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# Effect of Age of Seedlings, Weed Management Methods on Yield attributes and Economics under System of Rice Intensifications (SRI)

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**A B S T R A C T**

System of Rice Intensification (SRI) with weed management is an imperative to convince the today's crop production in a sustainable way. Due to scarcity of water and energy, the weed competition is going to be the major constraint in achieving higher production in transplanted rice. In order to standardize the age of seedlings and to evaluate alternate practices to cono weeding, two field experiments were conducted during Rabi 2010-11 and Kharif 2011 at Perunthalaivar Kamaraj Krishi Vigyan Kendra (PKKVK), Puducherry State experimental farm in a factorial randomized block design with three replication. The treatments were formed by combination of two ages of seedlings and five weed management practices that were tested on System of Rice Intensification crop. The findings of two seasons, use of 15 days old seedlings with four times cono weeding was performed excellent by registering higher yield attributes and grain yield of 5360 and 4020 kg $ha^{-1}$ during Rabi 2010-11 and Kharif 2011 respectively. The next best was three times cono weeding was economically feasible in both the seasons. Adopting 15 days old seedlings with four times cono weeding followed by 15 days old seedlings with three times cono weeding registered higher yield and yield attributes in rice, besides it also gave higher net return by reducing the cost production particularly in edging out higher inorganic fertilizers and weeding through cono weeding without affecting the grain yield in rice was proved by the study.

## Introduction

Asian Rice (*Oryza sativa*) is one of the most widely and leading cultivated cereal in the world, second to wheat in its annual contribution to food consumption[1]. It is a strategic crop for many Asian countries and is sometimes referred to as the "wonder cereal", commanding respect and recognition because of being a staple food for more than half the ethnic groups around the world. Rice is also a superior food commodity to mankind, ranked as life, culture, tradition, and means of livelihood for millions of people. Its cultivation requires a temperate climate, rainfall between 120 and 140 mm, temperature between 21 and 37 C, and a heavy to sandy loam soil. It is planted in different ecological regions with diverse production potentials, mostly as the main source of food for Asian and Southeast Asian countries including India. The total world production of rice in 2014 was

740.955973 million tons[2], of which Asian countries contributed 90% (667.258311 million tons). Major Rice producer countries in 2014 and their shared percentage of world production were China (28.1%), India (21.22%), Vietnam (6.07%), Thailand (4.4%), Pakistan (5.13%), and the United States (1.35%), with Malaysia contributing as low as 0.36%.

The increasing world population calls for more research and technological advancement to increase rice production for consumption in different countries. Yield and qualities of rice have an increasingly higher demand on a daily basis due to population expansion. This, however, necessitates practicing of more production through user and environmentally friendly modern technologies in the different field of rice production management in order to produce higher yield at the lowest production cost, and at the same time keeping production competitive through mechanization and automation. The trend in world rice production between 1961 and 2014 predicts that in 2020, total world production will be increased by 7% and reach to 792.84 million tons. Southeast Asian countries are therefore expected to increase their production by 27.2%. Such demand calls for new methods and improvement of current cultivation techniques.

Currently, main production constraints are the lack of sound integrated management principles in labor, land, water, crop, and inputs (including seeds, and fertilizer) and the required plant population. Plant population in manual labor is very low and decreases yield. In addition, due to the shortage of labor, transplanting is sometimes delayed, resulting in a progressive yield decline. Different attempts have been made in many countries, with Japan the first to develop a mechanical paddy transplanter that reduces workload from 15 to 30 man-days per hectare[3].

The System of Rice Intensification (SRI) was introduced to increase rice production through the exploitation of genetic capability, creating a favorable environment, improving soil condition, reducing production inputs (seeds, labor, and water).

Rice is a staple food for more than half of the global population and it is a predominant crop in lowland ecosystem. Tamil Nadu is one of the important rice growing states in India wherein rice is cultivated on 1.93 m ha with a production of 5.18 m t and the productivity is 2.68 t $ha^{-1}$ which is very low when compared to world average of 4.25 t $ha^{-1}$.

