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Effect of Seed Priming and Weed Management Techniques on System Productivity and Economics of Dry Direct Seeded Rice-Blackgram Sequence

M. Veerendra[1*], K. Srinivasulu[2], B. Sreedevi[3], S. Ratna Kumari[4] and V. Srinivasa Rao[5]

[1]Ph.D. Scholar, Department of Agronomy,
Agricultural College, Bapatla, ANGRAU (Andhra Pradesh), India.
[2]Professor, Department of Agronomy,
Agricultural College, Bapatla, ANGRAU (Andhra Pradesh), India.
[3]Principal Scientist, Agronomy, Indian Institute of Rice Research,
Rajendranagar, Hyderabad (Telangana), India.
[4]Professor & University Head, Department of Crop Physiology,
Agricultural College, Bapatla, ANGRAU (Andhra Pradesh), India.
[5]Professor, University Head & Associate Dean, Department of Statistics & Computer Applications,
Agricultural College, Bapatla, ANGRAU (Andhra Pradesh), India.

(Corresponding author: M. Veerendra)*
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ABSTRACT: Investigating the influence of treatments imposed during a particular season on entire cropping sequence in terms of system productivity and economics can help to understand the treatment effect more comprehensively. A field experiment was conducted at Agricultural College, Bapatla to find out the effect of seed priming and weed management techniques imposed during *kharif* in rice on system productivity and economics of rice-blackgram sequence during *kharif* and *rabi* seasons of 2021-22 and 2022-23. The experiment was laid out in a split plot design with seed priming treatments as main plots and weed management practices as subplots. No significant difference was observed among the seed priming treatments. However numerically higher system productivity and economics was realized in hormonal priming with gibberellic acid @ 150 ppm. During both the years, highest total rice equivalent yield (rice yield + rice equivalent yield) was recorded with hand weeding thrice at 20, 40 and 60 DAS followed by pretilachlor + safener @ 750 g a.i ha^{-1} with in 3 DAS as PE *fb* bis-pyribac sodium @ 25 g a.i ha^{-1} at 20-25 DAS *fb* fenoxaprop-p-ethyl + safener @ 69 g a.i ha^{-1}+ ethoxy sulfuron @ 18.75 g a.i ha^{-1} (tank mix) at 40-45 DAS as PoE. Highest gross returns were obtained with hand weeding thrice at 20, 40 and 60 DAS. Whereas higher net returns and B:C ratio were obtained with pretilachlor + safener @ 750 g a.i ha^{-1} with in 3 DAS as PE *fb* bis-pyribac sodium @ 25 g a.i ha^{-1} at 20-25 DAS *fb* fenoxaprop-p-ethyl + safener @ 69 g a.i ha^{-1}+ ethoxy sulfuron @ 18.75 g a.i ha^{-1} (tank mix) at 40-45 DAS as PoE. Negative net returns and b:c ratio were obtained with weedy check. No interaction was found between seed priming treatments and weed management practices.

Keywords: Economics, rice-blackgram cropping sequence, seed priming, system productivity, weed management.

INTRODUCTION

Cultivation of Dry Direct seeded rice (DDSR) involves direct sowing of seeds in dry and ploughed soil directly in main field without growing a nursery and transplanting seedlings (Ella *et al*., 2011). DSR is a viable alternative to conventional puddled transplanted rice with good potential for saving water, reducing labour costs, mitigating greenhouse gas emissions and adapting to climatic risks. Moreover, if the crop is properly managed, the yield can be comparable to that of transplanted rice (Kumar and Ladha 2011).

