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Research Article

Effect of sowing dates on different rapeseed varieties under rain fed condition

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ABSTRACT

Rapeseed is a leading oilseed crop of Nepal occupying 85% of total oilseed cultivation area. This research was conducted to determine the response of different sowing dates on different rapeseed varieties in their final yield under the rain fed condition in Phulbari, Dang. Two rapeseed varieties Unnati and Surkhet Local on three dates of sowing Oct 4, Oct 24 and Nov 14 were tested under two factorial RCBD design in the year 2018 A.D. Data consisted growth attributes like plant height, branch per plant, no. of siliqua per plant, aborted siliqua and siliqua abortion percentage and yield attributes such as biological yield, biomass yield, seed yield, harvest index and test weight. Statistically no difference was found between varieties whereas differences were found on different sowing dates. Result showed that among the varieties, the highest yield (8.59 q/ha) was obtained in Surkhet Local than in Unnati (8.54 q/ha). In case of sowing dates, higher seed yield was obtained in Oct 4 sown crop (15.93 q/ha) followed by Oct 24 (7.47 q/ha) and Nov 14 (2.29 q/ha).The higher seed yield obtained in early sowing is due to shorter vegetative and longer reproductive phase. The comparison of mean values of the seed yield for interaction between variety and sowing date showed that variety Surkhet Local sown in Oct 4 plant had the highest seed yield (16.33 q/ha) followed by variety Unnati on same sowing date (15.54 q/ha). Based on the result obtained, Surkhet Local*Oct 4 performed better in Dang condition.
Keywords: *Brassica campestris* var. *toria*; Variety; Sowing date; Rain fed

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INTRODUCTION

Rapeseed or oilseed rape is one member of the Brassicaceae family. This is a family of plants which has provided mankind with a significant and highly important range of crops, including cabbage and cauliflower (*Brassica oleracea*) and varieties of mustard (*Brassica* - various species). The family also includes turnip, the Latin name of which is *Brassica rapa,* and it is from the species name of turnip - 'rapa' - that the very closely related species *Brassica napus* receives its curious common name of rape, a name which was first employed in the 14th century and was later applied to all those plants from the family which were primarily grown for the extraction of vegetable oils (as opposed to those grown primarily for the consumption of roots

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or leaves). In Nepal, the most cultivated rapeseed is *Brassica campestris* var.*toria* which is called as *'tori'* in Nepalese language.The origins of rapeseed - *B. napus* - are uncertain, partly because of the close relationships and propensity for hybridizations between the different species of Brassica, but also because naming distinctions were not entirely clear until comparatively recent times. The wild form of *B. napus* has not been discovered, and it is possible that it is a natural hybrid between *Brassica oleracea* (cabbage) and *B. rapa* (turnip). Even in recent decades, selective breeding of new cultivars have involved hybridizations with several other species in addition to B. napus. But whatever the truth of its botanical history, geographically rapeseed would seem to be a plant originally from southern Europe. Globally, Canada is the largest rapeseed producing country. The statistics shows, in the year 2017/18, the production of rapeseed in Canada is 21.5 MMT (FAOSTAT, 2019). Accordingly, the productions of some leading countries in rapeseed with their production are China 14.4 MMT, India 5.85MMT and USA 1.65 MMT (FAOSTAT, 2019). In Europe, the European Union production of rapeseed is 22.13 MMT(FAOSTAT, 2019).

Oilseed is one of the important cash crops of Nepal, which occupied 2,13,706 ha area, with production of 1,76,186 mt and productivity of 0.82 MT/ha in 2010/2011, where as in 2011/2012, area increased to 2,14,835 ha, with production of 179145 MT and productivity of 0.83 MT/ha (MoAC, 2012).Rapeseed (*Brassica campestris*L. var. *toria*) alone occupies about 85% of the total oilseed area in the country and it is a dominant winter season oilseed crop(Basnet,2005). Other oilseed crops grown in the country are soybean, sunflower, sesame, groundnut, castor, linseed, and niger. Nepal's conventional oil crop is rapeseed-mustard which is grown in 1,65,560 ha of land with total production of 98,130 mt. On an average, 38% oil recovery is obtained although this rate is low due to inefficient oil mills in rural areas and losses during milling (Bhandari, 2015). Recently, the area of oilseed cultivation in Nepal is 207978 ha with the production of 214451 MT and yield is 1031 kg/ha (MOADSTAT,2016). Among which, rapeseed is cultivated in the area of 160405 ha with the production and yield of 159710 MT and 996 kg/ha respectively (MOADSTAT, 2016). It is mostly grown after monsoon maize in upland and after early rice in lowland of Terai, inner Terai and mid-hills (Ghimire *et al.*, 2000). In Dang district, the rapeseed production area is 17,500 ha, with the production of 18,350 MT and yield 1,049 kg/ha (MOADSTAT,2016). This crop is important from income generation point of view and is prominent sources of fats, protein and vitamins as compared to cereals and legumes in Nepalese diet (Chaudhary *et al.*, 1993). Its seeds contain 40-45% oil and 20-25% protein(Hasanuzzaman *et al.*, 2008). Similarly, 4.8% nitrogen, 2% phosphorus and 1.3% potash can be obtained from mustard oil cake(Prasai and Yadhav, 1999). Rapeseed is a cross-pollinated crop. It requires sufficient pollinating agents for better pollination and seed production. The flowers of rapeseed are very attractive to bees. Honeybees visit rapeseed flowers for collection of both pollen and nectar, which in turn results into florets cross-pollination. Honeybees are naturally important pollinators of plants throughout their natural range.

