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Impact of Sowing Dates on Wheat Varieties in Central Terai Region of Nepal

Mitali Kumari Sah[1*], Abhisek Shrestha[2], Pradeep Shah[3], Rajendra Prasad Yadav[4], Bisheshwar Prasad Yadav[1] and Anand Mishra[1]

[1]Directorate of Agricultural Research, Parwanipur, Bara, Nepal
[2]Agriculture and Forestry University, Rampur, Chitwan, Nepal
[3]National Agricultural Environment Research Centre, Khumaltar, Lalitpur, Nepal.
[4]National Wheat research Program, Bhairahawa.
[*]Corresponding author's email: sahmitali@gmail.com

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ABSTRACT

A suitable time of sowing and varieties are the most important factors for getting higher yield of wheat. To evaluate the effect of different sowing times on wheat varieties, an experiment was conducted at Directorate of Agricultural Research (DoAR), Madhesh Province, Parwanipur, Bara, Nepal during the winter seasons of 2018-2019. The experiment was conducted in a split-plot design with three replications that includes twelve treatments combination having three sowing dates as a main-factor (10th November, 25th November, and 10th December) and four promising wheat varieties (BL 4407, BL 4621, BL 4699, and Vijay) as a sub-factor. There was a significant effect of date of sowing on spike length, tillers, grain yield and 1000 grains weight, but the plant height and straw yield were not affected significantly by sowing dates. Variety had no significant effect on plant height and straw yield, but influenced significantly the spike length, effective tillers, 1000 grains weight and grain yield. The 25th November sown wheat crop gave a significantly higher grain yield (3925 kg ha^{-1}) and straw yield (8044 kg ha^{-1}) but declined in grain yield noted by 11-14% in the 10th November and 10th December sown wheat. A promising wheat variety BL 4407 (4017 kg ha^{-1}) produced the highest yield, (20% more) compared with released variety Vijay (3203 kg ha^{-1}). It can be concluded that proper time of sowing and selecting appropriate variety enhanced the grain yield of wheat.

Keywords: Date of sowing, varieties, wheat, yield

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INTRODUCTION

Wheat (*Titicum aestivum L.*) is the staple food crop and it stands 3rd position in terms of its area and production in Nepal, among the major crops. Rice-wheat cropping pattern is the main cropping system of Nepal, where the sowing of wheat crop is determined by the harvesting time of rice. In lowland Terai area, farmers prefer to plant medium to late maturing rice varieties, which gets harvested from late November to early December. The plantation of wheat in November-December provides a short period of growth and maturity time. During the time of maturity, the hot air movement causes the early maturation without physiological maturity, which declines the yield of wheat sharply (NARC 2020). So, enhancing the productivity of wheat is the main task during the short crop period time. The leading factor that is required for increasing the yield is breeding, recommended time, methods and other agronomical practices. But among them as the least-cost technologies and the top problem is the appropriate time of sowing (Meleha et al 2020).

The timely plantation provides an optimum environment for the crop to accumulate higher photosynthates and increase higher grain yield (Yusuf et al 2019), while delayed it exposed to low temperature at the germination cause delayed emergence and low plant population and higher temperature at the reproductive phase leads to force maturity and resulted to reduction of yield of wheat (Gupta 2017). Too early planting produces weak seedlings with poor root systems due to high temperatures that affect ultimately the crop yield. So, proper sowing time is a fundamental factor for deciding the crop performance and achieving the higher yield (Tahir et al 2019).

Sowing time is related to temperature dependent, the optimum temperature requirement of the crop in different stages should be optimized for higher yield and productivity (Meleha et al 2020). It is notice that there is a change in temperature and rainfall patterns on globe and regional aspects due to climate effects that have exerted a consequential impact in agriculture input and production (Meleha et al 2020). Nepal is one of the most vulnerable countries in terms of climate change. The lesser temperature rise during the growing season would have a less adverse impact on wheat production because, for each degree increase in temperature during the crop growing season, grain yield of wheat would be decreased by about 10% (Zhang et al 2004).

An appropriate date of sowing and varieties are the most important and low cost production factors for enhancing wheat yield. Hence, to find out the suitable wheat varieties and optimum date of sowing for wheat production in the context of the central region of Nepal, this experiment was conducted at DoAR, Parwanipur.

MATERIALS AND METHODS

The experiment was conducted at Directorate of Agricultural Research (DoAR), Madesh Province, Parwanipur, Bara, Nepal during the winter seasons of two consecutive years 2018/19 and 2019/20. The experiment was laid out in split-plot design with three replications, which consisted 12 treatments combination including three sowing dates (10th November, 25th November and 10th December) as a main-factor and four wheat varieties (BL 4407, BL 4621, BL4699 and Vijay) as a sub-factor. A released variety of wheat 'Vijay' was used as a standard check in the study. The total area of the experimental plot was 5m × 3m (15 m^2). A recommended seed rate 120 kg ha^{-1} was used in the experiment, and the seed was sown continuously with maintaining of 25 cm row to row spacing.