Because of late onset of monsoon and aberrant rainfall behaviour, sowings are getting delayed due to lack of moisture. In Krishna zone of Andhra Pradesh, second crop followed by paddy such as blackgram is getting affected due to late sowing, disturbing the entire rice-blackgram cropping sequence. The reproductive phase of the second crop is coinciding with the suboptimal weather leading to poorer yields. This problem is aggravated in the tail end areas of Nagarjuna sagar canal project, where, even availability of water through canal gets delayed. In order to avoid this problem, farmers are taking up dry direct seeded rice instead to transplanting and wet direct seeded rice. However, it is not without risks that could compromise the crop's overall agronomic performance. During sowing season, dry conditions exist in the field, generating abiotic stress. Furthermore, both rice seedlings and weeds emerge in the field at the same time, making the weed problem a major biotic stress due to lack of enough standing water to keep them at bay during the early stages. Zia-Ul-Haq *et al*. (2019) found that weed pressure in weedy check reduced yield by 76 % as compared to weed-free treatment. When compared to puddled transplanted rice, the risk of yield loss is as high as 50-91 percent due to these problems (Rao *et al*., 2008). So, there is a need to strengthen the seedlings to compete with weeds and cope up with initial dry conditions.

Seed priming is the process of controlled hydration of seeds that allows pre-germinative metabolic activities to proceed, but prevents actual emergence of the radical. A robust seedling stand emerged from primed seeds enhanced rice competitiveness against weeds and can tolerate dry conditions, thereby increase the yields. The reduced seed germination time, uniform emergence, quick growth, improved allometric attributes and vigorous growth are the advantages of priming. Besides that, better root system with improved nutrient uptake, biomass accumulation and better resource partitioning can enhance the agronomic performance of the crop which can be reflected in increased yields.

An experiment conducted by Farooq *et al*. (2020) revealed higher alpha amylase activity and total soluble sugars with hydropriming over no priming for two varieties (Seher-2006 and Shafaq-006) of bread wheat. Anwar *et al*. (2021) from Bangladesh found that priming with NaCl (10,000, 20,000 and 30,000 ppm) for 24 hours had no advantage over no priming for germination rate, seedling vigour & growth indices in 5 different winter rice varieties. In an experiment conducted by Mamun *et al*. (2018) at the Seed Laboratory of Bangladesh Agricultural Development Corporation on Nerica, BRRI dhan 51, BRRI dhan 41, and BRRI dhan 49 rice varieties revealed that highest germination percentage, speed of germination, shoot length, root length, seedling dry weight, and vigour index were possible with vitamin priming *i.e*., 10 ppm ascorbic acid. Dhillon *et al*. (2021) observed that hormone priming (50 ppm GA_3) for 12 and 24 hrs increased germination percentage, root length, shoot length, seedling dry weight, and SVI-I and II in rice *cv*. PR 126 rice at PAU, Ludhiana.

The seedlings in the rice nursery tray at 15 DAS emerged with nutripriming (0.1% Urea + 0.05% $ZnSO_4$ + 0.01% Borax) for 12 hrs produced more seedling length and biomass, as observed by Ancy *et al*. (2022) from Agricultural Research Station, Mannuthy, Kerala. In a field experiment on Maize conducted by Diyanat and Ghajar (2020) in Tehran, Iran, the higher grain and biological yield were observed in weed free plots and three times hand hoeing followed by hydropriming (24 hrs) + EPTC, one hand-hoeing and Nicosulfuron at recommended rate and at 33% reduced dose integrated with seed hydropriming.

Meanwhile, there is also a need for best weed management strategy for dry direct seeded rice which can control wide range of weed flora during critical period of crop weed competition. Even though hand weeding was proved to be the most effective practice, it is not economically feasible. A cost-effective weed management technique without any negative residual impact is required. Overall response due to treatments can be clearly understood by studying system productivity and economics of the entire cropping system. Keeping these facts in view, the present investigation was planned and executed.

