# Asian Journal of Plant Sciences

ISSN 1682-3974

Asian Journal of Plant Sciences 2 (12): 920-924, 2003
ISSN 1682-3974


# Effects of Trifluralin on Weed Spectrum and Yield of Canola (*Brassica napus* L.) Under Rainfed Conditions

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**Abstract:** Effects of 'trifluralin' as herbicide on weed spectrum and yield of canola were investigated in the field under rainfed conditions. Four application rates of herbicide were used as pre-plant soil incorporation. This study was carried out at the National Agricultural Research Centre (NARC), Islamabad for two growing seasons. Grassy, sedges and broad-leaf weeds were observed in the experimental field. Trifluralin applied @ 1.5 L. a.i. $ha^{-1}$ and 2.0 L. a.i. $ha^{-1}$ simultaneously had significant effects on total weed spectrum (density + biomass) of canola crop in both the growing seasons. Amongst different application rates of trifluralin, 1.5 L. a.i $ha^{-1}$ produced the highest seed yields of 1968 kg $ha^{-1}$ that was significantly ($p = 0.05$) higher than rest of the application rates during 1999-00. In 1998-99 growing season, the highest canola-seed yield of 1776 kg $ha^{-1}$ was also produced by 1.5 L. a.i. trifluralin $ha^{-1}$, which was remained at par with 1.0 L. a.i. trifluralin $ha^{-1}$. Both seed weight and seed yield of canola for the second season (1999-00) was higher than the first season (1998-99). However, the highest application rate (2.0 L. a.i. $ha^{-1}$) of the herbicide in both the seasons caused reduction in seed yield of canola that would be due to its phytotoxic effect on canola plants growth.

**Key word:** *Brassica napus*, trifluralin, weed biomass, seed weight, seed yield

## Introduction

Canola (*Brassica napus* L.), the especially bred rapeseed variety, is high yielding with oil low in erucic acid and oilseed cake low in glucosinolate. The oils, low in erucic acid are nutritionally more desirable for human health than the standard rapeseed oil. Similarly, standard rapeseed meal, with its high level of glucosinolates and resultant enzymatic hydrolysis breakdown products, can cause goiter and adversely effect on growth and reproductions in animals if fed at significant levels in diets. Thus, low-glucosinolate cakes make more desirable animal feed. Canola, the most important oilseed crop in North America, Europe and Australia, is recently introduced in Pakistan and it is becoming popular amongst the farming community of the barani (rainfed) areas of the country.

Weeds caused reduction in economic returns to canola growers through yield losses, associated with competition between the weeds and crop plants for light, water and nutrients (Blackshaw *et al.*, 1987; Mueller *et al.*, 1990). Further economic losses occur when harvested canola seeds are contaminated with weed seeds, particularly with cruciferous weeds (Mueller *et al.*, 1990). The mixed seeds of cruciferous-weed species are the serious problem when canola is processed into cooking oils and margarine as well as when the crop is grown for certified seeds. Wild-mustard seed increases the level of erucic acid in extracted canola oil, necessitating blending of high and low erucic acid oils to reduce the overall erucic acid level of the final product.

Control of weeds is therefore, essential to attain optimum yields and maintain canola-oil quality standard (Rose *et al.*, 1982; Thomas, 1984). Herbicide application affects the weed flora in the field crop through reduction of weed biomass and better crop growth through efficient uptake of nutrients by the crop plants that result in increased crop yield with better net return to the growers (Mishra and Kurchania, 2001). Trifluralin and Ethylfluralin are currently the most widely used herbicides in canola cultivation in North America, and they effectively control many weed species (Anonymous, 1991). Sandhu *et al.* (1998) reported that application of trifluralin and fluchloralin each @ 0.75 kg a.i. $ha^{-1}$ as pre-plant incorporation gave an effective control of both grass and broad-leaved weeds in *Brassica napus* L. The herbicide concentration in the soil varies with its rate of application and its incorporated depth that have significant effects on different weed flora and on crop yield and its quality. High volatility can result in poor performance of herbicide when no or poor incorporation was made (Smith *et al.*, 1973). Incorporation of herbicide too deeply may also reduce its effectiveness. Proper herbicide incorporation in soil places the herbicide close to the germinating weed seeds and thus enhances its effectiveness (Wisley *et al.*, 1989). This study was, therefore, conducted to determine the best application rate of trifluralin for optimum weed control through its effects on different weeds flora and the yields of canola under rainfed conditions.

