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Evaluation of brassica (*brassica napus* l.) for suitable sowing time under agro-climatic condition of Quetta

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Abstract

Pakistan is importing more than 80% edible oil, as the local edible oil production hardly met 16% of the domestic demand. The total availability of edible oil is 3.523 million tonnes. 2.205 million tonnes of edible oil is imported valuing Rs. 136.920 billion. So, a field trial was conducted during 2015 at Agriculture Research Institute, Quetta. *Brassica napus* was sown under treatments i.e different sowing dates viz: 26th November, 17th December, 6th January, 27th January, 17th February and 9th March. The crop sown on 26th November ranked first that produced the highest yield (1266.7 kg ha^{-1}) with the best performing agronomic parameters i.e. 95 cm plant height, 90 pods plant^{-1}, 37 seeds pod^{-1}, 18 g seed index, 24254 kg biological yield ha^{-1} and 5.21% harvest index. Similarly Brassica sowing on 9th March ranked second with 1093.7 kg yield ha^{-1} and other agronomic parameters i.e. 89 cm plant height, 83 pods plant^{-1}, 31 seeds pod^{-1}, 16.46 g seed index, 21850 kg biological yield ha^{-1}, and 5% harvest index. However, the crop sown on 17th February showed the lowest performance. It was concluded that the crop sown in November showed good results for Brassica cultivation while February proved non-beneficial economic returns. For the farming communities, it is suggested that sowing of Brassica under agro-ecological conditions of Quetta may be done in November to achieve maximum seed yield.

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Introduction

Next to food grain crops, oilseeds claim highest share in the world's agriculture economy. Oilseed crops are cultivated all over the world for edible and non-edible purposes (Wikipedia, 2017). Pakistan is importing more than 80% edible oil to meet domestic consumption, as the local edible oil production hardly met 16% of the domestic demand. The total availability of edible oil was 3.523 million tonnes. 2.205 million tonnes of edible oil is imported valuing Rs. 136.920 billion; whereas the local production is 0.462 million tonnes. Total availability of edible oil from all sources was 2.667 million tonnes. The area under brassica cultivation is 214 thousand ha, producing 196 thousand tonnes of seed and 67 thousand tonnes of edible oil, while the area under brassica is 211 thousand ha with seed production of 202 thousand tonnes and oil production of 65 thousand tonnes (GOP, 2016).

Brasicaceae family comprised of a number of oil producing species. The most common are *Brassica olderacea, Brassica napus, Brassica rapa, Brassica juncea, Brassica campestris* and *Brassica chinensis,* while the most popular are *Brassica juncea, Brassica napus, Brassica oleracea, Brassica rapa and Brassica campestris* (Bayer, 2010). Sarson and other varieties of *B. campestris* are very commonly grown as oilseeds in the subcontinent. Traditionally *B. napus* is an important cultivated crop among oilseeds (Bayer, 2010), originated from central Asia, China and Burma (Perry, 1999).

The early sown crops can suffer from lodging due to excessive vegetative growth (Haigh and McMullen, 2012). Sowing time has a role of prime importance to influence yield (Shah *et al.,* 2009). Brassica responds differently for yield and quality to varying sowing time. Therefore, deciding cultivation of Brassica for a particular region is of great importance depending upon prevailing ecological conditions and cultural practices very especialy sowing time (Salmasi *et al.,* 2006). Sowing of Brassica too early or late may have adverse effects on the crop performance (Hocking and Stapper, 2001). The delayed sowing of Brassica resulted in poor crop performance its seed yield and oil contents (Ozer, 2003). The decreased yield was observed in delayed sowing in most crops specialy Brassica (Robertson *et al*., 2004; Uzun *et al.,* 2009). The harmful effect of natural hazards like insect pests and diseases resulted in low crop yields (Yousaf *et al.,* 2002).

