Original Research Article

Comparing the Dibbling and Drilling Techniques in Wheat (*Triticum aestivum* L.) based on the plants' Reproductive and Vegetative Growth

ABSTRACT

Compared to the conventional way of sowing, drilling and dibbling assure a uniform distribution of seeds at the right depth, which improves germination, maximizes plant spacing, and eventually increases agricultural yields. So, current investigation was carried out in the Wheat Research Unit's research farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during the 2017–2018 Rabi seasons to evaluate the impacts of drilling and dibbling, the planting technique to assess the growth and reproductive characteristics, and, eventually, the yield of the wheat varieties being studied. Ten treatments were used in the Factorial Randomized Block design (FRBD) experiment, which was triple-replicated. First factors are varieties V1 (AKAW 4210-6) and V2 (AKAW 4627). Five different sowing techniques were used in the treatments: S1 (drilling at 20 cm @ 100 kg ha^{-1}), S2 (drilling at 20 cm @ 50 kg ha^{-1}), S3 (dibbling at 15 x 15 cm), S4 (dibbling at 15 x 20 cm), and S5 (dibbling at 20 x 20 cm) as the second component. In comparison to the other type chosen for the study, variety AKAW 4210-6 fared to be better in terms of in almost all the growth and reproductive traits and observed profitable. In the study comparatively, dibbling method of sowing at 20 × 20 cm possibly helped to improve the grain yield more than 10 percent because it significantly increased the growth attributes, such as number of leaves plant^{-1}, leaf area plant^{-1}, number of effective tillers m^{-2}, chlorophyll content index (%), and dry matter accumulation plant^{-1} (g), when compared to the drilling technique of sowing.

Key Words: Sowing methods**,** dibbling, drilling, vegetative growth, wheat

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important food grain in the world. Wheat farming's contribution to humanity's growing power as a land-mass colonizer is its most noteworthy feature. More land is used for Wheat production worldwide than for any other crop. The United States, Russia, China, Australia, Germany, France, Argentina, and India are the world's top producers of Wheat. One of the most popular cereal grains and a staple food in the world, Wheat is a member of the *Poaceae* family and is grown extensively for its seeds. One of the most extensively grown crops in the world, Wheat comes in top place, followed by Rice. With a global production of 761 million tons in 2020, wheat surpassed Maize as the most produced cereal (FAO, 2014). The states that have grown the most Wheat in the nation include Uttar Pradesh, Madhya Pradesh, Punjab, Rajasthan, Bihar, Haryana, West Bengal, Maharashtra, and Gujarat. Uttar Pradesh produces the most wheat and has the greatest acreage in India (Anonymous, 2016). Because of its large area, high productivity, and leading position in the global food grain trade, Wheat is frequently referred to as the "King of Cereals" (FAO, 2017). Nearly 90 % of the country's Wheat acreage is planted to *Triticum aestivum*, the most important species, *Triticum durum* (8–9%) and *Triticum dicoccum* (<1%) are next in line. Twenty percent of human calories come from wheat (Khichar and Nivas, 2007). The nutritional content of Wheat is comparable to that of other significant cereals. Compared to other cereals, it has higher protein content. Niacin and thiamine, which are particularly important, are found in relatively high concentrations in Wheat.