Rice contributes 20 to 25 per cent of agricultural GDP in India and its production has to be necessarily increased in India to meet the growing population and that too with reduced available irrigation water. System of Rice Intensification (SRI) is one of the ways to solve the water crisis in rice cultivation and to increase the rice yield three to four times as compared to conventional farmer's cultivation (Uphoff, 2002).

System of Rice Intensification (SRI) with weed management is an imperative to convince the today's crop production in a sustainable way. Due to scarcity of water and energy, the weed competition is going to be the major constraint in achieving higher production in transplanted rice In order to standardize the age of seedlings and to evaluate alternate practices to cono weeder. The findings of two seasons, use of 15 days old seedlings with four times cono weeding was performed excellent by registering higher yield attributes and grain yield.

## Materials and Methods

To evaluate the effect of age of seedlings and weed management practices on certain growth parameters of rice under SRI, two field

experiments were conducted at Rabi 2010-11 and Kharif 2011 at Perunthalaivar Kamaraj Krishi Vigyen Kendra (PKKVK), Puducherry State experimental research farm in a randomized block design with three replication with the rice variety ADT 45 during Kharif 2013. The soil type was clay loam in texture and Acidic in reaction (pH 6.91), acidic having electrical conductivity (EC) of 0.23 $dSm^{-1}$ and available N,P,K content were 145.6 kg $ha^{-1}$, 42.66 kg $ha^{-1}$ and 163 kg $ha^{-1}$ in Kharif 2013 during The rice variety ADT 43 during Rabi 2012-13. The soil type was clay loam in texture and Acidic in reaction (pH 7.31), acidic having electrical conductivity (EC) of 0.61 $dSm^{-1}$ and available N,P,K content were 179 kg $ha^{-1}$, 21.2 kg $ha^{-1}$ and 168 kg $ha^{-1}$ in Rabi 2012-13 with field duration of 105 days, was used in the trial. The treatments were factorial randomized block design with treatments formed by combination of two age of seedling (M1 – 10 days old seedlings and M2 - 15 days old seedlings) and four weed management practices (S1 – cono weeding two times at 10 and 20 DAT, S2 – cono weeding four times at 10, 20, 30 and 40 DAT, S3 – pre-emergence application of butachlor @ 1.5 kg a.i. $ha^{-1}$ on 3 DAT + hand weeding on 35 DAT and S4 – unweeded control). Butachlor was applied to respective plots by mixing it with sand @ 50 kg $ha^{-1}$. Standard package of practices were adopted for both the crops. Plant height, number of tillers $m^{-2}$ and crop dry matter production were recorded at harvest. Leaf area index (LAI) was computed at active tillering stage by using the formula suggested by Yoshida *et al.,* (1976).

## Results and Discussion

The findings of two seasons, use of 15 days old seedlings with four times cono weeding was performed excellent by registering higher yield attributes and grain yield of 5360 and 4020 kg $ha^{-1}$ during Rabi 2010-11 and Kharif 2011 respectively. The next best was three times cono weeding was economically feasible in both the seasons. Higher net returns and Benefit cost ratio (BCR) was observed in 15 days old seedlings with three times cono weeding with SRI principles. Adopting 15 days old seedlings with four times cono weeding followed by 15 days old seedlings with three times cono weeding registered higher yield and yield attributes in rice.15 days old seedlings followed by three times cono weeding with SRI principles may be recommended to the farmers based on its cost effectiveness and ecological friendliness. Young age of seedlings enhanced more tillering and also extended tillering period. By reducing the cost production particularly in edging out higher inorganic fertilizers and weeding through cono weeding without affecting the grain yield in rice was proved by the study. This observation was confirmed by the earlier findings of Tao *et al.,* (2002).

All the weed management practices exerted significant influence on growth parameters of rice. Within the weed management practices, cono weeding four times increased the plant height, LAI, tillers $m^{-2}$ and DMP over unweeded control in both seasons, respectively and was on par with butachlor application @ 1.5 kg a.i. $ha^{-1}$ + hand weeding on 35 DAT. Least growth parameters were registered in unweeded control in both the seasons.

