Original Research Article

ECONOMICAL EFFICACY OF WEED MANAGEMENT OPTIONS IN GROUNDNUT + PIGEONPEA RELAY INTERCROPPING SYSTEM

Abstract

- A field experiment was conducted at Junagadh during *kharif* 2019-20 and 2020-21 in Randomized Block Design with three replications to evaluate the effect of different weed management options on the economics in groundnut + pigeonpea relay intercropping on medium black clayey soils. The treatments included were: pendimethalin 0.9 kg ha^{-1} as PE *fb* interculturing and hand weeding at 45 DAS (T_1), pendimethalin 0.45 kg ha^{-1} + oxyfluorfen 0.09 kg ha^{-1} as PE *fb* interculturing and hand weeding at 45 DAS (T_2), interculturing and hand weeding at 15 DAS *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (ready mix) 1 kg ha^{-1} at 45 DAS as POE (T_3), interculturing and hand weeding at 15 DAS *fb* quizalofop p ethyl 40 g ha^{-1} at 45 DAS as POE (T_4), interculturing and hand weeding at 15 DAS *fb* propaquizafop 70 g ha^{-1} at 45 DAS as POE (T_5), pendimethalin 0.9 kg ha^{-1} as PE *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (ready mix) 1 kg ha^{-1} at 45 DAS as POE (T_6), pendimethalin 0.9 kg ha^{-1} as PE *fb* quizalofop p ethyl 40 g ha^{-1} at 45 DAS as POE (T_7), pendimethalin 0.9 kg ha^{-1} as PE *fb* propaquizafop 70 g ha^{-1} at 45 DAS as POE (T_8), weed free (T_9), and unweeded control (T_{10}). The results revealed that significantly highest cost of cultivation was recorded with the weed free treatment (T_9) due to higher investment on weed management by manual weeding and lowest amount was incurred with the unweeded control (T_{10}) as there were no expenses incurred on weed management. Significantly higher amount of gross returns were recorded with the weed free treatment (T_9), which was closely followed by interculturing and hand weeding at 15 DAS *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (ready mix) 1 kg ha^{-1} at 45 DAS as PoE (T_3). Statistically higher net returns and B:C ratio were registered with interculturing and hand weeding at 15 DAS *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (ready mix) 1 kg ha^{-1} at 45 DAS as PoE (T_3). The unweeded control (T_{10}) registered lower amount of gross returns, net returns and B:C ratio due to the lowered productivity of the crops seriously affected by the unrestricted growth of weeds.

Key words: Groundnut, pigeonpea, interculturing, pendimethalin, oxyfluorfen, sodium acifluorfen, clodinafop propargyl, quizalofop-p-ethyl and propaquizafop

Introduction

Inadequate and erratic rainfall as a consequence of climate change along with weed, insect and other pest attacks prove to be the reason for lower yields and in extreme cases may result in complete failure of the crop. Intercropping is a recommended cropping system to mitigate the aberrant climatic conditions (Willey, 1979). There is a greater difference between the demand and supply of edible oil due to low productivity of oilseed crops. Furthermore, the shortage of pulses and oilseeds has also intensified the problem of malnutrition. Thus, practice of intercropping system offers scope for maximizing and stabilizing returns from *kharif* oilseed crops rather than as a sole crop. In order to reap higher benefits from cultivation of pulses and oilseed crops, there is an urgent need to increase the area and the productivity of these crops. Due to the limiting factors like industrialization and urbanization, the scope for expansion of area under pulses and oilseeds is minimal or nil. This situation instigates the need to adopt appropriate agronomic measures required to increase production (Chaudari *et al.,* 2017). Intercropping has been in vogue for long time to sustain yield, minimize risk, utilize the lag phase and improve productivity. Selection of an appropriate and compatible component crops for intercropping system is necessary for reducing plant competition for resources (Singh *et al.,* 2009). To stabilize crop production and to provide insurance against aberrant weather situation, relay intercropping could be a viable agronomic option for risk minimizing, more profit and sustainable venture. To elevate yield of a cropping system, the most feasible approach is continuous cropping from beginning of the monsoon season to post-monsoon by adopting concept of mixed/inter/relay cropping system. It provides an opportunity to use per unit land, water, nutrient and money invested efficiently. Substantial yield advantage can be achieved through inter/relay cropping as compared to sole cropping. Groundnut + pigeonpea is an emerging most important relay intercropping system in India, especially in Gujarat and Maharashtra, which is advocated by the Pulses Research Station, JAU, Junagadh.