The productivity of rapeseed in Nepal is considerably lower as compared to the world productivity. There are several factors responsible for the low productivity of rapeseed (Bhatta *et al.*, 2019). Fink *et al.*, (2006) stated that sowing date is one of the most important production decisions. Either early planting or late planting can result in lower yield because the probability exists that unfavorable climatic conditions can occur after planting or during the growing season.Therefore, determination of sowing dates for maize genotypes is very crucial for better crop yield (BK et al., 2015).Crop cultivars show distinctive variation in response pattern among

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them related to planting date (Shrestha et al., 2018). Timely sowing of rapeseed has proven a key to maximize yield potential and by default reduce risk. With the delay in sowing date, all the investigated traits declined (Baghdadi *et al.*,2012).Too early or too late sowing of rapeseed has been found to be unfavorable (Hocking and Stapper, 2001;Robertson *et al.*,2004; Uzun *et al.*,2009).The early sowing produced higher seed yield this may be due to the variation in temperature, or attributed to more light, water and mineral absorption by plant canopies thus,increasing photosynthetic capacity (Fathi *et al.*,2003).Determining suitable planting date plays an important role in conformation of plant growth stages with desirable environmental conditions which results in maximum yield. Planting date has a considerable effect on seed yield by influencing the yield components so that late planting decreases secondary branches/plant and pods/plant and finally causes a remarkable reduction in seed yield (Thurling, 1974).

MATERIALS AND METHODS

Plant materials and site description

Two different rapeseed varieties, viz. Surkhet Local and Unnati which are preferred by the farmers of this locality were selected. Varieties were searched among the available agro vets and agricultural cooperatives of this area. The experiment was carried out in the field of Campus of Live Sciences under Agronomy Department in Phulbari, Dang. Dang Deukhuri District is located in Inner Terai in Province No. 5 in Mid-western Nepal. The district, with Ghorahi as its headquarters, covers 2,955 km² and has a population of 5,48,141. The site lies within the tropical agro ecological belt, between latitude 28.1545° N and longitude 82.3235° E. It is 448.1 km west from Kathmandu, the capital of the country. This valley lies in between the Mahabharata range in the North and Chure hill in the South.

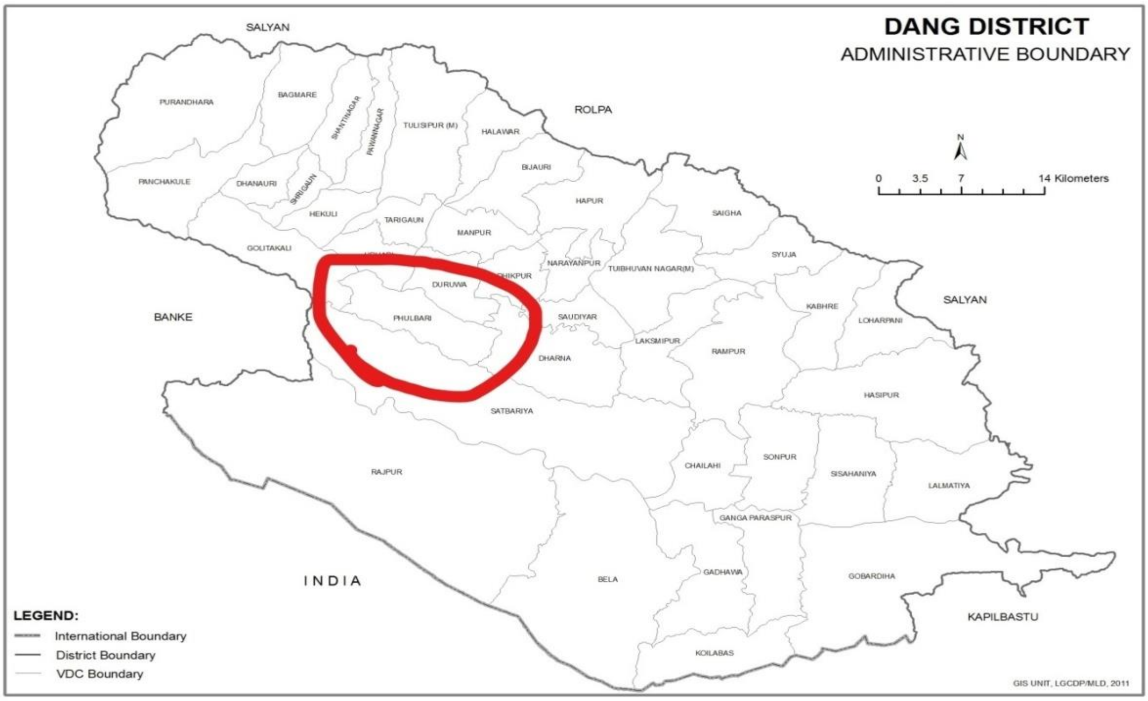

Figure1. Map of Dang district showing Phulbari village (inside red circle).

