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EFFICACY OF DIFFERENT PRE AND POST-EMERGENCE HERBICIDES FOR WEED MANAGEMENT IN CANOLA IN HIGHER ALTITUDES*

Khan Bahadar Marwat[1], Muhammad Saeed[1], Bakhtiar Gul[1], Zahid Hussain[1] and Nayyar Iqbal Khan[2]

ABSTRACT

To evaluate the effect of different pre and post-emergence herbicides for controlling weeds in rapeseed (variety Oskar), an experiment was conducted at Agriculture Research Station, Mingora during rabi season 2003–04, using randomized complete block (RCB) design, keeping four replications. The experiment was sown in mid-October, having eight treatments, viz; seven herbicides, a hand weeding and a weedy check. Each treatment consisted of 4 rows 75 cm apart and 4 m long thus giving a total size of 4m x 3m. The pre-emergence herbicides included; s-metolachlor @ 1.92 kg, pendimethalin @ 1.32 kg and trifluralin @ 1.2 kg, while the post-emergence herbicides were fenoxaprop-P-ethyl @ 0.75 kg, clodinafop @ 0.05 kg, oxadiazon @ 0.36 kg and propaquizafop @ 0.02 kg a.i ha^{-1}. The data were recorded on weeds density m^{-2}, fresh weed biomass (kg ha^{-1}), number of branches plant^{-1}, number of siliquae plant^{-1}, siliqua length (cm), plant height at maturity (cm), number of seeds siliqua^{-1}, 1000 seeds weight (g), seed yield (kg ha^{-1}) and cost-benefit ratio. The data recorded on weeds density m^{-2}, fresh weeds biomass (kg ha^{-1}) and seed yield (kg ha^{-1}) were significantly affected by the different herbicidal treatments. Pendimethalin treatment exhibited the best performance, with minimum weeds m^{-2} (13.5)and fresh weeds biomass (257.9 kg ha^{-1}) as compared to weedy check (38 m^{-2}) and (806 kg ha^{-1}), respectively. Similarly, maximum number of branches plant^{-1} (6.89), number of siliquae plant^{-1} (301), siliqua length (6.8 cm), number of seeds siliqua^{-1} (25.8), 1000 seeds weight (3.99 g), seed yield (1692 kg ha^{-1}) and cost-benefit ratio (1:7.47) were recorded in pendimethalin treated plots as compared to weedy check having (5.69), (216), (6.3 cm), (21.6), (3.62 g) and (1119 kg ha^{-1}), respectively.

Key words: Rapeseed, canola, weed control, herbicides, seed yield.

INTRODUCTION

Rapeseed and canola (*Brassica napus*; *B. campestris*, *B. juncea*) are the main oil producing crops in Pakistan. They are grown in rabi season and have remained the major sources of edible oil in the subcontinent for decades. The Canadian oilseed-breeding programme developed the sweet mustard or canola, which is a high producing type of mustard. It has a better taste as well as highest level of unsaturated fatty acid and thus helps lower blood cholesterol level. It is also a rich source of oil and protein and contains more than 40% oil (Weiss,

[1]Department of Weed Science, NWFP Agricultural University, Peshawar –Pakistan.
[2]Hazara Agricultural Research Station, Abbottabad – Pakistan.
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1983). Canola has recently been introduced to our country to increase the domestic edible oil production. It is rapidly replacing the older varieties of rapeseed and mustard.

In Pakistan, the area under rapeseed and mustard cultivation during 2002-03 was 280 thousand hectares with an average production of 837 kg ha^{-1}. While in NWFP the total area under rapeseed and mustard cultivation was 19.1 thousand hectares with an average production of 447 kg ha^{-1} (Anonymous, 2003). The low acreage of rapeseed is partially due to its sowing season that overlaps with the wheat-sowing season. As wheat is the staple food crop, therefore, lesser attention is given to oilseed crops. That's why mustard is only grown on almost rain fed and less fertile areas. As a result, not enough edible oil is produced to fulfill the domestic requirement. Edible oil is the second most important import item after petroleum. Canola is a smother crop because of its larger leaves, rapid growth and early canopy closing. Still weed competition is very critical during the early stand establishment particularly the parasitic weed, *Orobanche* sp. (Joel *et al.* 1995).

