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EFFECT OF HARVESTING DATES AND STORAGE PERIOD ON SEED YIELD AND SEED QUALITY OF CANOLA (*Brassica napus, L.*)

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ABSTRACT

Stage of seed development at harvest time influence both of canola seed yield and seed quality after harvest as well as seed storability. Two field experiments were conducted at the Farm of El-Serw Agricultural Research Station during 2007/2008 and 2008/2009 seasons, while storage study was conducted at Seed Technology Unit Lab. (ARC) Mansoura, Dakhlia Government, under normal conditions during 2008/2010 and 2009/2011 seasons (from 31 July 2008 till 31 January 2011). The aim of this study was to investigate the effect of four harvesting dates i.e. 75, 82, 89 and 96 days after beginning of flowering on seed yield and seed quality, directly after harvest as well as after 6 and 18 months from storage. The results revealed that harvested canola seed early after 75 days from beginning of flowering had low seed yield and slight 1000-seed weight, high seed moisture contents. Prolonging harvesting date increased seed yield/plant, 1000-seed weight, germinability as measured by (germination percentage, accelerated after seed aging and germination rate) and seedling vigor as measured by (seedling length, seedling dry weight). Meanwhile, increasing the period from beginning of flowering to harvest decreased seed moisture content, mean germination time and electrical conductivity of seed solution. On the other hand, increasing storage period reduced germinability and seedling vigor. Meanwhile, increasing storage period increased mean germination time and electrical conductivity of seed solution. In conclusion, Under the experiment conditions seed yield and seed quality characters can be achieved through harvesting canola seed var. (Serw 4) after 82 to 89 days from beginning of flowering.

INTRODUCTION

Canola *(Brassica napus L.)* is the second largest oilseed crop in the world next to soybean. There are many factors that affect yield, seed quality and its storage capacity, among them harvesting dates, while (Thomas 1984) reported that, harvest can be stated earlier and the higher moisture level may reduce mechanical losses due to pod shattering. Also, Sadeghi *et al.*, 2010 concluded that, stage of seed development at harvest influences both of canola yield and seed quality. Oil seed rape has relatively long flowering period and seed maturity occurred in different times so, the suitable time for canola is short thus, identification of the harvest time is very important. Oplinger *et al.*, 1989, reported that, harvesting too early may result in low yield and poor seed quality, whereas harvesting too late may result in shattering and reduce seed yield. Harvesting canola at full maturity stage (when seed moisture content is near 100 g kg -1) is preferred for better threshing and storability because of the suitable moisture content of both pods and seed. However, it may be advisable to harvest the crop at physiological maturity than at harvesting maturity (Salunkhe and Desai, 1986 and Fenwick, 1988) or to avoid excessive bird damage or unfavorable weather conditions during late maturation and harvest Therefore it is

important to determine the optimal harvesting time using high quality seed is essential for good stand establishment in any crop. Consequently, germination and selected vigor tests were used to determine the quality of canola seed. Although researchers have reported that seed of some crops attain maximum viability and vigor at physiological maturity (Delouche, 1974; Knittle and Burris, 1976). In Egypt, no reports of seed quality of canola seed at both physiological and harvesting maturity have been published. Canola can be harvested 2 week before reaching harvesting maturity without significant reduction in dry weight and yield. However, seed moisture content at this stage is too high for direct harvesting, threshing or storage without further drying (Elias and Copeland, 2001). Russ et. al., 2004 studied the effect of harvesting date at 1-to 2-week intervals on seed yield and seed oil content, they recorded seed yields declined sharply at a rate of about 10.6 kg ha-1 d-1, probably due to increased shattering. Khan, 1971, conclude that, canola seed quality improved at the time from physiological maturity to harvesting maturity while this explained by the physiological changes (e.g., hormonal mechanism) that occur after physiological maturity which can promote germination on the other side, Elias and Copeland, 2001, reported that the gab between germination capacity and seed vigor was decreased as the canola seed reached to harvesting maturity. Canola is more prone to deterioration in storage than cereals because of its high oil content. At 70% relative humidity the safe storage moisture is 8.3% for canola and 13.9% for wheat at $25C^0$ for long term storage. Girishi *et al.*, (1976) demonstrated that, the actual losses of grain that recorded during storage were mainly due to insect pests, also they reported that the loss in seed viability after storage for 6 months varied from 70 to 22%. Canola is very sensitive to heating in storage (Mills, 1976) and therefore requires better bin construction than that required for cereals to exclude moisture.