**Materials and Methods**

This study was carried out in the field during 1998-99 and 1999-00 growing seasons under rainfed conditions at National Agricultural Research Centre, Islamabad. The soil was sandy-clay loam, composed of 61% sand, 28% clay, 11% silt, 0.95% organic matter and with pH of 8.1. Prior to seeding, fertilizer was broadcasted and incorporated into the soil. Nitrogen was applied @ 90 Kg N $ha^{-1}$ and Phosphorus was @ 60 Kg $P_2O_5$ $ha^{-1}$ each year. The sources of nitrogen and phosphorus fertilizers were urea and diammonium phosphate (DAP).

Canola-type rapeseed variety "Shiralee" was used as test crop. The crop was seeded in mid of October each year one day after herbicide application at seeding rate of 6-Kg $ha^{-1}$ at a depth of 3-4 cm with 40 cm row spacing. The seeding was done with single row hand drill. Herbicide 'trifluralin' [2, 6-dinitro-N, N-dipropyl-4-(trifluoro-methyl) benzenamine] was used at four different rates, 0.5, 1.0, 1.5, 2.0 L a. i. $ha^{-1}$. Mechanical weeding and weedy control were included in the experiments. Herbicide was applied to soil surface with water using @140 L $ha^{-1}$ with a knapsack sprayer with a pressure of 275 KPa prior to seeding and incorporated to a depth of 7-8 cm. Experimental treatments were arranged in a randomized complete block design (RCBD) with four replications. Plot size was 4 x 5m.

Weed density was determined by counting the number of weed plants of each species from three randomly selected 1.0 sq. m. quadrant from each treatment in the first week of December. Then, these weed plants were used for determining the weed biomass by drying them in the oven at 75$^0$C. Yield components were measured at harvesting of the experimental crop by randomly selecting of ten plants from each treatment. Seed yield was measured by harvesting the four central lines of each plot. Harvested samples were sun dried, threshed manually, and cleaned to determine the 1000-seed weight and seed yield. Thousand-seed weight was calculated from the weight of 100 hand-counted seeds. The seeds were randomly drawn from the bulk seed-yield samples from each treatment.

MSTAT-C Computer Programme was used to analyze the data for weed species, yield and yield components of canola rapeseed.

**Results and Discussion**

Broad-leaf weeds, sedges and grasses were observed in the experimental field during both growing seasons (Table 1, 2). The maximum weed species were recorded as broad-leaf weeds followed by grasses. Among the broad-leaf weeds, *Lathyrus aphaca* was highest in number followed by *Rumex dentatus* during 1998-99 and 1999-00 growing seasons. Sedges (*Cyperus rotundus*) after broad-leaf weeds were ranked second followed by grasses during both growing seasons. Weed density and weed biomass were found highest in the control treatments during both seasons (Table 1, 2). However, both weed density and weed biomass were higher during growing season of 1998-99 than that of 1999-00. Application of 'trifluralin' @ 2.0 L a.i. $ha^{-1}$ significantly reduced not only the weed density but also the weed biomass in the growing season of 1999-00 followed by the application rates of 1.5 L a.i. $ha^{-1}$, 1.0 L a.i. $ha^{-1}$ and then by mechanical weeding measures. While, in 1998-99 growing season, the use of trifluralin @ 1.5 L a.i. $ha^{-1}$ significantly affected weed spectrum followed by the application rate of 2.0 L a.i. $ha^{-1}$. These findings were in consisted with the earlier studies (Mukhtar *et al.*, 1991; Kirkland, 1996; Lueschen *et al.*, 1997; Sandhu *et al.*, 1998; Mishra and Kurchania, 2001). Use of 'trifluralin' @ 1.5 L a.i. $ha^{-1}$ produced more consisted effects on weed spectrum (Weed density + biomass), than rest of the application rates of trifluralin during both seasons. Earlier study of El-Bastawesy *et al.* (1991) also revealed similar response of 'trifluralin' when used @ 1.5 liters a.i. per hectare. Minimum weed control amongst different application rates of 'trifluralin' observed in the plot where it was applied @ 0.5 L a.i. $ha^{-1}$. This would be due to low herbicide concentration existed in the soil owing to the low application rate of 'trifluralin'. The broad-leaf weed, *R. dentatus* was controlled more significantly by all application rates of 'trifluralin', while *Lathyrus aphaca* had least response to trifluralin. Similarly, *Sorghum halepens* was also affected significantly by the herbicide followed by *C. rotundus and Cynodon dactylon.* The trend of weed response to herbicide was almost similar throughout both the crop-growing seasons.