Inadequate sowing techniques can result in unproductive crops. Later, Bakht et al. (2011) found that the crop's yield per unit area decreased as a result of the smaller ears and overall size, as well as its increased susceptibility to lodging, pests, and diseases. Among the sowing techniques, dibbling is one that works best on soil that is suitable for it. Using this technique, a seed is planted in a shallow hole and covered with soil that is close by (Rehman et al., 1993). The dibbling method is a highly effective way to employ sun energy for sowing that can withstand drought. It is typically employed in areas where harrowing and plowing are challenging. According to Luo et al. (2016), dibbling is primarily utilized by small-scale farmers and is thought to take more time than drilling and other traditional sowing techniques because it is done by hand. Due of its consistent population per unit area, drilling is a recommended method of sowing. Tanveer et al. (2003) state that strong germination and uniform stands are anticipated when seeds are planted at a consistent depth and covered with soil. The new, very precise planting pattern has gained popularity in recent years. Instead of planting all the seeds in a line, as is done with drilling and dibbling, this novel broad precision sowing planting pattern separates the individual grains from one another (Dandan et al., 2013; Bian et al., 2016). Therefore, the use of efficient and effective technologies is the only way to make the shift from subsistence farming to commercial farming (Anonymous, 2009). The regularity with which the specified amount of seed is dispersed throughout the region is the true advantage of mechanical broadcasting over conventional (manual) broadcasting. According to Tahir et al. (2003), the true advantage of drilled crops is a 15% increase in yield, especially for Wheat. The yield of Wheat planted using this method is 15% higher than that of conventional soil preparation methods. Additionally, it is regarded as a great method for preventing water and wind erosion, which helps to retain water in the soil profile (Benites, 2001). Importantly, compared to a dense population, crops that are sown widely apart frequently mature more slowly. In addition to the ideal seed rate, appropriate sowing techniques should also be considered in order to provide farmers with a favorable yield (Mollah et al. 2009). Appropriate seeding techniques increase the availability of resources including nutrients, moisture, and sunlight. Once again, accessibility promotes the appropriate development and construction of the root system from the very beginning of crop growth.

In addition to allowing plants to use the available land and other resources more effectively and decisively toward growth and development, sowing techniques ensure good crop establishment and the most advantageous plant population in the field (Singh and Sharma. 2019). Insufficient seeding might result in unproductive crops. In the study area, little research was done on the drilling and dibbling methods of seeding to increase wheat productivity. In light of this, a study was conducted to examine the impact of the drilling and dibbling methods of sowing on the growth and reproductive characteristics of wheat types and, ultimately, their yield.

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MATERIALS AND METHODS

2.1. Experimental Site

The current study was carried out in the Rabi season of 2017–2018 at the Wheat Research Unit, Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra.

2.2. Preparatory tillage operation

The experimental area was ploughed with a mold board plough and harrowed twice after the soybean crop was harvested. This made it easier to prepare the seed beds in the designated plots and sow the seeds, which improved crop emergence and plant stand.

2.3. Manures and fertilizers application

Farm yard manure at a rate of 5 t ha^{-1} was applied to the field in a treatment-wise manner during field preparation. According to the recommended fertilizer dosage (120:60:40 N, P_2O_5, and K_2O kg ha^{-1}, respectively), the crop was fertilized with nitrogen, phosphate, and potassium. Urea was used for nitrogen application, single super phosphate for phosphorus, and murate of potash for potassium. Two equal doses of nitrogen were applied: half at the time of sowing and the other half as a top dressing, 30 days after emergence. All unit plots received a full dose of potash and phosphorus at the time of sowing.

2.4. Experimental materials, sowing and design

The Wheat Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, provided the seeds of the Wheat varieties AKAW 4210-6 and AKAW 4627 for use as experimental material. The Factorial Randomized Block design (FRBD) experiment was triple-replicated and employed ten treatments. Variety V1 (AKAW 4210-6) and variety V2 (AKAW 4627) are the first factors. S1 (drilling at 20 cm @ 100 kg ha^{-1}), S2 (drilling at 20 cm @ 50 kg ha^{-1}), S3 (dibbling at 15 x 15 cm), S4 (dibbling at 15 x 20 cm), and S5 (dibbling at 20 x 20 cm) were the five distinct sowing procedures utilized in the treatments. The seeds were drilled 20 cm apart between rows at different seed rates (i.e., 100 kg ha^{-1} and 50 kg ha^{-1}). Additionally, seeds were dubbed at several plant populations and spacing levels, specifically 15 x 15 cm (4,44,444), 15 x 20 cm (3,33,333), and 20 x 20 cm (2,50,000).

