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Economics and yield of wheat as affected by pre and post-emergence herbicides in western Terai Region of Nepal

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ABSTRACT

A field experiment was conducted to assess the growth, yield and profitability of wheat under different herbicides application in Kapilvastu and Rupandehi district, Nepal during winter season of 2018. The experiment was laid out in Randomized Complete Block Design (RCBD) with four treatments and five replications. The four treatments comprised of Pendimethalin 30 EC at 3.3 l ha^{-1} as a pre emergence herbicide, sulfosulfuron 75 WG at 33.3 g ha^{-1} as post emergence, pendimethalin 30 EC at 3.3 l ha^{-1} followed by sulfosulfuron 75 WG at 33.3 g ha^{-1} and weedy check (control treatment). Results revealed that application of pendimethalin 30 EC at 3.3 l ha^{-1} followed by sulfosulfuron 75 WG at 33.3 g ha^{-1} significantly reduced the weed population and produced higher wheat grain yield (4487 kg ha^{-1}). Economic analysis of different herbicides application also showed the highest net returns (NPR. 50,940 ha^{-1}) for application of pendimethalin followed by sulfosulfuron treatments. Among the tested herbicides, both pendimethalin and sulfosulfuron were found effective to weed management and profitable over weedy check.

Introduction

Wheat (*Triticum aestivum* L.) is the third most important cereal crop after rice and maize in Nepal. It is cultivated in 7,06,843 hectares with the production of 19,49,001 tonnes and average productivity is 2,757 kg ha^{-1} in 2017-2018 (MoALD, 2017). It is grown in Terai, river basins, mid-hills, and high-hills of Nepal during winter season i.e. October to July (CIMMYT, 2001). Wheat is grown more than 84% of an areas after harvesting of rice in Nepal. Rice-wheat rotation is a most prominent cropping system in Nepal occupies 37% of the rice and 85% of wheat area of the country (Tripathi et al. 2002). Although wheat is the major food grain crop of Nepal, its yield is low. There

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are several factors responsible for low wheat productivity in Nepal such as poor irrigation facilities, less availability of fertilizer, pesticides and insecticides (Pokharel et al. 2007; Devkota, 2013), delay sowing and weed problems (Shah, 2013). Many narrow leaved, broad leaved and grassy weeds are associated with wheat, which ultimately reduce the grain yield.

Many scientists from South Asia were reported weed as the major constraints to wheat cultivation. Nayyar et al. (1994) reported weed infestation as the main cause of yield reduction of wheat up to 25-30% in Pakistan. Pandey et al. (2006) observed an average of 309 weeds m^{-2} which reduced 29% grain yield of wheat in India. In Nepal also, reduction of wheat yield up to 50 % was reported by Ranjit (2002). Weed infestation removes nutrients from the soil which reflects negatively on crop yield (Shehata et al. 2017). Weeds not only compete with crop plants for nutrients, soil moisture, space, and light but also serve as an alternative hosts for numerous insect pests and diseases. Many weeds are noted to have an allelopathic effect on the crop (Ali et al 2016; Mehdizadeh et al. 2019). Weeds not only decrease the yield but also affect the quality of the crop resulting in lower income. Hence, control of weeds in the early stages of crop appears imperative as it plays a vital role in maximizing the crop yield production. Several methods were applied for evaluation of weeds population in crop field. Among those, chemical method is the most efficient, time, money and energy saving method. The present study was conducted with an objective to evaluate the yield comparison of wheat and economics assessment with different pre and post emergence herbicides application methods.

Materials and Methods

The experiment was conducted at farmer's field (Kapilvastu and Rupandehi district) in Randomized Complete Block Design (RCBD) with four treatments and five replications. Four treatments comprised of different pre and post emergence herbicides application including Pendimethalin (Stomp 30 EC) at 3.3 l ha^{-1} as a pre-emergence herbicide and applied after seeding of wheat, sulfosulfuron (Leader 75 WG) at 33.3 g ha^{-1} after 30 days of seeding, pendimethalin 30 EC at 3.3 l ha^{-1} followed by (fb) sulfosulfuron 75 WG at 33.3 g ha^{-1} and weedy check. Wheat variety BL 4341 as a recently released variety was sown in all locations. The crop was planted by broadcasting method and seed rate was 120 kg ha^{-1} for all treatment. The size of experimental plot was 1 Kattha (333.33 m^2) and each plot was separated by bund of 0.5 m width. The first irrigation was applied after 25 days of sowing (DAS). The fertilizers (N_2:P_2O_5:K_2O) were applied uniformly to all the treatments at the rate of 100:50:50 kg ha^{-1}. The sources of nutrient were Urea, Di-ammonium Phosphate (DAP) and Murate of Potash (MOP). Half Dose of Nitrogen and full dose of DAP and MOP was applied as basal and remaining nitrogen applied in two equal splits i.e. after first irrigation and

second irrigation (45 DAS). To workout the economics of different weed control treatments information on the existing market price of different herbicides and inputs was used. Labour units required for herbicide application was considered in addition to regular components of the cost of cultivation. Cost of labour was calculated by taking into account the prevailing labour wages at the time of investigation. Gross returns, net returns and benefit cost ratio were measured by using the following formulae and expressed in Nepalese rupee (NPR).

$$\text{Gross return} = \text{Grain yield} \times \text{market price of wheat grain}$$

$$\text{Net returns} = \text{Gross returns} - \text{total cost of cultivation}$$

$$\text{Benefit Cost ratio} = \frac{\text{Gross returns}}{\text{Total cost of cultivation}}$$

All recorded data were analyzed through GENSTAT statistical package and treatment means were compared using least significant difference (LSD) test at $P \leq 0.05$.

