Chemical Science Review and Letters ISSN 2278-6783

www.chesci.com Research Article

Performance of Buckwheat (*Fagopyrum Esculentum* Moench.) as Influenced by Integrated Weed Management Practices

Shreedhar Huddar, Gangadasari Sravana Lakshmi* and Hulihalli U. K

Department of Agronomy, College of Agriculture, UAS Dharwad 580005, Karnataka

Abstract

A field experiment was conducted during *rabi* 2020-21 at Main Agricultural Research Station, Dharwad to study the effect of integrated weed management practices on growth and yield of buckwheat. Experiment consisted of 15 treatments where three herbicides viz., pretilachlor, atrazine and pendimethalin were applied as pre-emergent in first six treatments and next six treatments included application of herbicides as pre-emergent along with one hand weeding + one intercultivation at 25-30 DAS, weedy check and weed free check with three replications. Weed free check recorded significantly higher seed (728 kg/ha) and straw (1247 kg/ha) yield of buckwheat and it was at par with (T_{13}) one hand weeding + one intercultivation at 25-30 DAS (674 kg/ha). All the growth and yield parameters followed the similar trend. Higher net returns (Rs.24583/ha) and B:C ratio (2.59) was recorded with treatment pretilachlor 50 EC @ 1.0 kg a.i. ha^{-1} *fb* one intercultivation at 25-30 DAS (T_{10}) and it was on par with, one hand weeding + one intercultivation at 25-30 DAS (Rs.23974/ha) and weed free check (Rs.23035/ha). The weed control efficiency was highest with atrazine and pendimethalin sprayed treatments the growth and yield parameters, yield, net returns, B:C Ratio were lowest because of the severe phytotoxic effect of atrazine and pendimethalin on buckwheat which affected growth and plants remained stunted.

Keywords: Buckwheat, Pretilachlor, Atrazine, Pendimethalin, Phytotoxicity, Net and gross, Returns, B:C ratio

***Correspondence**

Author: Gangadasari Sravana Lakshmi

Email: lakshmisravani001@gmail.com

Introduction

Common buckwheat (*Fagopyrum esculentum* Moench) belongs to the family polygonaceae. Buckwheat is one of the most important pseudocereal or underutilized potential crops of the mountain region widely cultivated in the middle and higher Himalayas between 1800 to 4500 m from MSL during *kharif* season. It is a multipurpose crop used as leafy vegetable, soil binding crop, as insectary crop which can attracts beneficiary insects including honey bees [1]. It is a short duration crop and very low input requiring crop [2].

Production and management of every crop depends on, genotype, nutrients, moisture weed management etc., plays an important role to achieve targeted yield. Weeds are the major constraints for the crop production as they are competing with crop for growth resources. Though buckwheat is considered as a weed smothering crop, weed management during early establishment phase is challenging [3, 4]. As 25-30 DAS is the critical period of crop weed competetion. Manual weeding along with cultural practices is the common method of weed control in buckwheat which is tedious and labour consuming, now a days it is not practical because of the scarce and high labour cost [5]. Chemical weed control through pre-emergent herbicides is a viable option to manage the weeds during early establishment phase, but due to less knowledge about chemical weed management in buckwheat, herbicides use is restricted. Relying only on one method of weed management is not cost effective. Since buckwheat was a newly introduced crop to the northern transition zone of karnataka, its sensibility to the different dose of herbicides was not known and relying only on manual weeding was costly. Hence with the main aim of managing the weeds in buckwheat through integrated weed management this experiment was conducted.is IWM is an environmentally sustainable way by using all components of weed control (Chemical, cultural and mechanical). Hence the present study was undertaken to manage the weeds in buckwheat through pre-emergent herbicides along with cultural practice *i.e.*, intercultivation and hand weeding.

