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Effect of Different Sowing Dates on Yield and Yield component traits of Wheat

Bhimsen Chaulagain[1*], Rajendra Kumar Bhattarai[1] and Bhanu Bhakta Pokharel[1]

[1]National Agronomy Research Center, Khumaltar, Lalitpur, Nepal
*Corresponding author's email: bhimsen.chaulagain@gail.com
*ORCID: https://orcid.org/0000-0002-9856-8301

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ABSTRACT

An experiment was conducted in winter season of 2020/21 and 2021/22 to evaluate the effects of different sowing dates on phenological traits, yield attributing traits and grain yield of wheat. The experiment was carried-out in Agronomy farm of National Agronomy Research Center, Khumaltar, Lalitpur, Nepal. The experiment was conducted in randomized complete block design (RCBD) with six sowing dates (10 Nov, 20 Nov, 30 Nov, 10 Dec, 20 Dec and 30 Dec) as treatment which were replicated four times. Wheat variety Swargdwari was used in the experiment. During the experiment, we took different observations starting from phenological parameters to yield traits like days to 50% flowering, days to 90% maturity, plant height, spike length, number of grains per spike, number of tillers per square meter, thousand grain weight, grain yield, straw yield and harvest index. The combined ANOVA of two years revealed that there was significant effect of sowing dates on days to 50% flowering, days to 90% maturity, plant height at physiological maturity, spike length, straw yield and grain yield of wheat. Number of grains per spike found non-significant. Number of tillers per square meter was found maximum (374.1) m^{-2} on 20 Nov. Thousand grain weight was found maximum on 10 Nov which was 54.37 g followed by 20 Nov with 51.77g. Straw yield was found the highest on 10 Nov which was 9.05 tha^{-1} followed by 7.83 tha^{-1} on 20 Nov. Similar result was shown by grain yield with maximum value of 6.13 tha^{-1} on 10 Nov followed by 20 Nov which is 5.90 tha^{-1}. Harvest index was found maximum on 10 Dec with 0.49. Nov sowing had more vegetative growth contributing higher straw yield and low economic return. Therefore, it is concluded that 10 Nov is optimum time for wheat sowing in Kathmandu valley and similar agro-climatic regions.

Keywords: Grain yield, optimum, phenological, significant, straw yield

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important and strategic cereal crop for the majority of the world's populations and has been described as the 'King of cereals' because of its large area cultivation, high production potential, good nutritional profile, and the prominent position in international food grain trade (Thapa et al 2023). Wheat is the second most produced cereal grain behind maize, and the global trade of wheat is greater than all other crops combined. In 2020, the total global production of wheat was 760 million tons. Wheat stands at third position in terms of production and area in Nepal. The annual production of wheat is 2144568 Mt, area is 716978 ha and productivity is 2.99 $Mtha^{-1}$ (MoALD 2080). The production and productivity of wheat remained constant for last three fiscal years. There can be several factors which are responsible for low wheat productivity in the country like irrigation, fertilizer, climate, insects, pests, etc. but with proper management of the crop wheat production and productivity can be improved from the present scenario (Pokharel et al 2007).

Generally sowing of wheat in Nepal starts from Nov and ends in late December depending on the land availability due to preceding crops, especially under the 'Rice-Wheat Cropping System' and soil moisture status (Thapa et al 2023). Though it is cultivated as a winter crop, differences in geography and topography makes the sowing period of wheat differ in different portions of the country (Poudel 2013). Under late sown conditions, wheat crops are exposed to heat stress during the critical growth stages, i.e., flowering and grain filling and cause production losses. Yields of late-sown wheat are reduced by as much as 40% in Nepal (Sharma and

Duveiller 2004). The sowing time of wheat has also been changing due to the effect of climate change. It has made some visible shift in the sowing time of wheat, change in weeds population dynamics, maturity time and finally in the yield. Early planting ensures optimum emergence through sufficient tiller number per unit area. However, each week delay of sowing reduces the vegetative and reproductive phases and affects the yield-attributing characteristics leading to yield reduction (Akmal et al 2011, Malik et al 2009).

A field experiment was conducted to study the effects of climate change adaptation on date of sowing under rice-wheat cropping system. The experiment's objectives were to assess how sowing time affects the crops phenologies, growths, yield and yield attributes.