The current shortage of both pulse and vegetable oils in India has stimulated thought on developing new systems of pigeonpea and groundnut intercropping. The approach may involve growing of a long duration crop like pigeonpea with groundnut, so that the loss sustained if any, groundnut may be compensated with long duration crop (Gunri *et al.*, 2015). Intercropping of groundnut + pigeonpea system in 2:1 row proportion is the recommended row proportion for southern Saurashtra region of Gujarat especially when semi-spreading groundnut varieties (GG-20) are used as recommended by Main Oilseeds Research Station, JAU, Junagadh. This combination is particularly prevalent on red soils of the Southern states of India.

Weed infestation is one of the major constraints in productivity of any crop. The slow initial growth of groundnut favours the weed growth and reduces yield up to 75% (Gnanamurthy and Balasubramaniyan, 1998). Adoption of manual weeding though efficient but costly too. Further availability of labour at appropriate time is another constraint which enables the vigorous growth of weeds to compete at initial stages. Use of herbicides could be an alternative and economically feasible method of weed control under these conditions. However, the success of weed control could be determined by the choice of suitable and safe herbicides for both sole and intercrop (Nambi *et al.,* 2006). In the present formulated study, the pigeonpea crop is planned to be sown one month after the sowing of groundnut due to the vigorous growth of pigeonpea may affect the groundnut during the crucial periods like flowering *etc*. Also, the different dates of sowing reduce the competition between the component crops and thereby increasing the yield of the crops. So, for the further increase in productivity of both the crops efficient weed control practices are needed as both the crops have slower initial growth. For the efficient weed management in the cropping system, pre-emergence as well as post-emergence herbicides are included to provide greater advantage to the crops reducing the competition effect of the weeds. The crop production per unit land can be increased with appropriate cropping system and weed management which also must be an economical feasible method which can be adopted by the farmers.

Materials and Methods

The study was conducted at Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh during *kharif* seasons of 2019-20 and 2020-21. Geographically, Junagadh is located at 21.5° N latitude and 70.5° E longitude with an altitude of 60 m above the mean sea level on

the western side on the foothill of mountain 'Girnar' under South Saurashtra Agro-climatic Zone of Gujarat state and enjoys a typically subtropical climate characterized by fairly cold and dry winter, hot and dry summer and warm and moderately humid monsoon.

The soil of the experimental plot was clayey in texture, medium in organic carbon (0.62 and 0.68%), slightly alkaline in reaction with pH (8.32 and 8.25) and EC (0.286 and 0.233 dS m^{-1}) in 2019-20 and 2020-21, respectively. The soil was medium in available nitrogen (270.20 and 257.18 kg ha^{-1}), medium in available phosphorus (28.2 and 31.3 kg ha^{-1}) and medium in available potash (251.7 and 261.2 kg ha^{-1}) in 2019-20 and 2020-21, respectively. In the study, additive series of intercropping was adopted, wherein the main/base crop is groundnut and intercrop is pigeonpea. "Gujarat Groundnut 20" was groundnut variety used for this study as base crop, pigeonpea variety "Gujarat Junagadh Pigeonpea 1" as intercrop. The experiment was laid out in randomized block design with ten treatments, which are replicated thrice to carry out the present investigation. The treatments comprised of pendimethalin 0.9 kg ha^{-1} as PE *fb* interculturing and hand weeding at 45 DAS (T_1), pendimethalin 0.45 kg ha^{-1} + oxyfluorfen 0.09 kg ha^{-1} as PE *fb* interculturing and hand weeding at 45 DAS (T_2), interculturing and hand weeding at 15 DAS *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (ready mix) 1 kg ha^{-1} at 45 DAS as POE (T_3), interculturing and hand weeding at 15 DAS *fb* quizalofop p ethyl 40 g ha^{-1} at 45 DAS as POE (T_4), interculturing and hand weeding at 15 DAS *fb* propaquizafop 70 g ha^{-1} at 45 DAS as POE (T_5), pendimethalin 0.9 kg ha^{-1} as PE *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (ready mix) 1 kg ha^{-1} at 45 DAS as POE (T_6), pendimethalin 0.9 kg ha^{-1} as PE *fb* quizalofop p ethyl 40 g ha^{-1} at 45 DAS as POE (T_7), pendimethalin 0.9 kg ha^{-1} as PE *fb* propaquizafop 70 g ha^{-1} at 45 DAS as POE (T_8), weed free (T_9), and unweeded control (T_{10}).