The late sowing not only reduces Brassica seed yield, but also decreased oil contents (Pritchard *et al.,* 2000; Ozer, 2003). Uzun *et al.* (2009) found that delayed sowing resuted in decreased duration of flowering and hence declined yield. The genotypes also respond variably to sowing times (Oz, 2002). With shortened flowering duration the yield and seed quality are adversely affected. Robertson *et al.* (2004) and Uzun *et al.* (2009) found early sowing affects inflorescence time and duration of flowering in plants, respectively. The yields of Brassica napus are far less than the existing potential due to poor crop management. There are numerous factors responsible for low productivity including low soil organic matter (Zubillaga *et al.,* 2002). One of the important lines of research towards this improvement is to study the effect of planting dates with different adaphic factors and environmental conditions on the yield and oil quality which differ widely from a region to another (Hocking and Stapper, 2001; Ozer 2003; Robertson *et al.,* 2004; Regan and Siddique, 2006; Salmasi *et al.,* 2006; Uzun *et al.,* 2009; Subrata *et al.,* 2010). There is need to enhance oilseed production and inspite, the seed and oil production that is following a decreasing trend. Keeping in view yield and quality reduction in Brassica the present study was designed to evaluate *Brassica napus* for suitable sowing time under agro-climatic condition of Quetta, Balochistan.

The study was carried out with the following objectives: 1) To find out the best sowing time of Brassica for high yield and to compare oil quality parameters, and 2) to compare economic benefit of Brassica with respect to sowing dates in upland cropping system of Quetta.

Materials and methods

The experiment was conducted during 2015 at Agriculture Research Institute, Quetta. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications.

The total area of experimental field was 75 m^2 and single plot size was (1.8 m x 5m) 9 m^2 in which row to row distance of 30 cm was maintained. The crop was sown for following six treatments: T_1. 26th November, T_2. 17th December, T_3. 06th January, T_4. 27th January, T_5. 17th February and T_6. 09th March

Among chemical fertilizers nitrogen (N), phosphorus (P), potassium (K), N was applied as Urea, P in the form of Triple Super Phosphate (TSP) and K in the form of Sulphate of Potash (SOP). The N, P and K were applied @ 100 kg N ha^{-1} and 90 kg P_2O_5 ha^{-1} and 60 kg K_2O ha^{-1}, respectively. Half of N along with all P and K were applied as basal dose in all the treatments equally, while remaining half N was divided equally into two doses and applied before flowering.

The study parameters were viz; Plant height (cm), Number of pods $plant^{-1}$, Number of seeds pod^{-1}, Seed index (g), Biological yield (kg ha^{-1}), Seed yield $plot^{-1}$ (g), Seed yield (kg ha^{-1}) and Harvest index (%).

Ten randomly selected plants from each replication for plant height were measured from base to tip of plant with the help of measuring tape and average was calculated.

Ten randomly selected plants from each replication were selected to count number of pods $plant^{-1}$ and then average number of pods $plant^{-1}$ was calculated.
Ten randomly selected pods from each replication were selected to count number of seed pod^{-1} and then average number of seeds $pods^{-1}$ were calculated.

One thousand seeds of each experimental unit were counted by using electrice seed counter and weighed using electric balance in grams and average was worked out. The whole plant sample by the help of Square Quadrate Method was harvested and weighted for biological yield kg ha^{-1}. The average was calculated. Crop was harvested by Square Quadrate Method at maturity stage and yield was measured by weighing seed of each plot and converted in to seed yield kg ha^{-1} by using the following formula:

$$Seed\ yield\ (kg\ ha^{-1}) = \frac{\text{Seed yield}(\text{g plot}^{-1})\text{x } 10}{\text{Plot size } (\text{m}^2)}$$

Harvest index was calculated by using following formula:

$$H.I\% = \frac{\text{Seed yield x } 100}{\text{Biological Yield}}$$

Brassica oil was examined for each treatment and compared for its quality parameters i.e., fat, crude protein and fiber contents.

Economic analysis

The data were compared economically to find better Brassica yield.

Statistical analysis

The data were analyzed statistically by using statistix 8.1 for Analysis of Variance (ANOVA) according to the Randomized Complete Block Design (RCBD) and the means were compared by Least Significant Difference (LSD) test at 0.5% probability level.

Results and discussion

Plant height (cm)

The data for plant height are illustrated in Table 1 and Fig. 3. Plant height of *Brassica napus* was significantly influenced by sowing time.

The results depicted that the Brassica produced the highest plants i.e., 95 cm when sown on 26th November, followed by the crop planted on 9th March , 17th December and 27th January with average plant height of 89 cm, 70 cm and 70 cm, respectively.

Brassica planting on 6th January resulted in a considerable adverse impact on this parameter, where the average plant height was 68 cm; while the lowest plant height of 64 cm was recorded on 17th February.

