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Effect of Weed Control on Yield and Yield Components of Some Canola Varieties (*Brassica napus* L.)

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Abstract: Two field experiments were carried out at the Agricultural Experimental Station of the National Research Center at Shalakan, Qalubeia Governorate Egypt during the two successive winter seasons 2005/2006 and 2006/2007 to study the effect of weed control treatments (unweeded, one-hand hoeing, two-hand hoeing and pendimethalin (stomp) at a rate of 1.7 L/fed. as pre-emergence) on weed control, yield and its components of three "canola" varieties (Serw-4, Serw-6 and Pactol). Serw-4 variety gave the lowest total fresh and dry weight of associated weeds/m^2 at 45 and 60 days after planting compared to the other two varieties in both seasons. Two-hand hoeing at 21 and 35 days after planting decreased total fresh and dry weight of associated weeds and increased fresh and dry weight of canola plants at 45 and 60 days after planting. Also, it recorded an increasing in yield and its attributes in both seasons compared to other weed control treatments. Serw-4 cv., surpassed significantly in seed and biological yields (kg/fed.) as well as, number of seeds/pod, number of pods/plant, seeds/ plant (g) and oil (%) except 1000-seed weight compared to Serw-6 and Pactol varieties. The interaction between canola varieties and weed control treatments was significant. The most successful treatment applying was Serw-4 cv. with two-hand hoeing, followed by the same variety with pendimethalin (stomp) at a rate of 1.7 L./fed., as pre-emergence, of all studied characters in both seasons.

Key words: Canola varieties · Yield and Yield Components · Weed control

INTRODUCTION

In Egypt, there is a great shortage in edible oils and large amounts imported from abroad. The government policy to meet the increasing demands of oils is to rely on winter rapeseed crops. Canola (*Brassica napus* and *Brassica campestris*) is the major edible rapeseed oil crop. It is grown in more than 120 countries around the world. Canola seeds are not only a rich source of oil (40-45%), but also a source of good quality protein (25%).

It is well known that weeds interfere with crop plants causing serious impacts either in the competition for light, water, nutrients and space or in the allelopathy. Canola as a slowly growing crop is particularly exposed to severe competition from weeds. Weed suppression by shading only begins after the canopy of canola leaves grown over the rows and early covered the field. Faster growth of weeds is disadvantageous for light and hence photosynthesis needed for canola plants. Through this light deprivation less energy is available to crop plant for metabolic production and hence growth, yield and its quality of canola plant will be reduced. In addition, weeds with branched, vigorous root systems inhibit the development of canola plant through severe nutrition deprivation. According to the mentioned reasons, a linear decline was observed in seed yield of Indian mustard with increasing in weed population and biomass. Rose and Bell [1] pointed out that growing some weed species such as wild mustard (*Sinapis arvensis*) and stinkweed (*Thlaspi arvensis*) in canola fields reduced canola seed quality by increasing the level of erucic acid in the extracted oil and increasing the glucosinolates content of the remaining meal.

Hands hoeing still the conventional weed control practice in canola and in other row spacing field crops in Egypt. In recent years, the hand labor is becoming scare and their wages have been increased. However, the manual weeding could not be perfectly provided. This in turn presents to view the needs for another reasonable alternative. Herbicide treatment alone surpassed some hand hoeing treatments in this respect. Gill *et al.*, [2] reported that weeds cause enormous damage to the

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mustard crop and the magnitude of loss ranges from 30-50 % depending on the growth and persistence of weed population in standing crop. Weed competition not only decreases canola crop yield, but also reduces its quality and market value. Pendimethalin as pre-emergence at a rate of 1.0 kg/ha were on a par with one hand-hoeing in seed yield 1401 kg/ha and significantly superior to other weedy control Tiwari and Kurchania, [3].

Concerning weed control treatments, other studies Yadav, [4] and Chauhan *et al.*,[5] revealed that two hand hoeing increased seed, straw, biological and oil yields and their components such as (number of pods/plant, number of seeds/pod, seed yield/plant, 1000-seed weight (g), except seed oil content. Recently, low free erucic acid varieties are called now canola. In Egypt, it is revealed that canola (spring types) could be grown successfully in the winter season Sharaan, [6].The cultivated area by canola in Egypt is relatively small in this decade. This is due to the strong competition between canola and other strategic winter season crops such as wheat and Egyptian clover on the limited arable land in Nile valley and Delta. Therefore, this investigation was carried out to study the effect of weed control treatments on yield and yield components of some canola varieties.