As the research proposal is on weed management, the practices were adopted in accordance to the proposed treatments. Interculturing in combination with hand weeding was carried in treatments 3, 4 and 5 at 15 DAS while in treatment 1 and 2 it was conducted at 45 DAS of groundnut. Pre emergence herbicide *viz*., pendimethalin 30% EC and oxyfluorfen 23.5% EC were applied on the next day of sowing of groundnut and post emergence herbicides, quizalofop-p-ethyl, propaquizafop and sodium acifluorfen + clodinafop propargyl were applied at 45 DAS after

intercultivation. The weed free was maintained clean with regular intercultivation and manual weeding. The unweeded control was left unweeding allowing the continuous growth of weeds.

Economics of Treatments

The expenses incurred for all the cultivation operations from preparatory tillage to harvesting including the cost of inputs *viz*., seeds, manures, irrigation, biopesticides, *etc*. applied to each treatment was calculated on the basis of prevailing local charges. The gross realization in terms of rupees per hectare was worked out taking into consideration the pod and haulm yields of groundnut and seed and stalk yields of pigeonpea from each treatment and local market prices. A net return of each treatment was calculated by deducting the total cost of cultivation from the gross returns. The Benefit : Cost (B:C) ratio was calculated with the help of following formula.

$$\text{B:C ratio} = \frac{\text{Gross returns (□ ha}^{-1}\text{)}}{\text{Total cost of cultivation (□ ha}^{-1}\text{)}}$$

Results

The data on economics of weed management treatments in groundnut + pigeonpea relay intercropping system during individual years (2019-20 and 2020-21) as well as average of both the years in relation to cost of cultivation, gross returns, net returns and benefit: cost ratio are furnished in Table 1-4. Net returns and cost of cultivation graphically portrayed in Fig. 1.

Cost of cultivation

The perusal of the data revealed that among the different weed management treatments, the weed free treatment (T_9) had higher cost of cultivation (□ 74424, 75584 and 75004 ha^{-1} during 2019-20, 2020-21 as well as pooled results, respectively), followed by the treatments T_3 (Interculturing and hand weeding at 15 DAS *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (Ready mix) 1 kg ha^{-1} at 45 DAS as PoE), T_6 (Pendimethalin 0.9 kg ha^{-1} as aPE *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (Ready mix) 1 kg ha^{-1} at 45 DAS as PoE), T_2 (Pendimethalin 0.45 kg ha^{-1} + oxyfluorfen 0.09 kg ha^{-1} as PE *fb* interculturing and hand weeding at 45 DAS), T_1 (Pendimethalin 0.9 kg ha^{-1} as PE *fb* interculturing and hand weeding at 45 DAS), T_5 (Interculturing and hand weeding at 15 DAS *fb* propaquizafop 70 g ha^{-1} at