MATERIALS AND METHODS

The present investigation was carried out at southern block of Agricultural College Farm, Bapatla of Acharya N.G. Ranga Agricultural University. The experiment was laid out in split plot design and replicated thrice. The soil of the experimental field was sandy clay loam in texture, slightly alkaline in reaction, EC was non-saline and below critical point, low in organic carbon and available nitrogen, medium in available phosphorus and high in available potassium. A preliminary field experiment was conducted to standardize the concentration of each priming agent and the best concentration was selected for main plot treatments.M_1: No priming (Sowing of dry and unprimed seeds), M_2: Hydro-priming (Soaking of seeds in normal water), M_3: Halo-priming (Soaking of seeds in Nacl @ 1%), M_4: Vitamin priming (Soaking of seeds in ascorbic acid @ 40 ppm), M_5: Hormonal priming (Soaking of seeds in gibberellic acid (GA_3) @ 150 ppm), M_6: Botanical extract priming (Soaking of seeds in neem leaf extract @ 2%) and M_7: Nutri-priming (Soaking of seeds in P (KH_2PO_4) and Zn (Zn-EDTA) solution @ 0.5 and 0.1%, respectively). Seed soaking with respective priming agents was done for a period of 12 hrs (Veerendra *et al*., 2022), then redried upto attainment of initial moisture and stored under cool temperature until sowing. Weed management practices were selected as subplot treatments. S_1: Weedy check, S_2: Hand weeding thrice at 20, 40 and 60 DAS, S_3: Pretilachlor + safener @ 750 g a.i ha^{-1} with in 3 DAS as PE *fb* bis-pyribac sodium @ 25 g a.i ha^{-1} at 20-25 DAS *fb*fenoxaprop-p-ethyl + safener @ 69g a.i ha^{-1}+ ethoxy sulfuron @ 18.75 g a.i ha^{-1} (tank mix) at 40-45 DAS as PoE, S_4: Pretilachlor + safener @ 750 g a.i ha^{-1} with in 3 DAS as PE *fb* mechanical weeding with rotary weeder at 20-25 and 40-45 DAS.The economics was worked out for both the years of study with the existing market price of rice and blackgram. The total cost of cultivation ha^{-1} was calculated for each treatment on the basis of all input costs including labour wages. Gross monetary returns for each treatment were calculated by multiplying the economic yield (grain + straw) with the prevailing market price.Net returns for each treatment were estimated at harvest by deducting the cost of cultivation of respective treatments from their gross returns. Net returns (₹ ha^{-1}) = Gross returns (₹ ha^{-1}) – Cost of cultivation (₹ ha^{-1}). Benefit: Cost ratio was worked out for each treatment is obtained by dividing net returns with cost of cultivation. Rice equivalent yield (REY) of blackgram was calculated by making use of the following formulae as stated by Munda *et al.* (2008) and was expressed in kg ha^{-1}.

$$\text{REY} = \frac{\text{Economic yield of blackgram (kg)} \times \text{Price of blackgram kg}^{-1}}{\text{Price of rice kg}^{-1}}$$

RESULTS AND DISCUSSION

A. Effect of seed invigoration and weed management practices on system productivity of rice-blackgram cropping system

System productivity can be studied through converting yield of one crop into another in terms of equivalent yields. Blackgram yield was converted into rice yield and was called rice equivalent yield of blackgram. Rice equivalent yield of blackgram and total rice equivalent yield were calculated and presented in Table 1. No significant difference was observed among the seed priming treatments. Whereas, the weed management treatments influenced the grain yield at different growth stages during both the years.

Higher rice equivalent yield of blackgram was observed with S_2 (Hand weeding thrice at 20, 40 and 60 DAS) which was at par with both S_3 (Pretilachlor + safener @ 750 g a.i ha^{-1} with in 3 DAS as PE *fb* bis-pyribac sodium @ 25 g a.i ha^{-1} at 20-25 DAS *fb* fenoxaprop-p-ethyl + safener @ 69 g a.i ha^{-1}+ ethoxy sulfuron @ 18.75 g a.i ha^{-1} (tank mix) at 40-45 DAS as PoE) and S_4 (Pretilachlor + safener @ 750 g a.i ha^{-1} with in 3 DAS as PE *fb* mechanical weeding with rotary weeder at 20-25 and 40-45 DAS) during both the years. Lowest rice equivalent yield of blackgram was recorded in weedy check (S_1).

