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Productivity and Economics of Late Sown Wheat (*Triticum Aestivum*) as Influenced by Seed Rates and Nitrogen Levels

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ABSTRACT: An experiment was carried out during *rabi* 2013 and 2014 under All India Co-ordinated Wheat Improvement Project, at research farm BTC, College of Agriculture & Research Station, Bilaspur (CG). Experiment was comprised of different level of seed rate (125, 150,175 &200 Kg/ha) as main plot and Nitrogen levels (80,100,120 &140 Kg/ha) as sub plot were laid out in split plot design replicated thrice with wheat variety HD 2932. Experiment is harvested and seed yield and yield attributing traits were recorded. The highest two year mean grain yield was recorded for150 Kg\ha seed rate (33.48q\ha),which was 17.02 percent higher than recommended seed rate 125 Kg/ha and 19.46 percent higher than 175 Kg/ha, lowest seed yield was recorded with seed rate 200 Kg/ha. Similar trend was also found for straw yield. This might be due to higher yield attributing character i.e. no. of tillers/sqm., number of grains/earhead and test weight (g) were recorded under seed rate 150 Kg/ha. Among four different nitrogen levels 80,100,120 & 140 Kg/ha., seed yield (q/ha) was increase with increase in fertilizer levels up to 120 Kg/ha after that at higher level of nitrogen 140 Kg N\ha yield was decrees (two year mean). Higher two year mean seed yield (32.87 q/ha) was recorded with nitrogen level 120 Kg/ha, which was 16.64 percent higher than lower nitrogen level 80 Kg/ha and 10.40 percent higher than nitrogen level 100 Kg/ha. Higher mean net return (39260 Rs./ha) was recorded under seed rate 150 Kg/ha and highest return per rupee invested 1.38 was found with nitrogen level 120 Kg/ha. Higher plant population per unit due to increased seed rate helps to mitigate terminal heat stress.

Keyword: Wheat, seed rate (kg/ha), nitrogen levels (kg/ha), terminal heat stress & late sown.

INTRODUCTION

Wheat, the most widely cultivated food crop of the word, is known for its remarkable adaption to a wide range of environments. On the global context, India is the second largest producer of wheat with approximately 12 percent world's wheat production and it is also the second largest consumer of wheat after China, and has a huge and growing demand (Anonymous, 2019-20). As a contrast to rice, which is mostly grown in Asia, wheat is grown in all the six continents of the world. In India, wheat has covered an area of 31.76 million hectares with a total production of 109.52 million tonnes and productivity 3464 Kgha^{-1} (USDA, 2021). In Chhattisgarh, wheat occupies an area about 112 (000, ha), with a production of 150 (000, t) and average productivity of 1340 Kg ha^{-1} (Director's Report, 2020-21) Wheat is the main source of energy and nutrition in human diet. It contributes about 60 percent of daily protein requirement and more calories to world human diet than other food crops (Mattean *et al*. 1970). It is the most important cereal crop and occupies prominent position in Indian agriculture after rice. Most wheat used for food requires processing. Its consumption provides approximately 70 percent calories and 80 percent protein of human diet (Zaeim *et al*., 2017) consumed mainly in the form of chapattis, bread, cake, biscuits, pastry, suji, macroni and other bakery products. There are endless uses for wheat flour in coking and baking, but its most important in bread. Most widely used for making bread due to the quality and quantity of characteristic protein called gluten. Wheat is an excellent health providing food having nutrient composition per 100 gm wheat contains 9.2 gm fat, 44.7 gm 5 carbohydrate, 28.7 gm starch, 16.0 gm total sugar, 22 mg vitamin E, 45 mg niacin, 0.72 mg riboflavin, 2.01 mg thiamin (Kumar *et al*., 2011).

The productivity of wheat in the state is around 13.40 qt/ha which is far lower than the national productivity (29 qt/ha). Winter is short in the state (about 80-90 days), normally the day (max.) temperature rises gradually after third week of January and reaches higher rate of increasing trends after 20th February. The wheat crop requires favorable winter about 100-110 days with fulfilling all other requirements for producing its potential yields. Therefore, the heat tolerance wheat variety and resource management practices is still one of the priority of agricultural research because of above the optimum temperature (22-24^{o}C) wheat yield is drastically affected. The reason behind this is the high temperature (short winter) reduce the crop cycle of the wheat cultivation (Pandey and Parihar, 1997). Recommended seed rate for late sowing of wheat is 125 kg\ha in Chhattisgarh. Wheat seed yield reduced significantly under late sown conditions in the state due to terminal heat stress. About 50 % of the wheat in Chhattisgarh is planted after first week of the December and suffer from heat stress and which causes the significantly yield loss. Late planted wheat suffers drastic yield losses which may exceed to 40-50%. It has already been established that heat stress can be a significant factor in reducing the yield and quality of wheat (Stone & Nicolas 1995). Normal sowing has longer growth duration, which consequently provides an opportunity to accumulate more biomass as compared to late sowing, hence resulted in higher

grain and biological yields (Singh and Pal 2003). Selection of suitable cultivars can maintain higher productivity of wheat in any region. In general, all wheat varieties, when sown late, faces severe temperature stress that significantly affects phenology, growth and finally yield (Hossain and da Silva, 2012). To mitigate the effect of terminal heat stress and optimize the seed rate for wheat yield maximization, a field experiment was conducted.