MATERIALS AND METHODS

Experimental site

The experiment was conducted in the research field of the National Agronomy Research Center of Nepal Agricultural Research Council (NARC), Khumaltar, Lalitpur, Nepal from Nov 2020 to May 2021 and Nov 2021 to May 2022. The station is located at 27°40'E and 85°20' with an elevation of 1360 meters above sea level.

Soil and climate

The soil of the experimental plot was tested by National Soil Science Research Center Lab under Nepal Agricultural Research Council (NARC). As per the available data, the soil was acidic in pH (5.98) containing low organic matter (2.01%), medium total Nitrogen (0.139%), high available P_2O_5 (478.6 kg ha^{-1}), and medium available K_2O (160.5 kg ha^{-1}). The soil texture was silty clay loam, and the average bulk density was 1.39 g cm^{-3} (Table 1).

Table 1. Physio-chemical characteristics of the soil in the experimental plot

Soil Characters	Description
Soil texture	Silty clay loam
Soil pH	5.98
Bulk density	1.39 g cm^{-3}
Organic matter content	2.01%
Total nitrogen	0.139%
Available P_2O_5	478.6 kg ha^{-1}
Available K_2O	160.5 kg ha^{-1}

Source: NARC, 2021

Average monthly maximum and minimum temperatures for each month were recorded using maximum and minimum thermometer during the entire research period from Nov 2020 to May 2021 and Nov 2021 to May 2022. In 2020/21, an average maximum temperature was 23.1˚C and average minimum temperature was 10.3˚C whereas in 2021/22, average maximum temperature was 22.2˚C and average minimum temperature was 9.6˚C. Total rainfall received during research period in 2020/21 was 235 mm and 325.6 mm in 2021/22 recorded using rain gauge. Monthly temperature and rainfall during research period is shown in Figures 1 and 2.

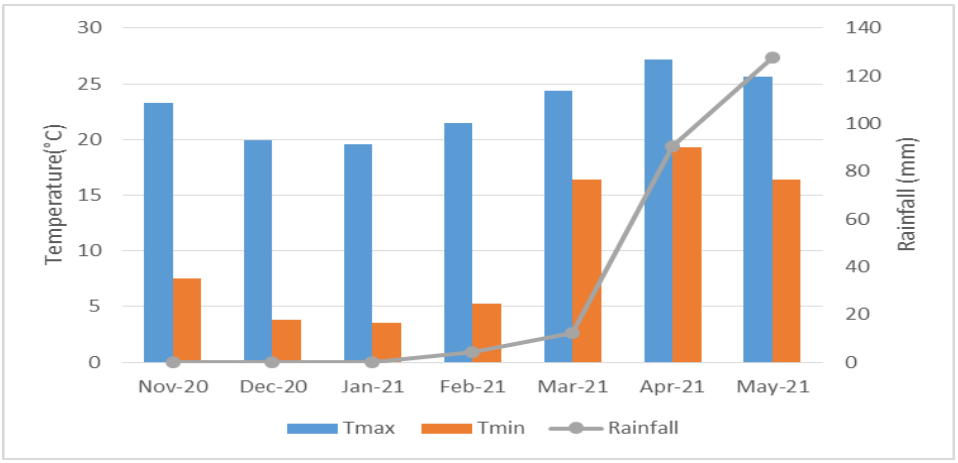

Figure 1. Monthly average temperature and rainfall during research period (2020/21)

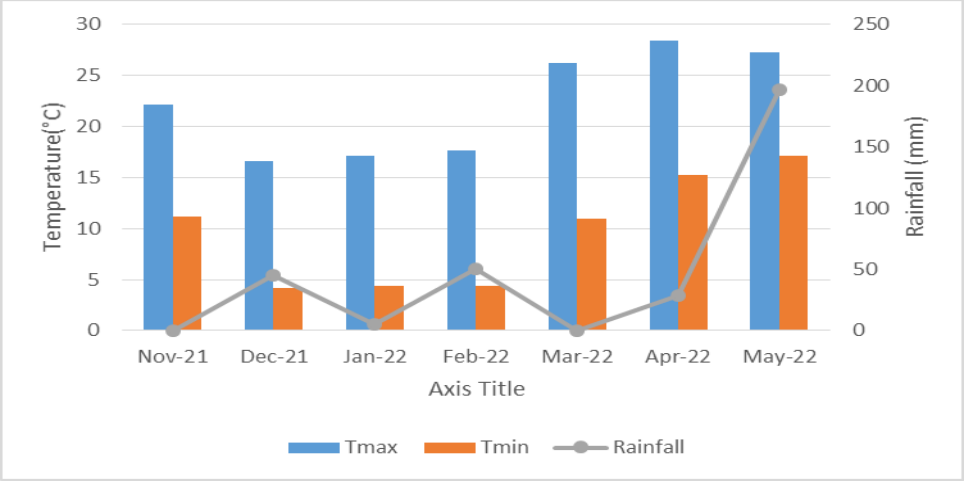

Figure 2. Monthly average temperature and rainfall during research period (2021/22)

Experimental Design and Treatment details

The experiment was conducted in a randomized complete block design with six treatments and four replications. Sowing dates were Nov 10, Nov 20, Nov 30, Dec 10, Dec 20, and Dec 30.