2.5. Soil Characteristics

Before the crop was sown, soil samples from 0 to 30 cm depth were gathered from representative marked places that were randomly chosen throughout the experimental area in order to determine the physico-chemical characteristics of the soil. The soil was then carefully mixed to create the composite samples. Mortar and pestle were used to grind the samples and air dries them, in a manner that crushed the aggregate particles without disturbing the final soil sample particles. It was appropriately labeled, packed in canvas bags, and sieved using a 2 mm sieve. The physico-chemical characteristics of the soils in the experimental plot were then analyzed using it.

Table 1: Physico-chemical properties of soils of experimental plot.

Sr. No.	Particulars	Value before sowing	Value after harvest	Analytical method adopted
A.	**Mechanical composition**			
1.	Clay (%)	59.30	59.30	Bouyoucos Hydrometer method (Piper, 1966)
2.	Silt (%)	29.50	29.50	
3.	Sand (%)	11.20	11.20	
4.	Textural Class	Clay	Clay	Textural Triangle
B.	**Chemical composition**			
1.	Available Nitrogen (kg ha^{-1})	228.32	204.52	Alkaline permanganate method (Subbaih and Asija,1956)
2.	Available phosphorus (kg ha^{-1})	24.80	12.38	Olsen's method (Jackson, 1967)
3.	Available potassium (kg ha^{-1})	369.19	343.59	Flame photometer (Jackson, 1967)
4.	Organic carbon (g kg^{-1})	6.9	4.8	Walkley and Black method (Jackson ,1967)
C.	**Soil Reaction**			
1.	Soil pH	7.48	7.36	Beckman's glass electrode pH meter (Jackson,1967)
2.	Electrical conductivity (dSm^{-1})	0.256	0.242	Electric conductivity bridge (Jackson, 1967)

2.6. Observations Collected

For the purpose of documenting the different growth observations, five plants were chosen at random from each unit plot for each treatment in each replication. Table 2 lists the specifics of the observations that were made along with how frequently they occurred.

Table 2: Details of biometric observations recorded during course of Investigation.

Sr.No.	Particulars	Frequency	Days After Sowing
A)	**Pre –harvest**		
1	Emergence count m^{-2}	1	10 DAS
2	Final plant population m^{-2}	1	At harvest
3	Plant height (cm)	5	20,40,60,80 DAS and at harvest
4	No. of leaves per plant	4	20,40,60,80 DAS
5	No of Effective tillers m^{-2}	4	40,60,80 DAS and at harvest
6	Leaf area per plant (dm^2)	4	20,40,60,80 DAS
7	Dry matter accumulation $plant^{-1}$	5	20,40,60,80 DAS and at harvest
8	Chlorophyll content index	4	20,40,60,80 DAS
9	Flag leaf area per plant (dm^2) at flowering	1	At flowering

2.6.1 Emergence count (m^{-2})

To determine the mean plant stand, the number of seedlings in an m-2 area was counted and noted ten days following sowing.

2.6.2 Final plant population (m^{-2})

To determine the mean final plant stand, the number of seedlings per square meter was counted and noted in the observation unit of each net plot at the time of harvest.

2.6.3 Plant height (cm)

From ground level to the length of the fully opened top leaf at 20-day intervals, the height of five chosen and labeled plants from each observation unit of one m^2 area was measured in centimeters. The height of the plant was measured up to the base of the ear head after it emerged.

2.6.4 Number of functional leaves plant^{-1}

Up to harvest, the mean number of functioning leaves from the five randomly chosen observation plants was calculated.

2.6.5 Leaf area plant^{-1} (dm^2)

The length and breadth approach were used to calculate the leaf area. Factor 0.65 was applied to it (Lazarow, 1965). Leaf area measurements were taken at 20, 40, 60, and 80 DAS. The unit of leaf area was dm^2.

Leaf area (dm^2) of each leaf in middle tiller= L x W x K

Where,

L = Maximum length of leaf

W = Maximum width of leaf

K= Adjustment factor (0.65)

2.6.6 Number of effective tillers (m^{-2})

The total number of tillers, including the main shoot, from each observation unit of one m-2 area was counted 20 days before to harvest in order to determine the number of tillers per plant.