MATERIALS AND METHODS

A field experiment was conducted on sandy loam soil during winter (*rabi*) 2013 and 2014 under All India Coordinated wheat improvement project, at BTC, College of Agriculture & Research Station Bilaspur (Chhattisgarh). The soils are sandy loam with pH 7.1, EC 0.27 dS\m, Organic carbon 0.52s%, Bulk Density 1.34 mg M^{-3} 239 kg/ha nitrogen, 18.7 kg/ha phosphorus & 335 kg/ha potash (Table 1). Experiment was conducted in split plot design with three replications having four seed rate (125 to 275 kg/ha with interval of 50 kg/ha) in main plot and four nitrogen levels (80 to 140 kg/ha with interval of 20kg/ha), in sub plot under late sown conditions. Wheat genotype HD 2932 was used during both the year. Grass (2.16m × 5.50m = 11.80m^{-2}) and net (1.80m × 4.50m = 08.10 m^{-2}) plot size were taken during experimentations. Fertilizers were applied as 1/3rd nitrogen, full dose of P&K as basal and remaining 2/3rd as 1/3rd at first irrigation and 1/3rd at second irrigation. For both the year experiment was sown on dated 19 December and harvested on 16.04.2013 & 19.04.2014. Average maximum & minimum temperature during crop period were 30.98 & 13.63 ^{o}C (2013) and 30.26 & 15.02 ^{o}C (2014), average winter rains during crop growth period was 5&108mm for 2013&2014.Wheat was sown in 20 cm. spacing during both the year. Generally seed drill using with 22.5 cm spacing, for closer spacing 20 cm seed drill furrow opener can be adjusted manually. For adjusting furrow opener in 20cm spacing in nine tine seed drill. Centre (5th furrow opener) will be keep intact in its original position. Fourth & six furrow-opener should be shifted one inch inside, three & seven furrow-opener two inch inside, two & eight furrow-opener three inch inside and one & nine furrow opener shifted four inch inside than fix all furrow opener for sowing of wheat at 20 cm spacing. Except seed rate other recommended package and practices should be same.

Table 1: Physiochemical properties of experimental soil (two year mean).

Soil Properties	Unit	Quantity	Methods	Soil Properties	Unit	Quantity	Methods
Partial size							
Sand	%	49.4	Black, 1965	Organic Carbon	%	0.52	Black, 1965
Silt	%	27.6	Black, 1965	Available Nitrogen	%	239	Subbiah and Asija, 1956
Clay	%	30.9	Black, 1965	Available Phosphorus	%	18.7	Olsen *et al.*, 1954)
Bulk Density	mg M^{-}_{3}	1.34	Black, 1965	Available Potassium	mg M^{-3}	335	Jackson, 1973
Field capacity	%	21.1	-	pH (1:2)	%	7.1	Piper, 1967
Permanent wilting point	%	9.8	-	EC (1:2)	%	0.27	Black, 1965

RESULTS AND DISCUSSION

Seed rates & nitrogen levels (Kg/ha) significantly influenced the grain & straw yield(q/ha) and economics of late sown wheat. The seed yield was increase with increase seed rate from 125 kg/ha to 175 Kg/ha after that at higher level of seed rate 200 Kg/ha, yield was decrease during both the year of experiments. *(*Behera, 995) reported that significantly higher seed yield (q/ha) of late sown wheat recorded under higher sowing rates (Kg/ha) with higher fertilizer dose. The significantly higher mean seed yield (34.03q/ha) was recorded for 150 Kgha seed rate, which was 18.60 percent higher than recommended seed rate 125 Kg/ha and 24.86 percent higher than 200Kg/ha seed rate during 2013. Next year of experiment the highest mean seed yield (33.79 q/ha), was recorded for 175 Kg/ha seed rate, which was at par with 150 Kg/ha seed rate (32.93 q/ha). Seed rate 175 Kg\ha was recorded 17.54 per cent higher seed yield than recommended seed rate (125 Kg/ha) during 2014. The highest two year mean seed yield (33.48q/ha) was recorded under 150 Kg/ha seed rate, which was 17.02 percent higher than recommended seed rate (125 Kg/ha) and 19.46 percent higher than 175 Kg/ha, lowest seed yield was recorded with seed rate 200 Kg/ha. There was no significant difference between sowing rates of 150 and 175 Kg/ha. Higher plant population per unit due to increased seed rate helps to mitigate terminal heat stress. Similar result was also found for biomass yield during both the year. (Thakur *et al*, 1996) reported that, the maximum grain and straw yield and highest net return were recorded with higher seed rate of 200 Kg/ha. Seed rate 225Kg/ha recorded significantly higher stand counts, ear heads/sq. m. & test weight; however, grains\spike was at par with 250kg/ha. The higher number of tillers/sqm., was found with 150 Kg/ha seed rate and highest number of grains/earhead and test weight (g) were recorded under seed rate 175 kg\ha. Lower number of tillers\sqm., number of grains/earhead and test weight (g) were recorded under seed rate 200 Kg\ha (two year mean data). Significantly higher earhead count was recorded under 175 Kg\ha seed rate during 2014. Non significant effect was observed for plant height under different seed rate for both year of experimentation. These results confirm the findings of (Singh *et al.*, 1999*)*. Seed yield (q/ha) was increase with increase in nitrogen levels up to 120 Kg N/ha., and decrease at highest nitrogen level 140 Kg/ha during 2013. Significantly higher seed yield (32.91 q/ha) was recorded in 120 Kg/ha nitrogen level, which was 17.38 per cent higher than lower nitrogen level 80 Kg/ha 6.53 percent higher than 100 kg/ha nitrogen level during first year experiment. Higher two year mean seed yield (32.87 q/ha) was recorded with nitrogen level 120 Kg/ha, which was 16.64 percent higher than lower nitrogen level 80 Kg/ha and 10.40 percent higher than nitrogen level 120 Kg/ha. Similar finding was reported by (Kushwaha *et al,* 2002). Highest 1000 grain weight (g) was registered under nitrogen level 120 Kg/ha, which was statistically superior than other nitrogen level during 2013.Higher two year mean value were recorded for yield attributing characters i.e number of tillers sqm., and number of grains/earhead. Non-significant difference was recorded for plant height (cm.) among different seed rates (Kg/ha) during both the year (Table 2). Higher mean net return (39260 Rs./ha) was recorded under seed rate 150 Kg/ha and highest return per rupee invested 1.38 was