Table 1. Effect of sowing time on plant height (cm), number of pods plant^{-1}, number of seed pod^{-1}, seed index (g), biological yield kgha^{-1}, Seed yield plot^{-1}, seed yield kgha^{-1} and Harvest Index (%).

Treatments	Plant height(cm)	Number of pods plant^{-1}	Number of seed pod^{-1}	seed index (g)	Biological yield kgha^{-1}	Seed yield plot^{-1} (g)	Seed yield kgha^{-1}	Harvest Index %
26th Nov	94.667A	90A	36.533A	17.733A	24254A	1140.0A	1266.7A	5.2133A
17th Dec	70.333C	70C	30.000B	13.400C	16179C	595.0C	661.1C	4.0867B
6th Jan	68.333D	67C	16.467C	10.133D	12675D	388.0D	431.1D	3.3933C
27th Jan	70.333C	63D	14.133D	8.600E	10057E	310.0E	344.5E	3.4200C
17th Feb	63.667E	56E	16.900C	7.300F	9126E	168.3F	187.0F	2.0467D
9th March	88.667B	82B	30.833B	16.467B	21850B	984.3B	1093.7B	5.0033A
Mean	76.000	71.611	24.144	12.272	15690	597.61	664.02	3.8606
CV	1.42	2.36	5.16	1.98	5.48	7.03	7.04	3.57
LSD	1.9650	3.0743	2.2661	0.4427	1564.5	76.481	85.007	0.2509

The values with different letters show significant differences at 5% probability level.

The Brassica plants showed maximum growth performance in November while gradually decreased with periodic delayed sowing. However, sowing of Brassica crop on 9th March again showed positive impact on plant height. Statistically, the differences in plant height in crop planted on 17th December and 27th January were insignificant. The decrease in temperature from December to February checked the plant height, while in March onwards with the rise of temperature, the Brassica plants grew faster and taller due to climatic suitability. Our results are in line with Ozer (2003) and Toba *et al.,* (2013). The acceptable planting dates are based upon location and elevation Uzun *et al.,* (2009).

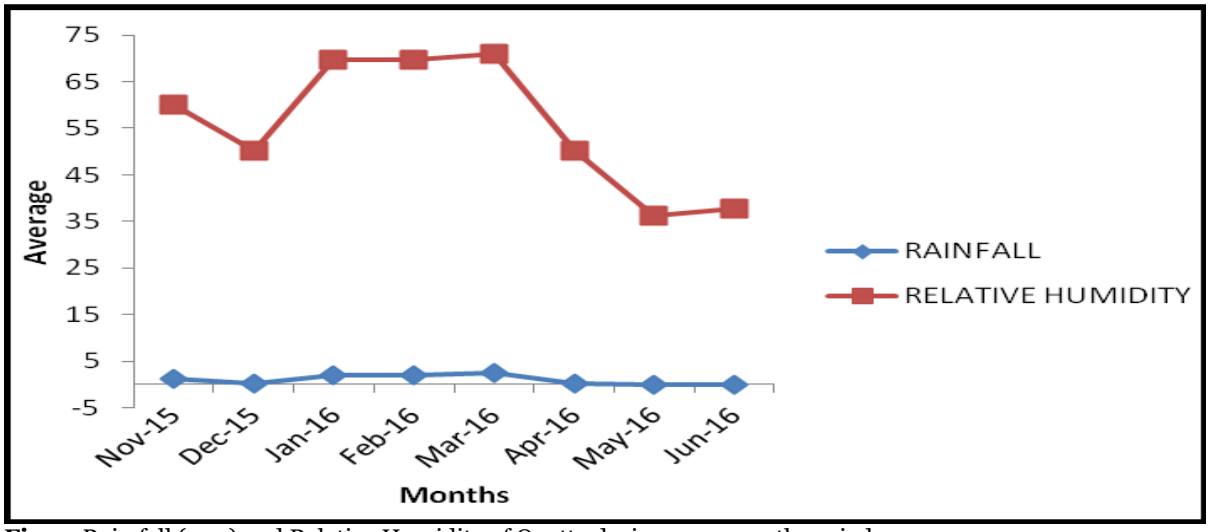

Fig. 1. Rain fall (mm) and Relative Humidity of Quetta during crop growth period.