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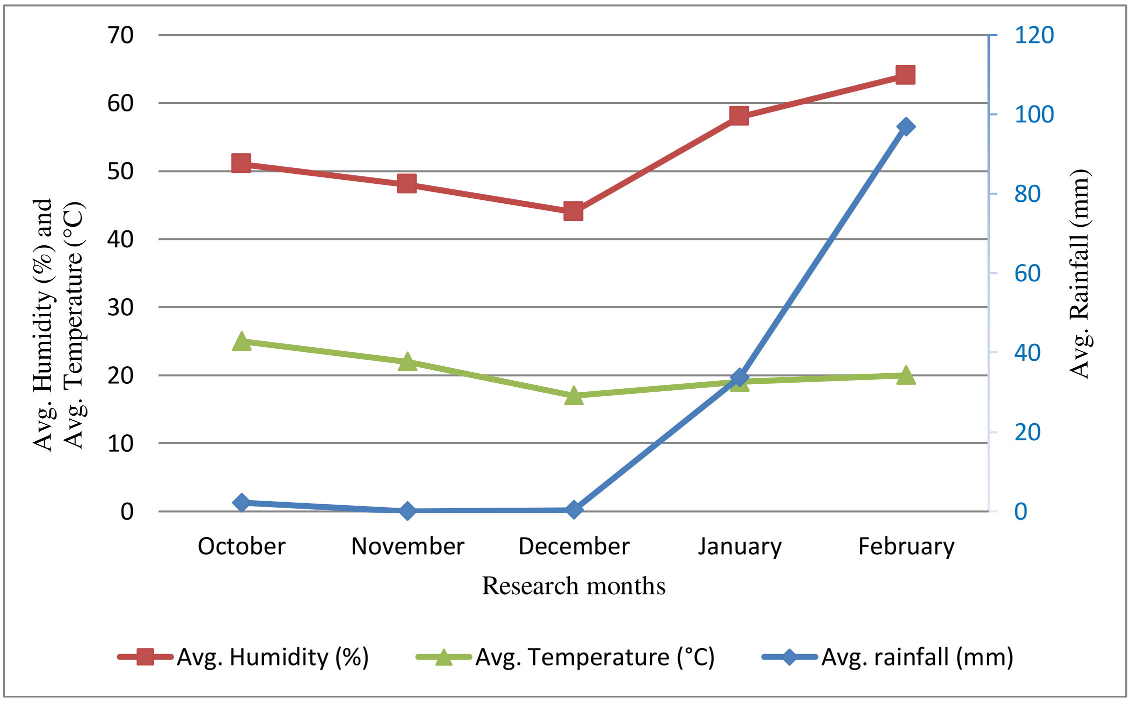
Climatic data

With an elevation ranged from 700 m to 1500 m, the research site has a humid, subtropical climate, warm in the winter and hot (often over 40^{0}C) in the summer. Average temperatures ranged from 8.08 °C (46.54 °F) in December-January (coldest months) to 34.91 °C (94.84 °F) in June. The weather parameters like average, maximum and minimum temperature (°C), rainfall (mm) and relative humidity (%) were recorded during the crop season of Oct 2018 to Feb 2019 (fig 2). The research site received a total of 133.09 mm of rainfall during the research period. Precipitation increased gradually from November (0 mm) to February (96.9 mm).The minimum temperature was recorded 13°C in December whereas maximum temperature was 32°C in October. The mean temperature during the research was 20.6°C. Relative humidity was recorded maximum during February (64%) and minimum (44%) during December.



Source: World Weather Online

Figure 2: Meteorological data for the cropping period 2018 to 2019.

Field experiments

Design of Experiment and treatment details

The experiment was laid out in two factor RCBD (Randomized Complete Block Design) with six treatments and each treatment was replicated four times, resulting a total of 24 plots. The two factors were varieties (Unnati and Surkhet Local) and sowing dates (Oct 4, Oct 24, and Nov 14).

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Factor A (variety):
V_1: Unnati **V_2**: Surkhet Local

Factor B (sowing dates):
D_1: Oct 4 **D_2**: Oct 24 **D_3**: Nov 14

Two different varieties of rapeseed were sown in three dates in the interval of 20 days. The treatment details can be summarized as follows:

T_1= Unnati * Oct 4 **T_2**= Unnati * Oct 24 **T_3**= Unnati * Nov 14
T_4= Surkhet Local * Oct 4 **T_5**= Surkhet Local * Oct 24 **T_6**= Surkhet Local * Nov 14

Field layout and randomization

Randomization of the above treatments was done by lottery method. The total number of plots laid out in the entire experiment was 24. Each plot was of 6 m^2 (3m * 2m).The space between two plots was 0.3 m and the space between replications was 0.5m.

Field preparation and sowing

Land was ploughed with the help of tractor followed by manual harrowing and planking. FYM 10 tons $ha^{-1}$and 60:40:20 kg ha^{-1} NPK was applied. Well decomposed FYM was applied to all the plots and well mixed to the field one week before sowing. The required amount of fertilizer (NPK) as basal dose was applied in each furrow and mixed well. In each plot, the dose of Urea (24.25 g $plot^{-1}$) was top dressed twice 30 DAS and during flowering stage and the basal dose of MOP (20g $plot^{-1}$) and DAP (52.176 g $plot^{-1}$) was applied. Line sowing was done in the respective hole made on each furrow after mixing the fertilizers in the recommended geometry of 30 x 10 cm. Five to six seed was dropped in the depth of 2-3 cm and covered lightly with the soil manually with the hand. As per the treatment requirement seed was sown on three different dates of Oct 4, Oct 24 and Nov 14.

Data collection and data analysis

The tabulation of data was done in Microsoft Excel2007. The mean value of data of different parameters were recorded in the study were analyzed by R- STAT version 3.0.3 in the computer software. Data were subjected to Analysis of Variance (ANOVA) to evaluate the significance of the treatment effect. Average means were compared using DMRT (Duncan's Multiple Range Test) at 5% level of significance. Mean comparison was carried out at $P < 0.01$, and $P < 0.05$ level of significance (Gomez & Gomez, 1984; Shrestha, 2019).

RESULTS AND DISCUSSION

Plant height

Date of sowing was found highly significant with the plant height while varieties and interaction between varieties and date of sowing were not. Among three dates of sowing, Oct 4 with mean 84.715 cm resulted as the highest plant height followed by Oct 24 with mean 60.325 cm whereas Nov 14 with mean 46.76 cm resulted the lowest plant height. Reason for the smaller plant height in the delayed dates of sowing may be due to the shorter time span for crop development and reduced air temperature as similar findings were obtained by Sharma, (1994);Thakur & Singh, (1998).

