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Effect of System of Wheat Cultivation, Nitrogen Level and Splitting on Growth, Yield and Economics of Wheat (*Triticum aestivum* L.)

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Abstract: The present investigation was conducted during *rabi* season of 2020-21and 2021-22 at Instructional cum Research Farm, DKS College of Agriculture and Research Station, Bhatapara, (CG) with the objectives to find out the effect of nitrogen levels on growth, yield and economics of wheat under conventional and System of Wheat Intensification (SWI) method of cultivation; The experimental soil was clayey in texture, slightly alkaline (pH 7.7) in reaction, medium in organic C (0.59 %) and the NPK content was found 118.2, 20 and 384 kg ha^{-1}which was at low, medium and high amount respectively. The climatic condition of this region is sub-humid to semi-arid and the maximum rainfall received during the entire season of experimental crop was at the month of February (35.6 mm) with the temperature and RH ranged between 28.7-35.7 ^{o}C and 70-85 % respectively. The experiment was conducted in split-split plot design with three replications and twelve treatment combinations. The system of cultivation; conventional method (CM) and System of Wheat Intensification (SWI) assigned as main plot and nitrogen doses N_{80}, N_{120} and N_{150} kg ha^{-1}assigned as sub plot and split doses of nitrogen into 2 split S_2 (50% Basal and 50% 21 DAS) and S_4 4 split (20% Basal, 20% 20-25 DAS, 30% 40-45 DAS and 30% 60-65 DAS) assigned as sub-sub plot. Wheat cv GW-366 was sown on 3rd week of November and harvested on 2nd week of March during both the years. Results revealed that wheat cultivated with SWI recorded highest grain yield (3230 kg ha^{-1}), straw yield (4274 kg ha^{-1}), HI (42.9%), net return (39718 Rs ha^{-1}) with 1.76 BC ratio. Application of higher amount of N fertilizer (N_{150}) gave maximum grain yield (3162 kg ha^{-1}) straw yield (4161) and highest HI (43.1 %) and BC ratio. The maximum grain yield (3174), straw yield (4237) and BC ratio with highest net return was found when N_{150} was applied into S_4 split doses. The grain and straw yield were highest from SWI, N_3 and S_2 were mainly due to more tillers $plant^{-1}$, length of ear head (cm), no. of grains ear^{-1}, no. of ear head m^{-2} and test weight.

Keywords: Economics, Nitrogen splitting, System of Wheat Cultivation

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important cereal in the world and is grown all across the world having the highest area, in which, India's ranked second in production (109.24 million tonnes) and area harvested (31.58 million ha). World's 55% population depends on wheat for the intake of about 20% calories. Wheat plays a crucial role in Nation's economical and nutritional security.

The System of Wheat Intensification (SWI), also known as "*Shri Vidhi Gehun*", is a revolutionary idea and method of wheat farming that involves manipulating the soil environment for better root and shoot growth adopting SWI principles. The system of wheat intensification is a method that has the ability to produce high wheat output per drop of water and per kg of agricultural inputs (fertilizer, seed, etc.) while also applying other SRI principles to wheat

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crops (Dhar *et al*., 2016). Here all agronomic principles are put into practices and integrated with package of practices in wheat crop. Wheat seeds are treated with hot water, cow urine, jaggery, vermicompost, and carbendazim to prevent fungal infection. Spacing of 20 cm × 20 cm is used for sowing of this sprouting seeds. At each hill, only two seeds are planted.

Nitrogen is the one of the major constituent of protein, nucleic acid, hormones, vitamins and chlorophyll. It is required by the all part of plants particularly the meristemetic tissue, metabolic active cell. It increases the growth and development of all living tissues specially tiller count in cereals like wheat, rice etc. and other graminaceous crop. It also increases utilization of P and K to appreciable extent. While a lack of it causes yellowing and stunted growth, reducing the quantity and quality of crop production. But its losses because of volatilization, denitrification, leaching and runoff mechanism. So, it is recommended to apply nitrogen in split amount for increasing nitrogen use efficiency which is around 30-35%.

Information on spacing, nitrogen levels are sufficiently available, but there is hardly any study on System of Wheat Intensification (SWI) in India and particularly in Chhattisgarh with nitrogen doses and split application. Considering above facts, the present experiment was carried out at Instructional cum Research Farm, Bhatapara (Chhattisgarh} during the *rabi* season of 2020-21 and 2021-22, to find out the effect of nitrogen levels on growth, yield and economics of wheat under SWI and conventional method of cultivation.

