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Impact of Sowing Pattern and Seed Rate on Quality of Wheat Seed

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Authors' contributions

This work was carried out in collaboration among all authors. Author PK Writing-review and formal analysis, Investigation, methodology; Author RKK supervision, Writing - review and editing, Author AS Writing - review and editing. All authors read and approved the final manuscript.

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ABSTRACT

Wheat (*Triticum aestivum* L.) is the world's most essential staple food. It is the most important crop in Himachal Pradesh during the winter season in the state's low and mid hills. Manipulation of agronomic practices such as planting pattern/geometry and seed rate is regarded as the first stage in achieving optimum plant distribution over cultivated area, resulting in greater utilization of above and below ground natural resources. A field and laboratory investigation was undertaken to study the effect of different planting patterns and seed rates on its quality in wheat by evaluating the quality parameters. The experiment with twelve treatment combinations comprising of four planting patterns (P_1-15 cm, P_2 -23 cm, P_3 -15 x 15 cm and P_4 -23 x 23 cm) and three seed rates (S_1 -100, S_2 - 120 and S_3 -140 kg/ha) was conducted in Randomized Block Design with four replications during Rabi season of 2015-16 at experimental farm of CSKHPKV, Palampur, Himachal Pradesh, India. Observations showed that 23 × 23 cm planting patterns produced significantly (2.96%) higher 1000 seed weight, (8.08%) seedling length, (6.01%) seedling dry weight, (8.34%) vigour index –I and (6.58%) vigour index- II over normal planting patterns (23 cm), whereas other planting

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techniques had no appreciable impact on germination percentage. Different seed rates had no appreciable impact on 1000 seed weight, germination rate, seedling length, seedling dry weight, and vigour index. Criss cross sowing (23 x 23 cm) with 140 kg per hectare is the best combination for quality seed production of wheat.

Keywords: Germination; planting pattern; seedlings; Triticum aestivum; vigour index.

ABBREVIATIONS

%	*: Per cent*
@	*: At the rate*
°C	*: Degree Celsius*
CD	*: Critical Difference*
Cm	*: Centimetre*
et al.	*:* et alii *(and other)*
g	*: Gram*
g/ha	*: Gram per Hectare*
ha	*: Hectare*
K	*: Potassium*
Kg	*: Kilogramme*
kg/ha	*: Kilogramme per Hectare*
mm	*: Millimetre*
m t	*: Million Tonnes*
N	*: Nitrogen*
No.	*: Number*
/	*: per*
P	*: Phosphorus*
pH	*: Power of Hydrogen Ions*
q/ha	*: Quintal per Hectare*
t/ha	*: Tonne per Hectare*

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is known as one of the most important cereal crop and is extensively grown worldwide. Wheat contributes to 50% and 30% of the global grain trade and production respectively [1]. The growing population of India receives more than half of its calories and half of its dietary protein from wheat, making it one of the main sources of food. As a result, scientists are constantly working to increase yields in order to feed the country [2]. It is the source of flour for the world's breadmaking. Wheat based food is rich in fibre contents than meat-based food. Dough produced from bread wheat flour has different viscoelastic properties than other cereals. Therefore, its positive effects on controlling cholesterol, glucose and intestinal functions in the body were observed. Primarily wheat is being used to make chapattis (Bread) but it also contributes to other bakery products. Wheat utility and high nutritional value made it the staple food for more than 1/3rd population of the world [3].

Triticum aestivum, *durum*, and *dicoccum*, which make up the majority of cultivated species in India, account for about 95%, 4%, and 1% of the country's land, respectively. *T. aestivum* is grown throughout the nation, whereas *durum* and *dicoccum* are exclusively grown in Karnataka and Punjab, respectively. With an output of 106.84 million tonnes and an average yield of 3507 kg/ha, wheat is grown on an area of 30.47 million hectares in India [4].

Wheat should be cultivated in a way that ensures a high grain yield of adequate quality to meet the requirements of food processing. Wheat grain yield and quality are determined by many factors, including genotype (cultivar), habitat conditions (soil and climate) and agricultural practices [5]. In order to achieve proper plant distribution over the cultivated area and better utilize above and below ground natural resources to increase seed quality, manipulation of agronomic practices like planting pattern/geometry and seed rate are thought to be the first and most important steps.