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Table 1:Effect of variety and sowing dates on plant height, branch per plant, siliqua per plant, seeds per siliqua, aborted siliqua, siliqua abortion % of rapeseed varieties during winter season, 2018/19.

Growth Attributes:

Treatment	Plant height (cm)	No. of Branch per plant	No. of Siliqua per plant	No. of aborted siliqua	Seeds per siliqua	Siliqua abortion %
Variety:						
Unnati	65.70	6.8	93.833	4.608	14.905	6.11
Surkhet Local	62.166	7.541	90.141	5.341	14.425	7.645
F-test	NS	NS	NS	NS	NS	NS
Date of sowing:						
Oct 4	84.715a	8.025	137.43a	2.85b	16.075[a]	2.18[c]
Oct 24	60.325b	5.4	73.837b	3.95b	15.403[a]	5.20[b]
Nov 14	46.762c	8.087	64.68b	8.12a	12.51[b]	13.24[a]
F-test	**	NS	**	**	**	**
Interaction	NS	NS	NS	NS	NS	NS
CV (%)	10.396	-	32.709	48.94	8.35	32.22
Grand mean	63.93	-	91.98	4.97	14.66	6.87
LSD	7.029	-	32.222	2.697	1.186	2.306

*Note: NS= Non-significant, *= Significant and **= Highly significant, CV= Coefficient of Variation,LSD= Least Significant Difference.*

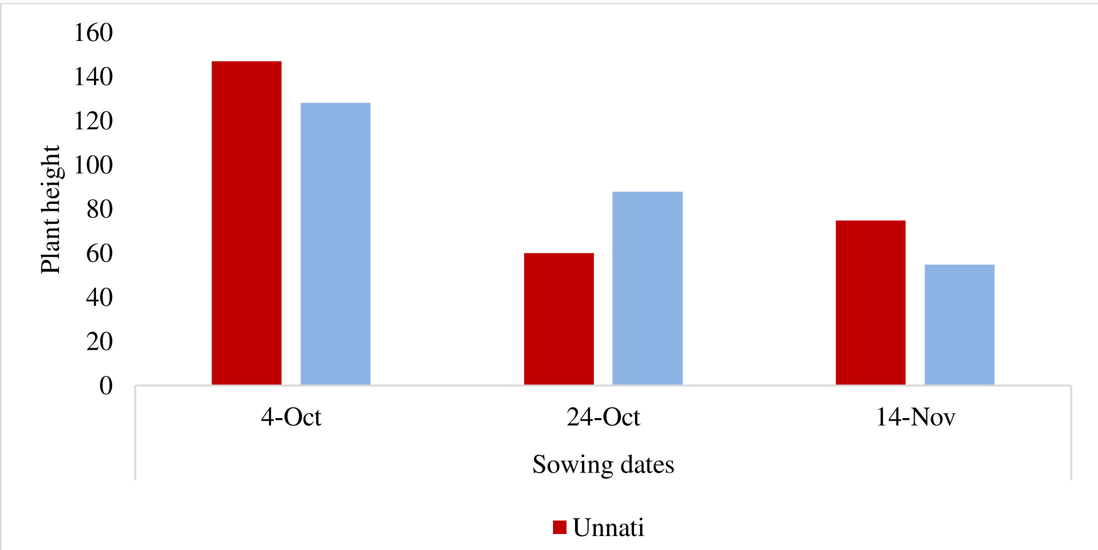

Figure 3. Effect of date of sowing on plant height.

Branch per plant

Date of sowing, varieties and their interaction did not show any significant result in branch per plant. The grand mean of branch per plant was 7.17. Maximum number of branches was found in Nov 14 (8.087) sown crop followed by Oct 4 (8.025) and lowest was found in Oct 24 (5.4) in case of sowing dates. But in case of variety, maximum branch per plant was found in Surkhet Local (7.541) followed by Unnati (6.8).

Siliqua per plant

The number of siliqua per plant is the most important component of the seed yield in rapeseed (Angadi *et al.*, 2003). It was significantly affected by different dates of sowing but was affected non-significantly by varieties and interaction of dates of sowing and varieties. Crop sown on

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October 4 recorded significantly higher number of siliqua per plant (137.437), Nov 14 (64.68) recorded the lowest no. of siliqua per plant which is at par with Oct 24 (73.83). Reason for more number of siliqua per plant in the earliest date of sowing (October 4) might be due to longer reproductive phase, suitable temperature and translocation of more photosynthates from source to sink than later dates of sowing.

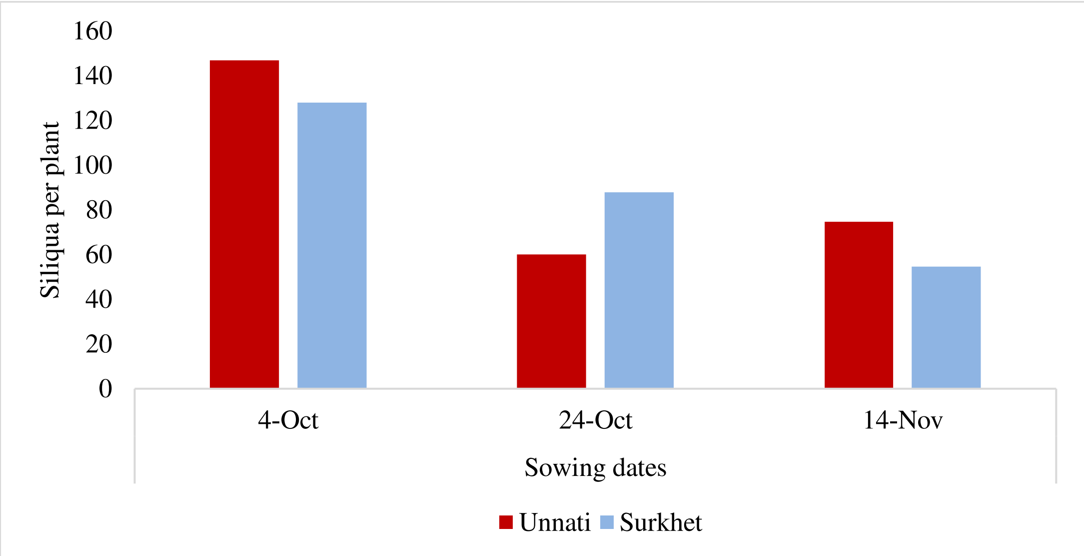

Figure 4. Relationship between siliqua per plant and treatments.