2.6.7 Dry matter accumulation plant^{-1} (g)

A plant was chosen at random from each plot, removed with its roots, and allowed to air dry before being oven-dried for 48 hours at 65°C and above. The weight of the plant was then determined. To determine the total dry matter per plant, the weight of each plant was recorded separately for the distribution of dry matter and then added together.

2.6.8 Chlorophyll content index (%)

The chlorophyll content meter CCM-200 (Opti-sciences) was used to measure the plant's chlorophyll content index (%). The observations were made every 20 days till 80 DAS.

2.6.9 Flag leaf area (cm^{-2})

The length and breadth approach were used to calculate the leaf area per plant. At the flag leaf stage, it was multiplied by a factor of 0.65.

3.7. Statistical analysis and interpretation of data

Using basic statistical techniques of analysis of variance, the SPSS program. Factorial Randomized Block Design was used to examine the experimental data acquired throughout the inquiry (Gomez and Gomez, 1984). In any case, the results were significant, and the comparison of treatment means was done with a critical difference estimated at the $P = 0.05$ level. Wherever interaction effect data are deemed important, they are displayed. The consequences of the treatment are appropriately displayed in tables and depicted in charts and graphs.

RESULTS AND DISCUSSION

The findings are addressed with a thorough grasp of how different elements, including as spacing and sowing techniques, relate to the crop's vegetative growth. Additionally, the outcomes are backed up by relevant facts and logical reasoning. When the plant was sown using the dibbling method at 20 × 20 cm, the following growth parameters exhibited a substantial increase: plant height (cm), number of leaves plant^{-1}, leaf area plant^{-1}, number of effective tillers m^{-2}, chlorophyll content index (%), and dry matter accumulation plant^{-1} (g).

4.1 Plant height (cm)

At every step of the crop growth period, the difference in plant height caused by different kinds was shown to be substantial (Table 3). The plant height of variety AKAW 4210-6 (V1) was noticeably higher than that of variety AKAW-4627 (V2). It could be caused by the genotype's genetic components. At every stage of the crop growth cycle, there was a considerable difference in plant height caused by varied seeding techniques. Up until harvest, the plant height was significantly highest with sowing method S1 (drilling @100 kg ha^{-1}), followed by treatment S2 (drilling @50 kg ha^{-1}). 15 cm by 15 cm (dibbling) S3 Both S4-15 and S5-20 x 20 cm (dibbling) are available. High plant density may be the cause, as it promotes competition among plants for resources. Throughout the experiment, it was determined that the interaction between varieties and seeding techniques was not significant. Dingkuhn et al. (1999), Singh et al. (2003), Abd El-Lattief (2014), and Shahzad et al. (2007) also corroborated this conclusion.

Table 3: Plant height (cm) as influenced by various treatments in wheat crop

Treatments	Plant height (cm)				
	20 DAS	40 DAS	60 DAS	80 DAS	AT Harvest
Varieties					
V_1- AKAW-4210-6	20.64	40.09	58.98	80.32	83.43
V_2- AKAW 4627	19.71	38.28	56.77	78.35	82.40
S.E. (m) ±	0.19	0.33	0.53	0.15	0.15
C.D. at 5%	0.57	0.99	1.57	0.46	0.47
Sowing Method					
S_1- Drilling @100 kg/ha	21.24	42.20	60.03	81.42	87.00
S_2-Drilling @50 kg/ha	20.99	40.31	59.46	80.76	85.00
S_3-Dibbling at 15 x 15 cm spacing	20.03	38.21	57.18	78.59	81.50
S_4-Dibbling at 15 x 20 cm spacing	19.64	38.00	56.72	78.12	80.50
S_5-Dibbling at 20 x 20 cm spacing	18.98	37.23	55.98	77.81	80.58
S.E. (m) ±	0.30	0.52	0.83	0.24	0.25
C.D. at 5%	0.90	1.56	2.49	0.74	0.74
Interaction (V x S)					
S.E. (m) ±	0.43	0.74	1.18	0.35	0.35
C.D. at 5%	NS	NS	NS	NS	NS
GM	20.17	39.19	57.87	79.34	82.91

