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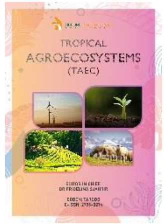

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RESEARCH ARTICLE

PERFORMANCE OF SPRING RICE CULTIVARS AGAINST SOWING DATES AT WESTERN TERAI, NEPAL

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ABSTRACT

An on-station experiment entitled "Performance of Spring Rice Cultivars against Sowing Dates at Western Terai, Nepal" was conducted at the agronomy farm of Paklihawa Campus from January to July 2022. The trial was set up in a split-plot design consisting of three sowing dates: (January 30 (early), February 15 (mid), and March 1 (late)) as the main factor and four varieties (Hardinath-1, Black Rice Coarse, Chaite-5 & Black Rice Fine) as sub-factor, each replicated three times. Plant height was higher on the late sowing in the Chaite-5 cultivar at 60, 90, and 120 DAS. The number of tillers wasn't significantly different among the sowing dates, however, a significantly higher value was recorded in Hardinath-1 at 60 DAS, Black Fine at 90 DAS, and Black coarse at 120 DAS. Early sowing dates and cultivars Chaite-5 and Black Fine had a longer duration for flowering and maturity. The yield and yield attributing parameters (panicle length, weight per panicle, spikelet per panicle, and biological yield) were recorded higher in late sowing in the Chaite-5 cultivar. However, grain filling wasn't observed due to biotic stresses like insect and bird pest infestation. Future research and policy formulation about spring rice should emphasize the management of insect and bird pests.

KEYWORDS

Biological Yield, Chaite-5, Cultivar, Late Sowing, Pests.

1. INTRODUCTION

Rice, the major staple crop of Nepal, accounts for nearly 7 % of the country's National Gross Domestic Product (GDP) and 21 % of its Agricultural GDP (MOALD,2020/21). Main-season and spring-season rice contribute 92% and 7% of total production respectively (CDD, 2015). Rice is the staple food for more than half of the world's population. Rice gives 20% of the world's dietary energy supply whereas wheat supplies 19% and maize 5% (FAO Food and Nutrition Division, 2004). Cooked, white, long-grained rice comprises 68% water, 28% carbohydrate, 3% protein, and irrelevant fat (USDA, 2019). In Nepal, rice ranks first in terms of area cultivated, production, and livelihood of the people (Ajaib, 2014). More than 1,700 rice landraces are reported in Nepal growing from 60 m to 3050 m altitude (Thakur et al., 2013). Yields of spring rice in Nepal, Lumbini Province, and Rupandehi district are 4.66, 4.93, and 5.34 mt/ha respectively (MOALD, 2021/22). In Nepal, rice is cultivated in 1.46 million hectares with a production of 5.1 Megatonne (Mt) and productivity of 3.4 tonnes/hectare (t/ha). The demand for rice is expected to increase from 496 Mt by 2020, 553 Mt by 2035, and 623 tonnes by 2050 (Timsina et al., 2021). Spring rice gives a higher yield than main-season rice due to higher light intensity, better fertilizer use efficiency, better control of water, and less weed infestation (Shrestha et al., 2022). Spring rice is resistant to numerous diseases and pests and is more effective in lower output loss rates (Ajay et al., 2020).

To achieve good grain quality, timely sowing ensures that vegetative growth takes place during a period of favorable temperatures and high levels of solar radiation, as well as that grain filling takes place when milder fall temperatures are more likely (Farrell et al., 2003). Rice is typically planted in the first week of July after being sown at the close of May. The traditional technique of transplanting produces a high and consistent yield but is also time-consuming and expensive. Producers are now utilizing other techniques to reduce these costs and challenges, such as direct rice seeding (Mehmood et al., 2002). A physiological evaluation of four hybrid rice varieties was recently conducted in Egypt under six distinct sowing dates. The results showed that early sowing dates are ideal for sowing for key characteristics like maximum tillering, panicle initiation, heading date, number of tillers m-2, plant height and root length at panicle initiation and heading stage, chlorophyll content, number of days to panicle initiation and heading date, leaf area index, sink capacity, spikelets/leaf area ratio, Number of grains per panicle, panicle length (cm), 1000 grain weight, five panicle weight (g), and grain yield per hectare (Khalifa, 2009).

