8	96.6	99.5
Zero tillage (without residue)	21.4	33.6	70.0	92.2	96.0	22.5	35.1	72.1	94.9	98.0
Broadcasting (CT)	19.1	30.7	66.2	88.1	89.8	19.0	31.8	66.4	89.8	92.9
Line sowing (CT)	21.0	33.3	69.6	91.8	95.4	22.0	34.5	71.4	94.2	97.3
SEm ±	0.5	0.7	0.9	1.0	1.5	0.7	0.6	1.2	1.2	1.1
CD (0.05)	1.6	2.5	3.3	3.5	5.2	2.4	2.2	4.4	4.2	3.8
Seed rate										
75 kg/ha	19.5	31.4	66.8	89.1	91.1	20.8	32.5	68.0	91.0	93.9
100 kg/ha	21.2	33.6	69.8	91.8	95.6	22.0	34.7	71.7	94.6	97.8
125 kg/ha	21.7	34.2	71.1	93.2	97.1	22.6	36.1	73.0	96.0	99.1
SEm ±	0.5	0.6	0.9	0.8	1.0	0.3	0.6	0.9	1.1	1.1
CD (0.05)	1.6	2.0	2.7	2.4	2.9	1.1	1.9	2.8	3.4	3.2

Table 3: Dry matter accumulation and productivity of wheat as influenced by crop establishment methods and seed rate

Treatments	2014-15						2015-16					
	Dry matter accumulation (g/m^2)					Grain Yield (kg/ha)	Dry matter accumulation (g/m^2)					Grain Yield (kg/ha)
	30 DAS	60 DAS	90 DAS	120 DAS	At maturity		30 DAS	60 DAS	90 DAS	120 DAS	At maturity	
Crop establishment methods												
Zero tillage (with residue)	36.16	153.96	650.03	932.55	1175.00	5477	38.04	166.99	722.11	1008.97	1245.33	5801
Zero tillage (without residue)	35.34	149.99	633.05	906.64	1139.44	5400	37.50	163.43	706.70	987.89	1216.78	5693
Broadcasting (CT)	32.34	135.88	565.95	808.08	1013.89	5181	34.01	147.10	625.88	868.56	1045.00	5438
Line sowing (CT)	35.31	148.80	627.12	898.33	1108.33	5384	37.13	161.48	696.77	975.05	1196.00	5687
SEm ±	0.72	1.54	9.10	18.36	25.25	54	0.80	2.08	12.26	14.68	39.39	69
CD (0.05)	2.54	5.44	32.09	64.77	89.07	189	2.82	7.35	43.26	51.79	138.95	244
Seed rate												
75 kg/ha	31.88	134.60	564.88	806.75	1019.50	5165	34.08	147.22	631.37	878.95	1065.67	5463
100 kg/ha	35.82	151.62	638.10	913.72	1131.33	5420	37.39	163.42	703.11	981.70	1207.17	5710
125 kg/ha	36.67	155.25	654.13	938.73	1176.67	5497	38.55	168.61	729.12	1019.70	1254.50	5791
SEm ±	1.01	1.71	11.17	18.00	23.66	31	1.01	2.23	11.21	20.93	21.74	36
CD (0.05)	3.04	5.17	33.78	54.42	71.53	94	3.04	6.74	33.90	63.30	65.73	108

CONCLUSION

Due to continuous intensive tillage practices, productivity of wheat decline in response to depletion of nutrient dynamics in soil which will need to be sustained using conservation based tillage practices with retention of rice residue to increase the crop productivity on long term basis. The results concluded that growth and productivity of wheat were recorded significantly higher under zero tillage with rice residue retained situation as compared to conventional tillage of broadcasting. Growth and productivity were produced significantly higher with 100 kg/ha seed rate than 75 kg/ha but there was no marked variation in growth and productivity when 25% more seed was used. Thus, seed rate of 100 kg/ha will be optimum for higher productivity under irrigated area of western IGP.

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