4.2. Number of functional leaves plant^{-1}

Table 4's results demonstrated that at every stage of crop growth, treatment changes brought on by different seeding techniques were shown to be significant. In comparison to all other owing methods at 20, 40, 60, and 80 DAS, dibbling at a spacing of 20 x 20 cm (S5) recorded the highest number of leaves per plant^{-1}. At 20, 40, 60, and 80 DAS, treatment S5 was also shown to be comparable to S3 (dibbling at 15 x 15 cm) and S4 (dibbling at 15 × 20). Wider row spacing may result in more leaves per plant, which could be caused by more tillers per plant.

Due to enhanced plant spacing and even resource distribution, which improve light interception and photosynthetic efficiency, the drilled method of sowing typically produces more functioning leaves than other methods of planting wheat. At every stage of crop growth, the interaction between cultivars and seeding technique was not significant. Meena et al. achieved similar outcomes (2021).

Table 4: Number of functional leaves plant $^{-1}$ as influenced by different treatments in wheat

Treatments	Number of leaves plant^{-1}			
	20 DAS	40 DAS	60 DAS	80 DAS
Varieties				
V_1- AKAW-4210-6	5.04	20.16	25.12	19.61
V_2- AKAW 4627	3.34	18.42	23.12	17.71
S.E. (m) ±	0.19	0.20	0.23	0.23
C.D. at 5%	0.58	0.60	0.70	0.70
Sowing Method				
S_1-Drilling @ 100kg /ha	3.38	16.25	20.71	15.15
S_2-Drilling @50 kg/ha	3.56	17.69	21.60	16.10
S_3-Dibbling at 15 x 15 cm spacing	4.16	20.43	25.76	20.25
S_4-Dibbling at 15 x 20 cm spacing	4.83	20.99	26.01	20.42
S_5-Dibbling at 20 x 20 cm spacing	5.02	21.10	26.56	21.41
S.E. (m) ±	0.31	0.32	0.37	0.37
C.D. at 5%	0.92	0.96	1.12	1.12
Interaction (V x S)				
S.E. (m) ±	0.43	0.45	0.53	0.53
C.D. at 5%	NS	NS	NS	NS
GM	4.19	19.29	24.12	18.66

4.4. Leaf area plant^{-1}(dm^{-2})

It's noteworthy that variety V1 (AKAW 4210-6) recorded a much larger leaf area than variety V2 (AKAW 4627), as seen in Table 5. The genetic composition and tillering capacity of that variety may be the cause of variations in leaf area per plant. At every stage of crop growth, treatment variance resulting from different seeding techniques was found to be substantial. Compared to all other sowing methods, strategy S5 (dibbling at 20 × 20 cm) produced a much higher maximum leaf area plant^{-1}. Likewise, drilling at 50 kg ha^{-1} (S2), drilling at 100 kg ha^{-1} (S1), and dibbling at 15 x 20 cm spacing (S4) were found to be better than drilling at 15 x 15 cm (S3). A wider space wheat crop may have a greater leaf area per plant due to an increase in the number of tiller plants per plant in addition to the leaves. According to Dwyer et al. (1999), population growth increased them per unit area but decreased the leaf area index plant^{-1}. Sharifi et al. (2011) have confirmed similar findings. Following sowing methods S1 (drilling at 100 kg ha^{-1}), S2 (drilling at 50 kg ha^{-1}), S4 (dibbling at 15 x 20 cm), and S5 (dibbling at 20 x 20 cm), S3 (15 x 15 cm) reported a noticeably higher number of tiller m^{-2}. At 40, 60, 80, and harvest, S1 (100 kg ha^{-1}) was also found to be significant compared to S2 (drilling at 50 kg ha^{-1}), S4 (dibbling 15 x 20 cm), and S5 (dibbling 20 x 20 cm). Maintaining the ideal row spacing may improve wheat yield and maximize tillering capacity. The main cause of the yield increase is the rise in the number of productive tillers per square meter. Similar findings also supported by Singh and Srivastava (1991), Ayaz et al. (1999), Thorsted et al. (2006); Ali et al. (2010); Iqbal et al. (2010) and Hussain *et al*. (2012). Interaction effects was non-significant at all stages of crop growth.