Farmers of Western Terai, Nepal mainly depends upon main-season rice cultivation. Very few farmers who grow spring rice are not getting suitable spring rice varieties and the annual production of spring rice is not as expected. Similarly, very few researches have been conducted concerning the identification of suitable spring rice varieties in this region. So, the main reason behind our study was to identify suitable spring rice cultivars for this region. The farmers are also not aware of the time of nursery preparation. Early sowing of seeds invites the problem of cold stress to seedlings and late-sowed rice faces the problem during harvesting by monsoon rain. There are varieties recommended for the spring season in the Terai region, however, their performance is still a question for extension officers. The trial would provide insight into spring rice cultivars' growth and yield performance under various sowing dates.

2. MATERIALS AND METHODS

An on-station experiment was conducted to understand the possibility of spring rice in the Western Terai region of Nepal. The experiment was carried out at the agronomy farm of Paklihawa Campus situated in Rupandehi District from January to July 2022. Geographically, the site is

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situated at 27.48007°N latitude, 83.44727°E longitude, and 108 meters above sea level. The physical and chemical properties of soil were analyzed before sowing of rice and found to be neutral (7.6) with low organic matter (2.1%), low total nitrogen (0.06%), medium phosphorus (48.3 kg/ha), and potassium (134.4 kg/ha). The experimental site received a total rainfall of 1436.5 mm during the experimentation period. The maximum temperature during the crop growth season ranged from 17.79 ºC in January to 34.98 ºC in July and the maximum temperature reached up to 36.67ºC in April. The minimum temperature ranged from 10.81 ºC in January to 27.5 ºC in July.

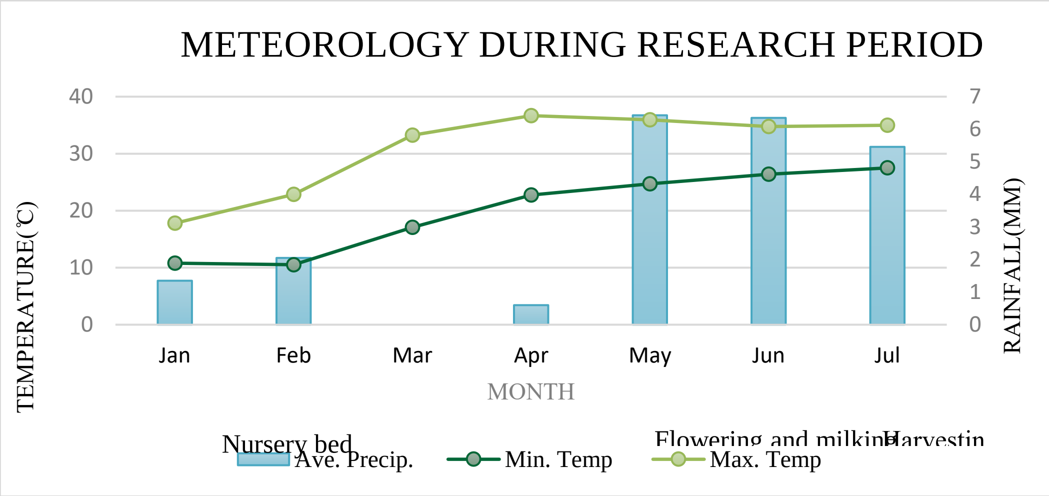

Figure 1: Temperature and Rainfall graph during the experimental period.

The experimental plots were laid out in a split-plot design consisting of three sowing dates in main plots (January 30 (early), February 15 (mid), and March 1 (late)) and four cultivars in sub-plots (Hardinath-1, Black Rice Coarse, Chaite-5 & Black Rice Fine). Each replication was separated by 1m alley, while each plot was separated by 0.5m bund space. The total number of plots was 36, each of size 3m*2m. Seeds were sown on three different dates at an interval of 15 days, i.e., January 30 (early), February 15 (mid) and March 1 (late). Seedlings were raised by the modified dapog method inside a poly house to prevent them from cold stress. The application rate of organic manure was 20 t/ha and chemical fertilizer was 100:60:40kg NPK ha-1. Hand weeding operation was done at 30 DAS and 60 DAS after transplanting. Irrigation was applied for puddling operation to rice and during critical stages.