The interaction between the age of seedlings and weed management practices was marked on the growth parameters during both the seasons. Transplanting of 15 days old seedlings coupled with cono weeding four times resulted in taller plants the higher number of tillers m-2, LAI, and DMP in both seasons, respectively. However, it was comparable with butachlor application @ 1.5 kg a.i. $ha^{-1}$ + hand weeding on 35 DAT. The least growth parameters were observed in unweeded control.

**Table.1** Rice cultivation as affected by age of seedlings and weed management practices during Rabi 2010-11 on grain yield (kg/ha)

| | Rabi 2010-11 (Variety - ADT-37) | | | Kharif 2011-12 (Variety- Improved White Ponni) | | |
|---|---|---|---|---|---|---|
| **Age of Seedlings Weed Management** | **A1** | **A2** | **Mean** | **A1** | **A2** | **Mean** |
| W1- 2 times cono weeder at 10 and 20 DAT | 4.61 | 4.6 | 4.61 | 3.47 | 3.60 | 3.53 |
| W2- 4 times cono weeder at 10, 20, 30 and 40 DAT | 5.19 | 5.53 | 5.36 | 3.73 | 3.92 | 3.83 |
| W-3 Herbicides pre emergence Butachlor @ 1.50 a.i/ha at 5 DAT followed by one hand weeding at 20 DAT | 3.97 | 4.13 | 4.05 | 3.85 | 4.02 | 3.93 |
| W4- 3 times cono-weeder at 10, 20, 30 DAT | 5.05 | 5.10 | 5.08 | 3.13 | 3.24 | 3.18 |
| W5- Unweeded control | 4.42 | 4.53 | 4.47 | 3.53 | 3.64 | 3.58 |
| Mean | 4.65 | 4.78 | 4.71 | 3.54 | 3.68 | 3.61 |
| | **M** | **S** | | **M** | **S** | **MXS** |
| **CD (0.05)** | NS | 0.32 | | NS | 0.30 | NS |
| **C.V. (%)** | 7.27 | 6.59 | | 7.11 | 6.26 | NS |

**Table.2** Rice cultivation as affected by age of seedlings and weed management practices on Panicle No. /$m^2$

| | Rabi 2010-11 (Variety - ADT-37) | | | Kharif 2011-12 (Variety- Improved White Ponni) | | |
|---|---|---|---|---|---|---|
| **Age of Seedlings Weed Management** | **A1** | **A2** | **Mean** | **A1** | **A2** | **Mean** |
| W1- 2 times cono weeder at 10 and 20 DAT | 287 | 330 | 309 | 321 | 331 | 326 |
| W2- 4 times cono weeder at 10, 20, 30 and 40 DAT | 333 | 386 | 359 | 371 | 391 | 381 |
| W-3 Herbicides pre emergence Butachlor @ 1.50 a.i/ha at 5 DAT followed by one hand weeding at 20 DAT | 248 | 313 | 281 | 406 | 455 | 430 |
| W4- 3 times cono-weeder at 10, 20, 30 DAT | 323 | 355 | 339 | 292 | 285 | 288 |
| W5- Unweeded control | 289 | 338 | 331 | 342 | 348 | 345 |
| **Mean** | 296 | 344 | 320 | 346 | 362 | 354 |
| | **M** | **S** | **MXS** | **M** | **S** | **MXS** |
| **CD (0.05)** | 13.64 | 23.41 | NS | 14.27 | 24.50 | NS |
| **C.V. (%)** | 3.83 | 6.41 | NS | 4.12 | 7.42 | NS |