Seed is a basic input in modern agriculture. A farmer's entire crop depends on the quality of the seed he sows. Therefore it is necessary to plant good quality seed. Seed quality is a concept made up of several attributes. Seed quality is the possession of seed with required genetic and physical purity that is accompanied with physiological soundness and health status. If the seed lots possess high genetic purity and high germination percentage and a minimum of inert matter, weed and other crop seed and are free from diseases, it is said to have high quality.

It is very vital to use good quality seed to achieve full benefit of various other expensive and limited inputs such as fertilizers, irrigation water, and plant protection measures. Bold and vigorous seed with high viability ensures uniform and quick germination, healthy crop stand that withstands pest-diseases attack as well as weed competition, thereby help in a significant increase in crop yields. Besides genetic potential and purity, other quality parameters of seed such as seed vigour, seed germination percentage, freedom from admixtures and inert material, etc.

depend very much on the agronomic practices, seed rate (plant population) and crop geometry (spacing and plant distribution pattern) play a significant role in influencing the physical, physiological and general health of the seed. Yet, there is no information on the effect of sowing pattern and seed rate on seed quality of bread wheat in the study area. Therefore, the present research investigation was undertaken with the objectives to work out the best planting pattern and seed rate for quality seed production of wheat.

2. MATERIALS AND METHODS

The investigation was carried out at the experimental farm of the Department of Seed Science and Technology at Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya in Palampur. The experimental farm is located at an elevation of 1290.80 m (a.m.s.l.) at 32 6' N latitude and 76 3' E longitudes. It is located in Himachal Pradesh's Shivalik Mountains' middle hill region. The region has a moist temperate climate with chilly winters and moderate summers (March to June). According to the Taxonomic System of Soil Classification, the soil at the experimental site had a silty loam texture, was slightly acidic in character, and was categorized as *Typic Hapludalf*. There was 10.3 meg/100 g soil CEC, 0.59% O.C., 356.1 kg/ha available N [6], 15.6 kg/ha available P [7] and 184.7 kg/ha available K [8]. An experiment with twelve treatment combinations comprising of four planting patterns (15 cm row to row , 23 cm row to row, 15 x 15 cm criss cross and 23 x 23 cm criss cross) and three seed rates (100, 120 and 140 kg/ha) was conducted in Randomized Block Design with four replications.

Wheat was sown by hand as per planting pattern. Seeds were dropped behind the plough in the furrow with the help of manual labour by hand. Recommended dose of nitrogen @ 120 kg/ha was applied in two equal splits through urea (46% N) half at sowing and the remaining half was top dressed at the time of first irrigation after 40 days of sowing at CRI stage by broadcast method. A uniform basal dose of 60 kg P_2O_5 and 40 kg K_2O per hectare were applied through SSP and MOP, respectively at the time of sowing, by band placement in the furrow. Isoproturon and 2,4-D were used for weed control after 40 days of sowing. Combination of isoproturon and 2,4-D @ 1.0 and 0.5 kg/ha respectively was used for the control of mixed population of weeds. Harvesting was done manually with sickles and crop produce was threshed with the help of a plot thresher.

2.1 Observations

1000 seed weight - Random samples of graded seeds from the produce of each plot were taken and 1000 seeds were counted and weighed.

Germination percentage - Germination test was conducted in four replications of 100 seeds each by adopting petri plate method as described by ISTA procedures. Petri plates were incubated in germinator. The temperature of 25 ± 1 ℃ and RH of 90 per cent was maintained during the germination test. Germination percentage was worked for each treatment of every replication on 7th day from the day when germination test was performed. The germination percentage was calculated as:

Germination percentage = Number of germinated seeds / Number of seeds kept for germination ×100

Seedling length **-** Ten normal seedlings were randomly selected on 7^{th} day after soaking and length of the seedlings was measured from the tip of the primary leaf to the root tip. Mean seedling length was worked out and expressed in centimeters.

Seedling Dry Weight - Ten normal seedlings used for seedling length measurements were put in butter paper pocket and kept in hot air oven at 80℃ for 17 h. The dry weight of the seedlings was recorded and expressed in grams.

Seedling Vigour Index - The seedling vigour index was worked out by adopting the method suggested by Abdul- Baki and Anderson [9] and expressed in number by using following formulae.

Seedling vigour index – I = Germination (%) X Seedling length (cm)

Seedling vigour index – II = Germination (%) X Seedling dry weight (g)

2.2 Statistical Analysis

The experimental data was statistically analyzed using Randomized block design (RBD), as per procedure given by Panse and Sukhatme [10] Least Square differences were used to test differences in treatment at 5 % level of significance.