Material and Methods

A field experiment was conducted at the MARS, University of Agricultural Sciences, Dharwad during *rabi* 2020-21. The soil of the experimental site was medium deep black soil having pH of 7.64. The experiment was laid out in randomized complete block design with 15 treatments replicated thrice. The net plot size was 2.4x2.8 m. The treatment details were T_1 – Pretilachlor 50 EC @ 0.5 kg a.i. ha^{-1}, T_2 – Atrazine 50 WP @ 0.5 kg a.i. ha^{-1}, T_3- Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1}, T_4-Pretilachlor 50 EC @ 1.0 kg a.i. ha^{-1}, T_5- Atrazine 50 WP @ 1.0 kg a.i. ha^{-1}, T_6- Pendimethalin 30 EC @ 1.5 kg a.i. ha^{-1}, T_7- Pretilachlor 50 EC @ 0.5 kg a.i. ha^{-1}*fb* one intercultivation at 25-30 DAS, T_8- Atrazine 50 WP @ 0.5 kg a.i. ha^{-1}*fb* one intercultivation at 25-30 DAS, T_9- Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1}*fb* one intercultivation at 25-30 DAS, T_{10}- Pretilachlor 50 EC @ 1.0 kg a.i. ha^{-1}*fb* one intercultivation at 25-30 DAS, T_{11}- Atrazine 50 WP @ 1.0 kg a.i. ha^{-1}*fb* one intercultivation at 25-30 DAS, T_{12}- Pendimethalin 30 EC @ 1.5 kg a.i. ha^{-1}*fb* one intercultivation at 25-30 DAS, T_{13}- one hand weeding + one intercultivation at 25-30 DAS, T_{14}- Weedy check and T_{15}- Weed free check. The herbicides were applied as pre-emergent at 1-2 days after sowing. Spray volume of Pretilachlor, Atrazine and Pendimethalin were as per the herbicidal treatments in water @ 750 l ha^{-1}. Seeds of buckwheat *var.* Nilagiri (DS 1) was sown with seed drill at the rate of 10 kg ha^{-1} in 30x10 cm spacing. Recommended dose of fertilizer (40:20:20 N; P_2O_5: K_2O kg ha^{-1}) was applied as basal and three herbicides were applied as per treatments using knapsack sprayer one day after sowing after field was irrigated. Total rainfall received during crop growth period (November 2020 to January 2021) was 27.8 mm with maximum (27.2 mm) during the first week of January. Hand weeing and hoeing were done manually with the help of *khurpi* and hand hoe at 25-30 DAS as per treatment so as to keep crop free from weeds during critical period of crop-weed competition. Yield and yield parameters were recorded as per standard procedures. The economics were calculated as per the market rates prevailed during *rabi* 2021.

Among grassy weeds Dinebra retroflexa (Vahl.) Panzer, Echinocloa colona, Cynodon dactylon and Digitaria sanguinalis were observed. Among the broad leaf weeds Digera arvensis, Trianthema portulacastrum L., Chrozophora rottleri (Geiseler) Spreng, Amaranthus viridis, Parthenium hysterophorous L., and Phyllanthus maderaspatensis L., were observed and Cyperus rotundus was observed among sedges. Among all weeds Dinebra retroflexa, Echinocloa colona, Cyperus rotundus, Digera arvensis and Trianthema portulacastrum L., were the major weeds observed in the experimental field.

Results and Discussion

Growth parameters of buckwheat

All the related growth parameters like plant height, LAI and total dry matter (TDM) were recorded at the time of harvest. And the results revealed that with respect to plant height, taller plants were observed in (T_{15}) weed free check (71.4 cm). It was significantly lower with (T_{14}) weedy check (62.6 cm) and it was on par with T_1 (64.7 cm), T_4, T_7 and T_{10}. The higher plant height was due to efficient utilization of the resources stimulated the metabolic and biochemical reactions in plant leads to the higher growth of crop in these treatments. Significantly shorter plants were recorded in weedy check compared to T_{15}, T_{13}, T_{10}, T_7 and T_4. These results are in close agreement with the findings of [6] in buckwheat (**Table 1**).

Leaf area index (LAI)

Similar trend of results was seen in LAI as that of plant height. LAI was higher in weed free check (1.37). Weed free conditions and reduced competition from weeds lead to increased availability of growth resources and increased growth and LAI. LAI recorded with atrazine and pendimethalin sprayed treatments were lesser than the (T_{14}) weedy check (1.07). Weedy check (T_{14}) recorded lower LAI, but it was at par with the T_1 (1.14). which might be due to inadequate supply of soil moisture and nutrients for crop because of stiff crop-weed competition that resulted in extensive depletion of available resources by weeds. Such results were earlier by [7] in buckwheat (Table 1).