Seeds per siliqua

Among the three dates of sowing, crop sown on October4 produced the highest number of seeds per siliqua (16.08) followed by October 24 (15.4) and lowest with November 14 sowing (12.52)as reported by Andersson and Benglsson, (1989) and Sudeep *et al.*, (1996). Date of sowing was found highly significant but the differences were non-significant among the varieties and their interactions. Due to translocation of more photosynthates from source to sink, suitable temperature and longer reproductive phase are the major reasons behind the more numbers of siliqua per plant in the earliest sowing than later dates of sowing.

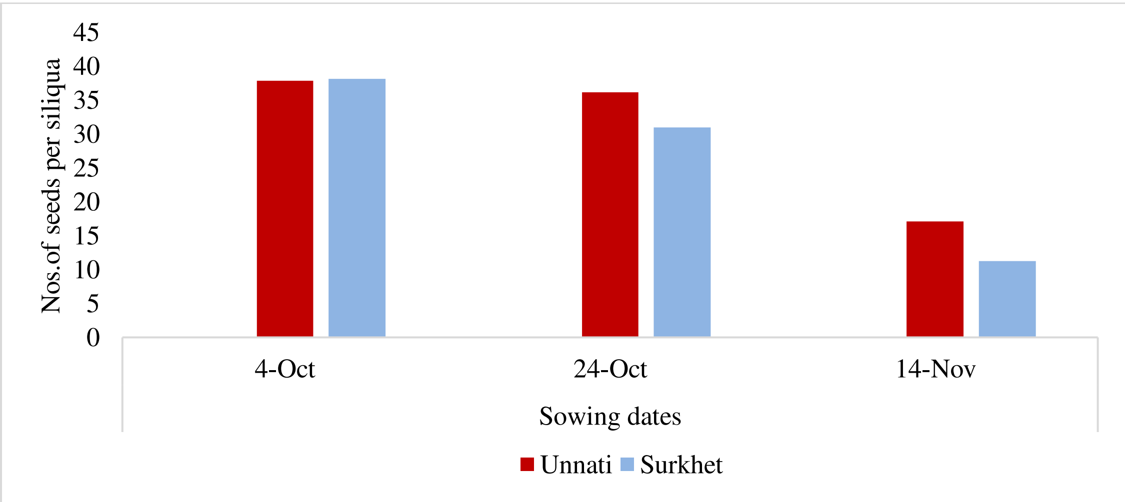

Figure 5. Relationship between varieties and date of sowing on seeds per siliqua

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Aborted siliqua

Abortion of siliqua was significantly affected by date of sowing but was not affected by variety and their interaction. Among the dates, the higher aborted siliqua was observed in delayed sowing than earlier two dates. The first date of sowing had 2.850 aborted siliqua which is at par with second date of sowing with 3.950 aborted siliqua whereas the delayed date had 8.125, which is also in agreement with the study of Alam *et al.*, (2014). The higher abortion of siliqua in delayed date might be due to severe fall in temperature and depleted soil residual moisture which hampered the fertilization process and nutritional translocation.

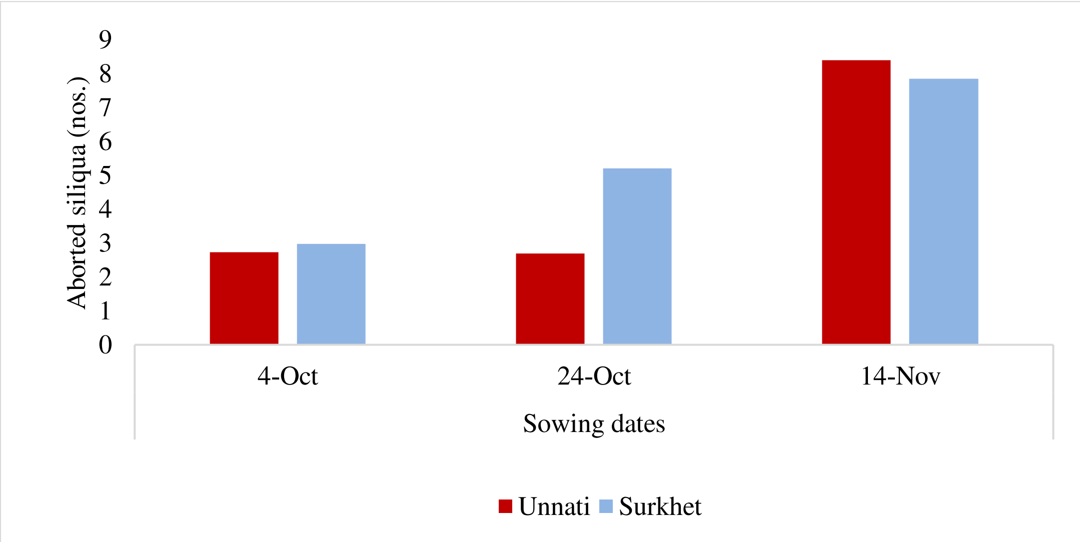

Figure 6. Relation between varieties and date of sowing on aborted seeds per siliqua

Siliqua abortion percentage

Difference among varieties and their interaction with sowing dates were non- significant but difference in date of sowing had found significant with siliqua abortion %. Among dates of sowing, highest siliqua abortion % was found on 14 Nov (13.246% sown crop followed by 24 Oct (5.206%) and the lowest on the date 4 Oct (2.183%).