For insect pest management (mostly bugs), we applied an insecticide named Roger @2ml/liter thrice in 15-day intervals during the milking stage and for bird pest management we used glitter ribbons, cassette reels, and balloons for the bird pest management. Growth observations recorded were plant height, number of leaves, and the number of tillers/ m2 at 60 and 120 DAS. Likewise, days to flowering and maturity were recorded as phenological parameters. 100 % yield failure was observed at the maturity stage (115~125 DAS) in all the cultivars and sowing dates due to the infestation of insect and bird pests. We randomly selected five panicles from each plot to record yield attributing parameters like panicle length, spikelets per panicle, panicle weight, and biological yield computed from the 1 m2 sample. Insect pest dynamics were determined by the numbering of insects (gundhi bug, other bugs, and beneficial insect) up to two times in 15-day intervals during the milking and soft dough stage. Recorded data were subjected to analysis of variance using R analytics software and mean separation was done by Duncan's multiple range test.

3. Result And Discussion

3.1 Effect of sowing dates on growth and phenological parameters of spring rice cultivars

3.1.1 Plant height

Plant height was significantly influenced by varieties at 60, 90, and 120 DAS. The mean plant height varied from 33.35 cm (60 DAS) to 59.18 cm (90 DAS) to 79.83 (120 DAS). Plant height was observed maximum on Chaite-5 i.e., 38.26 cm at 60 DAS, 68.11 at 90 DAS & 98.70 at 120 DAS. And, minimum height was observed in Black Fine (26.19 cm) at 60 DAS, (47.27 cm) at 90 DAS, and (56.72 cm) in Black Coarse at 120 DAS. The results revealed that the sowing dates also significantly affected plant height where late sowing is superior in all these (40. 27 cm at 60 DAS and 67.78 cm at 90 DAS). And the plant height was observed less in early sowing i.e., 23.18 cm at 60 DAS and 48.22 cm at 90 DAS. Taller plants in late sowing could be due to a favorable environment i.e., during the seedling stage, late sowing seedlings didn't face cold stress as much as early sowing. No of the genotype, rice plants sown on April 15th were the tallest, while those sown on May 15th were the smallest. This may be related to the lengthier vegetative development period, which contributed to the height enhancement. Due to the delayed planting, the duration of the rice plant's vegetative period gradually decreased, resulting in a small plant height (Osman, 2019).

Table 1: Effect of sowing date and varieties on plant height at different crop growth stages

Sowing (a)	Plant Height 30 DAS	Plant Height 60 DAS	Plant Height 90 DAS	Plant Height 120 DAS
S1	12.62±0.99[a]	23.18±0.93[b]	48.22±2.23[c]	77.52±4.38[a]
S2	9.97±0.66[a]	36.61±1.58[a]	61.55±3.03[b]	79.54±4.24[a]
S3	11.84±0.98[a]	40.27±2.26[a]	67.78±4.59[a]	82.44±6.15[a]
LSD (p=0.05)	9.48	4.89**	6.20**	6.54
SEM				
Cultivar (b)				
Hardinath-1	11.55±1.02[a]	35.56±2.98[b]	67.36±5.04[a]	89.08±1.71[b]
Black Coarse	11.79±1.00[a]	33.41±3.21[b]	53.99±1.32[b]	56.72±1.47[d]
Chaite-5	10.90±1.25[a]	38.26±3.20[a]	68.11±4.48[a]	98.70±2.74[a]
Black Fine	11.68±1.14[a]	26.19±1.71[c]	47.27±3.34[c]	74.84±1.39[c]
LSD (p=0.05)	1.62	2.49***	5.82***	3.92***
CV (%)				
CV (a)	72.90	13	9.2	7.2
CV (b)	10.80	7.6	9.9	5
Grand Mean	11.48	33.35	59.18	79.83

In a column, figures having the common letter(s) do not differ significantly as per LSD; SEM= Standard error of mean * Significant at 0.05 level of significance; ** Significant at 0.01 level of significance; *** Significance at 0.001 level of significance.

