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Performance of Wheat (*Triticum aestivum* L.) Cultivars under system of Wheat Intensification and Conventional methods of Sowing on Economics

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Abstract
A field experiment was conducted to determine the study of varieties as influenced by system of planting and spacing on wheat (*Triticum aestivum* L.) during the winter season (*Rabi*) of 2019. The experiment consists of 9 treatments with 3 replications laid out in a randomized block design. Three cultivars and Methods of sowing *i.e.* conventional, SWI at 15×15 cm, SWI at 20×20 cm at Crop Research Farm, Department of Agronomy, Faculty of Agriculture, SHUATS, Prayagraj. System of wheat intensification significantly influenced the yield attribute characters, yield and Economics of wheat. The result concluded that the treatment (20×20 cm + PBW343) recorded highest spike length (12.4 cm). However, higher grain yield (5.51 t/ha), straw yield (6.41 t/ha), harvest index (46.26 %), gross return (118669 ₹/ha), net return (86322 ₹/ha) and benefit cost ratio (2.67) was recorded with (15×15 cm + SHIATS W6).

Keywords: Wheat, System Wheat Intensification (SWI), Conventional sowing, Cultivars, Spacing, Grain yield, Economics

Introduction
Wheat (*Triticum aestivum* L.) is a crop plant of gramineae family. It is widely cultivated as staple food crop throughout the world.

The outstanding and unique historical feature of wheat cultivation is the prominence in humanity's progressive domination as a colonizer of worlds land surface. It is cultivated extensively in North Western and Central Zones. North West India along with Afghanistan probably forms the centre of origin of bread wheat and India is one of the ancestral lands of this essential food crop. More land is devoted worldwide to the production of wheat than any other crop. USA, Russia, China, Australia, Germany, France, Argentina and India are the main wheat producing countries required in order to survive.

Wheat (*Triticum aestivum* L.) is the most important cereal food crop ranking first in India both in area and production of the grain crops, And second largest production of world after China. It can be grown from below sea level to 5000 m altitude and in areas where rainfall ranges between 300-1130 mm. wheat contributes more calories and more protein to the world's diet than any other food crop. In India major wheat area is under subtropical region. The cool and sunny winters are very conductive for growth of wheat crop. Wheat contributes more towards public distribution system (PDS) and has become backbone of country's food security, (Prasad and Gupta, 2012) [7]. System of wheat intensification (SWI) is an adoption of technique used in the system of rice intensification (SRI) methodology of increasing the productivity of crops by changing the management of plant, soil, water and nutrients while reducing external inputs use. Fortunately, experience with the system of rice intensification developed in Madagascar over 30 years ago by father Hendrei de Laulani'e offers some ways to make production system, cost effective, efficient and of increase climate secure. The merit of system have now been demonstrated worldwide especially rice growing countries of Asia and many other countries as well as its concept and practices are now being extended beyond irrigated rice to wheat, ragi, sugarcane, beans and other crops (Thapa *et al.* 2011) [9]. System of wheat intensification (SWI) has been successfully promoted by many agencies like Pradhan (2007), an NGO in Bihar with World Bank funded project and Agriculture Technology Management Agency (ATMA) of government of India, people's Science Institute (PSI) another NGO in Uttarakhand (2008) in India.

System of wheat intensification has been tested as an innovative approach to increase productivity and being practiced in India, China, Ethiopia, Poland and USA. SRI has already been tested and evaluated by several NGOs, but System of wheat intensification is still a new technology for wheat cultivation in India. The main objective of this trail is to compare the yield from traditional practice with that from SWI. Results has sown that grain yield of wheat is increased by 91% at its maximum, with adoption of this technology (Khadka *et al.* 2011) [5].

The system of wheat intensification (SWI) method has a great potential to increase wheat productivity and creates a very good growing condition through modified soil, water, sowing method, plant and nutrient management. SWI and some modified SWI interventions may give 54% more yield than available best conventional sowing practices (Uphoff *et al.* 2011) [2].

The method is about managing the crop, soil and nutrients to promote a vibrant soil system that, in turn, promotes larger root systems. With adequate spacing and loose soil, the roots of the crop can grow deeper than conventional cropping methods. Compost is used instead of chemical fertilizer to maintain soil health. Moreover, irrigation of the field synchronized with the weeding operations in the early stages of crop growth made the soil more friable (Dhar *et al.* 2016) [2].

Healthy root development is an important factor for healthy growth of a plant. Conventionally, Wheat seeds are sown in a closer manner i.e., no specific space is maintained between the seeds leading to competition between the roots of the plants for nutrients, water and sunlight. The weed population will be higher because of closer spacing, thereby increasing the number of competitors for the resources (Kaur, 2012) [4].

Appropriate cultivars with proper row spacing is important for maximizing light interception, penetration, distribution in crop canopy and average light utilization efficiency of the leaves in the canopy, and thus affect yield of a crop. Wider spacing between rows or pairs of rows, not only allow more light to reach the lower leaves at the time of grain formation but also allows easy inter-culture for weed control and inter-cropping (Ayaz *et al.* 1999) [1].

SHIATS-W6 is Semi dwarf, matures in 115–120 days, high temperature tolerant (35-40^0 C), tolerant to water logging (7-10 days), resistant to- brown rust, leaf-sheath blight and smut, good for limited (2–3) irrigations. Its grains are bold and amber in colour with 13% protein and sugar 0.57%. Its yield potential under timely sown conditions (45-50 q/ha) and under late sown conditions (36- 40 q/ha).