The variety used was Swargadwari, a yellow rust resistant variety. Breeder seed was used in the experiment which performed the best in experimental plots of previous years.

A total of 24 plots with a size of 4m×3m was made with each plot consisting of 15 rows of wheat sown continuously at the spacing of 20 cm between the rows. To remove border effects, 0.4 m space on all sides was left and net plot of 7.04 m^2 was maintained for grain and straw yield calculation. All the recommended agronomic practices were followed during experiment.

Cultural practices

The experimental plot was cleared and primary tillage was done using Mould Board Plough and rotavator is used to break clods and pulverize soils for easy germination of seeds.

The recommended dose of the fertilizer for wheat cultivation in the hill region i.e. 6 mt ha^{-1} FYM and 100:50:50 $N:P_2O_5:K_2O$ kg ha^{-1}. In the experiment, fertilizer dose of 150:75:50 $N:P_2O_5:K_2O$ was applied to meet the crop nutrient demand. Urea, DAP, and MoP were the mineral fertilizer sources of the primary nutrients supplied to the crops. A full dose of P_2O_5, K_2O and half dose of nitrogen was applied as basal dose at the time of final land preparation before sowing. The remaining half dose of nitrogen was applied in two splits, first at the active tillering stage and second at the booting stage of the crop.

Breeder seeds of Swargadwari variety of wheat were sown continuously at the spacing of 20 cm between the rows and with seed rate of 120 kg/ha (9.6 g/row, 144 g/plot). The sowing of seeds was done manually on six different dates at an interval of ten days starting from the 10th Nov both years.

Crop-weed competition in the experimental field was managed by controlling weed population through hand weeding. Weeding was done as per the need to make the field weed free. Irrigation were provided during crown root initiation stage (CRI). The water requirement was fulfilled by irrigation as and when needed.

Crop maturity stage was judged by different maturity indices such as brittle/distorted awn, yellowing of stem and drying of flag leaf etc. Harvesting was done manually using sickles. The net plot harvested biomass was bundled and brought to threshing floor for threshing. A motorized thresher was used for threshing and winnowing was done for cleaning the seeds. The seeds were sundried and moisture was adjusted to 12% for grain yield estimation. The seed moisture was measured using grain moisture meter Wile 200.

Data collection: data were collected by researcher himself on scheduled time. Days to 50% flowering, days to 90% maturity and plant height were phonological traits were collected also.

Statistical Analysis: The data were collected, processed and analyzed. Statistical software GenStat 15th edition was used to analyze data. The graphs and tables were prepared using MS Excel.

RESULTS

Growth and phenological traits

Days to 50% flowering

The longest duration (121.5 days) for 50% flowering was observed when planted on 10th Nov in 2020/21 and 20th Nov in 2021/22 (114.5 days). Days to 50% flowering decreased continuously from first sowing to sixth sowing date. The shortest duration was 97.5 days on 30th Dec in 2020/21 and 93.25 days in 2021/22. In second year, days to 50% flowering was six days earlier than first year

Days to 90% maturity

Similar to flowering days to 90 % maturity was highest in the first date of sowing took 171 days in first year and 157.3 days in second years. Days to 90% maturity took longer duration in first year than second year. The average days to maturity was 153.2 days.

Plant height

Plant height reached 103.7 cm on 20th Nov which is almost same to first date (103 cm) in first year whereas plant height reached 113.9 cm on 10th Nov in second year. The average plant height of wheat was 97.6 cm for both years.

Yield and yield component traits

Spike length

Spike length varied in different sowing dates. 10th Nov sowing date had longer spike length (12.78 cm) in first year however 30th Dec sown wheat had longest spike length in second year (21.82 cm). The mean spike length of both years was 16cm.

