J Agric. Res., 2021, Vol. 59(4):361-366
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Agriculture Department
Government of Punjab

AGRONOMY

DRILL SOWING AND BROADCAST AUGMENTED WITH FURROWS IMPROVED THE PERFORMANCE AND PROFITABILITY OF WHEAT

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Article received on: 15/01/2021
Accepted for publication: 16/03/2021

ABSTRACT

Better sowing method of a crop leads to better production by ensuring seed placement at proper depth and resulting in uniform emergence and crop stand. Different sowing methods are being used by farmers according to their wisdom but a limited information is available about the production potential and economic efficiency of sowing methods. To evaluate better sowing method for better production of wheat and its economic efficiency under irrigated conditions was studied through field experiments conducted during year 2017-18 and 2018-19 at Agronomic research Institute, Ayub Agricultural Research Institute, Faisalabad, Pakistan. Five sowing methods such as drill sowing (DS), bed sowing (BS), broadcasting (BC), broadcasting augmented with furrows (BAF) and ridge sowing (RS) were evaluated in RCBD replicated thrice. Data regarding yield and yield contributing factors during both years of study revealed that performance of wheat was better when sown by DS and BAF. DS and BAF produced significantly higher plant population 10.84% and 9.84%, grains per spike 13.45%, 12.11%, 1000-grain weight 4.96% and 4.53% and grain yield 11.95% and 11.19% respectively during 2018-19 and 2020-21 than BC. Moreover a strong correlation of wheat yield was observed with its yield contributing attributes. Economic analysis of different sowing methods during both years of study revealed the profitability of DS and BAF as more benefit-cost ratio (BCR) 7.18, 6.54% over BC, respectively was recorded with these sowing methods. It was concluded that DS and BAF are suitable methods for better wheat production and profitability under irrigated conditions.

KEYWORDS: *Triticum aestivum;* sowing methods; benefit cost ratio; correlation; yield; Pakistan

INTRODUCTION

Wheat (*Triticum aestivum*) accounts 8.7% to value addition in agriculture and 1.7% to GDP. Wheat in Pakistan was sown on 8.8 thousand hectares during year 2019-20 and production was 24.95 million tonnes (GoP, 2020). Production of wheat lowers due to unavailability of climate change resilient varieties and their seed, delayed planting, inappropriate sowing method, imbalanced fertilizer application and poor water management (Tanveer *et al.,* 2003).

Sowing method plays an important role in production of a crop as it plays a critical role in seed placement in seedbed. Improper sowing method and poor irrigation method may depress the crop yield and cropping intensity (Hamdy *et al.,* 2003). Better sowing method ensures a uniform crop stand after uniform germination (Bodner *et al.,* 2015) which ultimately leads to better production of crop after suitable management of crop nutrition and irrigation. In different areas of the country, different sowing methods are used depending upon the type of soil, underground water table, weather pattern, availability of irrigation water and nutrient management options. In Pakistan usually wheat is sown by broadcasting which is not recommended due to poor or delayed germination, non-uniform crop stand. For cereals crops including wheat, bed sowing have been used from years ago and also had multiple advantages under the irrigated conditions of Pakistan (Akbar *et al.,* 2017). Adoption of raised bed technology may enhance water use efficiency and also avoids the impacts of excessive water under rain fed conditions (Sayre, 2004).

Ridge sowing is also adopted under saline soils, problem of water logging and excessive water during rainy seasons. Ridge sowing improved wheat yield by 12%, water saving upto 30-35% and better irrigation management, however lack of information about this method and difficulty in harvesting has

limited the adoption of this technology. Broadcasting augmented with furrows also enhances crop yield as more surface area is available for plants which lowers plant competition and enhances interception of solar radiation resulting in more photosynthesis rate and ultimately the photosynthates accumulation in developing grains (Hussain *et al.,* 2018).

Current study was conducted to evaluate the suitability and profitability of different sowing methods for wheat cultivation under the irrigated conditions of Faisalabad.