45 DAS as PoE), T_4 (Interculturing and hand weeding at 15 DAS *fb* quizalofop-p-ethyl 40 g ha^{-1} at 45 DAS as PoE), T_8 (Pendimethalin 0.9 kg ha^{-1} as PE *fb* propaquizafop 70 g ha^{-1} at 45 DAS as PoE), T_7 (Pendimethalin 0.9 kg ha^{-1} as PE *fb* quizalofop-p-ethyl 40 g ha^{-1} at 45 DAS as PoE). The lowest cost of cultivation (49277, 50437 and 49857 ha^{-1} during 2019-20, 2020-21 as well as pooled results respectively) was recorded with the unweeded control (T_{10}) during 2019-20, 2020-21 as well as pooled results

Gross Returns

Significantly gross returns (231265, 208047 and 219657 ha^{-1} during 2019-20, 2020-21 as well as pooled results respectively) were recorded with the weed free treatment (T_9) during 2019-20, 2020-21 and pooled results. During 2019-20, 2020-21, the weed free treatment (T_9) statistically at par with interculturing and hand weeding at 15 DAS *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (Ready mix) 1 kg ha^{-1} at 45 DAS as PoE (T_3) and pendimethalin 0.9 kg ha^{-1} as PE *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (Ready mix) 1 kg ha^{-1} at 45 DAS as PoE (T_6). While in pooled results it was observed that T_9 was on par with T_3 alone. Lower gross returns (65215, 50530 and 57872 ha^{-1} during 2019-20, 2020-21 and pooled results, respectively) were obtained with the unweeded control.

4.5.3 Net Returns

Statistically higher net returns (161201, 133584 and 147393 ha^{-1} during 2019-20, 2020-21 as well as pooled results respectively) were registered with interculturing and hand weeding at 15 DAS *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (Ready mix) 1 kg ha^{-1} at 45 DAS as PoE (T_3) during 2019-20, 2020-21 and pooled results at par with weed free treatment (T_9) and pendimethalin 0.9 kg ha^{-1} as PE *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (Ready mix) 1 kg ha^{-1} at 45 DAS as PoE (T_6) during 2019-20, 2020-21 and pooled data. The lower net returns (15938, 95 and 8015 ha^{-1} during 2019-20, 2020-21 and pooled results, respectively) were obtained with the unweeded control (T_{10}).

4.5.4 B:C ratio

A glance at the data (Table-4) indicated that among the weed management treatments, the highest B:C ratio (3.84, 3.30 and 3.57 during 2019-20, 2020-21 as well as pooled results, respectively) was obtained with T_3 (Interculturing and hand weeding

at 15 DAS *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (Ready mix) 1 kg ha^{-1} at 45 DAS as PoE), followed by the treatments T_6 (Pendimethalin 0.9 kg ha^{-1} as PE *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (Ready mix) 1 kg ha^{-1} at 45 DAS as PoE), T_1 (Pendimethalin 0.9 kg ha^{-1} as PE *fb* interculturing and hand weeding at 45 DAS), T_2 (Pendimethalin 0.45 kg ha^{-1} + oxyfluorfen 0.09 kg ha^{-1} as PE *fb* interculturing and hand weeding at 45 DAS), T_9 (Weed free treatment), T_4 (Interculturing and hand weeding at 15 DAS *fb* quizalofop-p-ethyl 40 g ha^{-1} at 45 DAS as PoE), T_5 (Interculturing and hand weeding at 15 DAS *fb* propaquizafop 70 g ha^{-1} at45 DAS as PoE), T_7 (Pendimethalin 0.9 kg ha^{-1} as PE *fb* quizalofop-p-ethyl 40 g ha^{-1} at 45 DAS as PoE) and T_8 (Pendimethalin 0.9 kg ha^{-1} as PE *fb* propaquizafop 70 g ha^{-1} at 45 DAS as PoE). The treatment of unweeded control (T_{10}) recorded the lowest B:C ratio (1.32, 1.00 and 1.16 during 2019-20, 2020-21 and pooled results, respectively) during 2019-20, 2020-21 along with pooled results.