Total dry matter production (TDM)

TDM at harvest was higher in weed free check (10.92 g plant^{-1}). However, T_{15} was on par with T_{13} (10.66 g plant^{-1}) and T_{10} (10.20 g plant^{-1}) *fb* T_7 (9.29 g plant^{-1}), T_4 (8.93 g plant^{-1}) and T_1 (7.90 g plant^{-1}). Total dry matter plant^{-1} recorded in (T_{14}) weedy check (6.85 g plant^{-1}) was significantly lower than the T_{15}, T_{13}, T_{10}, T_7, T_4 and T_1. Weed free check recorded 59.41 per cent of higher TDM plant^{-1} compared to weedy check. Total dry matter plant^{-1} recorded with T_{13} and T_{10} were 55.62 and 48.91 per cent higher than weedy check. This might be due to the better weed control which lead to the efficient utilization of available resources, which are essential for the production of photosynthates and distribution of these photosynthates to different plant parts. These results are in line with findings of [7] in buckwheat (Table 1).

Number of clusters plant^{-1}

Yield attributing parameter of buckwheat *i.e.*, number of clusters per plant, number of seeds per cluster varied significantly among different weed management treatments (Table 1). But othe yield parameters like 1000 seed weight and HI did not differ significantly among the treatments (**Table 1**). Significantly higher number of clusters plant^{-1} were recorded with (T_{15}) weed free check (11.80 plant^{-1}). However, this treatment was on par with (T_{13}) one hand weeding + one intercultivation at 25-30 DAS (11.27 plant^{-1}) and (T_{10}) pre-emergent application of Pretilachlor 50 EC @ 1.0 kg a.i. ha^{-1} *fb* one intercultivation at 25-30 DAS (10.67 plant^{-1}). The similar results were observed by [6] in buckwheat.

Table 1 Growth and yield parameters of buckwheat as influenced by different weed control treatments

Tr. No.	Growth at harvest			Cluster plant^{-1}	1000 seed weight (g)	Harvest index (%)
	Plant height (cm)	LAI	Dry matter (g plant^{-1})			
T_1	64.7^{bc}	1.14^{bc}	7.90^{d}	8.40^{cd}	27.69^{a}	35.28^{a}
T_2	55.4^{d}	0.81^{e}	5.75^{f}	6.73^{e}	26.69^{a}	36.47^{a}
T_3	56.0^{d}	0.92^{de}	6.02^{ef}	7.13^{de}	27.21^{a}	36.72^{a}
T_4	65.9^{a-c}	1.20^{a-c}	8.93^{c}	9.27^{bc}	27.84^{a}	35.57^{a}
T_5	54.4^{d}	0.78^{e}	5.42^{f}	6.20^{e}	26.57^{a}	37.34^{a}
T_6	53.4^{d}	0.82^{e}	5.88^{ef}	6.80^{de}	27.94^{a}	36.09^{a}
T_7	67.0^{a-c}	1.22^{a-c}	9.29^{bc}	9.73^{bc}	28.79^{a}	35.41^{a}
T_8	54.9^{d}	0.87^{e}	6.01^{ef}	6.93^{de}	26.83^{a}	37.33^{a}
T_9	56.7^{d}	0.89^{e}	6.40^{ef}	7.20^{de}	27.18^{a}	37.86^{a}
T_{10}	69.1^{a-c}	1.31^{ab}	10.20^{ab}	10.67^{ab}	28.08^{a}	36.63^{a}
T_{11}	53.2^{d}	0.77^{e}	5.70^{f}	6.80^{de}	26.75^{a}	36.41^{a}
T_{12}	55.8^{d}	0.85^{e}	5.98^{ef}	7.20^{de}	26.87^{a}	36.63^{a}
T_{13}	69.8^{ab}	1.33^{a}	10.66^{a}	11.27^{a}	28.60^{a}	36.39^{a}
T_{14}	62.6^{c}	1.07^{cd}	6.85^{e}	7.40^{de}	26.80^{a}	35.81^{a}
T_{15}	71.4^{a}	1.37^{a}	10.92^{a}	11.80^{a}	28.27^{a}	36.62^{a}
S.Em+	2.05	0.06	0.32	0.49	0.70	1.08

