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RESEARCH ARTICLE

DIVERSITY, DYNAMICS AND EFFICIENT WEED CONTROL MEASURES IN MUSTARD FIELD AT RAMGHAT SURKHET

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ABSTRACT

Weed management in agricultural fields is an important operation for better yield. The recent study was mainly focused on weed diversity, dynamics and control measures in mustard fields at Bheriganga Municipality of Surkhet district. The weeds on the field compete for nutrients, water, and sunlight with major crops. The study mainly focused on weed management practices in mustard fields conducted by a defined experimental plot. By adopting a randomized block design, the plots were prepared and assigned various treatments such as weed check, hand weeding at different intervals, and the application of herbicides like Pendimethalin, Oxyfluorfen, Isoproturon, Quizalofop, Oxadiaryzl, and Clodinoflop. Weed populations were observed at different growth stages, and weed dry matter was measured to assess biomass production. Weed control efficiency (WCE) and a Weed Index (WI) were calculated to quantify the effectiveness of different control methods. The results highlight the significant efficacy of hand weeding, with a control efficiency of 94.1%. Among the herbicides tested, Pendimethalin showed the highest control efficiency at 73.42%, followed by Oxyfluorfen, Isoproturon, and Quizalofop. The study concluded that integrated weed management strategies with herbicides and manual weeding contributed to successful weed control and enhances the productivity of the mustard crop in Ramghat Surkhet.

KEYWORDS

Mustard, Weed Control Efficiency, Herbicides, Integrated Weed Management

1. INTRODUCTION

A dynamic and complex relationship that affects crop yield and total agricultural productivity is the result of the intricate interactions between weed populations and agricultural ecosystems (Kaur et al., 2018). Mustard cultivation is an important oilseed crop having high nutritional and commercial value having 338 genera and 3709 species distributed all over the world (Warwick and Al-Shehbaz 2003). As per data from the Directorate of Agricultural Development, there was a rise in mustard production within Chitwan district of Nepal. In the fiscal year 2076/77, 12,180 metric tons were produced across 12,255 hectares, whereas during 2077/78, the production grew to 12,218 metric tons over 12,260 hectares (Directorate of Agricultural Development, 2021). Weeds are undesirable having allopathic behavior and support in habits of harmful organisms (Zaman et al., 2011). Weeds compete with crops for sunlight, water and nutrients that they increase the cost of production (Hasan et al., 2021). This competition resulted in a significant decrease in crop growth resulting in a low yield. This problem is especially severe in tropical and subtropical climates regions of Nepal. These regions are favorable for mustard cultivation because of a better combination of soil characteristics and climatic factors (Dhaliwal et al., 2022). The weeds have a negative impact that affects mustard fields including different species of grasses, sedges, and broadleaved plants. Weeds have adaptable and resilient characteristics having the ability to spread and establish within farmland. In such an instance cultivator of mustard on a large scale must have extensive knowledge and techniques for effective weed control. The cultural practices, cropping systems, agronomic techniques, and ecological dynamics influence the dynamics and potential of weed populations in a localized context, like the agro-ecological domain of Ramghat Surkhet. As a result, an in-depth study is necessary to assess the effectiveness of various weed control strategies in the mustard fields of this region. Therefore the present study was conducted to develop a better understanding of weed populations and the effectiveness of particular treatments in mustard fields. Weeding by hand, which represents conventional methods, and applying herbicide with caution which represents modern methods, are the two types of interventions that were followed during studying. The complex analysis of these measures took place against the unique context of Ramghat Surkhet, providing insightful information about the interactions between weed control techniques and agro-ecological variations.

2. MATERIALS AND METHODS

2.1 Research Design

The research on weed population and dynamics in Mustard fields was conducted in the agricultural farmland of the Graduate School of Agriculture and Forestry, Ramghat Surkhet. The randomized Completely Block Design was used as an experimental design. The study included several measures to suppress weed populations including a control group (weed check), hand weeding at 25 and 50 days after sowing (DAS), and the use of several herbicides (Pendimethalin, Oxyfluorfen, Isoproturon, Quizalofop, Oxadiaryzl, and Clodinoflop). Each treatment was replicated four times resulting in 32 plots with 8 treatments. About the area of four square meters were allocated to each treatment. The rows were spaced 35 cm apart and plants within each row were maintained 15 cm apart respectively. The accuracy of the results was improved by assigning treatments, giving each treatment an equal chance of being placed in a different plot.