Grains per spike

Number of grains per spike was found maximum in 30th Nov (3rd date) which is almost 43 grains per spike and 64 grains were found on 10th Nov sowing in second year. Shortest spike yielded most grains in second year. The average grains per spike was 46.9.

Effective tillers/m^2

Tillers per square meter was significantly high in early dates due to high early stand, good tillering capacity and favorable environment with highest value on 20th Nov in first year and 418.8 in second year. The average effective tillers/m^2 was 332.1.

Thousand grain weight

Thousand grain was counted using Automatic Seed Counter machine and weighed using digital balance. The mean thousand grain weight was 50.52 g. The highest thousand grain weight of 58.1 g was observed from the wheat sown on 10th Nov in first year and 50.65 g in second year.

Straw yield

The highest straw yield was observed in first and second sowing with 7.91 tha^{-1} while in second year 10th Nov sowing yielded 10.18 tha^{-1} Mean straw yield was 6.56 tha^{-1} in combined analysis.

Grain yield

It was observed that grain yield affected by sowing dates significantly. Wheat sown on 10th Nov produced the highest yield of 5.71 tha^{-1} and 6.55 tha^{-1} in first and second year respectively. The mean grain yield of two years was 5.25 tha^{-1}.

Harvest index

Highest harvest index value was 0.49 on 10th Nov in first year while from second year 30th Dec sowing had harvest index value of 0.51 where mean harvest index value was 0.45. Low straw yield in late sown date contributed to high harvest index as compared to early sown dates.

Table 1 Effect of different sowing dates on yield and yield component traits of wheat at Khumaltar in 2020/021

Treatments	50%FLR	90%MAT	PLH	SPL	GPS	Tillers	TGW	SYLD	GYLD	HI
10-Nov	121.5	170.8	103	12.78	36.1	346.2	58.1	7.91	5.71	0.42
20-Nov	117.5	169.8	103.7	12.28	41.9	386.2	56.5	7.91	5.64	0.42
30-Nov	116	165	99.3	12.51	42.8	327.8	56.3	6.54	4.69	0.42
10-Dec	111	158.5	88.7	10.76	42	294.8	53.5	5.33	5.14	0.49
20-Dec	104.5	150.5	92	10.2	39.7	326	49.8	5.81	4.8	0.48
30-Dec	97.5	143	88.2	9.58	34.7	340.5	49	5.61	4.56	0.45
LSD (<0.05)	1.403	0.992	2.27	0.601	5.06	55.15	2.25	0.858	0.73	0.03
CV%	0.2	0.2	0.7	1.9	4.7	4.4	1.8	5	4.4	2.2
Grand Mean	111.3	159.5	95.8	11.35	39.6	336.9	53.9	6.52	5.09	0.44

50%FLR= days to 50% flowering, 90%MAT=days to 90% maturity, PLH=plant height (cm), SPL=spike length (cm), GPS=grains per spike, Tillers= number of tillers per square meter, TGW= thousand grain weight (g), SYLD=straw yield (tha^{-1}), GYLD=grain yield (tha^{-1}), HI=harvest index

Table 2 Effect of different sowing dates on yield and yield component traits of wheat at Khumaltar in 2021/022

Treatments	50%FLR	90%MAT	PLH	SPL	GPS	Tillers	TGW	SYLD	GYLD	HI
10-Nov	112.5	157.5	113.9	18.98	64.5	418.8	50.65	10.18	6.55	0.39
20-Nov	114.5	151.2	109.2	19.71	57.7	323	47	7.75	6.16	0.44
30-Nov	109.5	155.5	101.5	20.32	51.5	334.2	44.58	7.05	5.95	0.46
10-Dec	105	145.5	94	21	43.6	305.5	48.73	5.81	5.29	0.48
20-Dec	99	143	93.5	21.77	53.4	293.8	44.68	4.67	4.87	0.5
30-Dec	93.25	128.2	84	21.82	54.5	289.2	47.48	4.15	4.16	0.51
LSD (<0.05)	1.649	12.92	4.44	1.52	12.7	75.8	3.605	1.545	0.507	0.056
CV%	0.4	2.5	0.9	0.7	4.1	5.3	3.2	6.5	4.6	4.1
Grand Mean	105.6	146.8	99.4	20.6	54.2	327.4	47.18	6.6	5.5	0.46

50%FLR= days to 50% flowering, 90%MAT=days to 90% maturity, PLH=plant height (cm), SPL=spike length (cm), GPS=grains per spike, Tillers= number of tillers per square meter, TGW= thousand grain weight (g), SYLD=straw yield (tha^{-1}), GYLD=grain yield (tha^{-1}), HI=harvest index, CV= coefficient of variation