Whereas, during both the years, highest total rice equivalent yield was recorded with S_2 (Hand weeding thrice at 20, 40 and 60 DAS) followed by S_3 (Pretilachlor + safener @ 750 g a.i ha^{-1} with in 3 DAS as PE *fb* bis-pyribac sodium @ 25 g a.i ha^{-1} at 20-25 DAS *fb* fenoxaprop-p-ethyl + safener @ 69 g a.i ha^{-1}+ ethoxy sulfuron @ 18.75 g a.i ha^{-1} (tank mix) at 40-45 DAS as PoE) and in turn followed by S_4 (Pretilachlor + safener @ 750 g a.i ha^{-1} with in 3 DAS as PE *fb* mechanical weeding with rotary weeder at 20-25 and 40-45 DAS). Whereas lowest was observed with weedy check (S_1). The interaction effect was not found during both the years of study.

B. Effect of Seed Invigoration and Weed Management Practices on Economics of Dry Direct Seeded Rice Cultivation

Data on economics (gross returns, net returns and b:c ratio) was presented in the Table 2. No significant difference was found among seed priming agents whereas weed management treatments influenced the economics of paddy cultivation significantly.

During both the years, highest gross returns were recorded with S_2 (Hand weeding thrice at 20, 40 and 60 DAS) followed by S_3 (Pretilachlor + safener @ 750 g a.i ha^{-1} with in 3 DAS as PE *fb* bis-pyribac sodium @ 25 g a.i ha^{-1} at 20-25 DAS *fb* fenoxaprop-p-ethyl + safener @ 69 g a.i ha^{-1}+ ethoxy sulfuron @ 18.75 g a.i ha^{-1} (tank mix) at 40-45 DAS as PoE) and in turn followed by S_4 (Pretilachlor + safener @ 750 g a.i ha^{-1} with in 3 DAS as PE *fb* mechanical weeding with rotary weeder at 20-25 and 40-45 DAS). Whereas lowest was observed with weedy check (S_1).

Highest net returns and b: c ratio were observed with S_3 (Pretilachlor + safener @ 750 g a.i ha^{-1} with in 3 DAS as PE *fb* bis-pyribac sodium @ 25 g a.i ha^{-1} at 20-25 DAS *fb* fenoxaprop-p-ethyl + safener @ 69 g a.i ha^{-1}+ ethoxy sulfuron @ 18.75 g a.i ha^{-1} (tank mix) at 40-45 DAS as PoE) followed by S_4 (Pretilachlor + safener @ 750 g a.i ha^{-1} with in 3 DAS as PE *fb* mechanical weeding with rotary weeder at 20-25 and 40-45 DAS) and in turn followed by S_2 (Hand weeding thrice at 20, 40 and 60 DAS). Lowest net returns and b: c ratio were observed with weedy check (S_1). The interaction among the main and subplots was found to be non significant during both the years of study.

Eventhough the yield and gross returns were higher for S_2 (hand weeding thrice) compared to other treatments, the net returns and B:C ratio were lower due to higher cost of cultivation. This is mainly because of higher labour wages involved in manual hand weeding, which could not compensate the additional grain yield obtained during both the years of study. Use of herbicides (S_3) was found to be cheaper and effective way of controlling the weeds and emerged as economically feasible option among other weed management treatments (S_2 & S_4). Similar findings were reported by Prasad *et al*. (2010); Jannu *et al*. (2017); Chadachanakar *et al*. (2017) ; Zia-Ul-Haq *et al*. (2019).

Also, it was observed that, even though the yields during second year were less compared to first year, higher gross, net returns and b:c ratio were obtained during second year. This is due to increased Minimum Support Price for paddy from Rs. 1940/- to Rs. 2040/- per quintal.

C. Effect of Seed Invigoration and Weed Management Techniques in Dry Direct Seeded Rice During Kharif on Economics of Blackgram Cultivation

Data on economics (gross returns, net returns and b:c ratio) of blackgram cultivation as effected by treatments applied in rice during *kharif* was presented in Table 3. There was no significant difference between the seed priming treatments. Whereas, the weed management methods had an effect on the economics.