Table 5: Leaf area plant $^{-1}$ as influenced by different treatment in wheat

Treatments	Leaf Area Plant^{-1} (dm^2)			
	20 DAS	40 DAS	60 DAS	80 DAS
Varieties				
V_1- AKAW-4210-6	0.22	2.65	3.91	2.76
V_2- AKAW 4627	0.21	2.57	3.80	2.73
S.E. (m) ±	0.00	0.01	0.00	0.09
C.D. at 5%	NS	0.05	0.01	0.02
Sowing Method				
S_1-Drilling @ 100kg /ha	0.19	2.03	3.62	2.32
S_2-Drilling @50 kg/ha	0.20	2.14	3.70	2.34
S_3-Dibbling at 15 x 15 cm spacing	0.23	2.80	3.93	2.96
S_4-Dibbling at 15 x 20 cm spacing	0.24	2.98	3.98	3.03
S_5-Dibbling at 20 x 20 cm spacing	0.23	3.11	4.06	3.08
S.E. (m) ±	0.01	0.02	0.00	0.01
C.D. at 5%	NS	0.08	0.02	0.04
Interaction (V x S)				
S.E. (m) ±	0.01	0.03	0.02	0.02
C.D. at 5%	NS	NS	NS	NS
GM	0.22	2.61	3.85	2.74

4.4. Number of effective tillers (m^{-2})

At every stage, the quantity of tillers m^{-2} was greatly impacted by the varieties. According to Table 6, variation V1 (AKAW 4210-6) had a noticeably greater number of tillers m^{-2} than variety V2 (AKAW 4627). Varieties may differ in the number of tillers per square meter depending on their environmental factors, soil type, and genetic makeup. Variations in sowing techniques had a major impact on the number of tillers m^{-2} at every stage of crop development. Following sowing methods S1 (drilling at 100 kg ha^{-1}), S2 (drilling at 50 kg ha^{-1}), S4 (dibbling at 15 x 20 cm), and S5 (dibbling at 20 x 20 cm), treatment S3 (15 x 15 cm) recorded a noticeably higher number of tiller m^{-2}. S1 (100 kg ha^{-1}) was also found to be more important than S2 (50 kg ha^{-1} drilling), S4 (dibbling 15 x 20 cm), and S5 (dibbling 20 x 20 cm) at 40, 60, 80, and harvest. Maintaining the ideal row spacing can improve tillering capacity and perhaps increase wheat output. Increases in the number of productive tillers per square meter are the main cause of the yield increase. Similar conclusions were also confirmed by Singh and Srivastava (1991), Ayaz et al. (1999), Thorsted et al. (2006), Ali et al. (2010), Iqbal et al. (2010) and Hussain et al. (2012), Throughout the whole crop growth cycle, interaction effects were not significant.

Table 6: Number of Effective tillers influenced by various treatments in wheat

Treatments	Number of Effective Tillers (m^{-2})			
	40 DAS	60 DAS	80 DAS	At Harvest
Varieties				
V_1- AKAW-4210-6	88.4	85.8	80.0	72.06
V_2- AKAW 4627	84.0	81.6	74.8	64.53
S.E. (m) ±	0.20	0.16	0.24	1.32