T_1 : Pretilachlor 50 EC @ 0.5 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS, **T_2 :** Atrazine 50 WP @ 0.5 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS, **T_3 :** Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS**, T_4 :** Pretilachlor 50 EC @ 1.0 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS, **T_5 :** Atrazine 50 WP @ 1.0 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS, **T_6 :** Pendimethalin 30 EC @ 1.5 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS, **T_7 :** Pretilachlor 50 EC @ 0.5 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS *fb* one intercultivation at 25-30 DAS, **T_8 :** Atrazine 50 WP @ 0.5 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS *fb* one intercultivation at 25-30 DAS,**T_9 :** Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS *fb* one, intercultivation at 25-30 DAS, **T_{10}:** Pretilachlor 50 EC @ 1.0 kg a.i ha^{-1} as pre-emergent at 1-2 DAS *fb* one intercultivation at 25-30 DAS **T_{11}:** Atrazine 50 WP @ 1.0 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS *fb* one intercultivation at 25-30 DAS,T_{12} : Pendimethalin 30 EC @ 1.5 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS *fb* one intercultivation at 25-30 DAS, **T_{13} :** One hand weeding + one intercultivation at 25-30 DAS, **T_{14} :** Weedy check, **T_{15} :** Weed free check. ***fb*** **:** followed by, **DAS :** Days after sowing, **EC :** Emulsifiable Concentrate, **WP :** Wettable powder, **HW:** Hand Weeding. *Means followed by the same lower case letter/s in a column do not differ significantly by DMRT (P=0.05).

Seed yield

Seed yield of buckwheat varied significantly among different weed management treatments (**Table 2**). Weed free check (T_{15}) recorded significantly higher seed yield compared to other treatments (718 kg ha^{-1}). Among different weed management practices (T_{13}) one hand weeding + one intercultivation at 25-30 DAS (674 kg ha^{-1}) recorded on par seed yield with T_{15} and seed yield produced by T_{10} (649 kg ha^{-1}) was on par with T_{13} (674 kg ha^{-1}). [8] reported hand weeding twice at 20 and 35 DAS *fb* one hand weeding at 20 DAS and hoeing at 35 DAS recorded higher seed yield of buckwheat. Seed yield produced with treatments *i.e.*, T_5 (49 kg ha^{-1}), T_6 (55 kg ha^{-1}), T_2 (57 kg ha^{-1}), T_3 (63 kg ha^{-1}), T_{11} (54 kgha^{-1}), T_{12} (62 kg ha^{-1}), T_8 (61 kg ha^{-1}) and T_9 (69 kg ha^{-1}) were significantly lesser than (T_{14}) weedy check (361 kg ha^{-1}).

Straw yield

Significantly higher straw yield (Table 2) was recorded with (T_{15}) i.e. weed free check (1247 kg ha^{-1}) and it was on par with T_{13} (1179 kg ha^{-1}). Among different chemical weed control practices T_{10} (1124 kg ha^{-1}) recorded higher straw yield and it was on par with T_{13}, followed by T_7 (1047 kg ha^{-1}). The straw yield recorded with (T_{14}) weedy check (655 kg ha^{-1}) was lesser as compared to T_{15}, T_{13}, T_{10}, T_7, T_4 and T_1. The seed and straw yield of buckwheat recorded in weed free check was about 98.89 per cent and 90.38 per cent respectively higher over weedy check. This was due to the reduced crop-weed competition by elimination of the weeds by manual weeding at regular intervals owing to utilization of available nutrients, moisture, space and light to the maximum extent. Better translocation of the photosynthates to all parts of the plant which is reflected in higher total dry matter production, growth and yield components of buckwheat. These results are in conformity with the findings of [9] in buckwheat.