**Table.3** Rice cultivation as affected by age of seedlings and weed management practices on panicle weight (g)

| | Rabi 2010-11 (Variety - ADT-37) | | | Kharif 2011-12 (Variety-Improved White Ponni) | | |
|---|---|---|---|---|---|---|
| **Age of Seedlings Weed Management** | **A1** | **A2** | **Mean** | **A1** | **A2** | **Mean** |
| W1- 2 times cono weeder at 10 and 20 DAT | 4.08 | 4.16 | 4.12 | 3.35 | 3.46 | 3.40 |
| W2- 4 times cono weeder at 10, 20, 30 and 40 DAT | 4.43 | 4.44 | 4.43 | 3.98 | 4.13 | 4.05 |
| W-3 Herbicides pre emergence Butachlor @ 1.50 a.i/ha at 5 DAT followed by one hand weeding at 20 DAT | 3.91 | 3.78 | 3.85 | 4.21 | 4.43 | 4.32 |
| W4- 3 times cono-weeder at 10, 20, 30 DAT | 4.35 | 4.43 | 4.39 | 2.90 | 3.04 | 2.96 |
| W5- Unweeded control | 4.25 | 4.31 | 4.28 | 3.62 | 3.87 | 3.74 |
| Mean | 4.20 | 4.22 | 4.21 | 3.61 | 3.78 | 3.70 |
| | **M** | **S** | **MXS** | **M** | **S** | **MXS** |
| **CD (0.05)** | NS | 0.38 | NS | NS | 0.33 | NS |
| **C.V. (%)** | 10.86 | 8.68 | NS | 9.82 | 8.43 | NS |

**Table.4** Economics of rice cultivation as affected by Age of seedlings and weed management practices during Rabi 2010-11 on cross return in Rs.

| | Rabi 2010-11 (Variety - ADT-37) | | | Kharif 2011-12 (Variety-Improved White Ponni) | | |
|---|---|---|---|---|---|---|
| **Age of Seedlings Weed Management** | **A1** | **A2** | **Mean** | **A1** | **A2** | **Mean** |
| W1- 2 times cono weeder at 10 and 20 DAT | 42443 | 42475 | 42459 | 44058 | 45745 | 44902 |
| W2- 4 times cono weeder at 10, 20, 30 and 40 DAT | 47490 | 50405 | 48948 | 47275 | 49525 | 48400 |
| W-3 Herbicides pre emergence Butachlor @ 1.50 a.i/ha at 5 DAT followed by one hand weeding at 20 DAT | 36885 | 38283 | 37584 | 48670 | 50695 | 49683 |
| W4- 3 times cono-weeder at 10, 20, 30 DAT | 46278 | 46733 | 46506 | 39985 | 41335 | 40660 |
| W5- Unweeded control | 40803 | 41663 | 41233 | 42483 | 46172 | 44328 |
| Mean | 42780 | 43912 | 43346 | 44494 | 46694 | 45594 |
| | **M** | **S** | | **M** | **S** | **MXS** |
| **CD (0.05)** | 0.13 | 0.29 | | 0.14 | 0.30 | NS |
| **C.V. (%)** | 3.59 | 5.43 | | 3.74 | 5.35 | NS |

**Table.5** Economics of rice cultivation as affected by age of seedlings and weed management practices on cost of cultivation in Rs.