3.1.2 Plant height (Interaction)

It was observed that Chaite-5 variety and late sowing date were recorded significantly greater plant height at 60 (48.66cm), 90 (83.30cm) and 120 DAS (108.9cm) in sowing and variety interaction. But also, it was recorded that early sowing dates and Chaite-5 were found greater height. A group researchers noted that when examined through the interaction of variety and transplanting dates, the plant height of different genotypes of fine rice was considerably impacted (Safdar et al., 2008). In contrast to all other treatment combinations, the fine grain rice genotype 99521 had the highest plant height (195 cm) on the 16th of June. When Super basmati was transplanted on May 16, the shortest plant height was noted.

Table 2: Effects of Interactions in plant height at different crop growth stages.

Sowing × Cultivar	Plant height 60 DAS	Plant height 60 DAS	Plant height 60 DAS
S1			
Hardinath-1	24.32^{de}	49.55^{ef}	87.74^{c}
Black Coarse	21.20^{e}	52.57^{def}	55.94^{e}
Chaite-5	26.85^{cd}	52.71^{def}	92.38^{bc}
Black Fine	20.37^{c}	38.04^{g}	74.03^{d}
S2			
Hardinath-1	40.98^{b}	72.88^{b}	87.16^{c}
Black Coarse	37.72^{b}	56.48^{d}	58.99^{e}
Chaite-5	39.28^{b}	68.34^{c}	94.75^{b}
Black Fine	29.74^{c}	48.52^{f}	77.26^{b}
S3			
Hardinath-1	41.38^{b}	79.65^{a}	92.33^{bc}
Black Coarse	41.32^{b}	52.92^{de}	55.24^{e}
Chaite-5	48.66^{a}	83.30^{a}	108.9^{a}
Black Fine	29.74^{c}	55.25^{d}	73.24^{d}
LSD (p=0.05)	4.32**	4.32**	6.80**
CV (%)	7.6	9.9	5.5

In a column, figures having the common letter(s) do not differ significantly as per LSD; SEM= Standard error of mean * Significant at 0.05 level of significance; ** Significant at 0.01 level of significance; *** Significance at 0.001 level of significance.

3.1.3 Number of leaves

The number of leaves was significantly influenced by sowing dates at 60 and 90 DAS. It was found higher in late sowing i.e., (29.33) at 60 DAS, and mid sowing i.e., (64.08) at 90 DAS. In the case of variety, higher number of leaves were recorded (23.62) in Hardinath-1 and lowest in Chaite-5 (17.15) at 60 DAS. But at 90 DAS number of leaves was recorded higher in Black Fine (59.77) followed by Hardinath-1 (52.55) and found lowest in Black Coarse (42.66). The rice crop planted on June 25 had considerably more leaves at 60 DAS than the crops planted on June 5, 10, or 15 (Dixit et al., 2004). In terms of how varied sowing dates affected the crop, the earliest planting on July 3 resulted in much higher growth characteristics than the sowing of crop on the latter dates. There were 48.39 leaves per plant. However, the 13th July planting date lowered these values nearly significantly, resulting in 46.84 leaves per plant (Tiwari et al., 2018).

Table 3: Effect of sowing date and varieties the on no. of leaves at different crop growth stages

Sowing (a)	Number of leaves 30 DAS	Number of leaves 60 DAS	Number of leaves 90 DAS
S1	2.45±0.10^{a}	8.98±0.63^{c}	43.33±4.13^{b}
S2	2.06±0.04^{a}	19.85±1.89^{b}	64.08±4.32^{a}
S3	2.22±0.10^{a}	29.33±2.32^{a}	42.75±3.71^{b}
LSD (p=0.05)	0.84	4.22***	16.42*
Cultivar (b)			
Hardinath-1	2.16±0.07^{a}	23.62±4.89^{a}	52.55±6.21^{ab}
Black Coarse	2.27±0.12^{a}	18.02±2.77^{b}	42.66±4.28^{b}
Chaite-5	2.25±0.12^{a}	17.15±2.01^{b}	45.22±3.97^{b}
Black Fine	2.30±0.15^{a}	18.75±3.60^{ab}	59.77±6.71^{a}
LSD (p=0.05)	0.18	5.21	11.60*
CV (%)			
CV (a)	33.3	19.2	28.9
CV (b)	8.1	27.2	23.4
Grand Mean	2.25	19.38	50.05

In a column, figures having the common letter(s) do not differ significantly as per LSD; SEM= Standard error of mean * Significant at 0.05 level of significance; ** Significant at 0.01 level of significance; *** Significance at 0.001 level of significance.