Table 2 Yield and economics of buckwheat as influenced by weed control treatments

Tr. No.	Seed yield ($kg\ ha^{-1}$)	Straw yield ($kg\ ha^{-1}$)	Cost of cultivation	Gross returns	Net returns	B:C Ratio
T_1	*22.00^d (484)	29.81^e (890)	13978	29908^d	15930^c	2.14^c
T_2	7.51^f (57)	9.87^g (97)	13953	3499^f	-10454^e	0.25^e
T_3	7.88^f (63)	10.34^g (108)	14873	3845^f	-11028^e	0.26^e
T_4	23.63^c (559)	31.80^d (1012)	14483	34529^c	20046^b	2.38^b
T_5	6.93^f (49)	8.93^g (81)	14433	2998^f	-11435^e	0.21^e
T_6	7.42^f (55)	9.85^g (97)	16273	3391^f	-12882^e	0.21^e
T_7	23.97^c (574)	32.36^{cd} (1047)	14978	35504^c	20526^b	2.37^b
T_8	7.83^f (61)	10.12^g (102)	14953	3751^f	-11202^e	0.25^e
T_9	8.28^f (69)	10.58^g (113)	15873	4252^f	-11621^e	0.27^e
T_{10}	25.47^b (649)	33.51^{bc} (1124)	15483	40066^b	24583^a	2.59^a
T_{11}	7.19^f (54)	9.36^g (90)	15433	3350^f	-12083^e	0.22^e
T_{12}	7.90^f (62)	10.37^g (107)	17273	3828^f	-13445^e	0.22^e
T_{13}	25.97^{ab} (674)	34.33^{ab} (1179)	17673	41647^{ab}	23974^a	2.36^b
T_{14}	18.99^e (361)	25.51^f (655)	12833	22311^e	9478^d	1.74^d
T_{15}	26.81^a (718)	35.29^a (1247)	21333	44368^a	23035^{ab}	2.08^c
S.E	0.56	0.80	--	1009	1009	0.06

T_1 : Pretilachlor 50 EC @ 0.5 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS, **T_2 :** Atrazine 50 WP @ 0.5 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS, **T_3 :** Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS**, T_4 :** Pretilachlor 50 EC @ 1.0 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS, **T_5 :** Atrazine 50 WP @ 1.0 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS, **T_6 :** Pendimethalin 30 EC @ 1.5 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS, **T_7 :** Pretilachlor 50 EC @ 0.5 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS *fb* one intercultivation at 25-30 DAS, **T_8 :** Atrazine 50 WP @ 0.5 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS *fb* one intercultivation at 25-30 DAS,**T_9 :** Pendimethalin 30 EC @ 0.75 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS *fb* one, intercultivation at 25-30 DAS, **T_{10}:** Pretilachlor 50 EC @ 1.0 kg a.i ha^{-1} as pre-emergent at 1-2 DAS *fb* one intercultivation at 25-30 DAS **T_{11}:** Atrazine 50 WP @ 1.0 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS *fb* one intercultivation at 25-30 DAS,T_{12} : Pendimethalin 30 EC @ 1.5 kg a.i. ha^{-1} as pre-emergent at 1-2 DAS *fb* one intercultivation at 25-30 DAS, **T_{13} :** One hand weeding + one intercultivation at 25-30 DAS, **T_{14} :** Weedy check, **T_{15} :** Weed free check. ***fb* :** followed by, **DAS :** Days after sowing, **EC :** Emulsifiable Concentrate, **WP :** Wettable powder **HW:** Hand Weeding. *Means followed by the same lower case letter/s in a column do not differ significantly by DMRT (P=0.05). ***Transformed values [$\sqrt{(x+0.5)}$], figures in the parenthesis indicate original values.***