'Trifluralin' had significant effect on crop stand of 1998-99 and 1999-00 crop seasons. The lowest plant density was recorded in the plots where trifluralin was applied @ 2.0 L a.i $ha^{-1}$. This would be due to phytotoxic effect of trifluralin because of its high rate of application that might resulted in its high concentration in the soil and caused mortality of canola seedlings. The crop-plant density was slightly higher in 1998-99 than 1999-00 growing season.

The effects of different weeding measures on the number of branches per plant were also found significant in both the seasons (Table 3, 4). The lowest number of branches per plant (3.2, 3.0) was recorded in the weedy check that would be due to high weed density. Among the herbicide-application rates, the maximum number of branches per plant (5.8, 8.0) were observed in the plot where trifluralin was applied @ 1.5 L. a.i. $ha^{-1}$. The number of branches per plant was higher (8.0) in 1999-00 than (5.8) 1998-99. Similar effects of trifluralin on branches development of rapeseed

Table 1: Effect Of Trifluralin On Weed Spectrum of *Brassica napus*, 1998-99

| Treatments | *Lathyrus aphaca* | *Euphorbia helioscopia* | *Rumex dentatus* | *Cyprus rotundus* | *Sorghum halepens* | *Cynodon dactylon* | Total |
|---|---|---|---|---|---|---|---|
| **Weed density ($m^2$)** | | | | | | | |
| Control | 22.00a | 03.75a | 05.25a | 14.50a | 06.25a | 09.50a | 61.25a |
| Weed free | 15.25ab | 00.50b | 02.25b | 09.50ab | 00.25b | 08.75ab | 39.00b |
| 0.5 L ai $ha^{-1}$ | 15.75ab | 00.00b | 00.80c | 15.00a | 00.50b | 04.00bc | 35.25b |
| 1.0 L ai $ha^{-1}$ | 07.00bc | 00.00b | 00.00c | 08.50ab | 00.25b | 04.50bc | 20.25c |
| 1.5 L ai $ha^{-1}$ | 03.00c | 00.25b | 00.00c | 05.50b | 00.85b | 02.75c | 12.50c |
| 2.0 L ai $ha^{-1}$ | 04.75c | 00.00b | 00.50bc | 04.50b | 00.50b | 03.00c | 13.25c |
| Lsd (0.05) | 9.27 | 1.57 | 1.79 | 7.92 | 2.33 | 4.82 | 13.77 |
| **Weed biomass ($g\ m^{-2}$)** | | | | | | | |
| Control | 07.47a | 02.17a | 03.09a | 05.92a | 02.84a | 05.58a | 27.08a |
| Weed free | 02.86b | 00.73b | 00.30b | 01.09b | 00.01b | 04.07ab | 09.07b |
| 0.5 L ai $ha^{-1}$ | 02.27bc | 00.00b | 00.16b | 02.83b | 00.27b | 03.42ab | 10.30b |
| 1.0 L ai $ha^{-1}$ | 01.53bc | 00.00b | 00.00b | 01.34b | 00.37b | 02.28ab | 05.52bc |
| 1.5 L ai $ha^{-1}$ | 00.46c | 00.02b | 00.00b | 01.11b | 00.16b | 01.05b | 02.81c |
| 2.0 L ai $ha^{-1}$ | 00.78bc | 00.00b | 00.06b | 01.38b | 00.18b | 00.66b | 03.09c |
| Lsd (0.05) | 2.35 | 0.97 | 0.81 | 2.12 | 0.92 | 3.52 | 5.06 |

Note: The treatments following the same letters are not significantly different from each other at 5% level of significance.