The oil fraction of canola seed absorbs less moisture than the starch and fiber fractions of wheat seed, therefore the equilibrium moisture level for canola is much lower than that of wheat (Thomas, 1984). For storage longer than 5 months, canola should be binned at a maximum of 8% moisture (Mills, 1989). To successfully store canola for periods of 6 to 24 months, particular attention must be given to conditioning and monitoring. Quality seed may be stored 2 to 3 years if its moisture and temperature are properly maintained (Thomas,1984). Stored canola differs from stored wheat because, unlike wheat, adverse changes can occur very rapidly. Canola goes through a period of active respiration after binning, and if the heat and moisture is not quickly removed, mold growth and increased respiration soon occurs (Mills, 1989). Sathya et. al. (2009), demonstrated that Germination of the 7.5 and 10.0% moisture content samples canola stored at 10 and 20°C remained germination above 80% throughout the study, whereas that of the other canola samples dropped over time with higher initial moisture contents and with higher storage temperature. Canola with 10.0% moisture content stored at 20°C will not deteriorate for at least 15 wk, whereas the 12.5 and 15.0% moisture content seeds stored at 25°C need to be dried within a week to avoid spoilage.

Thus, the aim of this study was to determine the optimal harvesting date for having high seed yield/plant and seed quality and study the effect

harvesting dates on canola seed storage capacity with having high seed quality.

MATERIALS AND METHODS

This investigation was conducted at the Farm of El-Serw Agricultural Research Station during 200٧/200٨ and 200٨/20٠٩ seasons, while storage studies were conducted at seed Technology Unit Lab. Mansoura, Dakhlia under normal conditions during 2008/2010 and 2009/2011 seasons (from 31 July 2008 till 31 January 2011). The purpose was to study effect of different harvesting dates and storage periods on seed yield, seed viability and seedling vigor of canola seeds (c.v. Serw 4) and determine the suitable harvesting date and storage period with obtain high seed quality. The experimental design was Factorial Complete Block Design with four replicates. Seeds samples of canola seeds were obtained from Oil Res. Department Field Crops Research Institute, Agricultural Research Center. Canola seeds were planted in 23th and 27th November during the first and second seasons, respectively. Other agronomic practices were done as recommended for the region of canola crop cultivation. The crop seeds were harvested at weekly intervals after 75 days from beginning of flowering (DABF). Number of days to flowering of tested canola variety (Serw 4) under the experimental conditions in both seasons was 70 days. The first factor, harvesting dates, four harvesting dates after beginning of flowering i. e. 75, 82, 89 and 96 days after beginning of flowering. Sampling was started when approximately 90% of the flowers in a plant formed pods, i.e., when the flower petals began to fall. Ten plants from each replicate were randomly chosen and tagged for subsequent sampling. Pods were harvested and immediately thrashed by hand to avoid seed injury and cleaned from dust. In the same time seeds were air dried before storage in cloth bags after harvesting under laboratory conditions. While the second factor was storage periods, three storage periods i.e. 0, 6 and 18 months after harvesting were conducted at the laboratory under normal conditions.

Recorded data:-

At harvest ten plants from each replicate were randomly chosen and tagged for subsequent sampling and the data are recorded:

Seed moisture content: After each harvesting date**,** some pods of the main stems were taken from each plant and handy thrashed and after that seed moisture content was determined according to ISTA, (1999).

Seed yield/ plant: Ten plants of the center row of each plot were harvested, dried, thearched and seed yield/ plant was calculated.

1000- seed weight (g): Four random samples were used to count and record it according to (ISTA., 1999).

The samples of each harvested date and of each storage period were undergo to various laboratory testes for evaluating seed quality traits.

Germination percentage: Germination percentage was performed according to (ISTA rules, 1999). While 400 seeds of canola in four replicates were sown at 20 C^{o} in sterilized sand culture. Germination percentage defined as the total number of normal seedlings.