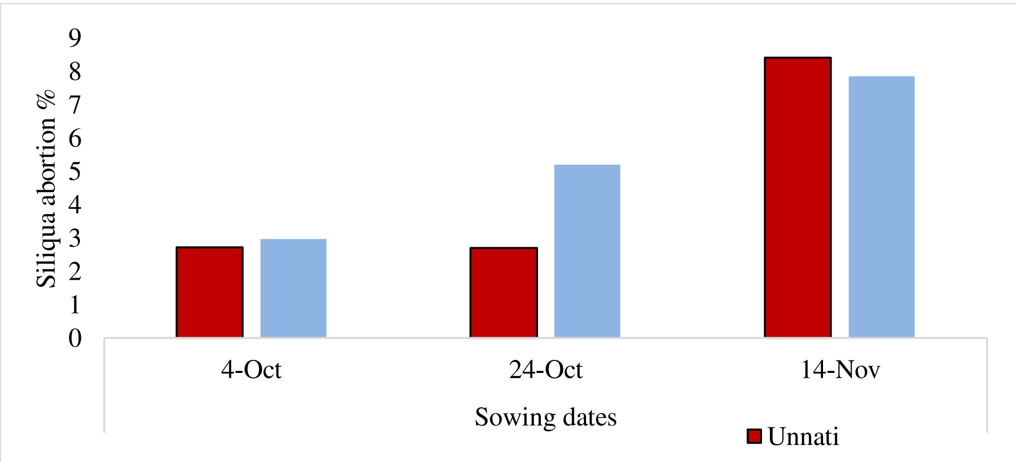

Figure 7. Siliqua abortion % among different treatments.

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Table 2:Effect of variety and sowing dates on biological yield, seed yield, biomass yield, Harvest index and test weight of rapeseed varieties during winter season, 2018/19.

Yield attributes:

Treatments	Biological yield (q/ha)	Seed yield (q/ha)	Biomass yield (q/ha)	Harvest index (%)	Test weight (gm)
Variety:					
Unnati	26.276	8.54	17.73	30.37[a]	2.91
Surkhet local	27.05	8.59	18.45	26.77[b]	2.70
F-test	NS	NS	NS	**	NS
Date of sowing:					
Oct 4	41.957[a]	15.939[a]	26.017[a]	37.978[a]	3.125[a]
Oct 24	22.374[b]	7.474[b]	14.899[b]	33.573[b]	3.162[a]
Nov 14	15.664[c]	2.295[c]	13.369[b]	14.17[c]	2.15[b]
F-test	**	**	**	**	**
Interaction	NS	NS	NS	**	NS
CV (%)	22.78	25.13	22.57	6.64	16.33
Grand mean	26.66	8.56	18.09	28.57	2.81
LSD	6.303	2.35	4.085	2.820	0.444

*Note: NS= Non-significant, *= Significant and **= Highly significant, CV= Coefficient of Variation, LSD= Least Significant Difference.*

Seed yield

Seed yield was found to be highly significant to dates of sowing whereas non-significant to varieties and interactions between them. The higher seed yield obtained on Oct 4 (15.93 q/ha) followed by seed yield on Oct 24 (7.47 q/ha) and the lowest yield on Nov 14(2.29 q/ha).Auld *et al.*, (1991);Mendham and Scott, (1975); Scarisbrick *et al.*, (1982);Taylor and Smith, (1992) and Thurling, (1974) also found a reduced rapeseed seed yield in delayed date of sowing. The higher seed yield obtained in early sowing is due to longer reproductive phase whereas shorter growth and shorter span of reproductive phase are the reason behind the reduced seed yield.

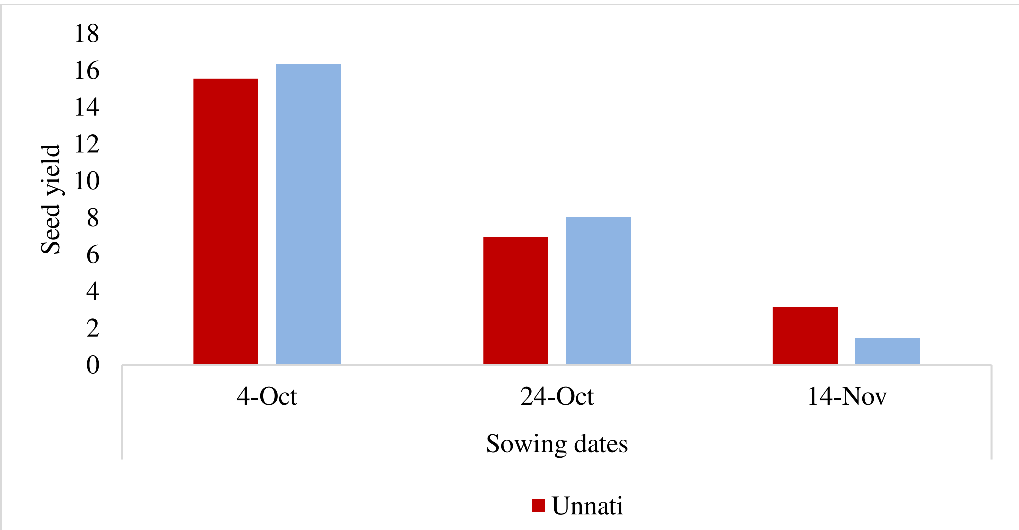

Figure 8. Effect of different treatments on seed yield (q/ha)