Table 2: Effect Of Trifluralin On Weed Specturm of *Brassica napus*, 1999-00

| Treatments | *Lathyrus aphaca* | *Euphorbia helioscopia* | *Rumex dentatus* | *Cyprus rotundus* | *Sorghum halepens* | *Cynodon dactylon* | Total |
|---|---|---|---|---|---|---|---|
| **Weed density ($m^2$)** | | | | | | | |
| Control | 20.50a | 03.75a | 05.00a | 14.00a | 06.50a | 09.25a | 59.00a |
| Weed free | 09.00bc | 00.25b | 02.25b | 09.00ab | 00.50b | 06.75ab | 27.75bc |
| 0.5 L ai $ha^{-1}$ | 14.00ab | 00.00b | 00.00c | 14.00a | 00.50b | 04.00bc | 32.50b |
| 1.0 L ai $ha^{-1}$ | 06.25c | 00.00b | 00.00c | 06.75b | 00.45b | 04.50bc | 17.75cd |
| 1.5 L ai $ha^{-1}$ | 02.75c | 00.25b | 00.00c | 04.25b | 00.85b | 02.75c | 10.75d |
| 2.0 L ai $ha^{-1}$ | 03.75c | 00.00b | 00.50bc | 02.75b | 00.50b | 02.25c | 09.75d |
| Lsd (0.05) | 7.20 | 1.61 | 1.79 | 7.07 | 2.21 | 3.75 | 11.21 |
| **Weed biomass ($g\ m^{-2}$)** | | | | | | | |
| Control | 06.47a | 02.17a | 02.85a | 05.42a | 02.84a | 05.33a | 25.10a |
| Weed free | 01.87b | 00.48b | 00.30b | 01.09bc | 00.21b | 02.32b | 06.27b |
| 0.5 L ai $ha^{-1}$ | 02.02b | 00.00b | 00.00b | 02.58b | 00.27b | 02.17b | 07.60b |
| 1.0 L ai $ha^{-1}$ | 01.03b | 00.00b | 00.00b | 01.34bc | 00.16b | 01.28b | 04.02bc |
| 1.5 L ai $ha^{-1}$ | 00.21b | 00.02b | 00.00b | 00.44c | 00.20b | 00.55b | 01.52c |
| 2.0 L ai $ha^{-1}$ | 00.53b | 00.00b | 00.06b | 00.36c | 00.18b | 00.46b | 01.49c |
| Lsd (0.05) | 1.90 | 0.72 | 0.06 | 1.60 | 0.92 | 2.33 | 4.29 |

Note: The treatments following the same letters are not significantly different from each other at 5% level of significance.

Table 3: Effect of trifluralin on yield and yield components of *Brassica napus*, 1998-99

| | Yield components | | | | | |
|---|---|---|---|---|---|---|
| Treatments | Plant density ($m^{-2}$) | Branches/ plant | Pod/ plant | Seeds/ Pod | 1000-Seed Weight (g) | Seed yield (kg $ha^{-1}$) |
| Control | 35.7ab | 3.2 c | 56.7c | 20.7c | 2.9b | 1164b |
| Weed free | 25.7c | 5.0 ab | 91.7ab | 25.0b | 3.4b | 1471ab |
| 0.5 L $ha^{-1}$ | 32.5abc | 4.2 abc | 77.7bc | 23.0bc | 3.3b | 1338b |
| 1.0 L $ha^{-1}$ | 32.0abc | 3.8 bc | 91.0ab | 24.0b | 3.3b | 1460ab |
| 1.5 L $ha^{-1}$ | 40.0a | 5.8 a | 112.8 a | 27.7a | 4.4a | 1776a |
| 2.0 L $ha^{-1}$ | 28.2bc | 5.2 ab | 89.7b | 24.7b | 3.3b | 1306b |
| Lsd (0.05) | 9.38 | 1.50 | 22.0 | 2.49 | 0.52 | 345.6 |

Note: The treatments following the same letters are not significantly different from each other at 5% level of significance.

Table 4: Effect of trifluralin on yield and yield components of *Brassica napus*, 1999-00

| | Yield components | | | | | |
|---|---|---|---|---|---|---|
| Treatments | Plant density ($m^{-2}$) | Branches/ plant | Pod/ plant | Seeds/ Pod | 1000-Seed Weight (g) | Seed yield (kg $ha^{-1}$) |
| Control | 31.5a | 3.0d | 59.2c | 21.0e | 2.8d | 1181d |
| Weed free | 31.5a | 6.5b | 107.0a | 27.0b | 3.9b | 1585b |
| 0.5 L $ha^{-1}$ | 30.0ab | 4.3c | 89.3b | 24.7cd | 3.3c | 1316cd |
| 1.0 L $ha^{-1}$ | 30.0ab | 4.0cd | 91.0b | 25.0c | 3.3c | 1423bc |
| 1.5 L $ha^{-1}$ | 32.2a | 8.0a | 116.8a | 28.98a | 4.5a | 1968a |
| 2.0 L $ha^{-1}$ | 26.2b | 3.5cd | 80.0b | 23.7d | 3.4c | 1272cd |
| Lsd (0.05) | 4.08 | 1.20 | 13.25 | 1.95 | 0.44 | 180.6 |