Table 3: Combined analysis of effect of different sowing dates on yield and yield component traits of wheat at Khumaltar in 2020/021 and 2021/022

Treatments (A)	50%FLR	90%MAT	PLH	SPL	GPS	Tillers	TGW	SYLD	GYLD	HI
10 Nov	117.0	164.1	108.5	17.3	50.3	329	54.37	9.05	6.13	0.41
20 Nov	116.0	160.5	106.4	17	49.8	374.1	51.77	7.83	5.90	0.43
30 Nov	112.8	160.3	100.4	16.8	47.2	337.7	50.45	6.80	5.32	0.44
10 Dec	108.0	152.0	91.3	15.5	42.8	294.3	51.10	5.57	5.22	0.49
20 Dec	101.8	146.5	92.7	15	46.6	321	47.23	5.24	4.66	0.47
30 Dec	95.4	135.6	86.1	14.3	44.6	336.7	48.21	4.88	4.27	0.47
LSD (<0.05)	1.00	6.16	2.41	0.76	ns	25.4	2.225	0.846	0.46	0.029

Treatments (A)	50%FLR	90%MAT	PLH	SPL	GPS	Tillers	TGW	SYLD	GYLD	HI
Year (B)										
2020/21	111.3	159.5	95.8	11.4	39.6	336.9	53.86	6.52	5.09	0.44
2021/22	105.6	146.8	99.4	20.6	54.2	285.3	47.18	6.60	5.41	0.46
LSD (<0.05)	0.58	3.56	1.39	0.44	3.76	24.51	1.285	Ns	0.26	0.016
A*B	1.42	8.72	3.41	Ns	9.21	60.03	3.147	1.197	0.65	Ns
CV%	0.3	1.3	0.3	0.7	2.2	4.0	1.4	4.4	3.9	2.1
Grand Mean	108.5	153.2	97.6	16	46.9	332.1	50.52	6.56	5.25	0.45

50%FLR= days to 50% flowering, 90%MAT=days to 90% maturity, PLH=plant height (cm), SPL=spike length (cm), GPS=grains per spike, Tillers= number of tillers per square meter, TGW= thousand grain weight (g), SYLD=straw yield (tha^{-1}), GYLD=grain yield (tha^{-1}), HI=harvest index, ns= non-significant, CV=coefficient of variation

DISCUSSION

From the combined analysis of two years data, we can observe that days to 50% flowering was less in 2021/022 than 2020/021 which is similar to days to 90% maturity however plant height was more in second year. Wheat sown on 10 Nov showed highest number of days to anthesis in comparison to 30 Dec. The result is in line with Tahir et al (2019) who noted delayed sowing led to reduction in days to anthesis. All three phenological traits were found significant. Tahir et al 2019 which reported that the days to maturity were found higher in the wheat sown on Nov 10^{th} (164.1 days) and it gradually decreased with delay in sowing. Unfortunately, treatments and year interaction was found significant for above three traits which is depicted in table 3.

Spike length was dramatically increased in second year reaching upto 20.6 cm compared to 11.4 cm in first year contributing in plant height as well in second year. Unlike phenological traits, spike length and year interaction was non-significant indicating that increased in spike length in second year was not due to year factor. The mean spike length from both year was 16 cm. Number of grains per spike was found non-significant in combined analysis while treatment and year interaction was found significant which was undesirable. Yield attributing traits like tillers per square meter, thousand grain weight, grain yield and straw yield were also significant and treatment and year interaction of above traits were also significant. Baloch et al (2012) and Poudel et al (2020) reported significantly higher yields in early sown wheat compared to late sown wheat because of maximum partitioning of photosynthate to grain. Unlike other yield attributing traits, harvest index was found inverse relation with sowing dates. Early sown dates had lower harvest index value due to taller plants, more tillers, and higher early stands attributed to high straw yield compared to late sown dates as shown in Table 3.

CONCLUSION

The effect of different sowing dates was obvious for various yield attributing traits of wheat and the crop sown on 10^{th} Nov performed best for wheat variety Swargadwari in mid hills conditions and areas depicting similar condition. Therefore, it is recommended that 10^{th} of Nov sowing date is suitable for mid hills farmers for getting good wheat yield.

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AUTHORS' CONTRIBUTION

B Chaulagain conducted the experiment, collected data and analyzed 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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