Biological yield and biomass yield

Biological yield was found significant with dates of sowing while it was found to be non-significant with both varieties and their interaction. The highest biological yield was found in

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Oct 4 (41.95 q/ha) followed by Oct 24 (22.37 q/ha) and the lowest was found in Nov 14(15.66 q/ha). As we know biological yield is combination of both biomass and seed yield. As assimilate transition efficiency to economical sinks (grains) is decreased, seed yield also decreased. The reduced vegetative growth, seed and stalk yield in later dates of sowing cause reduction of biomass yield on later sowing dates. Being reduction of biomass yield and seed yield, biological yield also reduced. The results were consistent with studiesof Rao & Mendham, (1991);Taylor & Smith, (1992) andWhitfield, (1992).The late planting of canola adversely affect the yield and yield components due to its adverse effect on growth, because the different growth stages canola acquired enough time for their development(Muhammad *et al.*, 2002).

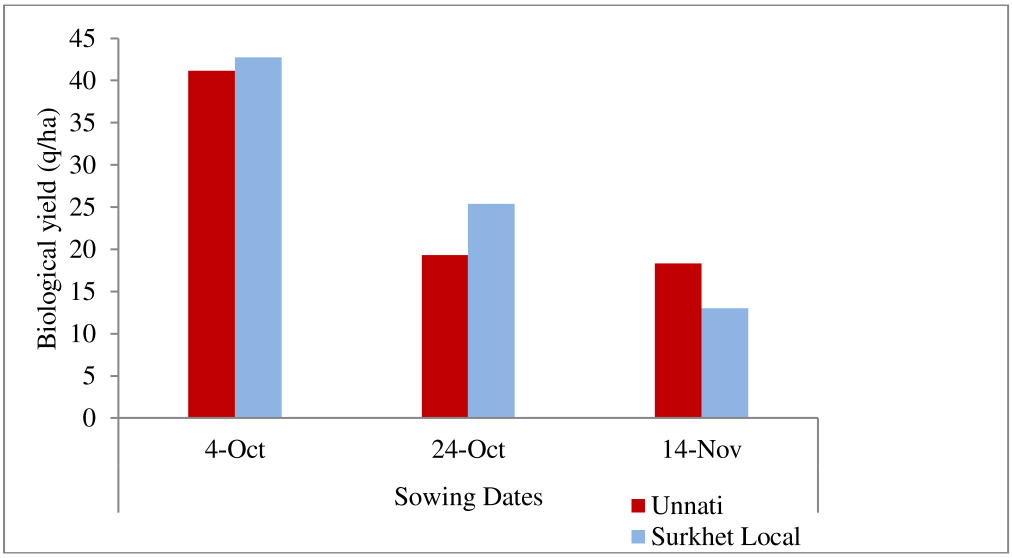

Figure 9. Effect of varieties and date of sowing on biological yield

Biomass yield was found to be non significant with varieties and significant with dates of sowing and their interaction. The highest biomass yield was found on Oct 4 sown crop (26.017 q/ha) followed by Oct 24 (14.899 q/ha) sown crop which is at par with Nov 14 sown crop (13.369 q/ha).This result might be due to the reduced vegetative growth, seed and stalk yield in later dates of sowing.

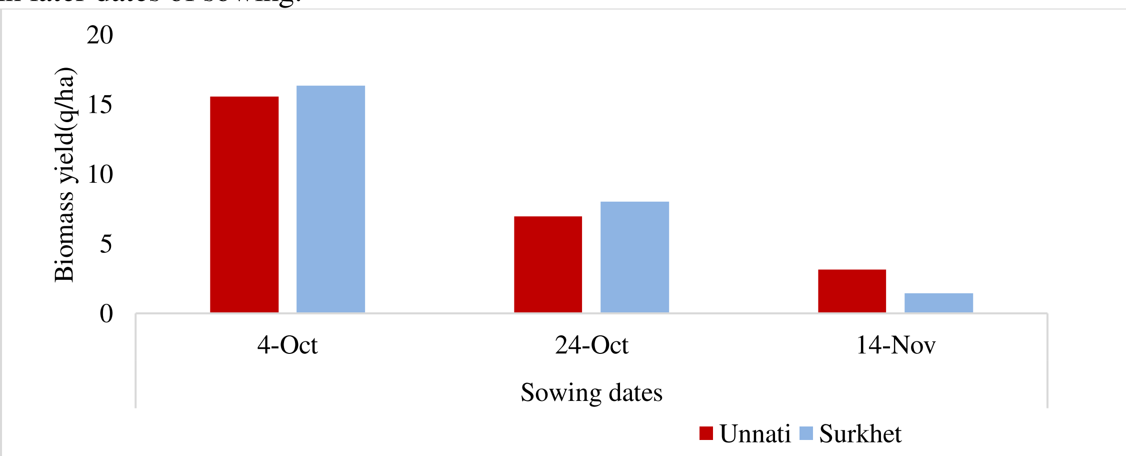

Figure 10. Effect of varieties and date of sowing on biomass yield

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Harvest index

Harvest index differed significantly due to varieties and date of sowing. Also, the significant difference was shown by their interaction. In case of variety, higher harvest index was recorded in variety Unnati while it was obtained significantly more in Oct 4 in case of date (Table 2.).Harvest index interaction was significant and higher in variety Surkhet sown on Oct 4 (38.13%). Lowest harvest index was recorded on variety Surkhet sown on delayed date i.e. Nov 14 (11.21%).The results were similar with the findings ofRao & Mendham, (1991) and Whitfield, (1992). Scarisbrick *et al.*, (1982)reported that HI reduction due to delayed sowing was the major cause which leads into decreased seed yield. This may be due to the higher seed yield and higher test weight of Unnati variety. Scarisbrick *et al.*, 1982 also reported that harvest index reduction due to delayed sowing was the major cause which leads into decreased seed yield.