MATERIALS AND METHODS

Two field experiments were carried out at the Agricultural Experimental Station of the National Research Center at Shalakan, Qalubeia Governorate during the two successive winter seasons 2005/2006 and 2006/2007 to study the effect of weed control treatments, on yield and its components of some "canola" (*Brassica napus* L.) varieties and associated weeds. The experimental design was split-plot with four replications. The main plots were devoted to the canola varieties (Pactol, Serw-4 and Serw-6), while weed control treatments (unweeded, one-hand hoeing at 21 days after planting (DAP), two-hand hoeing at 21 and 35 (DAP) and chemical herbicide pendimethalin (Stomp) at a rate of 1.7 L/fed. (one feddan = 4200m^2) as pre-emergence application were randomly occupied in the sub plots, respectively. The experimental unit area was 10.5 square meters consisting of ten rows (3.5 m long and 30 cm. between rows). Seeds were sown at a rate of 3.00 kg/ feddan in November 20th 2005/2006 and 2006/2007 growing seasons. The preceding crop was maize in the two successive seasons. Potassium fertilizer was added before sowing at a rate of 100 kg/fed., as potassium sulphate (48-50% K_2O), while nitrogen fertilizer has been added at a rate of 60 kg. N/fed., as ammonium nitrate (33.5%N) in two equal doses at 21 and 35 (DAP). Normal cultural practices of growing canola were conducted in the usual manner followed by the recommendations of this district.

At 45 and 60 DAP, weeds were hand pulled from one square meter in the middle of each plot, then the total fresh weight (g) for broad and grassy weeds were estimated, the fresh broad and grassy weeds were oven dried at 70°C till the constant weight and then the total dry weight in (g) was estimated. At the same growth periods, random samples of 5 canola plants from each plot were taken to estimate the fresh and dry weight (g) in the whole plant.

At harvest time, a random sample of ten plants from each plot were taken to determine some yield attributes such as number of pods/plant, number of seeds/pod, seed yield/plant (g) and 1000-seed weight (g).

Plants of one square meter from the middle rows of each plot were harvested. These plants were dried under sunshine for one week and seeds were cleaned after separated from the pods, then the seed, straw and biological yields (kg/feddan) were estimated.

Crude oil percentage in the seeds was determined according to A.O.C.S. [7] using Soxhlet apparatus and petroleum ether 40-60°C as a solvent.

Statistical Analysis: The analysis of variance procedure of split-plot design according to Snedecor and Cochran [8], treatments means were compared using Duncan's multiple range test [9] at 5% of probability.

RESULTS AND DISCUSSION

Data presented in Table 1 show that in both growing seasons, the total fresh and dry biomass of weeds at 45 and 60 DAP were significantly increased with Pactol cultivar followed by Serw-6, while the lowest was observed by Serw-4. Such increases in total fresh and dry weights in Pactol and Serw-6 are reflected to a decrease in the total fresh and dry weights of the whole plant at the same two growth stages. At the same time, the lowest content of total fresh and dry weights of weeds associated with Serw-4 resulted in an increase in total fresh and dry biomass of whole plant. This means that the Serw-4 cultivar seemed to be more competitive for both broad and grassy weeds than the other two cultivars. Martin *et al.*, [10] concluded that the effect of crop competition on weed growth resulted in a conservative estimate of the critical period of weed control.