3.1.4 Tillering behavior

The number of tillers/m^2 was significantly influenced by different sowing dates at 60 DAS and was found to be superior in late sowing i.e. (295). That could be due to late sowing date gets better environment during seedling stage for their growth. The variety was also significant influenced by the no. of tillers. It was recorded higher in Hardinath-1(253.33) in 60 DAS, Black Fine (453.33) at 90 DAS. Highest number of effective tillers/m2 was observed in Black Coarse (590) at 120 DAS due to nutrient distribution effects in black coarse variety i.e., pest infestation during the milking phase so, nutrient transfers into tiller emergence. Low tillers per hill were noticed in the early sowing date (April 1st) and tillers increased successively with the advancement of the sowing date until May 1st and again declined thereafter (Osman, 2019). In a field experiment on the hybrid rice variety "PA 6201, early planting on July 16 produced the most total and productive tillers per clump compared to planting on July 31 and August 16 (Nayak et al., 2003). Planting was delayed by one month starting on July 16th, which resulted in a 38% reduction in total tillers. Varietal traits may be the cause of the variation in tiller production among cultivars (Chandrashekhar et al., 2001). The nursery's 29th June planting produced a noticeably larger number of tillers than the nursery's 13th July sowing (Prabhakar and Reddy, 2010).

Table 4: Effect of sowing date and varieties on tillers per m. sq. at different crop growth stages			
Sowing (a)	**Tillers per m.sq. 60 DAS**	**Tillers per m.sq. 90 DAS**	**Effective tillers per m.sq. 120 DAS**
S1	102.5±8.62[c]	362.5±16.70[a]	387.5±38.81[a]
S2	227.5±20.04[b]	447.5±29.18[a]	405.0±50.83[a]
S3	295.0±23.60[a]	385.0±31.51[a]	375.0±40.53[a]
LSD (p=0.05)	43.16***	94.57	123.51
Cultivar (b)			
Hardinath-1	253.33±50.02[a]	406.66±28.33[ab]	386.66±25.71[b]
Black Coarse	203.33±25.38[b]	400.00±30.82[ab]	590.00±41.83[a]
Chaite-5	186.66±21.08[b]	333.33±15.36[b]	270.00±13.22[c]
Black Fine	190.00±33.54[b]	453.33±40.44[a]	310.00±20.00[c]
LSD (p=0.05)	48.77*	74.77*	75.53***
CV (%)			
CV (a)	18.3	20.9	28
CV (b)	23.6	19	19.6
Grand Mean	208.33	398.33	389.16

In a column, figures having the common letter(s) do not differ significantly as per LSD; SEM= Standard error of mean * Significant at 0.05 level of significance; ** Significant at 0.01 level of significance; *** Significance at 0.001 level of significance.

3.1.5 Days to flowering and maturity

Early sowing dates and cultivars Chaite-5 and Black Fine had a longer duration for flowering and maturity i.e., 119.58 and 119.44 days respectively. Late sowing date & Black Coarse variety had a shorter duration for flowering i.e., 99.25 and 92.66 days respectively. The delay in transplanting had a considerable impact on the days to 50% and 100% blooming. A maximum number of days were needed for transplanting on June 30 and a difference of 7–10 days was seen between June 30 and July 28 and August 4 planting for the occurrence of 50% and 100% blooming (Chopra et al., 2006). Results of field testing in China's Wuling Mountain region showed that later sowing dates caused a delay in the heading and differentiation dates of immature panicles (Xie et al., 1995).

Table 5: Effect of sowing date and varieties on days to flowering & maturity	
Sowing (a)	**Days to Flowering**
S1	119.58±3.34[a]
S2	110.33±3.50[b]
S3	99.25±4.21[c]
LSD (p=0.05)	5.19**
Cultivar (b)	
Hardinath-1	107.33±2.78[b]
Black Coarse	92.66±4.39[c]
Chaite-5	119.44±2.45[a]
Black Fine	119.44±4.05[a]
LSD (p=0.05)	5.52***
CV (%)	
CV (a)	4.2
CV (b)	5.1
Grand Mean	109.72

In a column, figures having the common letter(s) do not differ significantly as per LSD; SEM= Standard error of mean * Significant at 0.05 level of significance; ** Significant at 0.01 level of significance; *** Significance at 0.001 level of significance.