C.D. at 5%	0.61	0.48	0.71	3.93
Sowing Method				
S_1-Drilling @ 100kg /ha	91.5	89.5	84.0	71.83
S_2-Drilling @50 kg/ha	79.5	78.0	72.0	67.83
S_3-Dibbling at 15 x 15 cm spacing	105	102	95.0	86.0
S_4-Dibbling at 15 x 20 cm spacing	78.5	76.0	70.5	59.33
S_5-Dibbling at 20 x 20 cm spacing	76.0	73.0	65.5	56.5
S.E. (m)+	0.32	0.25	0.38	2.09
C.D. at 5%	0.96	0.76	1.13	6.22
Interaction (V x S)				
S.E. (m) ±	0.45	0.36	0.54	2.96
C.D. at 5%	NS	NS	NS	NS
GM	86.2	83.7	77.4	68.3

4.5. Dry matter accumulation plant^{-1} (g)

It's interesting to note that, according to Table 7, effect of varieties on dry matter accumulation shown significant effect during overall observation period. Variety V_1 (AKAW 4210-6) recorded significant higher dry matter accumulation over variety V_2 (AKAW4627). Treatment S_5 (dibbling at 20 x 20 cm) recorded significantly higher dry matter accumulation over rest of the treatments. Similarly, treatment S_5 was found to be at par with treatment S_3 (dibbling at 15 x 15 cm) S_4 (dibbling at 15 x 20 cm). Similarly, treatment S_3 was followed by S_1 (drilling @ 100 kg ha^{-1}) and S_2 (drilling @50 kg ha^{-1}). Higher dry matter accumulation in wider spacing might be due to better tillering response of wheat crop than that of narrow spacing. Interaction effect could not reach up to the level of significance. The results are in close conformity with those already reported by Jalota et al. (2006), Sarwar et al. (2010), Kharrou et al. (2011), Said and Amen (2016) and Kumar et al. (2019).

Table 7: Dry matter accumulation (g) as influenced by different treatments in wheat.

Treatments	Dry Matter Accumulation plant^{-1} (g)				
	20 DAS	40 DAS	60 DAS	80 DAS	At Harvest
Varieties					
V_1- AKAW-4210-6	0.24	6.33	19.70	37.22	46.31
V_2- AKAW 4627	0.22	4.34	17.45	35.42	44.74
S.E. (m) ±	0.00	0.19	0.22	0.21	0.41
C.D. at 5%	0.00	0.56	0.67	0.64	1.23
Sowing Method					
S_1-Drilling @ 100kg /ha	0.21	4.69	16.59	34.02	43.05
S_2-Drilling @50 kg/ha	0.22	4.94	17.22	34.51	43.46
S_3-Dibbling at 15 x 15 cm spacing	0.24	5.42	19.30	37.12	46.44
S_4-Dibbling at 15 x 20 cm spacing	0.24	5.61	19.52	37.96	47.33
S_5-Dibbling at 20 x 20 cm spacing	0.25	6.02	20.25	38.01	47.37
S.E. (m) ±	0.00	0.30	0.35	0.34	0.65
C.D. at 5%	0.01	0.89	1.06	1.01	1.95
Interaction (V x S)					
S.E. (m) ±	0.00	0.42	0.50	0.48	0.93

4.6. Chlorophyll content Index (%)

At every observation day, variations caused significant disparities (Table 8). Varieties V1 (AKAW 4210-6) and V2 (AKAW 4627) were shown to be superior. The genetic composition of that genotype, light interception, water availability, and soil fertility could all be contributing factors to variations in the chlorophyll index (%) of different types. Compared to all other sowing techniques, Treatment S5 (dibbling at 20 × 20 cm) outperformed them from 20 DAS to 80 DAS. Treatment S5 was also shown to be comparable to treatments S3 and S4 (dibbling at 15 x 15 cm and 15 x 20 cm, respectively). Similar to treatment S3, S1 (drilling @ 100 kg ha^{-1}) and S2 (drilling @ 50 kg ha^{-1}) came after S3. Excessive plant density promotes competition among plants for resources. Less light penetration in the crop canopy and increased competition for available nutrients will therefore impact the crop net photosynthesis process by influencing the plant's ability to translocate food material, which will result in a larger accumulation of photosynthesis. Weber et al. (1966) supported similar findings. At every stage of crop growth, no significant interaction was observed.