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2.2 Study Site and Sample Selection

The study was conducted in the winter season of 2022 at the research fields of the Graduate School of Agriculture and Forestry (GSAF), situated in Bheriganga Municipality of Surkhet district. The cultivation possibility for mustard crops in the Ramghat area had great production potential. The Bheriganga Municipality is bordered to the east by Gurbhakot, to the west by Barahatal, to the north by Birendranagar and Lekbesi, and the south by Bardiya District. The study area located in the Middle East section of the Surkhet district had an elevation of 1326 meters with geographic coordinates of 28.45° N and 81.61° E. The area was selected for study due to perfect for studying weed dynamics since it had the suitable soil, climate and other factors for growing mustard.

2.3 Weed Identification and Data Collection

To observe the dynamics of the weed population, trained researchers conducted field surveys at various growth stages, including 25 DAS, 50 DAS, 75 DAS, and harvest. The weed species that were observed in each treatment have been recognized and recorded. In each plot, they counted weeds by placing a 1m by 1m quadrate at random. To determine the total weed population per square meter, weeds were uprooted. Weed dry matter was also measured to gauge biomass production.

2.3.1 Weed Observation

During the field surveys, the recognized weed species' families, scientific names, common names, regional names, and life cycles were indicated.

2.3.2 Weed Population Dynamics

The weed population was observed at different stages of crop development (25 DAS, 50 DAS, 75 DAS, and harvest). Weed populations per square meter were determined at each stage by counting the number of weeds in the plots. Sedges, broadleaf weeds, and grassy weeds were all counted separately. To calculate the dry matter of the weed samples, they were dried in an electric oven and weighed.

2.3.3 Weed Dry Matter Production

At various growth stages, including 25 DAS, 50 DAS, 75 DAS, and harvest, an investigation was conducted to determine the amount of dry matter in the weeds. The biomass of the weeds was calculated based on their dry weight.

2.3.4 Weed Management Practices

Different weed management practices were applied to the experimental plots to evaluate their effectiveness. The treatments included:

Table 1: Treatment Details

Treatments Symbol	Name of the Treatments
T_1	Weed check
T_2	Hand weeding at 25 and 50 DAS
T_3	Pendimethalin 1.25 kg/ha (pre-emergence)
T_4	Oxyfluorfen 1.5 kg/ha (pre-emergence)
T_5	Isoproturon 0.75 kg/ha (post-emergence)
T_6	Quizalofop 1 kg/ha (post-emergence)
T_7	Oxadiaryzl 0.75 kg/ha (pre-emergence)
T_8	Clodinoflop 0.75 kg/ha (post-emergence)

2.4 Weed control efficiency (WCE) and Weed Index (WI) calculation

2.4.1 Weed control efficiency (WCE)

Weed control efficiency, an index to a reduction in the dry weight of weed, was computed by using the following formula:

WCE (%) = We - Wt/We × 100

Where,

We = Dry weight of weeds in the weedy plot

Wt = Dry weight of weeds in the treated plot

2.4.2 Weed Index (WI)

The weed index was used to assess the overall effectiveness of various weed management strategies. The level of weed control that had been attained was assessed using an index that took into account several variables, including weed population and weed production of dry matter. The formula shown below was used to calculate the weed index, an indicator used to measure crop yield reduction:

$$WI\ (\%) = \frac{X - Y \times 100}{X}$$

Where,

X = Yield obtained from minimum weed competition plot

Y = Yield obtained from the treated plot

2.5 Statistical Analysis

The standard analysis of variance (ANOVA) procedure for randomized block design (RBD) as described by Gomez and Gomez in 1984 was used to analyze data gathered from various observations. The 'F' test (variance ratio) was used to determine the significance of the treatment effect. In every instance, the standard error of the mean was calculated. When the 'F' test indicated a significant difference between the means, the difference between the treatment means was examined using the least significant difference (LSD) at a 5% level of probability.

3. Result and Discussion

3.1 Observation on Weeds

Table 2: Common Weed Found in Experimental Plots

Scientific name	Common name	Local name	Family	Life cycle
Grassy weeds				
Polypogon monspeliensis	Rabbit foot grass, foxtail grass	Lomarpunchh	Poaceae	Annual
Cynadon doctylon L.	Bermuda grass	Doob	Poaceae	perennial
Broadleaved weeds				
Chenopodium album L.	Common lambs quarters	Bathua	Chenopodiaceae	Annual
Anagallis arvensis L.	Scarlet pimpernel	Krishnaneel	Compositae	Annual
Convolvulus arvensis.	Fieldbind weed	Hirankhuri	Convolvulaceae	Annual
Parthenium hysterophorus L.	Congress grass	Gajar grass	Asteraceae	Perennial
Sedges				
Cyperus rotundus L.	Purple nuts edge	Motha	Cyperaceae	Perennial