3.2 Effect of sowing dates on yield and yield attributing parameters of spring rice cultivars

3.2.1 Panicle length

The length of panicle wasn't significantly affected by sowing date. The maximum panicle length was observed in late sowing (20.88 m) and minimum was observed in early sowing (18.91cm). In case of variety length of panicle was recorded higher in Chaite-5 (22.12) variety followed by Black Fine (21.48) and Hardinath-1 (21.01) and least in Black Coarse (14.49). There is also revealed that panicle length showed a positive correlation (0.8158) with biological yield that increase in panicle length increases biological yield. The sowing dates and cultivars both had a sizable impact on the panicle length. The crop sown on June 28 had much longer panicles (22.95 cm) than the crops sown on May 29 and July 13 (20.84 and 19.52 cm, respectively), but they were statistically comparable to the crop sown on June 13. (22.76cm). Varieties varied greatly in terms of panniculus length. While statistically at par with Ram, Hardinath-1's longer panicle (23.00 cm) was much longer than Sabitri's (18.86 cm) (21.93 cm). Statistics-wise, the latter two were comparable. Variety and sowing date interactions had no discernible impact on panicle length. Variable planting dates for Hardinath-1 often resulted in longer panicles, but different sowing dates for Sabitri generally resulted in shorter panicles. After the sowing on June 13, there may have been fewer filled grains per panicle due to the timing of the grain filling stage with low temperature, which increased grain sterility and reduced the proportion of filled grains (Dawadi and Chaudhary, 2013).

3.2.2 Weight per panicle

The weight per panicle wasn't significantly influenced by sowing dates in all sowing dates but was recorded higher late sowing date followed by early and mid-sowing. In the case of variety weight per panicle was recorded higher in Black Fine (0.67g) followed by Chaite -5 (0.65g) and lower in Black Coarse (0.23g). It is also revealed that panicle length showed a positive correlation (0.6741) with biological yield that increase in weight per panicle increases biological yield. Even though sowing dates had little to no impact on panicle weight, standard planting produced somewhat heavier panicles (3.5g) than delayed sowing (3.3g) (Janardhan et al., 1980).

3.2.3 Spikelet per panicle

The number of spikelets per panicle was not significantly affected by sowing dates. However, the highest number of spikelets per panicle was obtained in late sowing (129) and lowest in early sowing (86). The number of spikelets per panicle was significantly affected by variety where Chaite-5 (148.66) had the highest no. of spikelets per panicle and Black Coarse (38.77) had the lowest no. of spikelet per panicle which is due to the varietal characters. The spikelet per panicle showed a positive correlation

(0.8147) with biological yield which indicated that higher spikelet per panicle produce higher biological yield. Different sowing dates have a substantial impact on the number of kernels per panicle. The 20th June sowing produced the most kernels (84.90), but the 20th July sowing produced the least (46.57) per panicle. The number of kernels per panicle produced by the 10th June and 31st May seedings was statistically identical, as were the 10th July and 30th June plantings. In comparison to early sowing of the main season rice, late sowing caused the plant's growth phase to be shortened, which decreased the plant's leaf area, panicle length, and number of kernels per panicle (Bashir et al., 2010).

3.2.4 Biological yield

The biological yield was significantly influenced by sowing dates i.e., observed higher in late sowing (10.92 t/ha) and lower in early sowing (8.53 t/ha). Variety had a significant effect on biological yield where Chaite-5 (14.28 t/ha) had the highest yield and Black Coarse (4.82 t/ha) had the lowest yield. It was also revealed that the biological yield showed a positive significant correlation with, panicle length, weight per panicle and spikelet per panicle. The ideal time to sow is early if critical qualities like panicle length and panicle quantity m-2 are concerned (Khalifa, 2009). From a field experiment on the impact of planting time (15 June, 30 June, and 15 July) on yield and yield characteristics of rice cv. in Akola, Maharashtra during Kharif. According to reports, the 15 June planting produced a yield of 6302 kg/ha (Mahikar et al., 2001). The biomass output was higher with the crop seeded on July 30th than it was with the crop sowed on August 13th, and it was comparable to the other sowing dates (Prabhakar and Reddy, 2010). The sowing dates and types had a considerable impact on the production of straw (t ha-1). The June 13 planting produced the largest yield of straw (6.85 t ha-1), which was much higher than the yields of June 28, May 29, and July 13 (Dawadi and Chaudary, 2013).