Weeds decrease oil production as well as the oil quality. Several methods have been in use for weed control in canola, like hand weeding, cultivation in row cropping and use of chemicals. But most reliance is made on chemical weed control, as it is comparatively more independent of weather, cheap and saves labor. Pre-emergence herbicides are more effective than post-emergence or manual control methods (Rapparini, 1996). Khan *et al.* (1995) suggested the use of post-emergence plus hand weeding if proper pre-emergence herbicides are unavailable. Keeping in view the importance of the different herbicides for controlling weeds in canola, this experiment was conducted to select the most effective, economical and accessible herbicide.

MATERIALS AND METHODS

In order to study the impact of different herbicides on rapeseed (*Brassica napus* L.)" an experiment was sown at Agriculture Research Station, Mingora during 2003-04 on 15^{th} October 2003 using Oskar variety of rapeseed applying seed rate of 5 kg ha^{-1}. The experiment was laid out in randomized complete block (RCB) having 9 treatments replicated 4 times. The 9 treatments were Dual Gold 960EC, Stomp 330EC, Treflan 4EC, Puma Super 75EW, Topik 15WP, Ronstar 12L, Agil 100EC, a hand weeding and a weedy check. Each treatment had a size of 4m x 3m having 4 rows with row-to-row distance of 75 cm. Details of the treatments used in the experiment are shown in Table-1 as under:

Table-1. Detail of treatments in the experiment.

S.No.	Treatment	Common name	Application time	Rate (kg a.i ha^{-1})
1.	Dual Gold 960 EC	s-metolachlor	Pre-em.	1.92
2.	Stomp 330 EC	pendimethalin	Pre-em.	1.32
3.	Treflan 4 EC	trifluralin	PPI	1.20
4.	Puma super 75 EW	fenoxaprop-P-ethyl	Post-em.	0.75
5.	Topik 15 WP	clodinafop	Post-em.	0.05
6.	Ronstar 12 L	oxadiazon	Post-em.	0.36
7.	Agil 100 EC	propaquizafop	Post-em.	0.02
8.	Hand weeding	--	--	--
9.	Weedy check	--	--	--

Trifluralin was first incorporated into the soil and the pre-emergence herbicides were applied one day after sowing. The post-emergence herbicides were sprayed at 2-3 leaf stage of the crop after the second application of nitrogen fertilizer.

Data were recorded on weed density m^{-2}, fresh weed biomass (kg ha^{-1}), number of branches $plant^{-1}$, number of siliquae $plant^{-1}$, siliqua length (cm), plant height at maturity (cm), number of seeds $siliqua^{-1}$, 1000 seeds weight (g), seed yield (kg ha^{-1}) and cost-benefit ratio. The data recorded were individually subjected to the ANOVA Technique by using MSTATC computer software and means were separated by using Fisher's LSD test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Weeds density m^{-2}

The statistical analysis of the data showed that there was significant ($P<0.05$) effect of different herbicides on the weeds density. The data in Table-2 showed that maximum weeds m^{-2} (38) were recorded in the weedy check. Minimum weeds m^{-2} (13.5) were recorded in Stomp 330 EC treatments. The density in Stomp 330 EC treatment was however statistically at par with the rest of the herbicidal treatments along with the hand weeding. The reason for the minimum weeds in the Stomp 330 EC treated plots may be due to its strong killing effect on the weeds while the maximum weeds in the weedy check plots may probably be due to the fact that the weeds are left to grow freely without any disturbance. The difference in weed population in different treatments can be attributed to the fact that some herbicides are more effective for weed control than the other. Similar results have been reported by Tiwari and Kurchania (1993) and Khan *et al.* (2003). Lolas (1997) also reported that herbicides could effectively control weeds.

Fresh weed biomass (kg ha^{-1})

The analysis of variance recieved that different herbicidal treatments had significant effect ($P<0.05$) on weed biomass. The data in Table-2 indicated that minimum weed biomass (257.9 kg ha^{-1}) was found in Stomp 330 EC treated plots. However, it was statistically at par with Treflan 4 EC. Maximum weed biomass (806 kg ha^{-1}) was obtained in the weedy check. The difference in the weeds biomass in different treatments can be due to the phytotoxic effect of different herbicidal treatments. These findings have also been observed by Tiwari and Kurchania (1993). It is argued that pre-plant-incorporated or pre-emergence herbicide treatments are indispensable, controlling many weeds before they emerge. Weed biomass is reduced through the use of chemicals, which ultimately favours the yield (Lolas, 1997 and Sing et al, 2000).