MATERIALS AND METHODS

Area description

The research study was carried out at research area of Cereals and Pulses Section, Agronomic Research Institute, AARI, Faisalabad, Pakistan during 2017-18 and 2018-19. Study area was siturated between longitude 73° and 74° East, latitude 30° and 31.5° North at an elevation of 605 ft above sea level.

Soil preparation

Soil was prepared by using disc harrow followed by two (2) times cultivation with cultivator. Then soil was pulverized using Rotavator. After that final seed bed was prepared by two cultivations followed by planking.

Soil analysis

Soil samples were collected before sowing upto depth of 12 inches and were sent to Soil testing Laboratory. Results of soil analyses was given in Table 1.

Soil Character	2017-18	2018-19
EC (mS/cm)	1.48	1.46
Soil pH	7.7	7.8
Organic matter (%)	0.65	0.62
Available N (%)	0.05	0.04
Available P (ppm)	8.5	8.1
Available K (ppm)	245	225
Saturation	34	33
Texture	Sandy loam	Sandy loam

Crop sowing and data collection

Research was conducted during 2017-18 and 2018-19 at research area of Agronomic Research Institute, AARI, Faisalabad, Pakistan. Wheat variety Faisalabad-2008 was sown using seed rate of 125 kg/ha with five sowing methods (drill sowing, bed sowing, broadcast, broadcast augmented with furrows and ridge sowing) to evaluate the growth and productivity of wheat under different sowing methods. Crop was sown on November 15th during both years. The experiment was conducted under Randomized Complete Block Design (RCBD) with three replications. Recommended dose of fertilizer NPK @ 115:82:62 kg/ha was applied to the crop. All recommended P and K and 30% N were applied at seedbed preparation and remaining N was applied in two splits at first irrigation and booting stage. Drill sowing was done using rabi drill keeping row-row distance of 22.5 cm. Bed sowing was done on raised beds having 1.125 m width with help of hand drill. Broadcast was done by spreading the seed manually. In broadcast augmented with furrows seed was spread manually and then furrows were made by tractor mounted ridger. In Ridge sowing seed was sown on both sides of 60 cm apart ridges with the help of hand drill. All other agronomic practices were kept uniform for all sowing methods. At physiological maturity of crop, plants from 1 m row were counted from three different places in each treatment and were considered as plant population m^{-2}. At harvest maturity height of 20 plants from each treatment was measured with help of meter rod and averaged. Ten spikes were selected from each treatment and their length was measure with help of measuring scale and averaged. The same spikes were used for counting of spikelets per spike and averaged as spikelets per spike. Each spike was threshed manually and their grains were counted and averaged as grains per spike. After that crop was harvested on 24th April and 26th April in year 2017-18 and 2018-19, respectively and weight of above ground biomass was considered as biological yield. After threshing, weight of grains was considered as grain yield. Three samples of 1000-grains were taken from each treatment, weighed and their average was considered as 1000-grain weight. Harvest index was calculated by using following formulae:

$$\textit{Harvest index (H.I)} = \textit{(Grain yield /biological yield)} \times 100$$

All the recorded data were analyzed statistically using analysis of variance (ANOVA) technique and difference among treatments' means was compared by using least significant difference (LSD) test (Steel *et al.,* 1997). An association was drawn among the recorded attributes of wheat using Pearson's correlation from statistical software "Statistix 8.1". Cost of production was calculated by using standard rates of labor and market value. Benefit cost ratio (BCR) for each sowing method was computed after the economic analysis by using gross income and total expenditures with the following formulae.

$$\textit{Benefit cost ratio (BCR)} = \frac{\textit{Gross income}}{\textit{Total cost}}$$

RESULTS AND DISCUSSION

Different planting methods significantly affected the plant population, plant height, spike length and spikelets