Table 6: Effect of sowing date and varieties on, panicle length, weight per panicle, spikelet per panicle, biological yield.

Sowing (a)	Panicle length	Weight per panicle	Spikelet per panicle	Biological yield
S1	18.91 ± 0.74^{b}	0.51 ± 0.04^{ab}	86.00 ± 8.97^{b}	8.53 ± 0.87^{b}
S2	19.53 ± 0.98^{ab}	0.41 ± 0.05^{b}	97.25 ± 15.64^{ab}	10.19 ± 1.12^{a}
S3	20.88 ± 1.37^{a}	0.61 ± 0.09^{a}	129.00 ± 23.09^{a}	10.92 ± 1.50^{a}
LSD (p=0.05)	1.78	0.16	38.04	1.32*
Cultivar (b)				
Hardinath-1	21.01 ± 0.48^{a}	0.50 ± 0.04^{b}	96.88 ± 11.70^{b}	9.74 ± 0.59^{b}
Black Coarse	14.49 ± 0.43^{b}	0.23 ± 0.02^{c}	38.77 ± 3.66^{c}	4.82 ± 0.41^{c}
Chaite-5	22.12 ± 1.01^{a}	0.65 ± 0.09^{a}	148.66 ± 23.62^{a}	14.28 ± 1.2^{a}
Black Fine	21.48 ± 0.63^{a}	0.67 ± 0.03^{a}	132.00 ± 12.07^{a}	10.70 ± 0.81^{b}
LSD (p=0.05)	1.51***	0.11***	32.10***	1.97***
CV (%)				
CV (a)	8	27.3	32.2	11.8
CV (b)	7.7	23	31.1	20.2
Grand Mean	19.77	0.51	104.08	9.88

In a column, figures having the common letter(s) do not differ significantly as per LSD; SEM= Standard error of mean * Significant at 0.05 level of significance; ** Significant at 0.01 level of significance; *** Significance at 0.001 level of significance.

Yield and yield attributing parameters had influenced by sowing date and variety interaction, panicle length (25.81cm), weight per panicle (0.93g), spikelet per panicle (233.33), and biological yield (17.79 t/ha) was observed significantly higher in Chiate-5 variety at late sowing.

3.2.5 Yield and yield attributing parameters (Interaction)

Table 7: Effects of interaction on yield and yield attributing parameters

Sowing × Cultivar	Panicle length	Weight per panicle	Spikelet per panicle	Biological yield
S1				
Hardinath-1	20.79^{abc}	0.59^{a}	89.66^{e}	8.22^{bcd}
Black Coarse	15.19^{bcd}	0.26^{a}	43.33^{g}	4.82^{cd}
Chaite-5	19.64^{abcd}	0.57^{a}	92.00^{e}	10.08^{bcd}
Black Fine	20.02^{abcd}	0.62^{a}	119.00^{d}	11.00^{abcd}
S2				
Hardinath-1	20.40^{abcd}	0.38^{a}	79.00^{f}	9.44^{bcd}
Black Coarse	14.68^{cd}	0.22^{a}	41.00^{g}	5.17^{cd}
Chaite-5	20.91^{abc}	0.46^{a}	120.66^{d}	14.96^{ab}
Black Fine	22.15^{a}	0.59^{a}	148.33^{b}	11.22^{abcd}
S3				
Hardinath-1	21.85^{ab}	0.54^{a}	122.00^{cd}	11.55^{abc}
Black Coarse	13.61^{d}	0.20^{a}	32.00^{h}	4.46^{d}
Chaite-5	25.81^{a}	0.93^{a}	233.33^{a}	17.79^{a}
Black Fine	22.26^{a}	0.78^{a}	128.66^{c}	9.88^{bcd}
LSD (p=0.05)	2.61**	0.20*	55.61**	3.42*
CV(%)	7.7	23	31.1	20.2

In a column, figures having the common letter(s) do not differ significantly as per LSD; SEM= Standard error of mean * Significant at 0.05 level of significance; ** Significant at 0.01 level of significance; *** Significance at 0.001 level of significance.