Discussion

Maximum cost of cultivation was observed with the weed free treatment (T_9) and minimum cost was invested with the unweeded control (T_{10}). Cost of cultivation in the weed free treatment was the highest due to maximum variable cost, due to the high cost of labours during peak period. This cost was reduced in treatment comprising application of either pre-emergence or post-emergence herbicide in combination with hand weeding which was practically convenient and economically feasible integrated weed management practice. The weed free conditions and minimal weed growth due to the reduced competition had resulted in increased yield thereby increasing the gross returns. The weed free treatment (T_9) did not register higher net returns and B:C ratio due to the higher cost of cultivation incurred for intercultivation and hand weeding. The treatment T_3 (Interculturing and hand weeding at 15 DAS *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (Ready mix) 1 kg ha^{-1} at 45 DAS as PoE) registered higher net returns and B:C ratio as the gross returns obtained were close to the weed free (T_9) and cost of cultivation incurred. Though, the expenditure was higher on weed management in these treatments, it was compensated by increased economic yield of groundnut and pigeonpea with higher gross returns. Consequently, higher B:C ratio was obtained. The unweeded control (T_{10}) registered lower yields of groundnut and pigeonpea, thereby resulted in lower gross returns and net returns, even though the cost of cultivation was lower and finally leading to lower

B:C ratio. Similar results were also reported by Shinde *et al.* (2003) in pigeonpea + pearl millet intercropping system under integrated weed management system. The results are in line with those of Bundhar and Tamilselvan (2003), Sasikala *et al.* (2004), Solanki *et al.* (2005), Chandolia *et al.* (2010), Malunjkar *et al.* (2012), Padmaja *et al.* (2013), Rai *et al.* (2016), Reddy *et al.* (2016) and Priya *et al.* (2017).

Conclusion

The evaluation of the economics indicated that the weed free treatment registered higher gross returns, while higher net return and B:C ratio were recorded with interculturing and hand weeding at 15 DAS *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (Ready mix) 1 kg ha^{-1} at 45 DAS

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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Table-1: Cost of cultivation of various weed management practices in groundnut + pigeonpea relay intercropping system

Treatment	Cost of cultivation (□ ha^{-1})		
	2019	2020	Pooled
T_1 : Pendimethalin 0.9 kg ha^{-1} PE *fb* interculturing and hand weeding at 45 DAS.	53909	55069	54489
T_2 : Pendimethalin 0.45 kg ha^{-1} + oxyfluorfen 0.09 kg ha^{-1} PE *fb* interculturing and hand weeding at 45 DAS.	53978	55138	54558
T_3 : Interculturing and hand weeding at 15 DAS *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (Ready mix) 1 kg ha^{-1} at 45 DAS as PoE.	56853	58014	57434
T_4 : Interculturing and hand weeding at 15 DAS *fb* quizalofop-p-ethyl 40 g ha^{-1} at 45 DAS as PoE.	53675	54835	54255
T_5 : Interculturing and hand weeding at 15 DAS *fb* propaquizafop 70 g ha^{-1} at 45 DAS as PoE.	53786	54947	54367
T_6 : Pendimethalin 0.9 kg ha^{-1} PE *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (Ready mix) 1 kg ha^{-1} at 45 DAS as PoE.	55897	57057	56477
T_7 : Pendimethalin 0.9 kg ha^{-1} PE *fb* quizalofop-p-ethyl 40 g ha^{-1} at 45 DAS as PoE.	52718	53878	53298
T_8 : Pendimethalin 0.9 kg ha^{-1} PE *fb* propaquizafop 70 g ha^{-1} at 45 DAS as PoE.	52830	53990	53410
T_9 : Weed free	74424	75584	75004
T_{10} : Unweeded control	49277	50437	49857

Table-2: Gross returns of various weed management practices in groundnut + pigeonpea relay intercropping system