Table 1: Effect of conola varieties and weed control on weeds (fresh and dry weight) in 2005/2006 and 2006/2007 seasons

	Total Weeds fresh Weight (g/m²)		Total Weeds Dry Weight (g/m²)	
Treatment	45 DAP	60DAP	45 DAP	60DAP
	2005/2006 Season			
Serw (4)	190.03c	346.05c	31.03c	65.59c
Serw (6)	224.74b	363.14b	36.89b	67.77b
Pactol	255.03a	381.74a	43.52a	70.43a
Unweeded	386.92a	643.51a	66.41a	114.84a
One hoeing	189.79b	294.37b	27.75b	60.67b
Two hoeing	93.07c	153.06c	17.28c	28.28c
	2006/2007 season			
Serw (4)	229.80c	317.51c	33.82c	53.14c
Serw (6)	248.52b	369.22b	38.19b	57.52b
Pactol	264.57a	411.07a	41.20a	63.16a
Unweeded	444.77a	685.16a	69.73a	104.55a
One hoeing	231.79b	320.84b	35.64b	65.32b
Two hoeing	109.69d	172.41d	18.32d	30.59d
Stomp (1.7L/fed)	204.28c	285.34c	27.26c	40.32c

The mens have the same letter (s) in the same column are non-significant
DAP: Days ofter planting.

Table 2: Effect of the interaction between canola varieties and weed control treatment on weeds in 2005/2006 and 2006/2007 seasons

		Total Weeds fresh Weight (g/m²)		Total Weeds Dry Weight (g/m²)	
Treament		45 DAP	60DAP	45 DAP	60DAP
		2005/2006 Season			
Serw (4)	Unweeded	327.24c	624.84c	55.03c	112.75c
	One hoeing	161.42f	272.85f	22.69f	57.99f
	Two hoeing	81.42i	140.48i	15.37i	60.03i
Serw (6)	Unweeded	387.81b	639.24b	65.26b	114.76b
	One hoeing	195.52e	296.76e	28.05e	60.62e
	Two hoeing	90.87h	253.44h	17.35h	27.92h
Pactol	Unweeded	445.71a	666.45a	78.94a	117.00a
	One hoeing	212.44d	313.51d	32.50d	63.40d
	Two hoeing	106.94g	165.28g	19.11g	30.90g
		2006/2007 season			
Serw (4)	Unweeded	418.05c	601.58c	64.63c	98.64c
	One hoeing	217.77g	282.34g	31.39g	52.00f
	Two hoeing	94.171	141.87l	15.73l	27.64k
	Stomp (1.7L/fed.)	189.22i	244.25i	23.53i	34.46i
Serw (6)	Unweeded	446.23b	704.25b	70.84b	104.20b
	One hoeing	233.05e	319.15f	37.31e	56.76e
	Two hoeing	110.04k	172.92k	18.77k	30.38j
	Stomp (1.7L/fed.)	204.77h	280.56h	25.85h	38.76h
Pactol	Unweeded	470.04a	749.64a	73.70a	110.80a
	One hoeing	244.56d	361.02d	38.23d	60.19d
	Two hoeing	124.86j	202.43j	20.47j	33.94i
	Stomp (1.7L/fed.)	218.84f	331.21e	32.41f	47.72g

The mens have the same letter (s) in the same column are non-significant
DAP: Days ofter planting.

In this concern, the weed management, data in Table 1 also indicated that in both growing seasons, using one-hand or two-hand hoeing resulted in a decrease of total fresh and dry weights of weeds associated with canola plants in comparison to the treatment had unweeded. In both growing seasons using two-hand hoeing resulted in a sharp decrease in total fresh and dry weights of weeds. However, in the 2nd season, when canola plants received chemical herbicide (pendimethalin) as pre-emergence treatment at a rate of 1.7 kg/fed., it decreased the total fresh and dry weights of weeds at 45 and 60 DAP in comparison to the treatments used one-hand hoeing or untreated (control plants). Singh *et al*., [11] reported that while the weed management methods significantly reduced the intensity of weeds and dry matter, two manual weeding at 25 and 45 days after sowing were found the most effective in reducing the intensity and dry matter accumulation of weeds over the other methods of the weed control.

The lowest fresh and dry weights of weeds under the treatments received two-hand hoeing is reflected to the increase in fresh and dry biomass of whole canola plants at 45 and 60 DAP in both growing seasons. This means that the least competition between growing weeds and canola plants due to the weed control management may encourage canola plants to grow well.