Materials and Methods

The experiment was carried out during *Rabi* season of 2019 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P). The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.2), low in organic carbon (0.58%), medium in available N (238 Kg/ha), high in available P (32.10 Kg/ha) and low in available K (189 Kg/ha). The treatment consisted of 3 spacings *viz.* conventional (22 cm), SWI (15×15 cm) and SWI (20×20 cm) and 3 wheat cultivars PBW343, HD2967 and SHIATS W6. There are 9 treatments each replicated thrice. The experiment was laid out in Randomized Block Design. It was sown on 6th December 2019. Recommended doses of nitrogen, phosphorus and potassium were applied.

Table 1: Effect of System of Wheat Intensification (SWI) and Conventional methods on yield attributes of wheat crop

Treatment	Length of spike (cm)	Harvest index (%)	Grain yield (t/ha)	Straw yield (t/ha)
T_1 -Conventional sowing (22 cm) + PBW343	9.2	38.53	3.72	5.94
T_2 -Conventional sowing (22 cm) + HD2967	9.3	38.87	3.84	6.03
T_3 -Conventional sowing (22 cm) + SHIATS W6	10.4	41.79	3.97	5.53
T_4 -SWI at 15 × 15 cm + PBW343	9.8	41.86	4.56	6.33
T_5 -SWI at 15 × 15 cm + HD2967	10.2	44.99	4.99	6.10
T_6 -SWI at 15 × 15 cm + SHIATS W6	11.8	46.26	5.51	6.41
T_7 -SWI at 20 × 20 cm + PBW343	12.4	38.36	3.03	4.86
T_8 -SWI at 20 × 20 cm + HD2967	11.0	41.90	3.19	4.42
T_9 -SWI at 20 × 20 cm + SHIATS W6	12.3	46.23	3.32	3.86
F- test	S	S	S	S
SEm (±)	0.36	1.07	0.10	0.09
CD (P = 0.05)	1.09	3.21	0.30	0.26

Table 2: Effect of System of Wheat Intensification (SWI) and Conventional methods on Economics of wheat crop

Treatment	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio
T1 -Conventional sowing (22 cm) + PBW343	83304	50357	1.53
T2 -Conventional sowing (22 cm) + HD2967	85795	52848	1.60
T3 -Conventional sowing (22 cm) + SHIATS W6	87348	53401	1.57
T4 -SWI at 15 × 15 cm + PBW343	100219	68472	2.16
T5 -SWI at 15 × 15 cm + HD2967	108015	76268	2.40
T6 -SWI at 15 × 15 cm + SHIATS W6	118669	86322	2.67
T7 -SWI at 20 × 20 cm + PBW343	67832	35485	1.10
T8 -SWI at 20 × 20 cm + HD2967	70095	37748	1.17
T9 -SWI at 20 × 20 cm + SHIATS W6	71464	38317	1.16

Results and Discussions

Yield attributes

Length of spikes (cm)

Yield attributes and yield were significantly affected by System of wheat intensification, wheat crop sown at 20×20 cm along with wheat variety PBW343 resulted significant increase in length of spike (12.4 cm). The length of spikes significantly increased with increasing spacings. Wider spaced plant performed better than closer spaced plant due to adequate availability of nutrient, water, space and light interception that contribute better development of plant growth and yield attributing characters. This was in conformity with the findings of (Thakur *et al*. 2010) and (Zheng *et al*. 2013) [8, 11].

Harvest index (%)

The data of harvest index was significantly influenced by system of wheat intensification at harvest. At harvest the data recorded (46.26 %) significantly higher in wheat crop sown at SWI spacing 15×15 cm along with SHIATS W6. However, harvest index increased with increasing plant spacing. Maximum harvest index was recorded with 15×15 cm spacing and minimum value obtained under 10×10cm spacing. (Jayawardena & Abeysekera 2011) [3] reported the increasing trend in harvest index with the increasing spacing. At closer spacing, mutual shading may reduce the maximum utilization of available sunlight for the maximum dry matter production to give higher yield

Grain Yield, straw yield

Highest grain yield (5.51 t/ha), straw yield (6.41 t/ha) was recorded in wheat crop sown at SWI spacing 15×15 cm along with SHIATS W6 over conventional sowing. Spacing has a high impact on grain yield *i.e* grain yield of wheat significantly increases from 10×10 cm spacing to 15×15 cm spacing and decreased in 20×20 cm and thereafter, this was mainly due to the fact that wider spacing could not compensate the drastic decrease in plant population and productive tillers resulting in severe decreases in number of ear heads per unit area. This was in conformity with the finding of (Jayawardena and Abeysekera 2011) [3]. Straw yield decreased when plant spacing increased more than 15×15 cm. This was mainly due to the decrease in number of plant population and decrease in tillers number per meter square. This was in conformity with the finding of (Zheng *et al.* 2013) [11].

Wheat varieties also varied significantly in relation to the yield attributes and yield while performance of varieties in relation to harvest index was found significant. SHIATS W6 resulted in significantly higher number of effective tillers, harvest index, grain yield and straw yield as compared rest of the varieties. The variation among the varieties in relation to yield attributes and yield could be due to their genetic makeup and somehow could be due to environmental conditions. The results are supported by those of (Mahajan *et al*. 2018) [6].

Economics

The highest gross returns (118669 ₹/ha), net returns (86322 ₹/ha) and benefit cost ratio (2.67) was obtained in wheat crop sown at SWI spacing 15×15 cm along with variety SHIATS W6.

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