Note: The treatments following the same letters are not significantly different from each other at 5% level of significance.

plants was also reported by Lueschen *et al.* (1997). The use of 'trifluralin' @ 2.0 L a. I. $ha^{-1}$ slightly reduced the number of branches per plant in both the seasons that may be due to phytotoxic effects of the herbicide applied at high rate that might retarded development of the plant branches. The number of branches per plant was higher in the second growing season (1999-00) than the first season (1998-99).

Number of seeds per plant were remained lowest (20.7, 21.0) where no weeding was done in both seasons, whereas different weeding measures increased the number of seeds per pod significantly during both the seasons. The maximum number of seeds per pod (27.7, 28.98) were observed in those herbicidal treatments where trifluralin was applied @ 1.5 L a.i. $ha^{-1}$ during both growing seasons followed by the plots where mechanical weeding was done. These results were in agreement with the findings of Lueschen *et al.* (1997) and Bali *et al.* (1998). Seeds per pod were higher during 1999-00 than that of 1998-99 growing season. On the other hand use of 'trifluralin' @ 2.0 L a. I. $ha^{-1}$ decreased the seed number in both the years. This might be due to retardation of plant growth because of high herbicide concentration present in the soil.

The 1000-seed weight was also affected significantly by weeding measures during both growing seasons. The maximum seed weights of 4.4 and 4.5 grams per 1000 seeds were observed from the treatments where weeds were controlled by the herbicide, applied @ 1.5 L a.i. $ha^{-1}$ in the growing seasons of 1998-99 and 1999-00, respectively followed by the treatments where weeds were controlled by mechanical means (Table 3, 4). The lowest weights of 2.9 and 2.8 g of the 1000-seed were recorded from those treatments where no weeding measure was done. However, the overall weight of 1000-seed of the canola crop grown during 1999-00 crop season was higher than that of 1998-99 season.

Effects of weeding measures both chemical and mechanical on the seed yield were observed significant (Table 3, 4) and it was found in agreement with the earlier studies of El-Bastawesy *et al.* (1991) and Gaweesh & Bially (1991) who had also reported significant effect of 'trifluralin' on rapeseed yield in their respective studies. The minimum seed yields of 1164 kg and 1181kg $ha^{-1}$ were recorded from the control treatments during 1998-99 and 1999-00 seasons, respectively. Among the herbicide application rates, use of 'trifluralin' @ 1.5 L a.i. $ha^{-1}$ produced maximum seed yield of 1776-Kg $ha^{-1}$ and 1968 kg $ha^{-1}$ during 1998-99 and 1999-00, respectively. The second highest seed yields of 1471 kg $ha^{-1}$ and 1585 kg $ha^{-1}$ were harvested from the areas where mechanical means was used to control the weeds of canola crop during 1998-99 and 1999-00, respectively. Similar trend in seed increase was also reported by earlier studies (Ray, 1986; Shafiullah *et al.*, 1990; Bali *et al.*, 1998; Lueschen *et al.*, 1997). The increase in seed yield would be due to minimal competition between weed and crop plants for nutrient, moisture, light etc (Blackshaw *et al.*, 1987 and Mueller *et al.*, 1990). Seed yield of canola during 1999-00 was higher than that of 1998-99. This may be due to better weather conditions which might favoured the crop growth, consequently increased crop-seed yield. Further, the weed competition with crop plants was also lower during 1999-00 than 1998-99 growing season, which certainly helped the crop plants to attain maximum growth rate, subsequently resulted in higher seed yield. The use of 'trifluralin' with high application rate (2.0 L a.i. $ha^{-1}$) caused reduction in seed yield that would be due to its phytotoxic effect on crop stand and its growth rate.

Study, based on two year data, concludes that use of 'trifluralin' as pre-plant soil incorporation, @ 1.5 L a.i $ha^{-1}$ improved the canola-seed yield by minimizing the crop-weed competition for crop light, plant nutrients and soil moisture for crop plants growth and development and ultimately seed yield. Thus, canola growers can get better economic return by controlling the canola weeds by using trifluralin @ 1.5 L a.i $ha^{-1}$ through its proper incorporation in the soil a day before crop seeding under rainfed conditions.

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