Higher gross returns, net returns and b:c ratio were observed with S_2 (Hand weeding thrice at 20, 40 and 60 DAS) which was at par with both S_3 (Pretilachlor + safener @ 750 g a.i ha^{-1} with in 3 DAS as PE *fb* bis-pyribac sodium @ 25 g a.i ha^{-1} at 20-25 DAS *fb* fenoxaprop-p-ethyl + safener @ 69 g a.i ha^{-1}+ ethoxy sulfuron @ 18.75 g a.i ha^{-1} (tank mix) at 40-45 DAS as PoE) and S_4 (Pretilachlor + safener @ 750 g a.i ha^{-1} with in 3 DAS as PE *fb* mechanical weeding with rotary weeder at 20-25 and 40-45 DAS) during both the years. Lowest gross returns, net returns and b:c ratio was recorded in weedy check (S_1). The interaction among the main and subplots was found to be non significant during both the years of study.

D. Effect of seed invigoration and weed management techniques on economics of rice-blackgram cropping sequence

Economics of rice-blackgram sequence was calculated from the pooled rice and blackgram yield of both the years and presented in Figure1. No significant difference was observed among the seed priming treatments. Anyhow numerically higher monetary returns were observed with hormonal priming with gibberellic acid @ 150 ppm. Whereas, the weed management treatments influenced the economics at different growth stages.

Highest gross returns were obtained with S_2 (Hand weeding thrice at 20, 40 and 60 DAS) which was followed by sequential application of herbicides (S_3) and inturn followed by S_4 (Pretilachlor + safener @ 750 g a.i ha^{-1} with in 3 DAS as PE *fb* mechanical weeding with rotary weeder at 20-25 and 40-45 DAS) and least was obtained with weedy check (S_1). Whereas higher net returns were obtained with pretilachlor + safener @ 750 g a.i ha^{-1} with in 3 DAS as PE *fb* bis-pyribac sodium @ 25 g a.i ha^{-1} at 20-25 DAS *fb* fenoxaprop-p-ethyl + safener @ 69 g a.i ha^{-1}+ ethoxy sulfuron @ 18.75 g a.i ha^{-1} (tank mix) at 40-45 DAS as PoE (₹.96994 ha^{-1}) followed by pretilachlor + safener @ 750 g a.i ha^{-1} with in 3 DAS as PE *fb* mechanical weeding with rotary weeder at 20-25 and 40-45 DAS (₹ 89703 ha^{-1}) which was at par with hand weeding (₹.87429 ha^{-1}). Negative net returns were obtained with weedy check (₹.-5085 ha^{-1}).

Higher b:c ratio was realized with pretilachlor + safener @ 750 g a.i ha^{-1} with in 3 DAS as PE *fb* bis-pyribac sodium @ 25 g a.i ha^{-1} at 20-25 DAS *fb* fenoxaprop-p-ethyl + safener @ 69 g a.i ha^{-1}+ ethoxy sulfuron @ 18.75 g a.i ha^{-1} (tank mix) at 40-45 DAS as PoE (1.48) followed by pretilachlor + safener @ 750 g a.i ha^{-1} with in 3 DAS as PE *fb* mechanical weeding with rotary weeder at 20-25 and 40-45 DAS (1.33) inturn followed by hand weeding (1.07). Whereas negative was recorded in weedy check (-0.09). No interaction was found between seed priming and weed management techniques.

Table 1: System productivity of rice-blackgram cropping sequence as influenced by seed invigoration and weed management techniques in dry direct seeded rice.