All the experimental plots were ploughed twice before 15 days of sowing and weed residue of the field was also removed manually. Fertilizers were applied @ 100:50:25 kg $N:P_2O_5:K_2O$ ha^{-1} through urea, Di-Ammonium Phosphate and Murate of potash. The seed rate used in the experiment was 120 kg ha^{-1}. Data on various phenological, morphological and yield attributing traits such as: plant height), spike length, Spike m^{-2}, grain yield and thousand kernels weight were recorded. All the data were analyzed statistically at probability level ≤ 0.05 by using Genstat (GEN532-2), data analysis software. During the experiment periods, the meteorological data were also recorded. The mean minimum and maximum temperatures, and rainfall of the study area are presented in Figure 1.

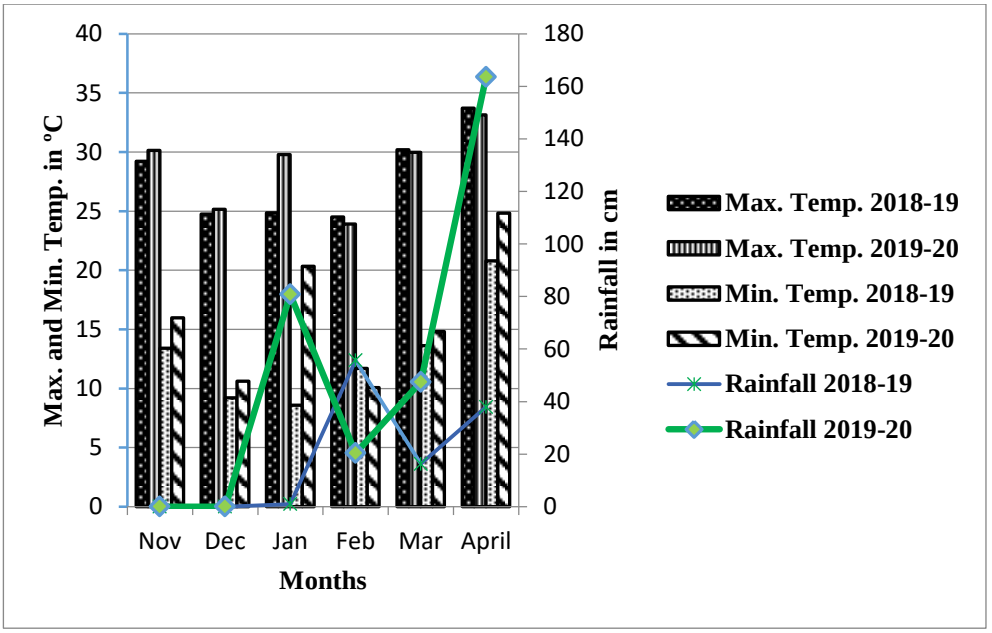

Figure 1. Meteorological records during the study periods of the year 2018/19 and 2019/20

RESULTS AND DISCUSSION

Days to heading and maturity

The data on days to heading and maturity are presented in Table 1. A combined results of two years showed that the days to heading and maturity were significant for both the date of sowing and variety. The general trend for the yield attributing parameters like number of days to maturity shortened with every 15 days delayed in seeding date. The 10th December sown wheat took shorter days to maturity (115 days), while the 10th November sown condition required longer days for maturing (123 days) (Table1).

Table 1. Response of date of seeding on wheat varieties on days to heading and maturity at DoAR, Parwanipur, Bara, 2018-2019

Treatment	Days to heading (Days)			Days to maturity (Days)		
	2018	2019	Pooled	2018	2019	Pooled
Factor A (Date of sowing)						
10th November	74	84	79	127	137	132
25th November	77	82	80	119	127	123
10th December	75	79	77	114	116	115
SEm (±)	0.26	0.166	0.1	0.32	0.26	0.11
LSD (<0.05)	1.034**	0.65	0.40**	1.28**	1.02**	0.44**
Factor B (Varieties)						
BL4407	75	79	77	118	125	122
BL 4621	75	82	79	119	127	123
BL 4699	79	85	82	123	129	126
Vijay	74	80	77	119	126	122
SEm (±)	0.18	0.14	0.12	0.21	0.136	0.11
LSD (<0.05)	0.563**	0.42**	0.36	0.63**	0.40**	0.34*
A×B	ns	ns	ns	ns	ns	ns
CV (%)	0.8	0.5	6.1	0.5	0.3	4.4

Plant height

Significant differences in the plant height among the varieties) were found in 2018 whereas it was noted non-significant due to the effect of different sowing dates. The maximum plant height (117.0 cm) was measured in BL 4699. Sowing wheat on a different date does not differ significantly because the vegetative growth period seems equal at all the different dates but the sowing date on 25th November shows the highest plant height at 106 cm and the same results was also reported by Fazily et al 2019. Though, the date of sowing might affect the plant height, but our data does not show such a trend and this might be due to the effect of high temperature during tillering stage. The various time of planting has significantly affected the spike length but not to plant height. The length of wheat spikes varied with the year and date of sowing. In the year 2018 and 2019, the wheat crop planted on 25th November showed the highest spike length and the same case was also recorded in pooled data.