Treatment	Gross returns (□ ha^{-1})		
	2019	**2020**	**Pooled**
T_1 : Pendimethalin 0.9 kg ha^{-1} PE *fb* interculturing and hand weeding at 45 DAS.	190075	171022	180548
T_2 : Pendimethalin 0.45 kg ha^{-1} + oxyfluorfen 0.09 kg ha^{-1} PE *fb* interculturing and hand weeding at 45 DAS.	187761	158451	173106
T_3 : Interculturing and hand weeding at 15 DAS *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (Ready mix) 1 kg ha^{-1} at 45 DAS as PoE.	218055	191598	204826
T_4 : Interculturing and hand weeding at 15 DAS *fb* quizalofop-p-ethyl 40 g ha^{-1} at 45 DAS as PoE.	164664	134586	149625
T_5 : Interculturing and hand weeding at 15 DAS *fb* propaquizafop 70 g ha^{-1} at 45 DAS as PoE.	156506	130665	143585
T_6 : Pendimethalin 0.9 kg ha^{-1} PE *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (Ready mix) 1 kg ha^{-1} at 45 DAS as PoE.	206900	181295	194098
T_7 : Pendimethalin 0.9 kg ha^{-1} PE *fb* quizalofop-p-ethyl 40 g ha^{-1} at 45 DAS as PoE.	146853	120346	133599
T_8 : Pendimethalin 0.9 kg ha^{-1} PE *fb* propaquizafop 70 g ha^{-1} at 45 DAS as PoE.	141433	110037	125735
T_9 : Weed free	231265	208047	219656
T_{10} : Unweeded control	65215	50530	57872
S.Em.±	7075	6354	4755
C.D. at 5%	21021	18878	13637
C.V. %	10.64	12.40	11.42

Table-3: Net returns of various weed management practices in groundnut + pigeonpea relay intercropping system

Treatment	Net returns (□ ha^{-1})		
	2019	**2020**	**Pooled**
T_1 : Pendimethalin 0.9 kg ha^{-1} PE *fb* interculturing and hand weeding at 45 DAS.	136166	115953	126060
T_2 : Pendimethalin 0.45 kg ha^{-1} + oxyfluorfen 0.09 kg ha^{-1} PE *fb* interculturing and hand weeding at 45 DAS.	133783	103313	118548
T_3 : Interculturing and hand weeding at 15 DAS *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (Ready mix) 1 kg ha^{-1} at 45 DAS as PoE.	161201	133584	147393
T_4 : Interculturing and hand weeding at 15 DAS *fb* quizalofop-p-ethyl 40 g ha^{-1} at 45 DAS as PoE.	110989	79751	95370
T_5 : Interculturing and hand weeding at 15 DAS *fb* propaquizafop 70 g ha^{-1} at 45 DAS as PoE.	102720	75718	89219
T_6 : Pendimethalin 0.9 kg ha^{-1} PE *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (Ready mix) 1 kg ha^{-1} at 45 DAS as PoE.	151003	124238	137621
T_7 : Pendimethalin 0.9 kg ha^{-1} PE *fb* quizalofop-p-ethyl 40 g ha^{-1} at 45 DAS as PoE.	94134	66468	80301
T_8 : Pendimethalin 0.9 kg ha^{-1} PE *fb* propaquizafop 70 g ha^{-1} at 45 DAS as PoE.	88604	56047	72325
T_9 : Weed free	156840	132463	144652
T_{10} : Unweeded control	15938	92	8015
S.Em.±	7075	6354	4755
C.D. at 5%	21021	18878	13637
C.V. %	7.17	7.56	7.36

Table-4: Benefit: cost ratio of various weed management practices in groundnut + pigeonpea relay intercropping system