Table 8: Chlorophyll content Index (%) as influenced by different treatments of wheat.

Treatments	Chlorophyll content Index (%)			
	20 DAS	40 DAS	60 DAS	80 DAS
Varieties				
V_1- AKAW-4210-6	22.00	27.17	36.54	25.16
V_2- AKAW 4627	21.00	26.00	35.61	23.77
S.E. (m) ±	0.07	0.14	0.13	0.14
C.D. at 5%	0.29	0.42	0.38	0.42
Sowing Method				
S_1-Drilling @ 100kg /ha	18.96	24.76	34.31	23.14
S_2-Drilling @50 kg/ha	19.06	24.96	34.50	23.18
S_3-Dibbling at 15 x 15 cm spacing	20.19	27.43	36.93	25.14
S_4-Dibbling at 15 x 20 cm spacing	20.23	27.69	37.46	25.38
S_5-Dibbling at 20 x 20 cm spacing	20.39	28.12	37.51	25.51
S.E. (m) ±	0.15	0.22	0.21	0.22
C.D. at 5%	0.46	0.67	0.63	0.66
Interaction (V x S)				
S.E. (m) ±	0.21	0.32	0.30	0.31
C.D. at 5%	NS	NS	NS	NS
GM	21.50	26.59	36.14	24.47

4.7. Flag leaf area $plant^{-1}$

The findings presented in Table 9 demonstrated that, over the whole observation period, the effects of varieties on flag leaf area $plant^{-1}$ were substantial. The flag leaf area $plant^{-1}$ of variety V1 (AKAW 4210-6) was much higher than that of variety V2 (AKAW 4627). For the remaining treatments, the maximum flag leaf area $plant^{-1}$ was recorded using the S5 sowing method (dibbling at 20 x 20 cm). Techniques like as wider-spread seeding, which improves individual plant growth and lowers computation, boost the photosynthetic capacity in the flag leaf area, and ultimately increase grain output. The interaction impact was not significant over the entire crop growth cycle. The findings of Meena et al. (2021) were comparable.

Table 9: Flag leaf area plant^{-1} (dm^{2}) of wheat as affected by varieties and sowing method.

Treatments	Flag leaf area plant^{-1} (dm^{2})
	At flowering
Varieties	
V_1- AKAW-4210-6	0.55
V_2- AKAW 4627	0.50
S.E. (m) ±	0.00
C.D. at 5%	0.01
Sowing Method	
S_1- Drilling @100 kg/ha	0.49
S_2-Drilling @50 kg/ha	0.50
S_3-Dibbling at 15 x 15 cm spacing	0.54
S_4-Dibbling at 15 x 20 cm spacing	0.54
S_5-Dibbling at 20 x 20 cm spacing	0.55
S.E.(m) ±	0.00
C.D. at 5%	0.02
Interaction (V x S)	
S.E. (m) ±	0.01
C.D. at 5%	NS
GM	0.52

CONCLUSION

At every stage of crop growth, treatment variance resulting from different seeding techniques was found to be substantial. Compared to all other sowing methods, strategy S5 (dibbling at 20 × 20 cm) produced a much higher maximum leaf area plant^{-1}. In a similar vein, drilling @50 kg ha^{-1}(S2) and drilling @100 kg ha^{-1} (S1) were found to be inferior to dibbling at 15 x 20 cm spacing (S4). The drilled method of sowing usually yields more functioning leaves than other methods of planting in wheat, which is ultimately beneficial for the more production of photosynthesis phenomenon which leads to the more accumulation of photosynthates which converts into more grain production in the wheat plants. This is due to improved light interception and photosynthetic efficiency, which is improved by enhanced plant spacing and even resource distribution.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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Details of the AI usage are given below:

1.

2.

3.

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