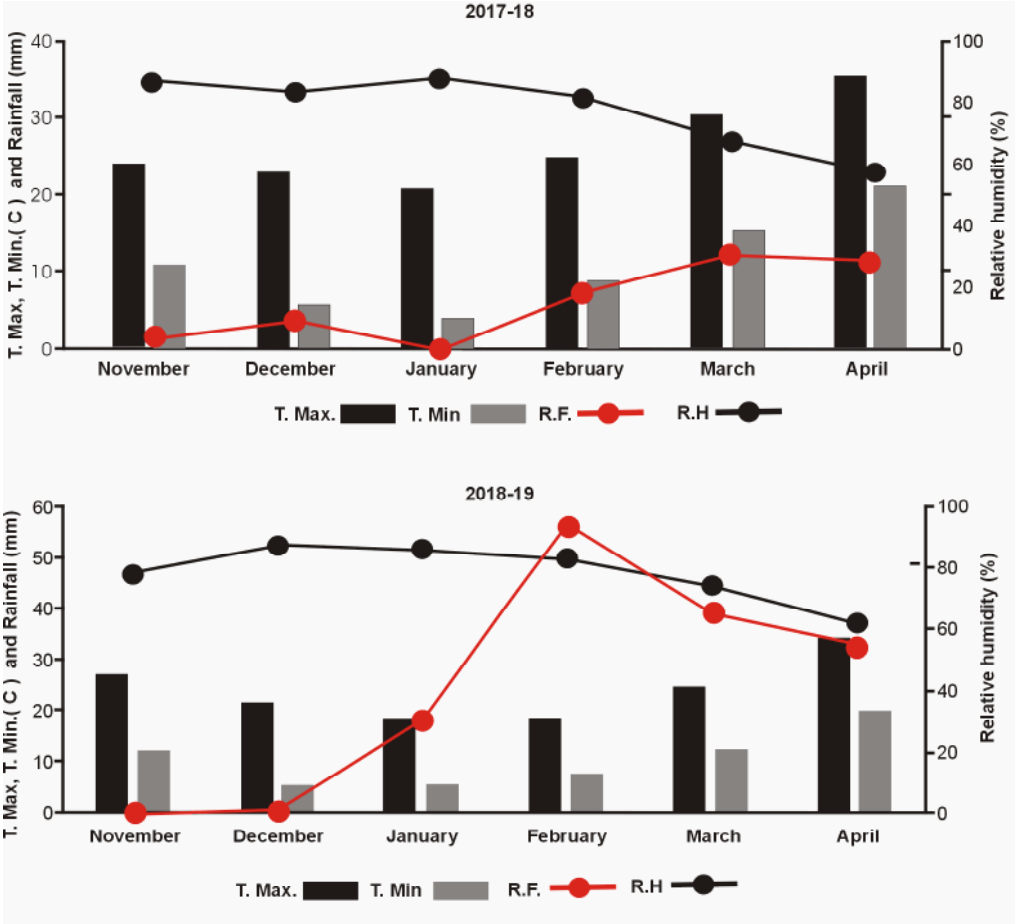

Fig. 1. Weather data for cropping season.

T Max. = Maximum temperature, T. Min. = Minimum temperature, R.F = Monthly rain fall, R.H. = Monthly relative humidity

Table 2. Yield components of wheat affected by different sowing methods

Sowing methods	Plant population		Plant height (cm)		Spike length (cm)		Spikelet per spike	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
Drill sowing	279 a	273 a	82.6 a	85.0 a	10.5 a	9.9 a	18.3 a	18.0 a
Bed sowing	256 b	254 b	77.6 b	81.3 b	8.5 b	8.4 b	16.3 bc	16.0 bc
Broadcast	249 c	249 bc	77.7 b	81.5 b	9.2 b	8.7 b	15.7 c	15.7 bc
Broadcast augmented with furrows	279 a	268 a	80.7 a	84.3 a	10.7 a	10.1 a	17.7 ab	17.0 ab
Ridge sowing	245 c	245 c	77.2 b	80.3 b	9.5 ab	8.8 b	15.7 c	15.3 c
LSD value ($p \leq 0.05$)	6.5	7.8	2.17	1.81	1.23	1.01	1.79	1.42