Treatment	B:C ratio		
	2019	2020	Pooled
T_1 : Pendimethalin 0.9 kg ha^{-1} PE *fb* interculturing and hand weeding at 45 DAS.	3.53	3.11	3.32
T_2 : Pendimethalin 0.45 kg ha^{-1} + oxyfluorfen 0.09 kg ha^{-1} PE *fb* interculturing and hand weeding at 45 DAS.	3.48	2.87	3.18
T_3 : Interculturing and hand weeding at 15 DAS *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (Ready mix) 1 kg ha^{-1} at 45 DAS as PoE.	3.84	3.30	3.57
T_4 : Interculturing and hand weeding at 15 DAS *fb* quizalofop-p-ethyl 40 g ha^{-1} at 45 DAS as PoE.	3.07	2.45	2.76
T_5 : Interculturing and hand weeding at 15 DAS *fb* propaquizafop 70 g ha^{-1} at 45 DAS as PoE.	2.91	2.38	2.64
T_6 : Pendimethalin 0.9 kg ha^{-1} PE *fb* sodium acifluorfen 16.5% + clodinafop propargyl 8% (Ready mix) 1 kg ha^{-1} at 45 DAS as PoE.	3.70	3.18	3.44
T_7 : Pendimethalin 0.9 kg ha^{-1} PE *fb* quizalofop-p-ethyl 40 g ha^{-1} at 45 DAS as PoE.	2.79	2.23	2.51
T_8 : Pendimethalin 0.9 kg ha^{-1} PE *fb* propaquizafop 70 g ha^{-1} at 45 DAS as PoE.	2.68	2.04	2.36
T_9 : Weed free	3.11	2.75	2.93
T_{10} : Unweeded control	1.32	1.00	1.16

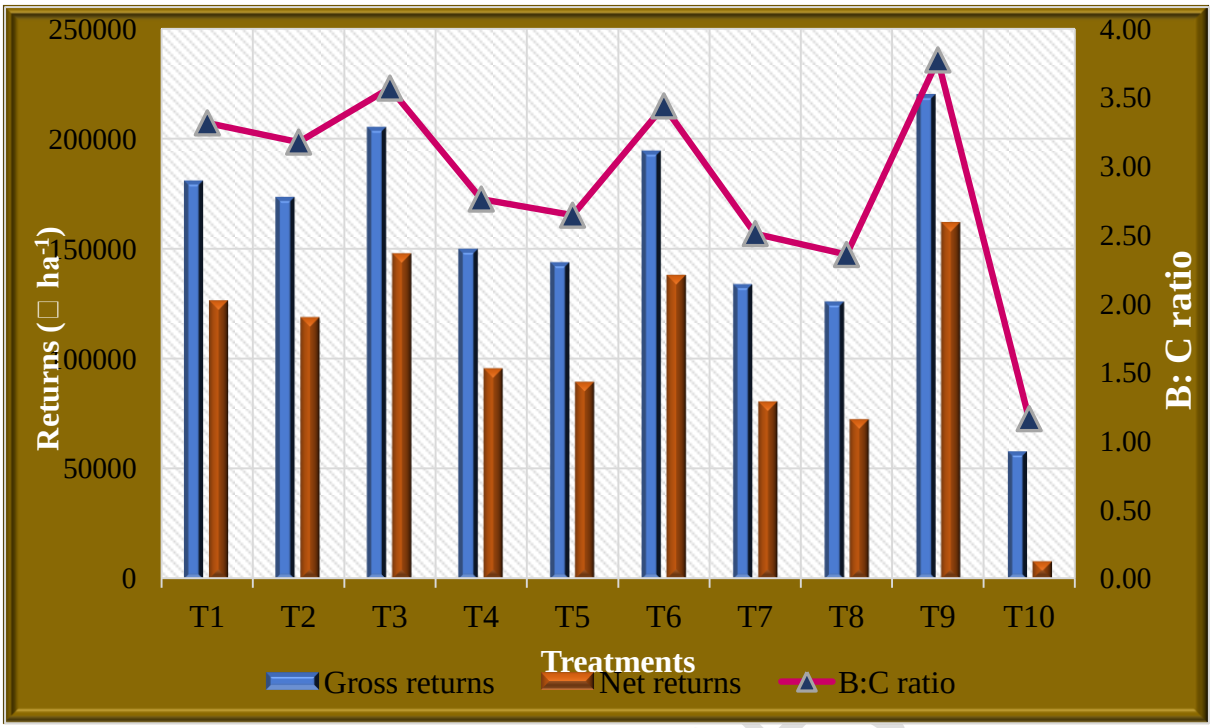

Fig-1: Economics of weed management treatments