Germination rate defined according to Bartlett (1937).

$$\text{Germination rate} = \frac{a + (a + b) + (a + b + c) + \ldots\ldots + (a + b + c + m)}{n\,(a + b + c + \ldots\ldots + m)}$$

Where (a, b, c,….. and m) number of seedlings emerged at the first count, second count and final count and (n) it is the number of counts.

$$\textbf{Mean germination time} = \frac{(N_1 \times T_1) + (N_2 \times T_2) + (N_3 \times T_3) + (N_4 \times T_4)}{N_1 + N_2 + N_3 + N_4}$$

N_1, N_2, N_3 and N_4 = First, Second, Third and Four Counts, respectively.
T_1, T_2, T_3 and T_4= Time of First, Second, Third and Four Counts, respectively.

Seedlings vigor index = Seedling dry weight X germination percentage

At the final count, ten normal seedlings from each replicate were taken randomly to measure seedling length (mm), after then, the seedlings were dried in hot-air oven at 85 ^{0}C for 12 hours to obtain the seedling dry weight (g) according to Krishnasamy and Seshu (1990).

Conductivity test: It was evaluated for each treatment according to the procedures outlined by Matthews and Alison (1987). The HANNA conductivity meter (Hi 80333) was used where fifty seeds in three replications of tested samples were weighted to 2 decimal numbers and placed in a 500 ml flask and 250 ml of distilled water was added. The flask were covered and placed in an incubator at a constant temperature of 20 C^0 for 24 hours after which the contents of the flasks were gently stirred. The electrical conductivity was measured in the solution after removing the seeds. The results were reported as (*mmohs* per gm of seed).

$$\textbf{E C} = \frac{\text{Reading}}{\text{Weight of 50 seeds /gm}}$$

Accelerated aging test:- Accelerated aging test was conducted according to ISTA (1999).

Seed oil content: Seed oil percentage was conducted according to A.O.A.C, 1990.

Data were statistically analysis according to Gomez and Gomez (1984). The treated averages were compared using the Least Significant Difference (LSD) method. Bartlett test was done to the homogeneity of error variances. The test was insignificant for all traits except germination after aging and oil content (%), thus the data of both years were combined for all traits except these traits only.

RESULTS AND DISCUSSION

From the presented data in Table 1, harvesting dates had significant effects on seed moisture content, 1000-seed weight and seed yield/plant. Canola seed harvested early (after 75 days from beginning of flowering) had the highest levels of seed moisture content while it reached (31.9%) and with increasing the period from beginning of flowering to harvesting, seed moisture content decreased gradually and it recorded 11.2% after 89 days

from beginning of flowering. On the other side, further decrease in canola seed moisture content with prolong the time from beginning of flowering to harvest for 96 days while the estimated seed moisture content recorded 6.9%. With respect to the effect of harvesting date on 1000-seed weight and seed yield/plant, as illustrate from the same table, as the harvest begain early both of 1000-seed weight and seed yield/plant decreased gradually, on contrast they increases with increasing the period from beginning of flowering to harvest to 82 days but delaying the harvest time to 96 days from beginning flowering lead to the decrease in 1000-seed weight and seed yield/plant to 2.84 gm and 73.8 gm, respectively.

Table (1): Effect of harvesting dates on seed moisture content,1000 seed weight and seed yield/ plant (combined over 2007/ 2008 and 2008/ 2009 seasons)..

Harvest date	Moisture content (%)	1000 seed Wight (g)	Seed yield/ plant (g)
75 DABF	31.9	2.58	57.6
82 DABF	18.2	2.88	75.4
89 DABF	11.2	2.95	77.6
96 DABF	6.9	2.84	73.8
L.S.D. at 0.05%	0.2	0.09	0.1

Data in Table 2, show the effect of interaction between harvesting dates and storage periods was significant on canola seed germination. Directly after harvest, seed germination for the harvested canola after 75 days from beginning of flowering were less than the harvested seed after 82 days, 89 days and 96 days, i.e. seed germination for the harvested seed after 75 days from start of flowering was 78% and reached 94% at harvest time 96 days from beginning of flowering. Seed germination after 6 months from storage in the open air under laboratory conditions for the harvested seed after beginning of flowering with 75 days was less than the acceptance level for the certified canola seed (75%) with 2%. On the other side, harvested seed after beginning of flowering with 89 days and 96 days recorded 83% and 87% after six months from storage.

Table (2): Effect of interaction between harvesting dates and storage periods on canola seed germination percentage (combined over 2007/ 2008 and 2008/ 2009 seasons)..