3. RESULTS AND DISCUSSION

The data related to 1000 seed weight as influenced by different sowing patterns and seed rates is presented in Table 1. Perusal of data revealed that different sowing patterns had significant influence on 1000 seed weight. Under cross sowing (23 x 23 cm), significantly more 1000 seed weight was recorded as compared to other treatments. Difference among other treatments was also significant. This could be on account of higher leaf area index and efficient translocation of metabolites towards grain formation. Kaur et al. [11]. Found that in wheat crop thousand grain weight was significantly higher in bidirectional over bed planting and strip planting, Hussian et al. [12] recorded maximum 1000 grain weight (48.70 g) at wider row spacing of 60 cm in wheat variety Inqilab-91 and Bakht et al. [13] in different wheat varieties reported that different row spacings significantly affected the 1000 seed weight. Seed rates had no significant effect on 1000 seed weight of wheat. Results showed reduction in 1000 seed weight with the increase in seed rate although the difference was not significant. This variation is due to flow of nutrients into the seed at the mother plant. Higher seed rate results into more number of plants per unit area and increases competition for nutrients among and produce smaller sized seed. Hussein et al. [14] found that increasing seed rate in wheat variety Giza 15 produced no significant effect on 1000 grain weight in wheat, Singh and Singh [15] studied effect of four seed rates (60, 80, 100 and 120 kg/ha) on wheat and observed that seed rate failed to influence 1000 grain weight, Samra and Dhillon [16] conducted a field trial on response of wheat varieties to seed rates (90 and 120 kg/ha) and observed that 1000 grain weight remained unaffected by seed rates, [17] studied that increase in the seed rate from 80 to 100 or 120 kg/ha showed that 1000 grain weight remained unaffected in wheat, Ahmed et al. [18] observed that 1000 grain weight decreased with increase in seed rates from 40-120 kg/ha in wheat, Pandey et al. [19] concluded that 1000 test weight were unaffected by seed rates and Rosy [20] concluded that 1000 grain weight decreased with increasing seed rate. However, Mahajan et al. [21] reported that 1000 seed weight was significantly enhanced by the higher seed rate (100 kg/ha, 125 kg/ha and 150 kg/ha) in wheat.

The results of germination percentage as influenced by different sowing pattern and seed rates are presented in Table 1. Different sowing patterns and seed rates had no significant effect on germination percentage of wheat. Similar results were reported by Kotia [22] in radish and Sharma [23] in African Tall maize due to different plant geometries.

According to the data given in Table 1 seedling length was recorded significantly higher at cross sowing (23 x 23 cm) over cross sowing at (15 x 15 cm), normal sowing at 23 cm and closer sowing at 15 cm. Difference among latter treatments was also significant and decreased in the same order. It was because of more bold and vigorous seeds due to more 1000 seed weight. Seedling length was statistically at par with the different seed rates. With the increase in the seed rate there was reduction in 1000 seed weight. This variation is due to flow of nutrients into the seed at the mother plant. Seed coat and embryonic axis are the first to develop in a seed and accumulation of food reserve occurs later one. This variation is exerted in size, later on, on mobilization of food reserve to growing seedling. As the 1000 seed weight was not affected significantly by seed rate so there were also no significant results in seedling length with respect to different seed rates.

As per the data given in Table 1 seedling dry weight was recorded significantly higher at cross sowing (23 x 23 cm) over cross sowing at (15 x 15 cm), normal sowing at 23 cm and closer sowing at 15 cm. Difference among latter treatments was also significant and decreased in the same order. It was because of more seedling length and ultimately more seedling dry weight. In case of seed rate, the seedling dry weight values were statistically at par because the seedling length was statistically at par with the seed rates.

3.1 Vigour Index

As per the data given in Table 1, vigour index-I and vigour index-II was recorded significantly higher with cross- sowing (23 x 23 cm) over cross sowing at (15 x 15 cm), normal sowing at 23 cm and closer sowing at 15 cm. Difference among latter treatments was also significant and decreased in the same order. It was because of more seedling length and seedling dry weight. No significant differences were recorded in respect of vigour index-I and vigour index-II due to seed rates. This was because different seed rates had no significant effect on the seedling length and seedling dry weight.