Number of branches $plant^{-1}$

Analysis of the data indicated that different herbicides had non-significant effect on the number of branches $plant^{-1}$. The data pertaining to number of branches $plant^{-1}$ as affected by different herbicidal treatments are presented in Table-2, which reflected that maximum number of branches $plant^{-1}$ (6.89) were recorded in Stomp 330EC treatment, while minimum number of branches $plant^{-1}$ (5.69) were counted in the weedy check. The results are in agreement with those reported by Singh *et al.* (1995) while Khan *et al.* (2003) also stated that application of some herbicides increases number of branches $plant^{-1}$ in rape and mustard.

Number of siliquae plant^{-1}

The analysis of variance of the data showed that different herbicides had non-significant effect on the number of siliquae plant^{-1} (Table-2). The highest number of siliquae plant^{-1} (301) were recorded in Stomp 330EC treated plots while lowest number (216) was noted in weedy check. The results are in conformity with those reported by Thomas (1998) who showed that herbicides efficiently enhance the yield components, while Khan *et al.* (1995) reported that application of some herbicides increases the number of siliquae plant^{-1} in rapeseed.

Siliqua length (cm)

The analysis of the data exhibited that different treatments had non-significant effect on siliqua length (Table-2). Maximum siliqua length (6.8 cm) was recorded in Stomp 330EC treated plots. The minimum siliqua length was observed in weedy check (6.3 cm). The result is supported by Raghavan and Hariharan (1991) and Khan *et al.* (2003) who stated that pre-emergence herbicides improve the siliqua length in the rapeseed crop.

Plant height at maturity (cm)

The effect of different treatments on plant height was non-significant. The data for plant height at maturity given in Table-3 indicated that treatments the weedy check plots possessed the highest plants (143.4 cm) while the hand weeding treatment had the minimum plant height (127.2 cm). The competition of the rapeseed plants with the weeds in the weedy check plots forced the crop plants to rise higher than their normal heights. All the herbicidal treatments possessed almost statistically equal plant height comparable with that of weedy check. Similar results have been reported by Khan *et al.* (2003) who stated that there was non-significant increase in the plant height with the application of some herbicides.

Number of seeds siliqua^{-1}

The analysis of the data revealed that number of seeds siliqua^{-1} was not significantly affected by various herbicidal treatments. The data in Table-3 exhibited the highest number of seeds siliqua^{-1} (25.75) that was obtained from Stomp 330EC treatment, while the lowest number of seeds siliqua^{-1} (21.63) was found in the weedy check. The highest number of seeds siliqua^{-1} obtained from Stomp 330EC treatment was perhaps due to its best phytotoxic effect on weeds, while the lowest number of seeds siliqua^{-1} obtained from weedy check plots were probably due to the weed competition against the rapeseed plants which might have greatly reduced the flow of nutrients towards the seeds in pods. These results are in line with those reported by Yadav *et al.* (1995) who stated that number of seeds siliqua^{-1} increases with the application of some herbicides.

1000 seeds weight (g)

The analysis of variance of the data showed that herbicides had insignificant effect on 1000-seeds weight. Data regarding effect of different herbicides on thousand seeds weight are given in Table-3. The plots treated with Stomp 330 EC gave the highest thousand seeds weight (3.99 g) while the weedy check plots exhibited the lowest thousand seeds weight (3.62 g). The reason for the lowest seed weight in the weedy check plots might be the weed competition offered by the weeds against the crop plants. These results are similar to those reported by Yadav *et al.* (1995) and Khan *et al.* (2003) who mentioned that seed weight increases with the use of chemical method of weed control.