Net returns

Significantly higher net returns were recorded in (T_{10}) pre-emergent application of Pretilachlor 50 EC @ 1.0 kg a.i. ha^{-1} *fb* one intercultivation at 25-30 DAS (24583 ₹ ha^{-1}) it was on par with (T_{13}) one hand weeding + one intercultivation at 25-30 DAS (23974 ₹ ha^{-1}) and (T_{15}) weed free check (23035 ₹ ha^{-1}) *fb* T_7 (20526 ₹ ha^{-1}), T_4 (20046 ₹ ha^{-1}) and T_1 (15930 ₹ ha^{-1}). Weedy check (T_{14}) recorded significantly lesser amount of net returns (9478 ₹ ha^{-1}) compared to above mentioned treatments which was mainly because of lower seed and straw yield due to stiff crop-weed competition. These results are in line with the findings of [8] in buckwheat. There was negative net returns obtained with the treatments received Atrazine and Pendimethalin as pre-emergent *i.e*., T_2 (-10454 ₹ ha^{-1}), T_3 (-11028 ₹ ha^{-1}), T_5 (-11435 ₹ ha^{-1}), T_6 (-12882 ₹ ha^{-1}), T_8 (-11202 ₹ ha^{-1}), T_9 (-11621 ₹ ha^{-1}), T_{11} (-12083 ₹ ha^{-1}) and T_{12} (-13445 ₹ ha^{-1}) because of increased cost of cultivation and reduced gross returns due to phytotoxicity plant population was reduced and decreased yield.

Benefit-cost ratio

Significantly higher benefit-cost ratio was realised with (T_{10}) pre-emergent application of Pretilachlor 50 EC @ 1.0 kg a.i. ha^{-1} *fb* one intercultivation at 25-30 DAS (2.59) *followed by* T_4 (2.38), T_7 (2.37), T_{13} (2.36), T_1 (2.14) and T_{15} (2.08). Significantly lower benefit-cost ratio was recorded with (T_{14}) weedy check (1.74), but T_2 (0.25), T_3 (0.26), T_5 (0.21), T_6 (0.21), T_8 (0.25), T_9 (0.27), T_{11} (0.22) and T_{12} (0.22) were recorded significantly lower or negative B:C ratios. Seed and straw yield of buckwheat produced in atrazine and pendimethalin sprayed treatments *i.e*., T_2, T_3, T_5, T_6, T_8, T_9, T_{11} and T_{12} were significantly lower compared to weedy check and other treatments (Table 2). This was due to only few plants were survived and they were remained with stunted growth, because of higher phytotoxicity of atrazine and Pendimethalin which lead to lower seed and straw yield of buckwheat. These results are in line with findings of [9] in buckwheat. B:C ratio was recorded significantly higher in (T_{10}) pre-emergent application of Pretilachlor 50 EC @ 1.0 kg a.i. ha^{-1} *fb* one intercultivation at 25-30 DAS. This was due to the lesser cost of cultivation and higher gross returns in this treatment.

Conclusion

Hand weeding is the oldest and most efficient way of weed management in different crops, but in the present senario of labour scarcity and high cost of labour, it is better to explore the other methods of weed management. It was concluded from the above results that the weeds in buckwheat are very well managed with pre emergent application Pretilachlor 50 EC @ 1.0 kg a.i. ha^{-1} *fb* one inter cultivation at 25-30 DAS to get higher net returns and B:C ratio compared to either sole chemical or cultural methods of weed management.