Treatments	2021-22				2022-23			
	Rice grain yield	**Blackgram grain yield**	**Rice equivalent yield**	**Total REY**	**Rice grain yield**	**Blackgram grain yield**	**Rice equivalent yield**	**Total REY**
Main plots : Seed Priming Treatments								
M_1: No priming (control)	4145	560	1820	5965	4269	531	1718	5983
M_2: Hydro-priming	4274	564	1831	6106	4257	534	1726	5979
M_3: Halo-priming	4286	560	1819	6106	4172	535	1730	5898
M_4: Vitamin priming	4411	574	1863	6274	4375	541	1751	6122
M_5: Hormonal priming	4498	574	1865	6363	4424	544	1761	6182
M_6: Botanical extract priming	4339	567	1842	6181	4268	539	1745	6009
M_7: Nutri-priming	4470	570	1851	6321	4323	535	1730	6049
SEm±	**93.61**	**11.68**	**37.94**	**91.79**	**119.16**	**13.87**	**44.88**	**141.00**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CV (%)	**7.4**	**7.1**	**7.1**	**5.1**	**9.6**	**8.9**	**8.9**	**8.1**
Sub plots : Weed Management Practices								
S_1: Weedy check	1048	444	1442	2490	988	418	1354	2342
S_2: Hand weeding thrice at 20,40 and 60 DAS	5686	622	2020	7705	5642	588	1903	7545
S_3: Pretilachlor + safener as PE *fb* bis-pyribac sodium at 20-25 DAS *fb* fenoxaprop-p-ethyl + ethoxy sulfuron (tank mix) at 40-45 DAS	5440	605	1964	7404	5397	570	1844	7240
S_4: Pretilachlor + safener as PE *fb* mechanical weeding with rotary weeder at 20- 25 DAS and 40-45 DAS	5210	598	1941	7152	5166	571	1849	7000
SEm±	**69.90**	**9.51**	**30.89**	**76.46**	**75.63**	**9.05**	**29.28**	**81.66**
CD (P=0.05)	**200**	**27**	**88**	**218**	**216**	**26**	**84**	**233**
CV (%)	**7.4**	**7.7**	**7.7**	**5.7**	**8.1**	**7.7**	**7.7**	**6.2**
Interaction	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 2: Economics of dry direct seeded rice as influenced by seed invigoration and weed management techniques during *kharif*.

Treatments	2021-22			2022-23		
	Gross Return (₹ ha^{-1})	Net Return (₹ ha^{-1})	B:C ratio	Gross Return (₹ ha^{-1})	Net Return (₹ ha^{-1})	B:C ratio
Main plots : Seed Priming Treatments						
M_1: No priming (control)	90651	39481	0.71	97096	45240	0.80
M_2: Hydro-priming	93277	42107	0.77	97028	45173	0.81
M_3: Halo-priming	93548	40878	0.72	95289	41933	0.73
M_4: Vitamin priming	96123	44454	0.80	99588	47232	0.84
M_5: Hormonal priming	97955	44785	0.79	100674	46819	0.82
M_6: Botanical extract priming	94612	43442	0.79	97179	45323	0.81
M_7: Nutri-priming	97338	42668	0.72	98545	43190	0.73
SEm±	**1938.92**	**1938.92**	**0.04**	**2434.89**	**2434.89**	**0.05**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CV (%)	**7.1**	**15.8**	**17.5**	**8.6**	**18.7**	**20.3**
Sub plots : Weed Management Practices						
S_1: Weedy check	23518	-18360	-0.44	23106	-19458	-0.46
S_2: Hand weeding thrice at 20,40 and 60 DAS	123678	57800	0.88	128233	61668	0.93
S_3: Pretilachlor + safener as PE *fb* bis-pyribac sodium at 20-25 DAS *fb* fenoxaprop-p-ethyl + ethoxy sulfuron (tank mix) at 40-45 DAS	118434	68806	1.39	122736	72421	1.44
S_4: Pretilachlor + safener as PE *fb* mechanical weeding with rotary weeder at 20- 25 DAS and 40-45 DAS	113513	61935	1.20	117582	66318	1.25
SEm±	**1358.94**	**1358.94**	**0.03**	**1554.21**	**1554.21**	**0.03**
CD (P=0.05)	**3878**	**3878**	**0.08**	**4436**	**4436**	**0.09**
CV (%)	**6.5**	**14.6**	**16.3**	**7.3**	**15.8**	**17.7**
Interaction	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 3. Economics of blackgram during *rabi* as influenced by seed invigoration and weed management techniques in dry direct seeded rice.