Results and Discussion

Effect of different herbicides on wheat yield and yield components

The results revealed that application of different herbicides had significant effect on yield and yield attributes of wheat (Table 1). Plant height, panicle length, number of tillers m^{-2}, 1000 grain weight and grain yield were found significantly highest in application of pendimethalin followed by sulfosulphuron herbicides treatment followed by pendimethalin and sulfosulfuron only. The maximum plant height of 104 cm, panicle length of 10.9 cm, number of tillers m^{-2} of 414, and 1000 grain weight of 43.6 gram was observed from pendimethalin fb sulfosulfuron applied plots, which showed that the application of pendimethalin fb sulfosulfuron effectively controlled maximum number of weeds compared to other treatments. Significantly higher grain yield in application of pendimethalin fb sulfosulfuron subjected to chemical weed control was probably the result of higher number of fertile tillers produced in this treatment combination. Similarly, the data concerning the grain yield of wheat indicated that significantly the highest grain yield of wheat (4487 kg ha^{-1}) was recorded in application of pendimethalin fb sulfosulfuron herbicides but it was found at par with application of pendimethalin and sulfosulfuron separately. The lowest grain yield was obtained from weedy check treatment. Chopra et al., (2001) with pendimethalin reported significant reduction in weed dry weight in wheat. Choudhary et al. (2016) reported maximum weed control efficiency under sulfosulfuron application at 25 g ha^{-1} (83.85%) followed by

clodinofop at 60g + metsulfuron methyl at 4g ha^{-1} (83.17%), metribuzin at 200g ha^{-1} (75.85%) and pendimethalin at 1000 g fb 2,4-D at 400 g ha^{-1} (70.90 %) respectively.

Table 1. Effect of different herbicides on grain yield and yield attributes of wheat.

Treatment	Plant Height (cm)	Panicle Length (cm)	No. of Tillers m^{-2}	1000 grain weight (gm)	Grain Yield (kg ha^{-1})	Grain yield increment over weedy check %
Pendimethalin (Stomp 30 EC)	103	10.2	375	42.4	4297	11.2
Pendimethalin fb Sulfosulfuron	104	10.9	414	43.6	4487	14.9
Weedy check (weed treatment)	100	9.2	310	39.8	3815	-
Sulfosulfuron (Leader 75 WG)	102	10.1	352	41.8	4120	7.4
F-Test	**	**	**	**	*	
LSD (0.05%)	2.2	0.6	35.9	2.1	467.3	
CV %	1.6	4.6	7.4	3.7	8.3	

** and *denotes significant at 1 % and 5% levels

All tested herbicides were found superior over weedy check. Grain yield increment in pendimethalin fb sulfosulfuron was found to be 14.9 % over weedy check, whereas pendimethalin only recorded 11.2 % and sulfosulfuron only recorded 7.4%. The increment of grain yield in herbicide application treatment may be due to enhancement the effectiveness of weed control. Chhokar et al. (2001), Banga and Yadav (2004) and Kaur et al. (2007) have also reported better control of *Phalaris minor* and *Chenopodium album* in wheat with sulfosulfuron. Significantly lower grain yield in the weedy control compared to chemical and non-chemical weed control was also reported by Das and Yaduraju (1999) and Abbas et al. (2009).

Economics

Economic analysis of different herbicides (Table 2) revealed that the application of pendimethalin fb sulfosulfuron resulted in the highest net return (NPR 50940 ha^{-1}), whereas pendimethalin (NPR 49218 ha^{-1}) remained at second and sulfosulfuron (NPR 44406 ha^{-1}) at third position. No weed control gave the lowest net return (NPR 38755 ha^{-1}). Regarding the benefit: cost ratio (BCR), application of pendimethalin was superior to the others as it gave NPR 1.62 by costing only one rupee. However, pendimethalin fb sulfosulfuron application remained at second (BCR = 1.61) and sulfosulfuron application at third position (BCR = 1.56). Results also revealed that increment in benefit over weedy check was found the highest in application of pendimethalin fb

sulfosulfuron (23.9 %) followed by pendimethalin (21.3 %) and sulfosulfuron (12.7 %). Chachar et al. (2009) reported that chemical weed management was found more effective as compare to weedy check.

Table 2. Economic analysis of wheat as affected by different herbicide application.

Treatment	Total Variable cost (NPR ha^{-1})	Production Cost (NPR ha^{-1})	Total Expenditure (NPR ha^{-1})	Grain Yield (kg ha^{-1})	Gross returns (NPR ha^{-1})	Net returns (NPR ha^{-1})	B:C Ratio	Increment in benefit over weedy check %
Pendimethalin (Stomp 30 EC)	1980	77703	79683	4297	128901	49218	1.62	21.3
Pendimethalin fb Sulfosulfuron	3480	80203	83683	4487	134623	50940	1.61	23.9
Weedy check (control treatment)	-	75703	75703	3815	114458	38755	1:51	-
Sulfosulfuron (Leader 75 WG)	1500	77703	79203	4120	123609	44406	1.56	12.7

Conclusion

On the basis of the results obtained in this study, it is concluded that pre emergence application of pendimethalin at 3.3 l ha^{-1} followed by post emergence application of sulfosulfuron at 33.3 g ha^{-1} may recommended in wheat to get maximum reduction of weeds and higher grain yield.

Conflicts of Interest

Authors declare no conflict of interest.

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