Table 3. Yield components of wheat affected by different sowing methods

Sowing methods	Grains per spike		1000- grain weight (g)		Grain yield (kg/ha)		Biological yield (kg/ ha)		Harvest index (%)	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
Drill sowing	44.0 a	43.7 a	33.60 a	33.33 a	3244 a	3212 a	6573 a	6461 a	49.38	49.73
Bed sowing	39.8 b	38.9 b	32.70 b	31.93 b	2833 b	2801 bc	5589 c	5448 c	50.70	51.43
Broadcast	38.7 b	38.6 b	32.10 c	31.67 bc	2903 b	2865 b	5852 b	5745 b	49.61	49.88
Broadcast augmented with furrows	43.0 a	43.6 a	33.43 a	33.23 a	3233 a	3179 a	6477 a	6383 a	49.92	49.81
Ridge sowing	40.1 b	37.7 b	31.60 d	31.37 c	2781 b	2719 c	5565 c	5450 c	49.97	49.89
LSD value ($p \leq 0.05$)	1.54	1.31	0.332	0.362	149.5	120.2	157.4	165.6	NS	NS

per spike during both years of study (Table 2). Drill sowing (DS) and broadcast augmented with furrows (BAF) produced significantly more and statistically alike number of plants (plant population), plant height, spike length and spikelets per spike than other sowing methods during both years. Bed sowing (BS) produced more plant population than broadcast (BC) and ridge sowing (RS) but less than DS and BAF during both years however, in case of other three parameters BS, BC and RS performed statistically alike (Table 2). This can be attributed to the fact that in case of DS and BAF, not only the uniform seed placement and seeding depth were ensured but also the moisture availability and sufficient space for capturing light and aeration were ensured.

Maximum grains per spike, 1000-grain weight, grain yield and biological yield were recorded in DS which were statistically at par to BAF during both years, while grains per spike were less in BS, BC and RS and were statistically alike. Among BS, BC and RS 1000-grain weight was more in BS while grain and biological yield were more in BC. Other two sowing methods were at par in case of these parameters during both years of study. HI of wheat was non-significant during both study years (Table 3).

Economic analysis of both years (Table 6, 7) shows

Table 4. Correlation analysis of yield components of wheat showing the strength of association between each other 2017-18

	BY	GPS	GY	HI	PH	PP	SL	SPS
GPS	0.88*	*						
GY	0.99**	0.90*	*					
HI	-0.63^{NS}	-0.41^{NS}	-0.54^{NS}	*				
PH	0.96**	0.95*	0.96*	-0.35^{NS}	*			
PP	0.94*	0.93*	0.97**	-0.33^{NS}	0.94*	*		
SL	0.89*	0.87^{NS}	0.88*	-0.66^{NS}	0.84^{NS}	0.79^{NS}	*	
SPS	0.92*	0.97**	0.94*	-0.38^{NS}	0.98**	0.98**	0.79^{NS}	*
TW	0.87^{NS}	0.85^{NS}	0.90*	-0.21^{NS}	0.89*	0.97**	0.63^{NS}	0.95*

BY = Biological yield, GPS = Grains per spike, GY = Grain yield, HI = Harvest index, PH = Plant height, PP = Plant population, SL = Spike length, SPS = Spikelets per spike, TW = Test weight/1000 grain weight, NS = Non-significant, * Significant at p ≤ 0.05, ** = Significant at p ≤ 0.01

Table 5. Correlation analysis of yield components of wheat showing the strength of association between each other 2018-19

	BY	GPS	GY	HI	PH	PP	SL	SPS
GPS	0.97**	*						
GY	0.99**	0.99**	*					
HI	-0.58^{NS}	-0.38^{NS}	-0.45^{NS}	*				
PH	0.98**	0.99**	0.99**	-0.39^{NS}	*			
PP	0.93*	0.98**	0.97**	-0.26^{NS}	0.98**	*		
SL	0.96*	0.94*	0.93*	-0.63^{NS}	0.91*	0.87^{NS}	*	
SPS	0.91*	0.95*	0.94*	-0.29^{NS}	0.97**	0.98**	0.84^{NS}	*
TW	0.95*	0.99**	0.98**	-0.30^{NS}	0.99**	0.99**	0.91*	0.96*