Harvest date	Storage periods/months		
	0	6	18
75 DABF	78	73	68
82 DABF	83	77	71
89 DABF	91	83	75
96 DABF	94	87	77
L.S.D. at 0.05%	3		

Further decrease in germination percentage was noticed with prolonging the storage period for 18 months, while canola seed germination under optimum condition for the harvested seed at the first and second harvest time (after 75 days and 82 days) were 68% and 71%, respectively, meanwhile germination percentage for the harvested seed after 89 days and 96 days still above the acceptance level for the certified canola seed.

Presented data in Table 3, significant effect for the interaction between harvesting dates and storage periods on canola seed germination rate. At the first storage period (directly after harvest) harvested seed after beginning of flowering with 89 days and 96 days had the highest means of seed germination rate comparing to the harvest seed early (after 75 days) and it maintains with its highest means with prolonging the storage periods for 6 and 18 months. From the data in Table 4, although insignificant effect for the interaction between harvesting dates and storage periods on mean germination time was noticed, but mean germination time for the harvested canola seed at the first date after 75 days from beginning of flowering was late comparing to the harvested seed at the next harvesting dates after 82, 89 and 96 days also with increasing the storage periods for 6 and 18 months, mean germination time for the harvested seed at 96 days from beginning of flowering was the earliest comparing the other harvesting dates.

Table (3): Effect of interaction between harvesting dates and storage periods on germination rate of canola seed (combined over 2007/ 2008 and 2008/ 2009 seasons).

Harvest date	Storage periods/months		
	0	6	18
75 DABF	0.589	0.519	0.430
82 DABF	0.681	0.591	0.493
89 DABF	0.814	0.633	0.538
96 DABF	0.829	0.651	0.555
L.S.D. at .05%	0.022		

Table (4): Effect of interaction between harvesting dates and storage periods on mean germination time (day) of canola seed (combined over 2007/ 2008 and 2008/ 2009 seasons).

Harvest date	Storage periods/months		
	0	6	18
75 DABF	3.7	4.2	4.8
82 DABF	3.3	3.7	4.0
89 DABF	2.8	3.2	3.6
96 DABF	2.7	3.2	3.4
L.S.D. at .05%	NS		

With respect to the effect of the interaction between harvesting dates and storage periods on seedling vigour traits as measured by seedling length, seedlings dry weight and seedlings vigour index, significant effects for this interaction on these traits except seedling length as presented in Tables 5, 6 and 7. Means of seedling vigour traits for the harvested canola seed at the first harvesting date 75 days after beginning of flowering were less than

means of the harvested canola at the next dates. Also seedlings of the germinated seed directly after harvest were strong comparing seedlings of the stored canola seed for 6 and 18 months.

Table (5): Effect of harvesting dates and storage periods on seedling length of canola (cm) (combined over 2007/ 2008 and 2008/ 2009 seasons).

Harvest date	Storage periods/months		
	0	6	18
75 DABF	10.0	9.2	8.1
82 DABF	10.5	10.4	8.6
89 DABF	12.0	11.4	10.2
96 DABF	12.5	12.2	11.3
L.S.D. at .05%	NS		

Table (6): Effect of harvesting dates and storage periods on seedling dry weight of canola (gm) (combined over 2007/ 2008 and 2008/ 2009 seasons).

Harvest date	Storage periods/months		
	0	6	18
75 DABF	0.209	0.148	0.127
82 DABF	0.338	0.155	0.136
89 DABF	0.423	0.287	0.165
96 DABF	0.474	0.289	0.167
L.S.D. at .05%	0.014		

Table (7): Effect of harvesting dates and storage periods on seedling vigour index of canola (combined over 2007/ 2008 and 2008/ 2009 seasons).

Harvest date	Storage periods/months		
	0	6	18
75 DABF	16	11	9
82 DABF	28	12	10
89 DABF	39	24	16
96 DABF	45	25	13
L.S.D. at .05%	2		

Electrical conductivity for leached canola seed significantly affected by the interaction between harvesting dates and storage periods as presented in Table, 8. Harvested canola seed after 75 days from beginning of flowering had the highest read of electrical conductivity for leached seed and it gradually decreased with increasing the period from beginning of flowering to harvest for 82, 89 and 96 days. This was an indicator for the increase of seed vigor with increasing the time from flowering to harvest. The more mature seed the higher germination percentage, seed vigor and seedlings vigor traits. On the other side, readings of electrical conductivity of leached seed and mean germination time gradually increased with prolong the storage period from 0 to 6 and 18 months. Also this was indicator for the decrease in seed vigour with increasing storage period.