Table-2. Effect of different herbicdes on weed density and biomass and number of branches, number of Siliquae and Siliqua length in canola

Treatments	Weed density m^{-2}	Fresh weed biomass (kg ha^{-1})	No. of branches $plant^{-1}$	No. of siliquae $plant^{-1}$	Siliqua length (cm)
Dual Gold 960 EC (s-metolachlor)	18.0 ab*	520.8 ab*	6.15	260	6.69
Stomp 330 EC (pendimethalin)	13.5 b	257.9 b	6.89	301	6.80
Treflan 4 EC (trifluralin)	17.8 ab	296.6 ab	6.56	272	6.77
Puma super 75 EW (fenoxaprop-P-ethyl)	22.3 ab	653.8 ab	6.00	242	6.44
Topik 15 WP (clodinafop)	21.8 ab	590.0 ab	6.00	247	6.48
Ronstar 12 L (oxadiazon)	29.3 ab	682.9 ab	5.81	229	6.42
Agil 100 EC (propaquizafop)	26.5 ab	654.6 ab	5.88	239	6.43
Hand Weeding	19.0 ab	540.4 ab	6.00	251	6.62
Weedy check	38.0 a	806.0 a	5.69	216	6.30
LSD at 0.05α level	21.23	522.8	N.S	N.S	N.S

*Means followed by different letters in the respective column are significantly different at 5% probability level according to LSD test.

Seed yield (kg ha^{-1})

Analysis of variance of the data depicted that different herbicides had significant ($P<0.05$) effect on the seed yield. Table-3 shows the effect of different herbicide treatments on the seed yield. The data indicated that maximum seed yield (1692 kg ha^{-1}) was produced by Stomp 330EC treated plots. Minimum seed yield (1119 kg ha^{-1}) was obtained in the weedy check. However, the result from the best treatment was statistically similar to Treflan 4EC (1666 kg ha^{-1}) and statistically at par with the rest of the herbicidal treatments. The best performance of Stomp 330EC can be attributed to the best control of weeds due to which weed competition was reduced thus enabling increased flow of nutrients towards the seeds and ultimately the seed yield in rapeseed was significantly increased. The results are supported by Khan *et al.* (2003) who stated that using pre-emergence herbicides had significantly increased the seed yield of rapeseed crop. Similar results are promulgated by Singh *et al.* (2000), Yadav *et al.* (1995) and Khan *et al.* (1995). Almost all of them stated that pre-emergence herbicides significantly increases the seed yield by efficiently reducing the weed population to avoid any weed competition in the early critical stages of the crop.

Cost-Benefit ratio (CBR)

The cost-benefit ratio was found significant for different treatments. The data in Table-3 shows the cost-benefit ratio for different treatments. Maximum cost-benefit ratio was recorded for Stomp 330 EC (1: 7.47) followed by Treflan 4 EC treatments (1: 6.67). The lowest cost-benefit ratio was recorded for the hand weeding treatment (1: 1.31), which is due to the highest labor cost. These values indicated that all the herbicidal treatments gave optimum cost-benefit ratio as compared to the yield in the weedy check. The possible reason for the highest return of herbicides might be their cost and timely weed control as compared to other weeds control methods. Similar work has been done by Khan *et al.* (1995) and Singh *et al.* (2000).

Table-3. Effect of herbicides on plant height, number of seeds siliqua^{-1}, 1000 seed weight, seed yield and cost benefit ratio.

Treatments	Plant ht. at maturity (cm)	No. of seeds siliqua^{-1}	1000 seeds weight (g)	Seed yield (kg ha^{-1})	Cost Benefit Ratio
Dual Gold 960 EC (s-metolachlor)	139.4	25.1	3.88	1550	5.02
Stomp 330 EC (pendimethalin)	137.9	25.8	3.99	1692	7.47
Treflan 4 EC (trifluralin)	136.6	25.5	3.92	1666	6.67
Puma super 75 EW (fenoxaprop-P-ethyl)	141.1	24.4	3.79	1396	4.45
Topik 15 WP (clodinafop)	140.9	23.4	3.68	1400	3.98
Ronstar 12 L (oxadiazon)	132.8	22.2	3.65	1275	1.86
Agil 100 EC (propaquizafop)	134.8	23.3	3.72	1380	1.83
Hand Weeding	127.2	24.9	3.84	1535	1.31
Weedy check	143.4	21.6	3.62	1119	--
LSD at 0.05α level	N.S	N.S	N.S	N.S	--

*Means followed by different letters in the respective column are significantly different at 5% probability level according to LSD test.

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