MATERIALS AND METHODS

The present study, was carried out at the Instructional cum Research Farm, Bhatapara (Chhattisgarh) during 2020-21 and 2021-22. The experiment was carried out in split-split plot design with three replications keeping method of cultivation *viz*., conventional method (CM) and system of wheat intensification (SWI), as main plot treatment and three nitrogen doses N_{80} - 80 kg ha^{-1} , N_{120} - 120 kg ha^{-1} and N_{150} -150 kg ha^{-1} as sub-plot treatment and two split doses S2 - 2 split doses (50% Basal and 50% 21 DAS), S_4 -4 split doses (20% Basal, 20% 20-25 DAS, 30% 40-45 DAS, 30% 60-65 DAS) as sub-sub plot treatment. N was fulfilled by straight fertilizer, urea as per the treatment and basal dose of P at 60 kg P2O5 and K at 40 kg K2O ha^{-1} was also applied in the form of single super phosphate and muriate of potash, respectively. Wheat (variety GW-366) was planted on 2nd week of November, 2020 and 2021 using a seed rate of 25 and 100 kg ha^{-1} in SWI, and conventional methods of cultivation respectively. Seeds were seeded at a row spacing of 22.5 cm in the conventional method, while germinated seeds were sown at a depth of 4-5 cm in the soil with a spacing of 20 cm × 20 cm in the SWI method. Wheat crop was harvested on 2nd week of March after attaining physiological maturity. The soil of the experimental field was clayey (*Vertisols*) in texture with slightly alkaline in reaction (pH 7.7). The soil was categorized as medium in organic carbon (0.59 %) and available N (188.16 kg ha^{-1}) and medium in available P (20.0 kg ha^{-1}) and K contents was high (384 kg ha^{-1}). In the months of February and March, the wheat crop received 37.8 mm of rain during 2021. Other weather conditions were practically ideal for the crop's growth and development.

RESULTS AND DISCUSSION

Effect of methods of cultivation

In SWI, the largest number of average tillers (5.71 plant^{-1}) was seen, which was much higher over conventional sowing method (3.54 tillers plant^{-1}). In SWI, plants utilized all the available resources more efficiently for producing more ear bearing tillers per unit area. Similar results have been reported by Adhikari (2013) who found more number of ear head m^{-2} in SWI method. The mean value of the yield attributes such as no. of ear head m-2 , no. of grains ear head^{-1} and the length of ear head was found significantly higher in the SWI 401.74, 41.19 and 10.86 respectively, over the conventional method of cultivation which was found 376.78, 37.12 and 10.13 respectively (Table 1). The greater number of grains ear^{-1} head of wheat in SWI might be due to uniform space, light and nutrient utilization by the plants. Hence, efficient utilization of space, light, moisture and nutrients by plants resulted

in maximum ear length coupled with more number of grains per ear head. These results are in accordance with the results of Khan *et al*. (2007) who found maximum number of grains spike^{-1} in line planted wheat compared to other methods of sowing. It might be due to more space, light and nutrients available to the plants in wider row spacing adopted in SWI. Moreover, lack of intra-specific competition in conventional method plots for nutrients and space when compared to broadcasting ones.

SWI produced highest grain yield (3230 kg ha^{-1}) and straw yield (4274 kg ha^{-1}) as well as the highest harvest index (42.9) when compared to the conventional method of cultivation (CM), which was found to be inferior in terms of yield and harvest index (Table 2). The conventional method of cultivation not only necessitates a higher seed rate, but it also results in fewer tillers, resulting in higher wheat grain and straw yields. The results were in confirmation with result that reported by Suryawanshi *et al*. (2013) who found that crop sown under SWI resulted significantly higher grain yield in comparison to conventional system due to better utilization of moisture, nutrients and solar radiation. Due to differences in crop stand establishment and more number of productive tillers in present experiment, wheat grain yield was significantly affected. Higher yield in SWI was ascribed to more no. tillers m^{-2}, more grains earhead^{-1} and 1000-grain weight and better harvest index. It is obvious from the data that SWI proved the best sowing technique regarding the grain yield due to superior values of yield attributes. These findings are in consonance with Adhikari (2013) who found that in SWI, pre-germinated seed sown gave 6.5 tons ha^{-1} grain yield compared to 3.7 tons ha^{-1} with conventional, and 5 tons ha^{-1} with row sowing under similar conditions of irrigation and fertilization. These results are in close conformity with the findings of Kumar *et al*. (2015) and Dhar *et al*. (2016) who have also reported higher grain yield in SWI.

Effect of nitrogen doses

The character of yield attributes such as no. of ear head m^{-2} , no. of grains ear head^{-1} and length of ear head (cm) was found significantly higher value, 417.67, 47.51, 11.31 in N_{150} over N_{120} and N_{80} (Table 1). Higher grain yield, straw yield and harvest index was found significantly 3162, 4161 and 43.1 at N_{150} over N_{120} and N_{80} (Table 2). Increased use of N, water, and other associated soil improving organic sources may have improved yield under this treatment, making plants more efficient in photosynthetic activity. Although major fraction of photosynthates assimilated during growth phase was translocate to the storage organs, yet because of the increased plant height as well as number of tillers in wheat on account of better nutrient supply through use of increased amount of nitrogen, might have helped in improving the growth and development of the crop and thereby straw yield of wheat. These findings are in agreement with Shah and Ahmad (2006) who indicated maximum straw yield of wheat from treatment received high amount of N. There was significantly higher gross return, net return and BC ratio was also in the higher value, 60916, 38717 and 1.71 in N_{150} over N_{120} and N_{80}.