In this regard, at early application of pendimethalin (stomp) herbicide in Egypt was carried out by Fayed *et al*., [12], who reported that application of herbicide significantly decreased the fresh weight of total winter weeds in comparison to unweeded treatments. Also, Rajput *et al*., [13] concluded that, application of hand hoeing twice at 30 and 45 days after sowing resulted in a decrease in dry weight of weeds associated with Indian mustard plants.

Data also presented in Table 1 show that in both growing seasons the all three canola cultivars using two-hand hoeing resulted in a decrease in fresh and dry weights of weeds at 45 and 60 DAP. In the second season, the plants treated with herbicide pendimethalin showed an increase of both fresh and dry biomass of weeds over the treatment had two-hand hoeing.

However, the treatment received one-hand hoeing or unweeded treatment gave the highest fresh and dry weights of weeds in comparison to the treatment received chemical herbicide alone. In general the interaction between canola varieties and weed control treatments showed that, unweeded Pactol variety significantly increased fresh and dry weights of the weeds after 45 and 60 DAP, whereas Serw-4 x hand hoeing twice gave the lowest weed weights in the two seasons. In this respect, Doshora *et al*., [14] mentioned that amongst the

Table 3: Effect of canola varities and weed control on yield and yield components in 2005/2006 and 2006/2007

Treatment	No. of Pods/plant	No. of Seeds/plant	Seed Yield/plant (g)	1000-seed Weight (g)	Seed Yeild (kg /Fed.)	Straw Yield (Kg/fed.)	Biological Yield (kg/fed.)	Oil(%)
				2005/2006 season				
Serw (4)	212.91a	21.64a	14.02a	3.06a	973a	1398b	2371a	42.19a
Serw (6)	197.85b	20.86b	12.27b	3.04a	867b	1413a	2280b	41.80b
Pactol	191.56c	20.60c	12.07c	2.96b	836c	1310c	2146c	41.79c
Unweeded	193.68c	20.15c	11.23c	2.90c	718c	1254b	1972c	42.08a
One hoeing	199.83b	21.37b	13.03b	3.05b	848b	1263b	2111b	41.91a
Two hoeing	208.82a	21.58a	14.10a	3.12a	1110a	1603a	2713a	41.80a
				2006/2007 season				
Serw (4)	219.66a	19.47a	13.34a	3.11a	910a	1979a	2889a	42.11a
Serw (6)	210.31b	19.23b	12.36b	3.05b	859b	1924b	2783b	41.52b
Pactol	207.35c	18.34c	11.35c	2.97c	785c	1856c	2641c	41.46b
Unweeded	195.55d	18.49d	10.67d	2.94d	685d	1787d	2472d	41.74ab
One hoeing	213.13c	18.87c	12.10c	3.00c	787c	1824c	2611c	41.98a
Two hoeing	223.22a	19.53a	13.73a	3.14a	1066a	2147a	3213a	41.73ab
Stomp (1.7L/fed.)	217.85b	19.16b	12.89b	3.09b	867b	1921b	2788b	41.33b

The mens have the same letter (s) in the same column are non-significant

herbicidal treatments, pendimethalin at a rate of 0.75 kg/ha was found to be more affective. Similar observations were reported by Saudy, [15].

Data in Table 2 indicated that the lowest fresh and dry weights of weeds associated with Serw-4 cultivar was observed when that cultivar was treated by two-hand hoeing, that is true during 45 and 60 DAP. These findings are in line with those obtained by Singh *et al.*, [11] and Sharma and Jain, [16], who reported that the maximum dry matter were recorded in the weedy check at 45 DAP. The reduction in associated weeds with Serw-4 is reflected to increase the total fresh and dry biomass of whole canola plant under the same condition of two-hand hoeing treatments (Table 2).