Number of pods plant^{-1}

The data for number of pods plant^{-1} are shown in Table 1 and Fig. 3. Number of pods plant^{-1} of *Brassica napus* was significantly influenced by sowing time. It can be seen from the results that the *Brassica napus* produced plants with maximum number of pods plant^{-1} (90) when the crop was sown on 26th November, followed by the crop planted on 9th March , 17th December and 6th January where the crop produced 83, 70 and 67 average number of pods plant^{-1}, respectively. A significant decrease in the number of pods plant^{-1} (63) when *Brassica napus* was planted on 27th January, while the minimum number of pods plant^{-1} (56) when sown on 17 February.

It is evident from the results that early sown *Brassica napus* produced more fruiting bodies as compared to late sown in December, January or February and sowing in March also resulted in increased fruting bodies. This indicates that sowing of Brassica in cool weather produce poor results, while the plants of early sown Brassica in November established well and sustained physical plant health and hence produced increased number of pods plant^{-1}. In December, January and even in February, when frost occurs the late sown crop produced poor plants as poor seedling emergence and poor reproductive process under such weather conditions. Our findings are in agreement with those of Chahal *et al.,* (2009) who examined the effect of various sowing dates on the growth and yield of Brassica and obtained the highest values for growth parameters in 5th October sowing as compared to late sowing (30th October and 25th November). Fruiting bodies in early sowing was associated with longer time period to utilize resources like light, nutrients, moisture Shargi *et al.*, (2011).

Fig. 2. Field layout. Where, R: Replication and T: Treatment, T_1: 26 Nov. 2015, T_2: 17 Dec. 2015, T_3: 06 Jan. 2016, T_4: 27 Jan. 2016, T_5: 17 Feb. 2016, T_6: 09 Mar. 2016.

Number of seeds pod^{-1}

The data for number of seeds pod^{-1} are presented in Table 1 and compared in Fig. 3. Number of seeds pod^{-1} of *Brassica napus* was significantly influenced by sowing time. It is obvious from the results that the *Brassica napus* produced pods with maximum number of seeds pod^{-1} (37) when the crop was sown on 26th November, followed by Brassica sown on 9th March and 17th December where the crop produced pods with 31 and 30 seeds pod^{-1}, respectively. A significant decrease in the number of seeds pod^{-1} upto 17 and 16 was recorded in plots sown with *Brassica napus* on 17th February and 6th January, respectively. However, the minimum number of seeds pod^{-1} (14) was recorded on 27th January. The results showed that *Brassica napus* sown early in November-December or in March produced pods with more seeds as compared to plots sown in January and February. The results for the number of seeds pod^{-1} are directly proportional to the results for number of pods plant^{-1} as well as plant height. Statistically, the differences in number of seeds pod^{-1} in crop planted on 17th February and 6th January were at par with each other.

Months during which the temperature was low and when the weather of Quetta faced on freezing point, the seed emergence and seedling developent are adversely affected as compared to months of moderate temperature. Similar findings have also been seen in the research reported by Horton *et al.* (2006) who found that the highest value for yield contributing traits of Brassica in early sowing; while Vaezi *et al.* (2009) evaluated the effect of different sowing dates on the growth and yield of brassica and reported higher values for yield attributes including seeds per pod in the early planting dates (23 September and 23 October).

Seed index (g)

The data for seed index are illustrated in Table 1 and compared in Fig. 3. This parameter for *Brassica napus* was significantly influenced by sowing time. It is apparent from the results that the seed index of *Brassica napus* was highest (17.73 g) on first treatment i.e., 26th November, followed by the average seed index of 16.46 g, 13.40 g and 10.13 g recorded when Brassica sown on 9th March, 17th December and 6th January, respectively. A seed index decreased to 8.60 g in plots sown with *Brassica napus* on 27th January, while the minimum seed index (7.30 g) was noted in treatment i.e., on 17th

February. This higher seed index in case of 26th November sowing was may be mainly associated with increased plant height, more number of pods plant^{-1} and greater number of seeds pod^{-1}, as the values of these parameters were also higher on 26th November. The *Brassica napus* needs a certain period of time to attain required seedling emergence and well established crop stand. The Brassica when sown in November might has chance to attain proper seedling emergence and good crop stand due to moderate temperature, while decreased temperature in December onwards caused relatively poor seedling emergence and hence poor seed development.