Source: Field survey, 2022

3.3 Weed population

There were distinct weed populations in each treatment at 25 days after sowing (DAS). The Weed Check treatment had the most weeds, totaling 313.83, followed by Pendimethalin (241.37), Isoproturon (227.03), Quizalofop (247.7), Oxyfluorfen (239.7), Oxadiaryzl (254.03), Clodinoflop (284.27), and hand weeding, which had the least amount of weeds, 31. The hand weeding treatment was still the most effective at 50 DAS, with 44.667 weeds observed. In contrast, there were significantly more weeds in the Weed check treatment (582.2), which had the highest weed population. Pendimethalin (454.33), Isoproturon (473.87), Quizalofop (481.53), Oxyfluorfen (478.2), Oxadiaryzl (491.87), and Clodinoflop (528.53) all produced intermediate results, indicating varying levels of effectiveness. Similarly, with a weed population of 37 at 75 days after sowing (DAS), hand weeding continued to be more effective than weed checking, whose population remained high at 523.2.

Table 3: Total Weeds Population Influenced By Weed Management Practices

Treatments	Total weed populations			
	25 DAS	50 DAS	75 DAS	At harvest
Weed check	313.83	582.2	523.2	439.27
Hand weeding	31	41	35	25
Pendimethalin @ 1.25 kg/ha (PE)	241.37	454.33	383.5	274.9
Oxyfluorfen @1.5 kg/ha (PE)	239.7	478.2	416.11	285.73
Isoproturon @0.75 kg/ha (PoE)	227.03	473.87	410.5	290.27
Quizalofop @1.0 kg/ha (PoE)	247.7	481.53	424.5	318.27
Oxadiaryzl @0.75 kg/ha (PE)	254.03	491.87	444.5	314.6
Clodinoflop @ 0.75 kg/ha (PoE)	284.27	528.53	459.5	319.6
SEm (±)	**31.01**	**72.04**	**72.98**	**43.11**
CD 5%	**79.69**	**185.16**	**187.84**	**110. 77**

Standard error of the mean (SEm) and the critical difference at a 5% significance level (CD 5%)

Following the trend, it was noted that pendimethalin (392), isoproturon (404), quizalofop (417), oxyfluorfen (409.67), oxyadiaryzl (436), and clodinoflop (459.5) were visible. Hand weeding demonstrated its effectiveness at harvest time with a weed population of 26, while Weed check recorded the highest population at 439.27. Oxyfluorfen (294.333), Pendimethalin (261.333), Isoproturon (278.667), Quizalofop (307.667), Oxadiaryzl (305), and Clodinoflop (308) all showed varying degrees of effectiveness. The consistently low weed populations attained by hand weeding at every stage of growth also highlight the effectiveness of this weed control method. The herbicides Pendimethalin, Isoproturon, Oxyfluorfen, Quizalofop, Oxadiaryzl, and Clodinoflop consistently demonstrated varying degrees of control in comparison to the Weed check. These findings are consistent with Joshi et al.'s investigation in 2022, which produced similarly effective outcomes.

3.4 Weed dry matter production

Table 4: Total Weed Dry Matter Production Influenced by Herbicidal Control of Weed

Treatments	Total weed dry matter (gm^{-2})			
	25 DAS	50 DAS	75 DAS	At harvest
Weed check	32.73	51.9	43.83	31.67
Hand weeding	11.17	15.03	14.1	11.26
Pendimethalin @ 1.25 kg/ha (PE)	18	34.06	25.38	15.75
Oxyfluorfen @1.5 kg/ha (PE)	28.23	42.23	28.3	17.53
Isoproturon @0.75 kg/ha (PoE)	24.73	35.66	25.53	17.67
Quizalofop @1.0 kg/ha (PoE)	28.51	43.1	31.13	20.6
Oxadiaryzl @0.75 kg/ha (PE)	30	46.03	34.3	20.33
Clodinoflop @ 0.75 kg/ha (PoE)	30.8	51.13	37.13	23.62
SEm (±)	**2.73**	**4.45**	**3.07**	**2.23**
CD 5%	**7.03**	**11.36**	**7.89**	**5.76**

Standard error of the mean (SEm) and the critical difference at a 5% significance level (CD 5%)