The results presented in Table 3 show that the studied canola varieties were significantly different in all yield characters, except 1000-seed weight. Serw-4 variety surpassed the two other varieties in number of pods/plant, number of seeds/pod, seed yield/plant, seed and biological yields per feddan as well as oil (%). The positive relationship between number of pods and 1000-seed weight with seeds per plant and consequently with seed yield (kg/fed.) were reported by Ozer *et al.*, [17] and Mekki, [18]. Pactol variety recorded the lowest seed, straw and biological yields as well as seed oil percent (836, 1310, 2146 kg/fed. and 41.79 (%), respectively) in the 1st season. Canola variety Serw-6 exceed Pactol cv., yield and its components, it recorded the highest value of straw yield compared with the other two canola varieties, but Serw-4 variety was the best of canola varieties of the three studied in the 2nd seasons. This may be attributed to suitable Egyptian agro ecological conditions for growing the local varieties. These results are in agreement with those obtained by Ahmed *et al.*, [19], Keshta and Leilah [20] and Mekki, [21].

Seed yield and other yield components were also significantly affected due to application of different weed management. In general, data in Table 3 show that seed yield (kg/fed.) was significantly increased by using two-hand hoeing in both growing seasons in comparison to the treatments had one-hand hoeing or the treatment received chemical herbicide in the 2nd season. The highest seed yield (1087.70kg) as average of two seasons was obtained at two-hand hoeing followed by the treatment received pendimethalin as chemical herbicide in the 2nd season (867kg). Such increase in seed yield mainly due to the lowest weed intensity associated with canola plants as a result of direct effect of weed management method either by hand-hoeing twice or by using the Stomp herbicide. The increase in seed yield estimated by 55.05% over the treatment unweeded as average of two seasons, while the increase due to chemical herbicide estimated by 22.66% was over the unweeded treatment too. Similar findings were reported by Yadav, [4] who concluded that unchecked weeds caused nearly 37.5% seed yield loss with the minimum net returns.

On account of reduced weed biomass and weed density, it resulted in an increase of scalability of growth resources. Whytok *et al.*, [22] stated that the highest cost of weed control in relation to the often small effects of weed competition on yield suggest that herbicides are a good target for reducing the cost of inputs in oilseed rape. Similar observation was also reported by Tiwari and Kurchania, [3].

Table 4: Effect of the interaction between canola varieties and weed control treamens on yield and yield components of canola in 2005/2006 and 2006/2007 seasons

		Character							
Var.	Weed Control	No. of Pods/plant	No. of Seeds/pods	Seed Yield /Plant (g)	1000-Seed Weight (g)	Seed Yield (kg/fed.)	Straw Yield (Kg/fed.)	Biological Yield (kg/fed.)	Oil Seed (%)
				2005/2006 season					
Serw (4)	Unweeded	204.57c	20.75e	12.40f	3.01cd	757e	1255f	2012f	42.74a
	One hoeing	212.35b	21.80b	14.18b	3.07bc	918c	1281de	2199d	42.22ab
	Two hoeing	221.82a	22.37a	15.47a	3.11ab	1245a	1656b	2901a	41.89ab
Serw (6)	Unweeded	191.04f	19.86f	10.70g	2.82e	732f	1243f	1975g	41.60b
	One hoeing	197.36e	21.40c	12.57e	2.97d	825d	1293d	2118e	41.50b
	Two hoeing	205.15c	21.32c	13.52c	3.09ab	1044b	1702a	2746b	42.00ab
Pactol	Unweeded	185.41g	19.85f	10.57g	2.87e	664g	1267ef	1931h	41.60b
	One hoeing	189.79f	20.91de	12.34f	3.10ab	802d	1213g	2015f	41.99ab
	Two hoeing	199.49d	20.05d	13.31d	3.14a	1041b	1451c	2492c	41.79ab
				2006/2007 season					
Serw (4)	Unweeded	205.37i	18.83ab	11.73de	3.03a	704j	1808i	2512i	42.38ab
	One hoeing	219.71d	19.24ab	13.14a-d	3.10ab	825f	1874f	2699f	42.57a
	Two hoeing	229.08a	20.31a	14.68a	3.15a	1161a	2240a	3401a	42.05abc
	Stomp(1.7L/fed.)	224.48b	19.52ab	13.81ab	3.14a	949d	1995d	2944d	41.44bc
Serw (6)	Unweeded	194.4j	18.75ab	10.74ef	2.95a	687k	1788j	2475j	41.58abc
	One hoeing	211.15g	19.1ab	12.08cde	3.00a	802g	1817h	2619h	41.5bc
	Two hoeing	219.55d	19.67ab	13.65abc	3.15a	1069b2	177b	3246b	41.56abc
	Stomp(1.7L/fed.)	216.14e	19.37ab	12.97bcd	3.10ab	878e	1916e	2794e	41.22c
Pactol	Unweeded	186.89k	17.89b	9.56f	2.85a	6511	1779k	2430k	41.26c
	One hoeing	208.54h	18.27ab	11.08ef	2.90a	749i	17661	2515i	41.88abc
	Two hoeing	221.04c	18.6ab	12.87bcd	3.12a	958c	2023c	2991c	41.59abc
	Stomp(1.7L/fed.)	212.92f	18.58	11.90de	3.02a	774h	1852g	2626g	41.33bc