Spike length

The maximum spike length on pooled data (12 cm) was recorded in BL 4699 whereas BL 4621 produced a shorter spike length of 11cm. Other varieties had statistically similar spike length to BL 4621. The date of sowing also had a significant effect on spike length. Planting wheat on 25th November produced longer spikes (13.6 cm), as it observed by Tripathi et al 2019. Short spike length was measured in December sown condition. The long spike length is one of the most important traits for higher grain yield in wheat.

Number of tillers

Tillering mainly depends upon the green photosynthetic area which is responsible for carbohydrate formation, grain filling and final grain yield (Khalifa 1968). The data given in Table 2 revealed that a maximum number of tillers (258 m^{-2}) was recorded in wheat variety Vijay, which is at par with BL 4621 (251 m^{-2}) and BL 4407. From the analysis, it is shown that time of planting had a significant effect on tillers production. Sowing wheat on November 25th

produced the maximum number of tillers 280 m^{-2} followed by 10th November. Sowing wheat on 10th December produced the minimum number of tillers because of low temperatures during initial stage. Early sowing wheat significantly increased the number of tillers, wherein the contribution of tillers towards final yield was maximum on 25th November, but it is decreased in later sown condition especially at the end of December when the temperature was too low for germination (Wajidet al 2004).The high temperature also reduced the number of tillers under later sown crop because of the period between anthesis and senescence was shortened by higher temperature (Akasha 1968)Differences in number of tillers among varieties might be attributed to their genetic diversity (Shah et al 2006).

Thousand grain weight

Thousand grains weight is a genetic character and least influenced by the environment. There were significant variations among varieties for the 1000-grain weight (Table 3). BL 4699 produced heavier seeds (49.0 g) which is at par with check variety Vijay (50.0 g). The data showed statistically significant differences among various planting dates. The highest and significantly similar grain weight was recorded in crop seeded on 25th November followed by 10thNovember. There was a gradual decrease in grain weight with each successive sowing date and the minimum grain weight (43.9 g) was recorded under 10th December sown condition. Many researchers have also reported a decrease in wheat grain weight due to the late sowing (Khan 2000; Tripathi et al 2019; Akhtar et al 2006). This is because the delayed sowing shortened the each development phase which ultimately reduces the grain filling period resulted the lower grain weight (Spink et al 2000). Also, the late sown crop has to face increasing temperatures at the anthesis stage, which generally decreases the weight per grain (Dhillon et al 1994). Smith and Humphreys (2001) reported that at higher temperature the duration of the grain-filling period is reduced with a net effect of the lower kernel weight. The higher temperature coupled with desiccating winds during the month of March-April brings forced maturity of late sown wheat and results in a reduction of test weight (Thakar and Dhaliwal 2000). It showed that the earlier planted crop enjoyed a prolonged growth period and favourable pre-heading conditions, which have had a carryover effect on grain weight via stem reserves or the setting of potential grain weight soon after anthesis (Dhillonet al 1994). The interaction effect showed no significant differences between varieties and sowing time.

Grain yield

As shown in Table 3 that there were significant differences among wheat varieties for grain yield. A wheat variety BL 4407 produced a comparatively higher grain yield (4017 kg ha^{-1}) based on pooled year data, followed by BL 4621. The lowest grain yield was obtained in Vijay, a check variety. Among planting dates, the highest and statistically similar grain yield (3925 kg ha^{-1}) was obtained from 25th November sowing dates, whereas the last planting date (10th December) produced the lowest (3328 kg ha^{-1}) grain yield. Higher grain yield in BL 4407 was mainly due to the higher number of tillers and comparably higher grain weight. Wheat varieties produced poor grain yield when planted in December. This explains that the spikes population or seed weight in late sowing condition could not compensate for the increases in the yield of earlier sown wheat because a high temperature at the anthesis stage and reduction in season length (Naceur et al 1999). The low temperature of December reduced the germination of seeds and early vegetative growth. The optimum temperature for grain development ranges from 12 to 22°C (Farooq et al 2011).Although, increasing temperature and photosynthesis boosts supply of assimilates, this may not fully compensate for a shortened duration of starch deposition, where higher temperature produces smaller grains that limits grain yield (Spiertz et al 2006).