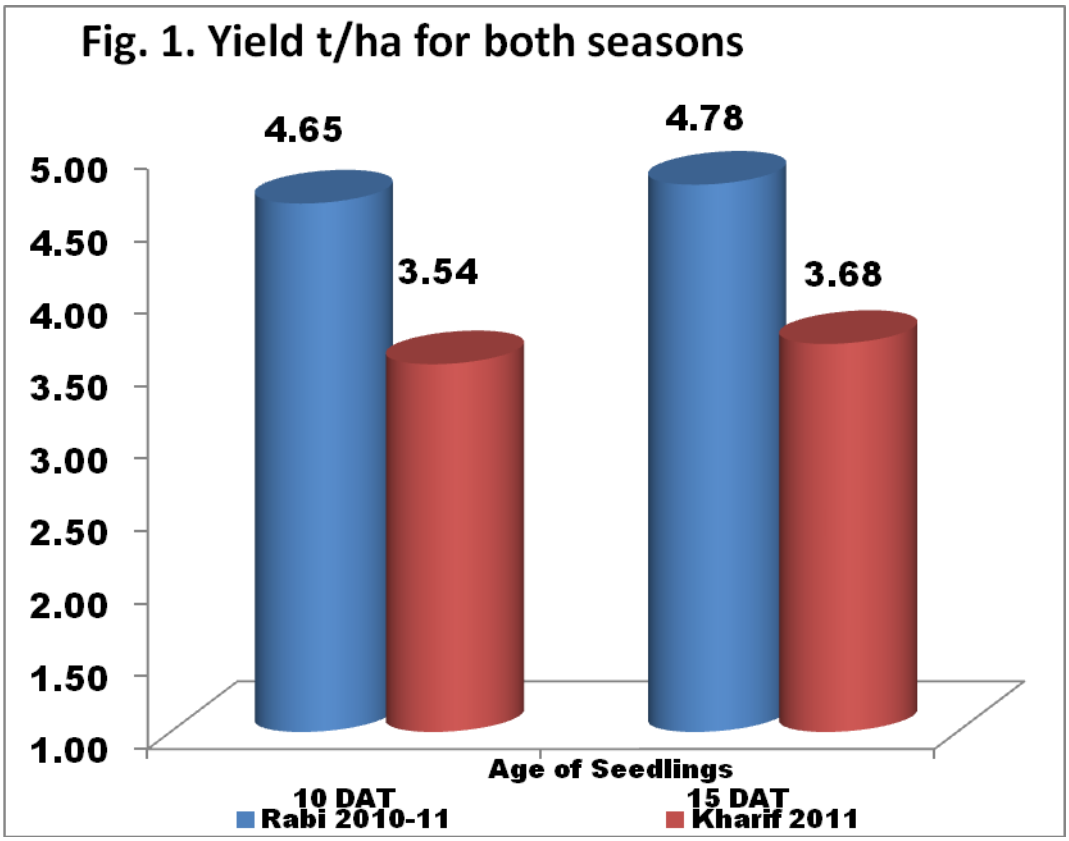
| | Rabi 2010-11 (Variety - ADT-37) | | | Kharif 2011-12 (Variety- Improved White Ponni) | | |
|---|---|---|---|---|---|---|
| **Age of Seedlings Weed Management** | **A1** | **A2** | **Mean** | **A1** | **A2** | **Mean** |
| W1- 2 times cono weeder at 10 and 20 DAT | 22495 | 22495 | 22495 | 22400 | 22495 | 22448 |
| W2- 4 times cono weeder at 10, 20, 30 and 40 DAT | 24495 | 24495 | 24495 | 23400 | 24495 | 23948 |
| W-3 Herbicides pre emergence Butachlor @ 1.50 a.i/ha at 5 DAT followed by one hand weeding at 20 DAT | 23195 | 23195 | 23195 | 24400 | 23195 | 23798 |
| W4- 3 times cono-weeder at 10, 20, 30 DAT | 23495 | 23495 | 23495 | 22525 | 23495 | 23010 |
| W5- Unweeded control | 24695 | 24695 | 24695 | 24415 | 24695 | 24555 |
| **Mean** | 23675 | 23675 | 23675 | 23428 | 23675 | 23552 |

**Table.6** Economics of rice cultivation as affected by age of seedlings and weed management practices on net returns in Rs

| | Rabi 2010-11 (Variety - ADT-37) | | | Kharif 2011-12 (Variety- Improved White Ponni) | | |
|---|---|---|---|---|---|---|
| **Age of Seedlings Weed Management** | **A1** | **A2** | **Mean** | **A1** | **A2** | **Mean** |
| W1- 2 times cono weeder at 10 and 20 DAT | 19948 | 19980 | 19964 | 21658 | 23345 | 22502 |
| W2- 4 times cono weeder at 10, 20, 30 and 40 DAT | 23003 | 25910 | 24457 | 23875 | 26125 | 25000 |
| W-3 Herbicides pre emergence Butachlor @ 1.50 a.i/ha at 5 DAT followed by one hand weeding at 20 DAT | 13690 | 15088 | 14389 | 24270 | 26295 | 25283 |
| W4- 3 times cono-weeder at 10, 20, 30 DAT | 22783 | 23238 | 23011 | 17460 | 18810 | 18135 |
| W5- Unweeded control | 16108 | 16968 | 16538 | 18068 | 21757 | 19913 |
| Mean | 19106 | 20237 | 19672 | 21066 | 23266 | 22166 |