found with nitrogen level 120 Kg/ha. Higher mean net return (39260 Rs./ha) was recorded under seed rate 150 Kg/ha and highest return per rupee invested 1.38 was found with nitrogen level 120 Kg/ha (Table3).

Table 2: Wheat yield & yield attributing characters as influenced by seed rates & nitrogen levels.

Treatments	Grain Yield, (q./ha)		Straw Yield, (q./ha)		Earhead\ Sq.m.		Grains\ Earhead		1000 Grains Weight, (g)		Plant Height, cm.	
A. Seed rates, kg/ha	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
S1:125	27.70	27.86	55.76	54.49	194.66	208	37.66	34.42	45.63	41.62	85.38	85.33
S2:150	34.03	32.93	68.25	66.47	218.75	226	41.91	36.00	50.90	45.49	85.63	85.65
S3:175	28.69	33.79	57.66	67.21	199.42	245	41.50	37.42	49.24	47.44	86.16	86.26
S4:200	26.23	28.58	53.23	57.05	181.25	223	36.50	34.75	48.24	43.15	85.02	85.04
CD at 5%	1.16	0.95	2.78	1.25	6.09	4.25	1.45	2.07	NS	2.39	NS	NS
B. Nitrogen levels kg\ha												
N1:80	27.19	27.61	54.27	55.13	193.92	210	36.41	34.25	47.55	41.91	85.49	85.29
N2:100	30.76	28.14	63.24	56.21	218.00	229	37.50	34.75	49.56	44.27	84.33	86.42
N3:120	32.91	32.83	65.77	65.83	203.67	231	42.50	37.08	51.08	45.73	86.97	85.77
N4:140	25.79	34.04	51.61	67.59	178.50	235	41.16	36.50	45.83	46.79	85.41	84.78
CD at 5%	1.91	1.29	3.87	1.08	15.98	1.56	3.52	1.29	1.29	1.56	NS	0.92

Table 3: Effect of seed rates & nitrogen levels on Cost incurred, Grass realization, Net realization and Return rupees^{-1} invested ha^{-1} on wheat.

Treatments	Cost incurred, Rs. ha^{-1}		Gross realization, Rs. ha^{-1}		Net realization, Rs. ha^{-1}		Return rupee^{-1} invested	
A.Seed rates, kg/ha	2013	2014	2013	2014	2013	2014	2013	2014
S1:125	27,000	27,150	55,400	55,720	28,400	28,570	1.05	1.05
S2:150	27,625	27,775	68,060	65,860	40,435	38,085	1.46	1.37
S3:175	28,250	28,400	57,380	67,580	29,130	39,180	1.03	1.37
S4:200	28,875	29,025	52,460	57,160	23,585	28,135	0.81	0.96
B Nitrogen levels kg\ha								
N1:80	27,000	27,150	54,380	55,220	27,380	28,070	1.01	1.03
N2:100	27,259	27,409	61,520	56,280	34,261	28,871	1.25	1.05
N3:120	27,518	27,668	65,820	65,660	38,302	37,992	1.39	1.37
N4:140	27,777	27,927	51,580	68,080	23,803	40,153	0.85	1.43

CONCLUSION

Recommended seed rate for late sown (December) is 125 Kg/ha, but higher seed rate 150 Kg/ha gave higher economic yield. Additional 25 kg/ ha seed will be used in late sown (December) wheat and 6.0 qt yield advantage gain than recommended seed rate (125kg/ha) This results helps to reduce the misuse of seed as the wheat grower of Chhattisgarh using very high seed rate of 200-250 kg\ha (especially in Raigarh district).

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