Table 1. Effect of sowing pattern and seed rate on quality parameters of wheat

Treatments	1000 seed weight (g)	Germination %	Seedling length (cm)	Seedling dry weight (mg)	Vigour Index-I	Vigour Index-II
Sowing pattern (cm)						
15	48.6	96.8	17.8	72.4	1718.7	7.0
23	49.1	97.2	18.2	73.5	1766.1	7.1
15 x 15	49.8	97.2	18.6	74.7	1808.9	7.3
23 x 23	50.6	97.4	19.8	78.2	1926.7	7.6
SEm±	0.25	0.34	0.11	0.35	13.09	0.04
CD at 5%	0.71	NS	0.32	1.00	37.42	0.12
Seed rate (kg/ha)						
100	49.7	96.9	18.5	74.6	1795.24	7.2
120	49.6	97.2	18.6	74.8	1805.9	7.3
140	49.3	97.3	18.6	74.8	1814.1	7.3
SEm±	0.21	0.30	0.10	0.30	11.34	0.04
CD at 5%	NS	NS	NS	NS	NS	NS

Table 2. Interaction effect of sowing pattern and seed rate on quality parameters of wheat

Treatment combinations	1000 seed weight	Germination %	Seedling length	Seedling dry weight	Vigour index-I	Vigour index-II
$P_1 S_1$	48.55	96.38	17.24	72.30	1661.80	6.96
$P_1 S_2$	49.38	97.50	18.37	72.81	1791.30	7.09
$P_1 S_3$	47.83	96.63	17.63	72.15	1703.05	6.98
$P_2 S_1$	49.13	96.88	18.45	75.22	1787.15	7.29
$P_2 S_2$	48.85	97.88	17.88	73.55	1749.53	7.20
$P_2 S_3$	49.35	96.75	18.21	71.74	1761.55	6.94
$P_3 S_1$	50.05	97.63	18.50	75.05	1805.48	7.35
$P_3 S_2$	50.65	97.00	18.12	74.05	1757.80	7.15
$P_3 S_3$	48.83	97.00	19.21	75.12	1863.48	7.28
$P_4 S_1$	50.95	97.00	19.86	75.77	1926.55	7.32
$P_4 S_2$	49.68	96.50	19.95	78.68	1925.28	7.57
$P_4 S_3$	51.23	98.75	19.53	80.07	1928.35	7.90
SE±	0.44	0.59	0.19	0.61	22.68	0.07
CD at 5%	1.26	NS	0.55	1.74	64.81	0.21

3.2 Interaction Effect

As per the data given in Table 2 the interactive effects of sowing pattern and seed rate indicated significant highest 1000 seed weight (51.23) with P_4 S_3 which was found to be statistically at par with P_4 S_1 (50.95), P_3 S_2 (50.65) and P_3 S_1 (50.05) whereas, minimum 1000 seed weight (47.83) was recorded with P_1 S_3. The interactive effects of different sowing patterns and seed rates had no significant effect on germination percentage of wheat. The combined effects of sowing pattern and seed rate on seedling length was recorded significantly highest (19.95) at P_4 S_2 which was found to be statistically at par with P_4 S_1, (19.86) and P_4 S_3 (19.53) and lowest seedling length (17.24) was recorded with P_1 S_1 which was found to be statistically at par with P_1 S_3 (17.63). The interactive effects of sowing pattern and seed rate on seedling dry weight was recorded significantly highest (80.07) with P_4 S_3 which was found to be statistically at par with P_4 S_2 (78.68) and lowest seedling dry weight (71.74) was recorded with P_2 S_3 which was found to be statistically at par with P_1 S_1 (72.30), P_1 S_2 (72.81) and P_1 S_3 (72.15). Sowing pattern and different seed rate interactive effects on vigour index-I was recorded significantly highest (1928.35) with P_4 S_3 which was found to be statistically at par with P_4 S_2 (1925.28), P_4 S_1

(1926.55) and lowest vigour index-I (1661.80) was recorded with P_1 S_1 which was found to be statistically at par with P_1 S_3 (1703.05). The effects of interaction of sowing pattern and seed rate on vigour index-II was recorded significantly highest (7.90) with P_4 S_3 and lowest vigour index-II (6.96) was recorded at P_1 S_1 which was found to be statistically at par with P_1 S_2 (7.09), P_1 S_3 (6.98) and P_3 S_2 (7.15).

4. CONCLUSIONS

The experimental results showed that plant geometry of 23X23 cm recorded significantly more 1000 seed weight, seedling length (cm), seedling dry weight (g) and vigour index. Proper plants distribution allowed optimal sunlight penetration for photosynthesis and proper root depth for water and nutrient uptake. Criss cross sowing (23 x 23 cm) with 140 kg per hectare is the best combination for quality seed production of wheat.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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