Treatments	2021-22			2022-23		
	Gross Return (₹ ha^{-1})	Net Return (₹ ha^{-1})	B:C ratio	Gross Return (₹ ha^{-1})	Net Return (₹ ha^{-1})	B:C ratio
Main plots : Seed Priming Treatments						
M_1: No priming (control)	35948	19998	1.25	35664	20114	1.29
M_2: Hydro-priming	36173	20223	1.27	35839	20289	1.30
M_3: Halo-priming	35938	19988	1.25	35916	20366	1.31
M_4: Vitamin priming	36799	20849	1.31	36344	20794	1.34
M_5: Hormonal priming	36821	20871	1.31	36548	20998	1.35
M_6: Botanical extract priming	36370	20420	1.28	36233	20683	1.33
M_7: Nutri-priming	36567	20617	1.29	35924	20374	1.31
SEm±	**733.59**	**733.59**	**0.05**	**914.40**	**914.40**	**0.06**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
CV (%)	**7.0**	**12.4**	**12.4**	**8.8**	**15.4**	**15.4**
Sub plots : Weed Management Practices						
S_1: Weedy check	28571	12621	0.79	28199	12649	0.81
S_2: Hand weeding thrice at 20,40 and 60 DAS	39858	23908	1.50	39481	23931	1.54
S_3: Pretilachlor + safener as PE *fb* bis-pyribac sodium at 20-25 DAS *fb* fenoxaprop-p-ethyl + ethoxy sulfuron (tank mix) at 40-45 DAS	38759	22809	1.43	38246	22696	1.46
S_4: Pretilachlor + safener as PE *fb* mechanical weeding with rotary weeder at 20- 25 DAS and 40-45 DAS	38308	22358	1.40	38341	22791	1.47
SEm±	**597.97**	**597.97**	**0.04**	**596.28**	**596.28**	**0.04**
CD (P=0.05)	**1707**	**1707**	**0.11**	**1702**	**1702**	**0.11**
CV (%)	**7.5**	**13.4**	**13.4**	**7.6**	**13.3**	**13.3**
Interaction	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

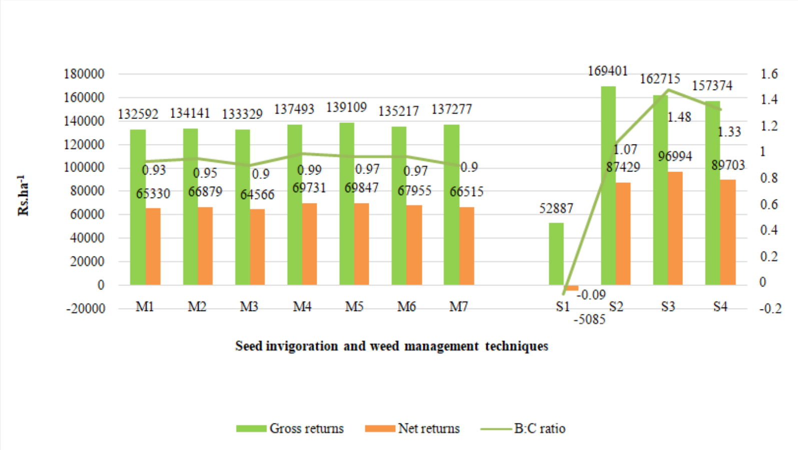

Fig. 1. Economics of rice-blackgram cropping sequence as influenced by seed invigoration and weed management techniques in dry direct seeded rice.

CONCLUSIONS

Numerically, higher benefits were obtained with hormonal priming compared to all the other methods. Higher system productivity and gross returns were obtained with hand weeding thrice at 20, 40 and 60 DAS followed by sequential application of herbicides. However, considering the net returns and b: c ratio, pretilachlor + safener @ 750 g a.i ha^{-1} with in 3 DAS as PE *fb* bis-pyribac sodium @ 25 g a.i ha^{-1} at 20-25 DAS *fb* fenoxaprop-p-ethyl + safener @ 69 g a.i ha^{-1}+ ethoxy sulfuron @ 18.75 g a.i ha^{-1} (tank mix) at 40-45 DAS as PoE is economically feasible option over hand weeding. Thus, sequential application of herbicides in dry direct seeded rice can yield higher benefits to the farmers.

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Conflict of Interest. None.

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