Effect of split applications of nitrogen doses

The yield attributes such as no. of ear head m^{-2}, no. of grains ear head^{-1} and length of ear head (cm) was found significantly higher value, 403, 40.9 and 10.81 on S_2 (50% Basal and 50% 21 DAS) split dose of N over S_4 (20% Basal and 20% 20-25 DAS, 30% 50-45 DAS and 30% 60-65 DAS) (Table 1). The grain, straw yield and harvest index was found significantly higher, 3175 kg ha^{-1} 4237 kg ha^{-1} and 42.7 % harvest index in S_2 (50% Basal and 50% 21 DAS) split dose of N over S_4 (20% Basal and 20% 20-25 DAS, 30% 50-45 DAS and 30% 60-65 DAS). The gross, net return and BC ratio was found significantly higher, 61393, 39519 and 1.80, in S_2 (50% Basal and 50% 21 DAS) split dose of N over S_4.

CONCLUSIONS

Cultivation methods and the application of high amount of nitrogen along with two split applications had a significant impact on wheat grain and straw production. When compared to the conventional method of cultivation (CM), SWI produced significantly higher grain yield (3231 kg ha^{-1}) and straw yield (4274 kg ha^{-1}) as well as maximum harvest index (42.9 %). By increasing

Table 1: Effect of nitrogen doses and split application on yield attributes of wheat under conventional and system of wheat intensification method (pooled data of year 20-21 & 21-22)

Treatments	*No. of ear head m $^{-2}$*	*Test weight (g)*	*No. of grains ear head $^{-1}$*	*Length of ear head (cm)*
System of wheat cultivation				
CM (conventional method)	376.78	48.56	37.12	10.13
SWI (System of Wheat Intensification)	401.74	51.75	41.19	10.86
SE(m)±	1.99	0.49	0.46	0.03
CD (P=0.05)	12.33	3.07	2.83	0.18
Nitrogen doses (N Kg ha^{-1})				
N_{80}	346.1	48.03	31.48	9.69
N_{120}	404.01	50.35	38.48	10.49
N_{150}	417.67	52.10	47.51	11.31
SE(m)±	2.31	0.29	0.35	0.12
CD (P=0.05)	7.52	0.94	1.14	0.38
Split application of N				
S_2 (two splits-50% Basal and 50% 21 DAS)	403.0	50.99	40.93	10.81
S_4 (four splits -20% Basal and 20% 20-25 DAS, 30% 50-45 DAS and 30% 60-65 DAS)	375.52	49.32	37.38	10.17
SE(m)±	3.01	0.16	0.24	0.06
CD (P=0.05)	9.27	0.50	0.75	0.19

Table 2: Grain yield, straw yield, harvest index and economics as influenced by nitrogen doses and split application of wheat under conventional and SWI method (pooled data of year 20-21 & 21-22)

Treatments	*Grain yield (kg ha^{-1})*	*Straw yield (kg ha^{-1})*	*Harvest index (%)*	*Gross return (Rs ha^{-1})*	*Net return (Rs ha^{-1})*	*B: C ratio*
System of wheat cultivation						
CM (conventional method)	2573	3616	41.5	50479	28957	1.35
SWI (System of Wheat Intensification)	3231	4274	42.9	62324	39718	1.76
SE(m)±	62.3	47.14	0.19	1059	949	0.04
CD (P=0.05)	384.6	290.8	1.19	6538	5859	0.22
Nitrogen doses (N Kg ha^{-1})						
N_{80}	2575	3699	40.9	50852	29259	1.36
N_{120}	2967	3974	42.7	57437	35330	1.60
N_{150}	3162	4161	43.1	60916	38718	1.70
SE(m)±	32.0	50.27	0.25	597	576	0.03
CD (P=0.05)	104.2	163.7	0.83	1945	1875	0.09
Split application of N						
S_2 (two splits-50% Basal and 50% 21 DAS)	3175	4237	42.7	61393	39519	1.80
S_4 (four splits -20% Basal and 20% 20-25 DAS, 30% 50-45 DAS and 30% 60-65 DAS)	2629	3652	41.7	51410	29156	1.31
SE(m)±	45.5	52.2	0.19	824	810	0.05
CD (P=0.05)	140.3	160.9	0.60	2539	2496	0.15

nitrogen fertilizer, wheat grain yield and harvest index increased. Wheat grain and straw yields of 3162 kg ha^{-1} and 4161 kg ha^{-1}, respectively, were achieved when the high amount of nitrogen N_{150}. The SWI together with high amount of N_{150} and split on two times (S_2) produced the maximum grain, straw and harvest index of wheat. Wheat intensification was regarded the most profitable because it yielded the highest net returns (Rs 39718 ha^{-1}) and had a B: C ratio of 1.76. The largest amount of N coupled with S_2 split doses yielded the best net returns (Rs 38718 ha^{-1}) with a greater B: C (1.71) ratio. Various treatment combination indicated that the highest net returns (Rs 39718 ha^{-1}) was shown in $SWIN_{150}S_2$ treatment combination, while greater B:C ratio of 1.80 was obtained when wheat was planted with SWI and fertilized with 150 kg N ha^{-1} in two split doses (50% Basal and 50% 21 DAS).

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