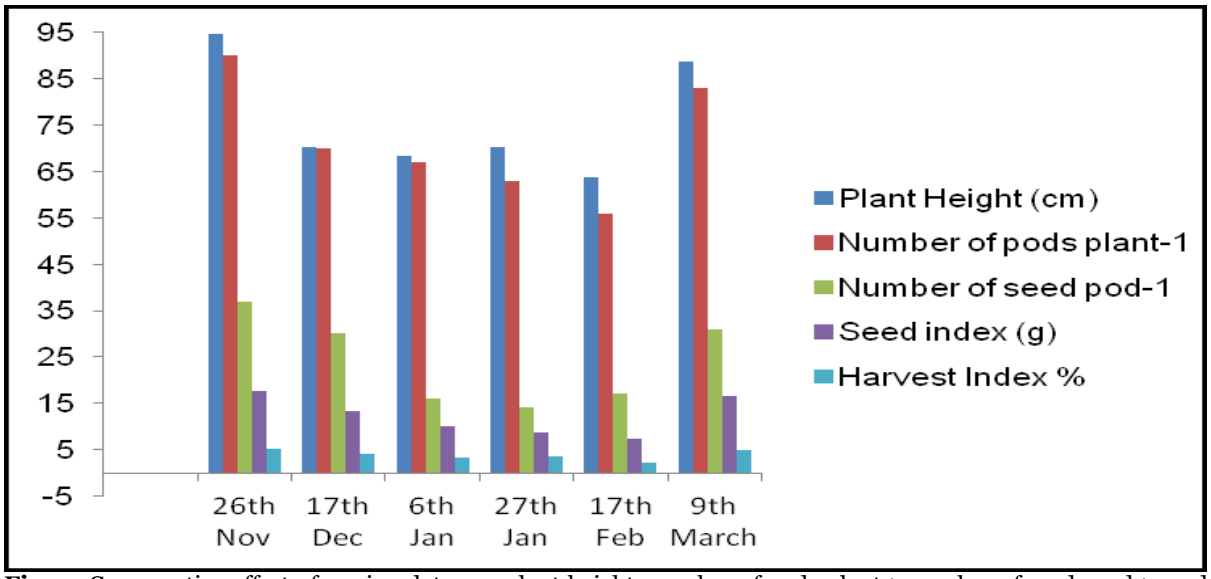

Fig. 3. Comparative effect of sowing dates on plant height, number of pods plant^{-1}, number of seeds pod^{-1}, seed index and harvest index.

The results of the present research on seed index of brassica are also supported by Bukhtiar *et al.* (1992) who found that the planting on end of September produced higher seed index and end of October planting dates also had greater values for this trait. Angerj Singh *et al.* (2002) reported that higher seed index was obtained when the crop was sown between 10 and 30 October.

Biological yield (kg ha^{-1})

The data for biological yield are illustrated in Table 1 and compared in Fig. 3. Biological yield of *Brassica napus* was significantly influenced by sowing time. The crop produced maximum biological yield (24254 kg ha^{-1}) when sown on 26th November, followed by the sowing dates of 9th March , 17th December and 6th January where the crop produced average biological yield of 21850 kg ha^{-1}, 16179 kg ha^{-1}and 12672 kg ha^{-1}, respectively. The biological yield diminished to 10057 kg ha^{-1} when sown on 27th January, while the minimum biological yield (9126 kg ha^{-1}) was obtained for Brassica on 17th February. The B. napus planting on 26th November or 9th March remained satisfactory sowing dates for achieving good crop growth high as compared to the sowing in December, January and February. The results for 27th January and 17th February were at par with each other. Due to low temperature in December, January and February the brassica sowing during this period might not flourish better and weaker seedlings were emerged and hence lower biological yield was received. Higher biological yield ha^{-1} in early sown Brassica on 26th November was might be associated with the increased plant height, more pods plant^{-1}, greater number of seeds pod^{-1}, seed index and higher seed yield plot^{-1}; because all these parameters showed similarity in their response to different sowing dates. Rafiei *et al.* (2011) reported the highest biological yield from early

sowing of 30th August. Bhuiyan *et al.* (2008) reported that biological yield of last planting 30th November was also satisfactory as of the prolong winter season.