**Table.7** Economics of rice cultivation as affected by age of seedlings and weed management practices on B: C Ratio

| | Rabi 2010-11 (Variety - ADT-37) | | | Kharif 2011-12 (Variety- Improved White Ponni) | | |
|---|---|---|---|---|---|---|
| **Age of Seedlings Weed Management** | **A1** | **A2** | **Mean** | **A1** | **A2** | **Mean** |
| W1- 2 times cono weeder at 10 and 20 DAT | 1.88 | 1.89 | 1.89 | 1.97 | 2.04 | 2.01 |
| W2- 4 times cono weeder at 10, 20, 30 and 40 DAT | 1.94 | 2.06 | 2 | 2.02 | 2.12 | 2.07 |
| W-3 Herbicides pre emergence Butachlor @ 1.50 a.i/ha at 5 DAT followed by one hand weeding at 20 DAT | 1.59 | 1.65 | 1.62 | 1.99 | 2.08 | 2.03 |
| W4- 3 times cono-weeder at 10, 20, 30 DAT | 1.97 | 1.99 | 1.98 | 1.78 | 1.84 | 1.81 |
| W5- Unweeded control | 1.65 | 1.69 | 1.67 | 1.74 | 1.89 | 1.82 |
| Mean | 1.80 | 1.85 | 1.83 | 1.9 | 1.99 | 1.94 |