Table (8): Effect of harvesting dates and storage periods on electrical conductivity *(mmohs/cm/g seed)* of soaked canola seed (combined over 2007/ 2008 and 2008/ 2009 seasons).

Harvest date	Storage periods/months		
	0	6	18
75 DABF	0.287	0.336	0.427
82 DABF	0.261	0.320	0.405
89 DABF	0.216	0.237	0.380
96 DABF	0.209	0.218	0.327
L.S.D. at .05%	0.013		

Data in Table (9) show the effect of interaction between harvesting dates and storage periods on physiological seed quality as measured by germination after aging was significant only in 2007/2008 season. Initially after harvest, accelerated aging germination of canola seed which harvested after 75 days from beginning of flowering was 60% in the first season. Meanwhile, harvested canola after 96 days from beginning of flowering recorded 69% germination after accelerated aging test. On the other hand, values of germination after aging reduced with increasing the storage period for 6 and 18 months. It is clear that seeds harvested at 89 and 96 days after beginning of flowering were less affected by aging treatment, compared to seed harvested at earlier time. It is apparent that environmental variation during seed maturity has little effect on the viability of canola seed, provided that the ripening processes are not interrupted by premature harvesting**.** On the other side, with increasing storage period means of germination after aging decreased and it is cleared that as the storage period increased seed vigor decreased.

Although, insignificant effects for the interaction between harvesting dates and storage periods on canola seed oil content in the two seasons, but seed oil content for the harvested canola early was less than the harvested lately. Also, seed oil content decreased with increasing the storage periods. The results of oil seed content had similar trend as those of germination testes before and after seed aging. Similar observation were reported by Elias and Copland (2001), they reported that the germination percentage and accelerated aging test of Topas Varity at physiological maturity was 79% and 70%, respectively. However, as the seeds reached harvesting maturity the gap between germination capacity and vigor was narrowed. Also, they found that total seed oil content was influenced by harvest date, the later the seed harvest, the higher oil content. From data In Tables 9 and 10, germination after accelerate aging test and seed oil content significantly affected with prolong harvesting date in the two seasons, while obtained canola seed from harvesting date 75 days after beginning of flowering produced the lowest means of seed germination after aging and seed oil content in the two seasons, meanwhile, increasing the period from beginning of flowering to harvest to 89 and 96 day resulted in the highest means of seed germination after aging and seed oil content in the two studied seasons.

Table (9): Effect of harvesting dates and storage periods on germination after accelerated aging (%) of canola seed in 2008/ 2009 and 2009/ 2010 seasons.

Harvest date	2007/ 2008			2008/ 2009		
	Storage periods/months			Storage periods/months		
	0	6	18	0	6	18
75 DABF	60	61	45	62	57	46
82 DABF	63	60	46	65	60	47
89 DABF	68	64	55	69	67	56
96 DABF	69	64	55	70	66	56
L.S.D. at .05%	2			NS		

Table (10): Effect of harvesting dates and storage periods on oil seed content (%) of canola in 2008/ 2009 and 2009/ 2010 seasons.

Harvest date	2007/ 2008			2008/ 2009		
	Storage periods/months			Storage periods/months		
	0	6	18	0	6	18
75 DABF	42.3	41.9	40.6	42.6	42.0	41.1
82 DABF	43.1	42.7	41.6	43.4	42.7	41.9
89 DABF	43.9	43.5	42.8	44.0	44.2	42.5
96 DABF	44.5	44.0	43.6	44.5	44.7	42.9
L.S.D. at .05%	NS			NS		