Seed yield plot^{-1} (g)

The data for seed yield plot^{-1} are illustrated in Table 1 and compared in Fig. 4. Seed yield plot^{-1} of *Brassica napus* was significantly influenced by sowing time. Seed yield plot^{-1} of *Brassica napus* that the crop produced maximum seed yield plot^{-1} (1140 g) when sown on 26th November, followed by the sowing dates of 9th March, 17th December and 6th January where the crop produced 984.3 g, 595 g and 388 g average seed yield plot^{-1}, respectively.

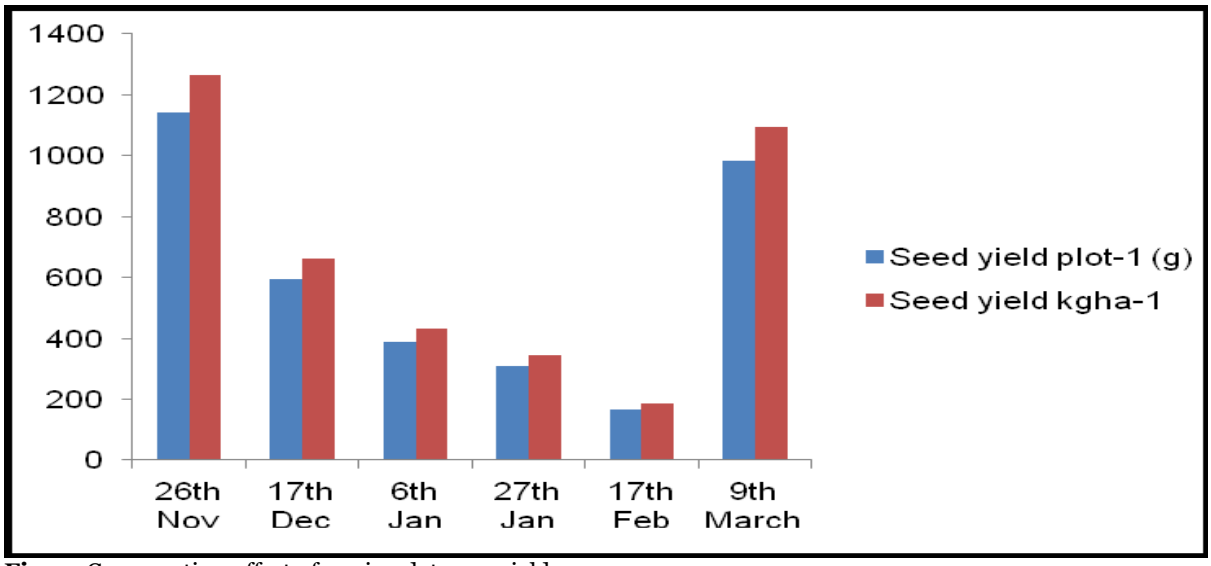

Fig. 4. Comparative effect of sowing dates on yield.

The seed yield plot^{-1} declined to 310.0 g when *Brassica napus* was planted on 27th January, while the lowest seed yield plot^{-1} (168.3 g) was recorded in 17th February sown crop. The results also suggested that *Brassica napus* sowing on 26th November produced comparably the highest seed yield plot^{-1} among all sowing dates.

Seed yield (kg ha^{-1})

The data for seed yield are illustrated in Table 1 and demonstrated in Fig. 4. Seed yield of Brassica napus was significantly influenced by sowing time. The crop produced maximum seed yield (1266 kg ha-1) when sown on 26th November, followed by the sowing dates of 9th March and 17th December where the crop produced average seed yield of 1093.7 kg and 661.1 kg ha^{-1}, respectively. The seed yield declined to 431.1 kg and 344.1 kg ha^{-1} when sowing of *Brassica napus* was done on 6th January and 27th January, respectively, while the lowest seed yield (187 kg ha^{-1}) was obtained when Brassica was sown on 17th February. The crop sown in last week of November or in the second week of March showed good results in relation to seed yield ha^{-1}, while Brassica cultivation in December, January and February proved nonbeneficial for producing desired crop yields. The sowing of Brassica may be optimistic when done in November before starting the severe cold. This satisfactory performance of *Brassica napus* in relation to higher seed yield ha^{-1} when early sown on 26th November was mainly associated with higher values for plant height, pods plant^{-1}, seeds pod^{-1} and seed index, as all these parameters followed a similar trend in response to sowing dates. Hence, it is concluded that the best sowing for brassica is November.