The mens have the same letter (s) in the same column are non-significant

Concerning, the biological yield was also significantly affected by different weed managements (Table 3). In both growing seasons, application of two-hand hoeing lead to an increase in the biological yield in comparison to the treatment had one-hand hoeing or unweeded. However, in the 2nd season when canola plants treated by chemical herbicide pendimethalin (stomp) significantly increased the biological yield over the treatment treated by one-hand hoeing or the control plants. The increase in biological yield estimated by 18.09 and 25.47% as average of two seasons, respectively. Such increases in the biological yield under two-hand hoeing may be attributed to the increase of seed yield and also the total dry biomass of the whole plants under the same condition of weed management treatments (Table 1, 2). Jat and Giri [23] concluded that the maximum increase in seed and biomass yields was recorded with pendimethalin, whereas hand-weeding proved to be equally effective. All the weed control methods significantly increased seed yield over unweeded (control) method is believed to be a direct or indirect expression of a reduction in weed-crop competition which significantly helped to increase seed yield Singh *et al*., [11].

Data presented in Table 3 show that the yield attributes mainly seed yield/plant, number of pods and seeds/pod as well as 1000-seed weight were significantly affected due to using different weed management methods. It is obvious that all the yield traits were significantly increased as a result to using two-hand weeding in comparison to the treatment had one-hand weeding or the control plants in the 1st season and also in comparison to the treatment received chemical herbicide in the 2nd season. The increase in yield traits due to two-hand hoeing treatment is reflected to the increase of final seed yield/fed. These results are in line with those obtained by Chauhan *et al*., [5], Saudy, [15], Sharma and Jain, [16] and Sharma *et al*., [24].

Data presented in Table 3 show that the seed oil percent under weed management, in the 1st season no trend was noticed due to application of hand hoeing treatments, the insignificant difference in oil % was observed. In the 2nd season, using one-hand hoeing gave the highest oil percent.

Concerning the interaction effect between the three canola varieties and different weed control methods, data in Table 4 indicated that seed and biological yields were significantly increased by using two-hand hoeing in the

1st season and also the treatment received chemical herbicide in the 2nd season. However, the treatment had chemical herbicide resulted in an increase in seed and biological yields over the treatment had one-hand hoeing, that is true in all cultivars used. Serw-4 cultivar yielded the highest seed yield (1245 and 1161kg) when the plants treated with two-hand hoeing in the 1st and 2nd seasons, respectively. At the same time, under the same condition of the hand-hoeing the same cultivar produced the highest values of biological yield in both growing seasons.

Yield components were also significantly affected by the interaction between canola cultivars x weed management methods. In general, the plants treated with two-hand hoeing or chemical herbicide pendimethalin produced more number of pods/plant in comparison to the plants had one-hand hoeing or control plants. However, in the 1st season Serw-4 produced more seed yield/plant, number of seeds/pod and also 1000-seed weight when it received two-hand hoeing. Also, Serw-6 variety recorded the highest value of straw yield with the same weed control treatment, while in the 2nd season the same cultivar produced the highest seed and straw yield /plant, as well as, 1000-seed weight with application of pendimethalin at a rate of 1.7 kg/fed., as pre-emergence. On the other hand, the seed oil content in all three cultivars seems to be the same values under all weed management treatments. However, Serw-4 cultivar produced the highest oil content in their seeds under the treatment had one-hand hoeing or unweeded (control) in both growing seasons (Table 4).

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