From the former results, harvesting canola seed after beginning of flowering with 75 days, seed moisture content were high and reached unsuitable levels for harvest or storage also 1000-seed dry weight not excesses 2.58 g and seed yield /plant was less than the later harvesting dates, McDonald and Phaneendranath,(1978) concluded that harvesting to early may result in low yield and seed quality, decrement of viability and seed germination. On the other side seed germination and seed vigour for the stored harvested seed at this time was low and did not rich the acceptance levels. Meanwhile, at the harvest dates 82 days and 89 days after beginning of flowering, seed moisture content decreased to 18.2% and 11.2%, 1000-seed weight increased to 2.88 and 2.95 g also seed germination and seed vigour were increased, while at this time canola seed may reached to the physiological maturity stage while Elias and Copeland, (2001) showed that, spring cultivars reached physiological maturity 36 and 37 days after pod formation, also seed germination and seedlings vigor increased from 82 days to 89 days from beginning of flowering at this time may meet the period between physiological maturity and harvesting maturity Khan, 1971,reported that after physiological maturity, physiological changes occurred as hormonal mechanism occurs after physiological maturity which can promote germination. On the other side, storage the harvested seed at this time for 18 months remained its germination percentage near to the standard level for the certified seed. Harvest canola seed at 96 days, from beginning of flowering seed moisture content decreased to 6.87 % , seed yield /plant decreased while at the late harvesting time after 96 days seed loss increased while, Oplinger *et al.,* (1989) reported that, harvesting too early may result in

low yield and poor seed quality, whereas harvesting too late may result in shattering and reduce seed yield. Under the experiment conditions seed yield and seed quality character can achieved through harvesting canola seed var. (Serw 4) at moisture content (18% to 10%) after 82 to 89 days from beginning of flowering.

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تأثير ميعاد الحصاد ومدة التخزين على محصول وجوده تقاوي الكانولا

إبراهيم فتحي مرسال, عبير الورد أحمد إبراهيم و فيصل إبراهيم يوسف
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يهدف هذا البحث إلى تحديد الميعاد الملائم لحصاد محصول الكانولا صنف سرو ٤ المزمع أعداده كتقاوي وكذلك تأثير مدة التخزين على جودة التقاوي. أجريت تجربتان حقليتان بمحطة البحوث الزراعية بالسرو محافظة دمياط التابعة لمركز البحوث الزراعية خلال موسمي ٢٠٠٨/٢٠٠٧ ، ٢٠٠٩/٢٠٠٨ . تم تخزين عينات التقاوي تحت الظروف العادية خلال الفترة من يوليو ٢٠٠٨ حتى نهاية يناير ٢٠١١. تم حصاد محصول الكانولا في أربعة مواعيد هي ٧٥، ٨٢، ٨٩، ٩٦ يوم بعد بداية التزهير وتم تخزين عينات من المحصول الناتج لمدد ٠، ٦، ١٨ شهر و أجريت تجارب تقدير حيوية التقاوي بمعامل وحدة بحوث تكنولوجيا البذور بالمنصورة

أوضحت النتائج أن الحصاد المبكر بعد ٧٥ يوم من بداية الإزهار أدى إلى انخفاض محصول البذور ونقص وزن ١٠٠٠ بذره وارتفاع مستوى الرطوبة بالبذور كذلك أدى إلى انخفاض إنبات وقوه البذور والباردات الناتجة مقارنه بمواعيد الحصاد الأخرى . أدى زياده الفترة من بداية الإزهار حتى الحصاد إلى زيادة محصول البذور/النبات وزيادة وزن ١٠٠٠ بذره , وزيادة نسبه الإنبات و جوده البذور الناتجة وانخفاض مستوى الرطوبة بالبذور إلى مستويات مناسبة للحصاد والتخزين.

أدى التأخير في ميعاد الحصاد إلى ٩٦ يوم من بداية الإزهار وتكوين القرون إلى انخفاض محصول البذور مقارنه بالحصاد بعد ٨٩ يوم من بداية الإزهار. أدى زيادة فترات التخزين حتى ١٨ شهر إلى انخفاض إنبات و قوه البذور و البادرات الناتجة مقارنه بالتخزين لمده ٦ شهور, خاصة البذور التي تم حصادها بعد ٧٥ يوم من بداية الإزهار.. إلا أن نسبه الإنبات كانت عند مستويات مقبولة للبذور التي تم حصادها بعد ٨٢ و ٨٩ يوم من بداية الإزهار.

من خلال هذه الدراسة فإنه تحت ظروف التجربة يمكن الحصول على محصول بذور مرتفع وكذلك بذور عاليه الجودة مع إمكانية تخزينها تحت ظروف الجو المفتوح لمده ١٨ شهر من خلال حصاد بذور الكانولا صنف سرو ٤ بعد ٨٢ إلى ٨٩ يوم من بداية الإزهار.

قام بتحكيم البحث

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