Table 2. Effect of date of sowing and varieties on growth and yield attributing parameters of wheat in central Terai region of Nepal, 2018-2019

	Plant Height (cm)			Spike length (cm)			Effective Tillers m^{-2}		
Treatment	**2018**	**2019**	**Pooled**	**2018**	**2019**	**Pooled**	**2018**	**2019**	**Pooled**
Factor A (Date of sowing)									
10th November	104.9	101.3	103	11.3^{b}	11.7^{b}	11.5^{b}	255^{b}	241^{b}	248^{b}
25th November	105.1	106.3	106	13.0^{a}	14.2^{a}	13.6^{a}	277^{a}	283^{a}	280^{a}
10th December	105.4	102.6	104	10.8^{c}	11.2	11^{c}	236^{c}	239^{b}	237^{b}
SEm (±)	0.66	1.03	1.3	0.37	0.13	0.1	8	2.49	6.12
LSD (<0.05)	ns	ns	ns	0.4**	0.35*	0.45*	15**	19*	17*
Factor B (Varieties)									
BL4407	102.3	99.3	101^{b}	11.2^{b}	11.3^{b}	11^{b}	263	226	244.6^{ab}
BL 4621	97.9	103.5	101^{b}	10.8^{b}	11.5^{b}	11^{b}	275	228	251.2^{a}
BL 4699	117	111.3	114^{a}	12.0^{a}	13.0^{a}	12.0^{a}	242	224	232.8^{b}
Vijay	103.2	99.5	101^{b}	11.1^{b}	11.4^{b}	11^{b}	289	233	258^{a}
SEm (±)	0.81	3.23	1.5	0.2	0.23	0.2	6.8	6.54	7.06
LSD (<0.05)	2.42**	ns	4.3**	0.61*	0.69*	0.5**	20.2*	ns	13.7*
A×B	ns	ns	ns	ns	ns	ns	ns	ns	ns
CV (%)	2.3	9.4	6.2	5.7	6.1	6.2	7.7	8.6	12.2

Table 3. Effect of date of sowing and varieties on yield and yield attributes of wheat in central terai region of Nepal, 2018-2019

Treatments	1000 grain weight (gm)			Grain yield (kg ha^{-1})			Straw Yield (kg ha^{-1})		
	2018	**2019**	**Pooled**	**2018**	**2019**	**Pooled**	**2018**	**2019**	**Pooled**
Factor A (Date of sowing)									
10th November	43.2^{b}	48.9^{b}	46.0^{b}	3484^{b}	3594^{b}	3539^{b}	5314	9417	7365
25th November	46.2^{a}	50.7^{a}	48.4^{a}	3662^{a}	4189^{a}	3925^{a}	6312	9775	8044
10th December	42.9^{b}	44.9^{c}	43.9^{c}	3367^{b}	3290^{c}	3328^{b}	6529	8458	7493
SEm (±)	1.18	0.54	0.9	107.8	119.7	88.6	333.8	163.2	410.4
LSD (<0.05)	2.0*	2.1**	2.05**	285*	269**	277*	ns	640*	ns
Factor B (Varieties)									
BL4407	41.7	45.2	43.4^{b}	3899^{a}	4135^{a}	4017^{a}	6146	9438	7792
BL 4621	39.3	44.3	41.8^{b}	3373^{b}	3893^{b}	3633^{b}	6098	9218	7658
BL 4699	46.2	51.8	49.0^{a}	3374^{b}	3700^{c}	3468^{b}	6450	9694	8072
Vijay	49.4	51.3	50.4^{a}	3137^{b}	3269^{d}	3203^{c}	5512	8516	7014
SEm (±)	0.97	1.71	1.04	130.1	130	102.3	256.9	310.4	473.9
LSD (<0.05)	2..8**	5.08**	**	386**	186*	286*	ns	ns	ns
A×B	ns	ns	ns	ns	ns	ns	ns	ns	ns
CV (%)	6.6	10.6	9.5	11.2	10.2	11.9	12.9	10.1	26.3

CONCLUSIONS

The yield contributing characters like effective tiller, 1000 grains weight, grain yield and straw yield of wheat were significantly varied due to different sowing dates. A higher tiller numbers were noticed in 25th November sown condition, followed by 10th November sown condition and the lowest tiller numbers was found under later sown condition. The boldness of grain was observed in 25th November sown condition, which was followed by 10th November, while the lowest grain weight was observed in 10th December sown condition. The early and delay sowing of wheat crop resulted yield reduction by 10-15%. So, it is concluded that the proper sowing time of wheat is November 25th and the variety is BL 4407 in the central Terai of Nepal.

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AUTHORS' CONTRIBUTION

M Shah conducted the experiment, generated data and analysed them and wrote the manuscript. Other authors supervised and edited the manuscript.

CONFLICTS OF INTEREST

The authors have no any conflict of interest to disclose.

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