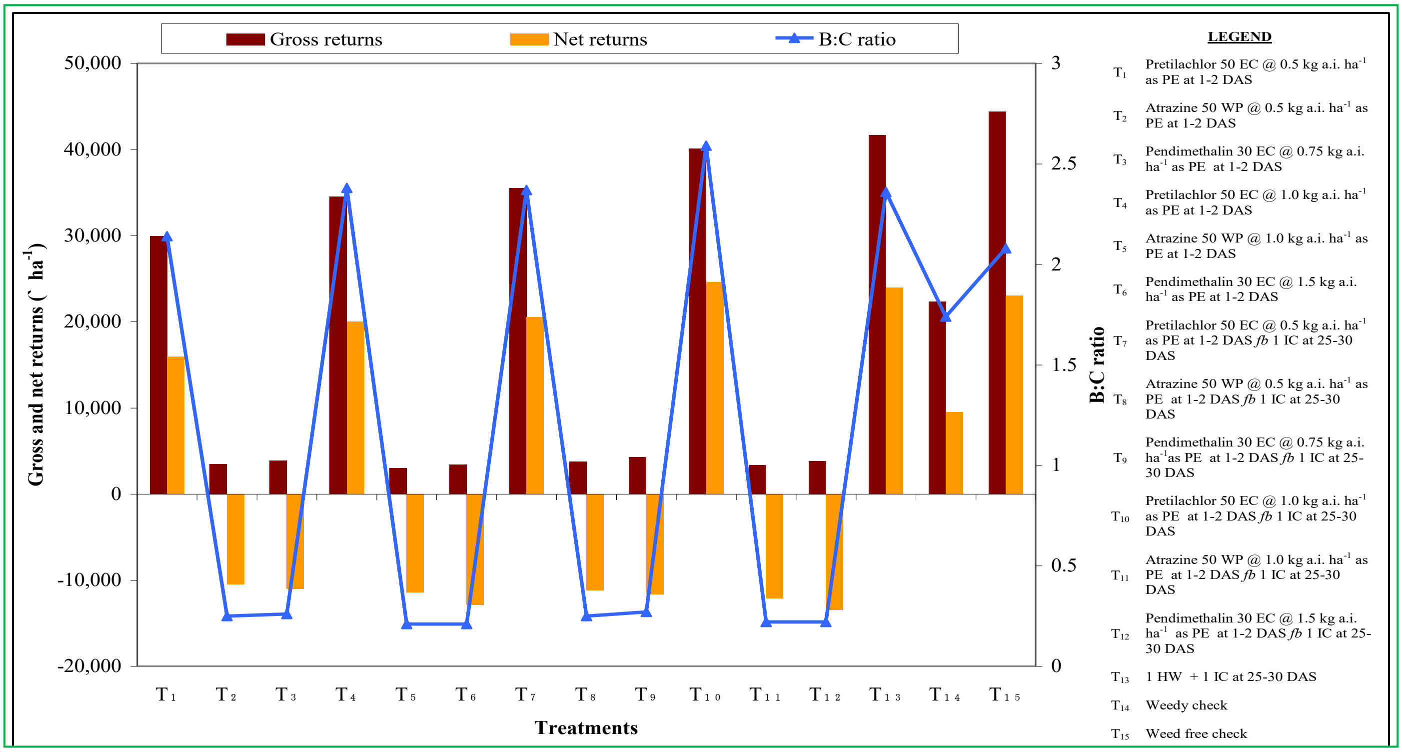

Figure1 Economics of buckwheat as influenced by different weed control treatments

References

[1] Kambrekar DN, Hulihalli UK, Natikar PK, Nisarga HS, Reddy K. Pollinator fauna associated with buckwheat Fagopyrum esculentum Moench (Polygonales: Polygonaceae) in North Karnataka. Journal of Entomology and Zoology studies. 2018;6(5):2098-2101.

[2] Rana SS, Mondal KK, Pankaj S, Rajinder P. A preliminary study on the herbicidal weed control in buckwheat. Fagopyrum. 2003;20:81-84.

[3] 3Jakubiak S. Importance advantages and weed control in minor crops. Progress in Plant Protection. 2005;45:185–195.

[4] 4Podolska G. Weed control in buckwheat and its effect on yield. Fragmenta Agronomica. 2006;27:161–173.

[5] 5Rana SS, Pankaj S, Rana MC. Integrated weed management in buckwheat. Fagopyrum. 2004;21(2):108-113.

[6] 6Sinha B, Sinha CA. Effect of integrated weed management on yield, yield attributes and economics of buckwheat (Fagopyrum esculentum Monech.) under rainfed condition in Terai region of West Bengal. International Journal of Bio-resource and Stress Management. 2012;3(3):299-302.

[7] 7Chhetri B. Response of weed management practices on buckwheat (Fagopyrum esculentum Moench.) under rainfed condition. International Journal of Research in Applied and Natural and Social Science. 2016;4(10):39-44.

[8] 8Chhetri B, Mahato SK. Eco-friendly and alternative weed management practices in buckwheat (Fagopyrum esculentum Moench.) in relation to yield potential under rainfed condition. International Journal of Agriculture Science and Research. 2015;5(2):165-172.

[9] 9Wall DA, Smith MAH. Tolerance of common buckwheat (Fagopyrum esculentum) to low rates of 2,4-D and MCPA. Canadian Journal of Plant Science. 2000;80:407-410.

Publication History

Received	11.09.2025
Revised	26.10.2025
Accepted	26.10.2025
Online	31.10.2025