Table 6. Economic analysis of wheat sown by different sowing methods year 2017-18

Sowing method	Fixed cost	Variable cost	Total cost	Gross income	Net field benefits	BCR
Drill sowing	29800	1500	31300	52896	21596	1.69
Bed sowing	29800	2000	31800	45671	13871	1.44
Broadcast	29800	100	29900	47229	17329	1.58
Broadcast augmented with furrows	29800	1300	31100	52461	21361	1.69
Ridge sowing	29800	1200	31000	45101	14101	1.45

BY = Biological yield, GPS = Grains per spike, GY = Grain yield, HI = Harvest index, PH = Plant height, PP = Plant population, SL = Spike length, SPS = Spikelets per spike, TW = Test weight/1000 grain weight, NS = Non-significant, * Significant at p ≤ 0.05, ** = Significant at p ≤ 0.01

Table 5. Economic analysis of wheat sown by different sowing methods year 2018-19

Sowing method	Fixed cost	Variable cost	Total cost	Gross income	Net field benefits	BCR
Drill sowing	30700	1600	32300	52896	20596	1.64
Bed sowing	30700	2100	32800	45671	12871	1.39
Broadcast	30700	200	30900	47229	16329	1.53
Broadcast augmented with furrows	30700	1400	32100	52461	20361	1.63
Ridge sowing	30700	1300	32000	45101	13101	1.41

BCR = Benefit cost ratio

that maximum benefit cost ratio (BCR) was recorded with DS and BAF during both years and after these two sowing methods BC showed more BCR than BS and RS. Owing to the less variable cost of DS and BAF in comparison to BS and higher net benefits than all other methods, maximum BCR was calculated for these methods i.e. DS and BAF during both years of study.

Seed placement at proper depth and space results in better germination which leads to better crop stand and ultimately the crop productivity (Tanveer *et al.,* 2003). Proper seed placement helps plant to utilize available nutrients and space for capturing of light and photosynthesis which leads to synthesize more photosynthates. Moreover, proper spaced plants avoid root competition for moisture and nutrients and has positive effects on growth and yield of a crop. Suitable planting method ensures seed placement at proper depth and uniform placement which results in faster emergence, better seed to soil contact and homogenous crop stand (Mehrvar and Asadi, 2006). So sowing methods play significant role in crop productivity. Govaerts *et al.* (2006); Wang *et al.* (2009) found that better grain yield of maize was attributed to better plant population and uniform plant to plant distance. According to data in Table 2, 3 more plant population, plant height, spike length, spikelets per spike, grains per spike and 1000-Grain weight was recorded in DS and BAF which might be attributed to the more surface area available in BAF and uniform depth of seed in DS. Moreover, water and nutrients might be easily available to plants either in DS or BAF. More yield contributing factors lead to more crop yield which might be result of strong correlation of yield contributing factors with grain yield and biological yield (Table 4, 5). Tanveer *et al.* (2003) found that wheat sown by drill resulted in better emergence and stand establishment due to seed placement at proper depth. Sowing wheat by BS, BC and RS produced less plant population, plant height and all other yield contributing factors resulting in less crop yield. Reason might be the unavailability of proper space, water and nutrients to plant as Beds and Ridges become dry early and nutrients may leach down from root zone of wheat. Wheat having tap root system may unable to absorb nutrients and moisture in BS, BC and RS for the better growth and development. Tanveer *et al.* (2003) found that wheat sown at raised bed faced the problem of emergence and at grain filling stage of wheat water stress may lead to lower 1000 grain weight and grain yield.

CONCLUSION

It is concluded that wheat should be planted by Drill sowing (DS) or by broadcast augmented with furrows (BAF) in irrigated area.

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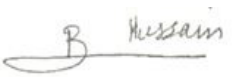
4.	Muhammad Zafar	Supervised the experiment and reviewed the manuscript	
5.	Tariq Mahmood	Proof read the article	
6.	Muhammad Saqib	Assisted in results and discussion write-up	
7.	Babar Hussain Babar	Helped in field crop management and data collection	
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