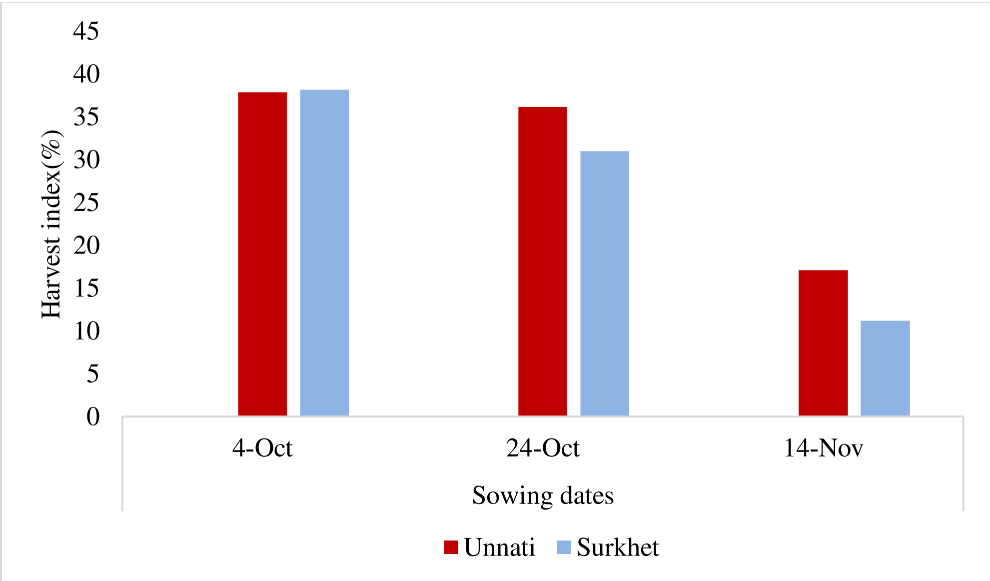

Figure 11. Effect of date of sowing on Harvest index

Test weight

Highest test weight was recorded in October 24 (3.16 gm) sown crop which is at par with October 4(3.125 gm) and lowest test weight was found on 14 Nov (2.15 gm) shown crop. It revealed that dates of sowing showed highly significant effect on test weight while varieties and their interaction with sowing dates didn't show any significant effect. A decreasing trend was recorded from the earliest date of sowing to the last date. These findings are in agreement with Brar *et al.*, (1998);Bali *et al.*, (1992) in gobi sarson andChauhan *et al.*, (2007) in rayo.

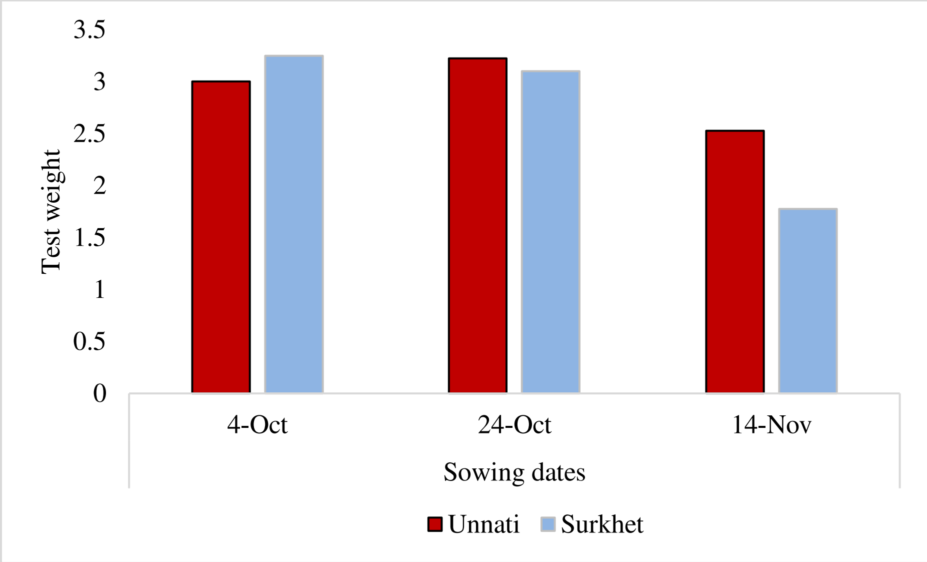

Figure 12. Effect of date of sowing on test weight (gm)

CONCLUSION

The present study concluded that there is presence of significant difference among the different sowing dates in Dang condition. We found that both the varieties, i.e. Unnati and Surkhet Local sown in Oct 4 had higher yield rather than sown in Oct 24 and Nov 19. Since sowing date and variety selection is one of the most important factor in increasing productivity, appropriate date would help in escaping yield reducing factors such as frost, pest attack and insufficient reproductive period. Even though, this study did not show significant differences among two varieties, appropriate variety would perform better in recommended domain. Since, climate change has been a major issue for fluctuation of the global temperature in recent times, further researches on appropriate date of sowing would help in maximizing and maintaining the yield.

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Authors' Contributions

G. Ranabhat and P. Tiwari analyzed, conducted, and prepare the manuscript of the experiment. A. Dhakal and P. Oli collected all the information from fields and extracted information from literatures and prepared figures and table. A. Chapagain revised the final paper, S. Neupane helped in the experiment and G. Ranabhat edited whole manuscripts, language checking, and verified the analysis and data presented in the manuscript.All author approved the final version of this manuscript.

Conflict of interest

The authors declare no conflicts of interest regarding the publication of this manuscript.

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