At 25 DAS, the Weed check treatment had a weed dry matter of 32.73 g/m2, whereas the Hand weeding treatment had an efficient control of 11.17 g/m2. Pendimethalin was most effective at 18 g/m2, followed by Oxyfluorfen at 28.23 g/m2, Isoproturon at 24.73 g/m2, Quizalofop at 28.51 g/m2, Oxadiaryzl at 30 g/m2, and Clodinoflop at 30.8 g/m2. At 50 DAS, Pendimethalin was the most effective treatment at 15.03 g/m2, followed by Oxyfluorfen at 42.23 g/m2, Isoproturon at 35.66 g/m2, Quizalofop at 43.1 g/m2, Oxadiaryzl at 46.03 g/m2, and Clodinoflop at 51.13 g/m2. Similarly, at 75 DAS, hand weeding control was performed 14.1 g/m2, while plots treated with various herbicides showed a range of results, including Quizalofop at 31.13 g/m2, Oxadiaryzl at 34.3 g/m2, and Clodinoflop at 37.13 g/m2. At harvesting time the lowest weed dry matter was recorded by hand weeding at 11.26 g/m2, followed by herbicides: Pendimethalin at 15.75 g/m2, Oxyfluorfen at 17.53 g/m2, Isoproturon at 17.67 g/m2, Quizalofop at 20.6 g/m2, Oxadiaryzl at 20.33 g/m2, and Clodinoflop at 23.62 g/m2.

3.5 Weed control efficiency

It was found that hand weeding demonstrated an impressive weed control efficiency of 94.1%. The method effectively suppressed weed growth, improving the overall health and productivity of the crop. In terms of herbicide performance, Pendimethalin was the most effective at 73.42%, followed by Oxyfluorfen at 64.64%, Isoproturon at 65.092%, Quizalofop at 52.2%, Oxadiaryzl at 51.63%, and Clodinoflop at 38.73%.

Table 5: Weed Control Efficiency Influenced by Weed Management Practices

Treatments	Weed control Efficiency (%)
Weed check	-
Hand weeding	94.1
Pendimethalin @ 1.25 kg/ha (PE)	73.42
Oxyfluorfen @1.5 kg/ha (PE)	64.64
Isoproturon @0.75 kg/ha (PoE)	65.092
Quizalofop @1.0 kg/ha (PoE)	52.2
Oxadiaryzl @0.75 kg/ha (PE)	51.63
Clodinoflop @ 0.75 kg/ha (PoE)	38.73
SEm (±)	7.25
CD 5%	18.65

3.6 Weed Index

A weed index of 55.53% was observed for the "Weed check" treatment, which served as a benchmark for comparison. Among the treatments, "Pendimethalin" applied at 1.25 kg/ha before emergence (PE) resulted in a weed index of 21.42%, suggesting effective weed control. Similarly, "Oxyfluorfen" applied at 1.5 kg/ha (PE) yielded a weed index of 22.26%, indicating a successful weed management rate. For post-emergence herbicides, "Isoproturon" at 0.75 kg/ha (PoE) showed a weed index of 21.52%, demonstrating comparable efficacy to the pre-emergence treatments. "Quizalofop" at 1.0 kg/ha (PoE) had a weed index of 24.74%, indicating moderate weed control.

Table 6: Weed Index Influenced by Weed Management Practices

Treatments	Weed Index (%)
Weed check	55.53
Hand weeding	-
Pendimethalin @ 1.25 kg/ha (PE)	21.42
Oxyfluorfen @1.5 kg/ha (PE)	22.26
Isoproturon @0.75 kg/ha (PoE)	21.52
Quizalofop @1.0 kg/ha (PoE)	24.74
Oxadiaryzl @0.75 kg/ha (PE)	25.73
Clodinoflop @ 0.75 kg/ha (PoE)	28.45
SEm (±)	**3.34**
CD 5%	**8.57**

Among the pre-emergence treatments, "Oxadiaryzl" at 0.75 kg/ha (PE) exhibited a weed index of 25.73%, and the post-emergence treatment "Clodinoflop" at 0.75 kg/ha (PoE) had a weed index of 28.45%, suggesting these treatments might have been somewhat less effective in weed management compared to others.

4. Conclusion

The study assessed the dynamics of weed populations in mustard fields as well as different weed control techniques in Ramghat conditions. Maximum crop yields and agricultural productivity of crops depend on effective weed management practices. Due to the competition for resources such as water, nutrients, and light, weed growth can severely reduce crop production potential and yields. Broadly, herbicide application and manual weeding were compared as two primary weed control methods. According to the results, hand weeding was significantly effective at controlling weeds, achieving 94.1% control efficiency. Hand-weeding methods also improved the yield in mustard fields that suppressed weed growth as well. Among all the herbicides tested, the treatment Pendimethalin had the best weed control efficiency at 73.42%. It was followed by Oxyfluorfen (64.64%), Isoproturon (65.092%), and Quizalofop (52.2%). Several factors including dry matter production and weed population were taken into account to calculate the Weed Index that demonstrated the best weed management techniques and highly effective. Pendimethalin and Oxyfluorfen treatments had a better potential to suppress the weeds populations in integrated weed management techniques.

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