3.3 Effects of sowing dates on insect pest dynamics on spring rice cultivars

Gundhi bug, Other bug (Green sting bugs), and beneficial insects weren't significantly influenced by sowing dates. Although Gundhi bug (68.50) was recorded higher in mid-sowing and beneficial insect (15.50) in late sowing date. In the case of variety, Gundhi bug was recorded higher in Chaite-5 (96.55) due to its longer height and panicle length and was found lower in Black Coarse (33.66). Other bugs were recorded significantly higher in Hardinath-1 (10.11) and lower in Black Coarse (2.33). But beneficial insects haven't differed among varieties during the period.

Table 8: Effect of sowing date and varieties on insect pest dynamics (Gundhi bug, Other bugs and Beneficial Insect)

Sowing (a)	Gundhi bug	Other bug	Beneficial insect
S1	54.50±8.08[a]	5.91±1.69[a]	12.66±1.49[a]
S2	68.50±12.17[a]	3.50±1.06[a]	11.58±1.46[a]
S3	61.25±17.10[a]	4.41±1.32[a]	15.50±2.31[a]
LSD (p=0.05)	38.81	5.67	7.07
Cultivar (b)			
Hardinath-1	54.66±5.15[b]	10.11±1.93[a]	10.77±1.64[a]
Black Coarse	33.66±4.71[b]	2.33±0.57[b]	13.44±1.41[a]
Chaite-5	96.55±18.44[a]	2.88±0.82[b]	13.55±2.13[a]
Black Fine	60.77±17.29[ab]	3.11±1.09[b]	15.22±2.95[a]
LSD (p=0.05)	36.85*	3.03***	6.09
CV (%)			
CV (a)	55.8	108.5	47.10
CV (b)	60.6	66.5	46.40
Grand Mean	61.41	4.61	13.25

In a column, figures having the common letter(s) do not differ significantly as per LSD; SEM= Standard error of mean * Significant at 0.05 level of significance; ** Significant at 0.01 level of significance; *** Significance at 0.001 level of significance.

4. Conclusion

The performance of spring rice cultivars against different sowing dates was studied in the western terai of Nepal. Plant height was recorded higher on the late sowing in the Chaite-5 cultivar at 60, 90, and 120 DAS. The number of leaves was recorded higher on mid-sowing in the Black Fine cultivar at 90 DAS. The number of tillers wasn't significantly different among the sowing dates however, a significantly higher value was recorded in Hardinath-1 at 60 DAS, Black Fine at 90 DAS, and Black coarse at 120 DAS. Early sowing dates and cultivars Chaite-5 and Black Fine had a longer duration for flowering and maturity. The yield and yield attributing parameters (panicle length, weight per panicle, spikelet per panicle, and biological yield) were recorded higher in late sowing in the Chaite-5 cultivar. Therefore, these results conclude that there was better performance in terms of growth, yield, and yield attributing parameters, and also interaction in Chaite-5 on late sowing conditions (March 1). However, due to the occurrence of biotic stress like insect and bird pest infestation in the ripening period of spring rice in June, primarily in the milking stage, grain filling was not observed. So, we couldn't come to a concrete conclusion about suitable cultivars in the spring season. To reach a clear conclusion and make additional recommendations regarding the performance of spring rice under western terai conditions, future research and policy formulation about spring rice should emphasize the management of insect and bird pests.

Data Availability Statement

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Ethics Statement

The manuscripts present the research do not require ethical approval.

Authors Contributions

Prakash Ghimire proposed and initiated the experiment and supervised it throughout the research project. Mahesh Kumar Bhandari performed data processing and analysis, reviewing different articles, and referencing and shaping the main document. Nawa Raj Regmi helped in the data analysis, review, and editing process. Prakriti Ghimire performed data entry and Bipin Panthi was charged for the overall editing of articles. All authors are involved equally in the field of data collection and management.

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Conflict Of Interest

The author declares that they have no conflict of interest.

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