Harvest index (%)

The data for harvest index are illustrated in Table 1 and Fig. 3. Harvest index of *Brassica napus* was significantly influenced by sowing time. The harvest index is the percentage of obtained seed yield from the total crop biomass (biological yield).

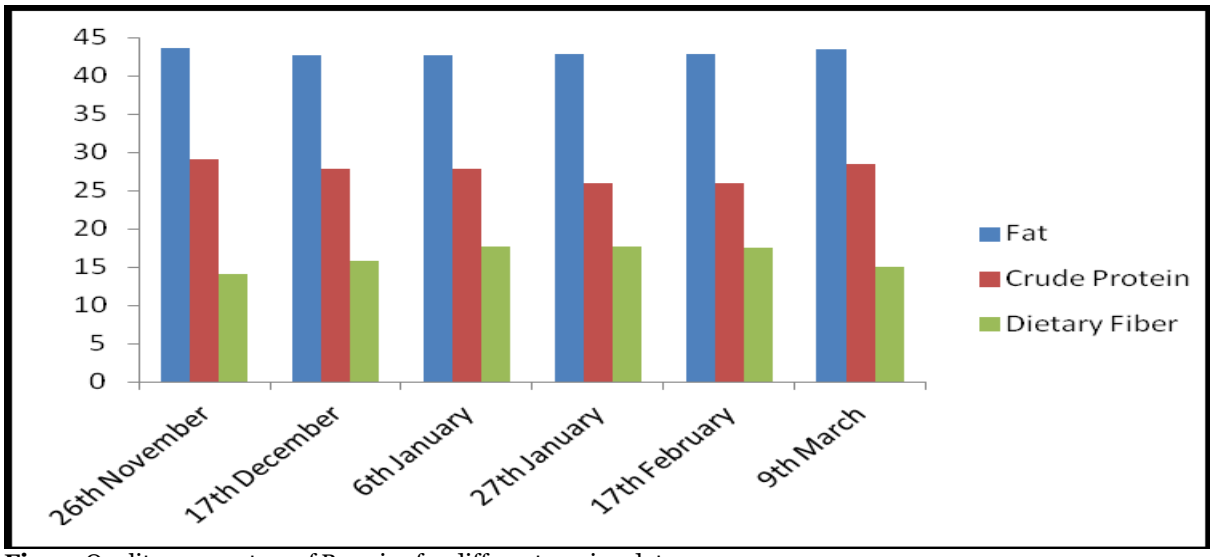

Fig. 5. Quality parameters of Brassica for different sowing dates.

The maximum 5.21% harvest index was calculated in crop sown on 26th November, followed by the average harvest index of 5 and 4 % calculated in Brassica when sown on 9th March and 17th December, respectively. There was sharp decrease in harvest index i.e. 3.42 % and 3.39 % when sowing of *Brassica napus* was done on 27th January and 6th January, respectively, while the lowest 2% harvest index was calculated in brassica crop sown on 17th February. These results are partially supported by many past researchers. Shah (2005) reported that higher grain yield and total crop biomass was obtained from 6th November sowing that was 49, 7 and 18% higher than 7th October, 22nd October and 21st November sowings, respectively. Akhter *et al.,* (2015) found that there was no significant difference among the sowing dates with respect to harvest index. Thus, it can be suggested that first sowing date (1st October) might result in a higher harvest index than rest of the sowing dates. There were no significant differences in Brassica seed yield when early sown on 10th and 20th of August in first year and late sown on 10th of September in second one (Azizi *et al.,* 2003). All yield differences depending on the sowing date were significant rather than different dates of different years (Balodis *et al.,* 2012).

Sowing date has significant effects on the growth and yield of Brassica. It is one of essential factors to guarantee Brassica surviving through the cold winter to obtain a reasonable and stable yield (Jun *et al.,* 2006). Sowing time of winter Brassica has significant influence on plant survival rate, growth period, seeds yield and oil content (Liao *et al.,* 2001; Yuan *et al.,* 2003; Zhang *et al.,* 2005). Planting date has a considerable effect on seed yield by influencing the yield components, late planting decreases the most important traits (Sharief and Keshta, 2002; Siadat and Hemayati, 2009). Delayed sowing resulted in a weak plant growth and most of them couldn't survive in winter. Plants survive rate of sowing on August was more then 80% while that of sowing on September i.e., only 39% (Jun *et al.,* 2006). Hence, it is concluded that brassica cultivation under agro-ecological condition of Quetta may be economically beneficial if the sowing is done in November as early crop and achieving good post winter crop harvest.

Quality parameters

The data for quality parameters viz. Fat, Crude protein and Dietary fiber are demonstrated in Fig. 5. The each quality parameter for *Brassica napus* was non-significant which clearly indicats that the sowing time did not effect on Brassica quality especially Fat, Crude protein and Dietary fiber. However, the highest fat contents were observed in treatment i.e., 26th November, Followed by sowing dates of 9th March, 17th December, 6th January, while the lowest fat

contents were obtained when Brassica was sown on 17th February. The same trend for results were recorded incase of Crude protein. The better crop for its quality has high contents of fat and crude protein. In case of dietary fiber the invers trend was recorded that is the lowest dietary fiber was observed in treatment i.e., 26th November, followed by sowing dates of 9th March, 17th December, 6th January, while the highest fiber contents were obtained when Brassica was sown on 17th February.

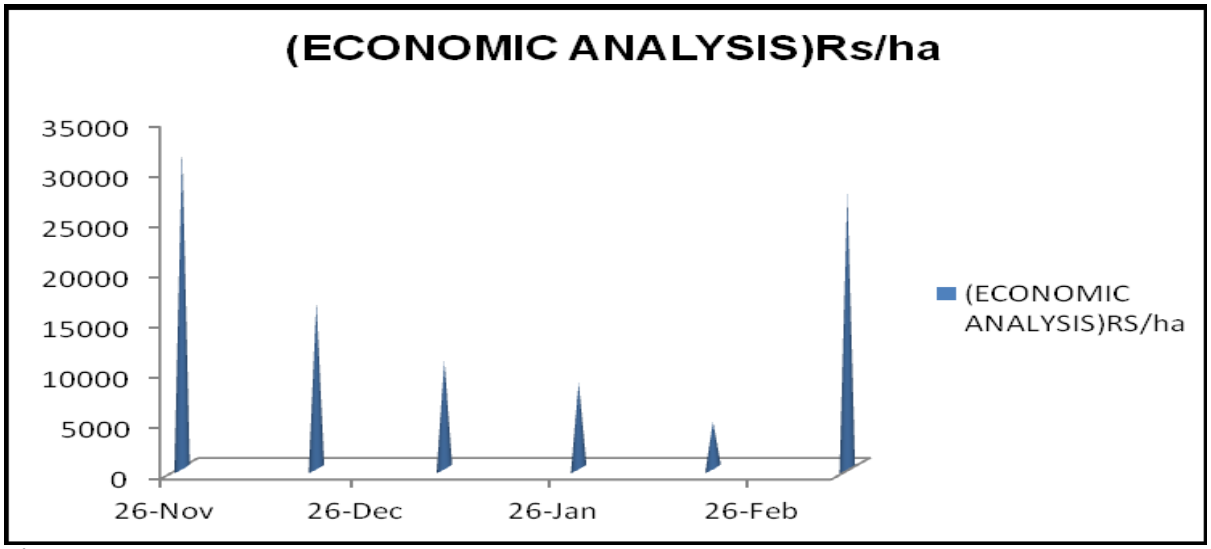

Fig. 6. Economic Analysis of Brassica for different sowing dates.

Economic analysis

The economic analysis for brassica under different sowing dates is demonstrated in Fig. 6 in terms of Rupees for seed yield ha^{-1}. The crop gave maximum economic return (Rs. 31667.5) when sown on 26th November followed by sowing dates of 9th March and 17th December where the brassica gave net return of Rs. 27342.5 and Rs. 16540, respectively. The net return declined to Rs. 10777.5 and Rs. 8612.5 when sowing of brassica napus was done on 6th January and 27th January, respectively, while the lowest net return (Rs. 4675) was obtained when Brassica was sown on 17th Feburary. The above economic returnes showed that the Brassica cultivation under agro-ecological condition of Quetta might be economically beneficial if the sowing is done in November as early crop and achieving good post winter crop harvest period.

Conclusion

It was concluded that the brassica sown in last week of November gave the best results for seed yield ha^{-1} and harvest index while Brassica cultivation in December, January and February proved as undesirable sowing dates for Brassica. The farmers are suggested that sowing of Brassica under agro-ecological condition of Quetta may be done in November to achieve maximum Brassica yield, comparating good quality and economic benefit.

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