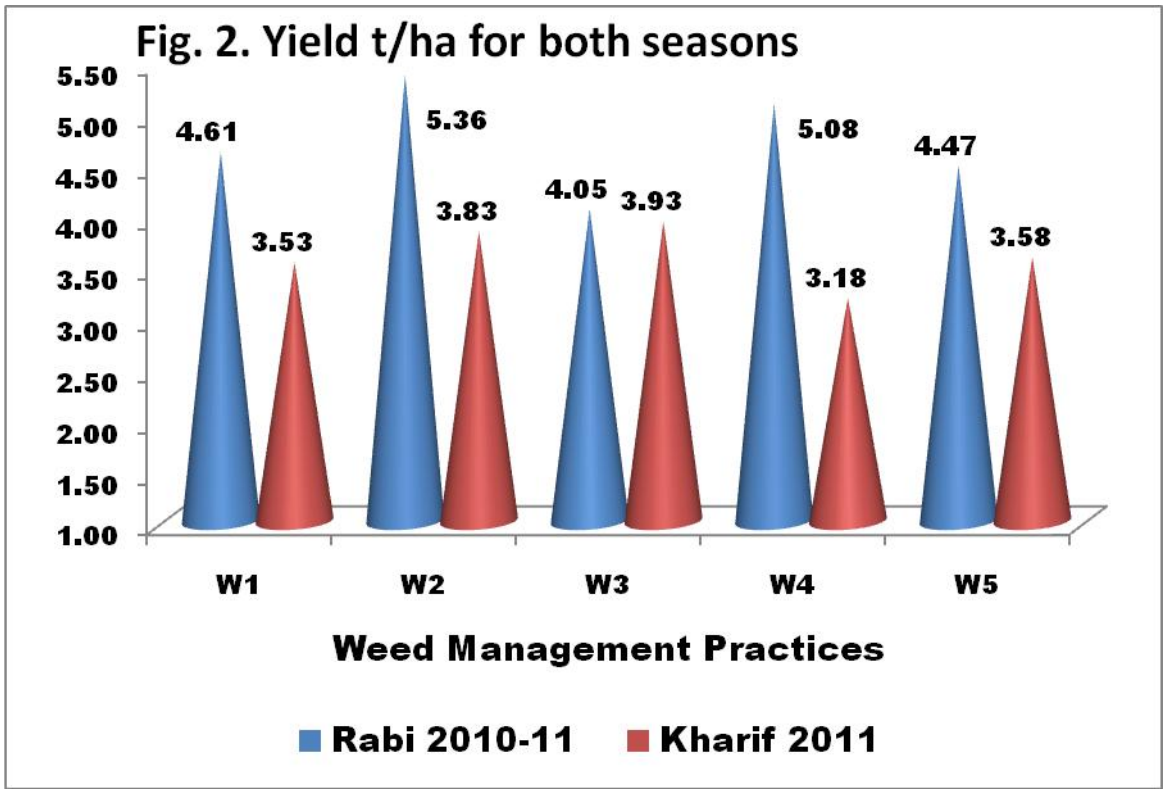


Fig. 2. Yield t/ha for both seasons
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
4.61
3.53
5.36
3.83
4.05
3.93
5.08
3.18
4.47
3.58
W1
W2
W3
W4
W5
Weed Management Practices
Rabi 2010-11
Kharif 2011

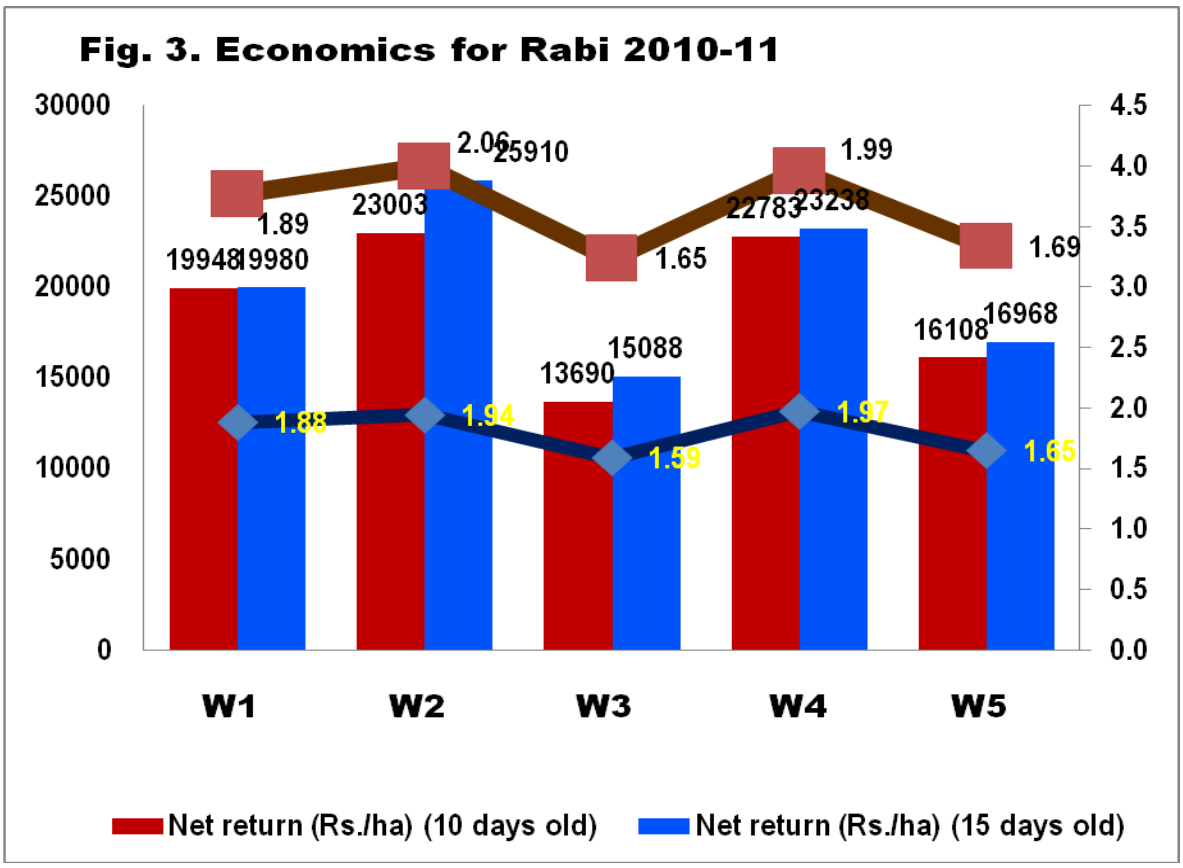
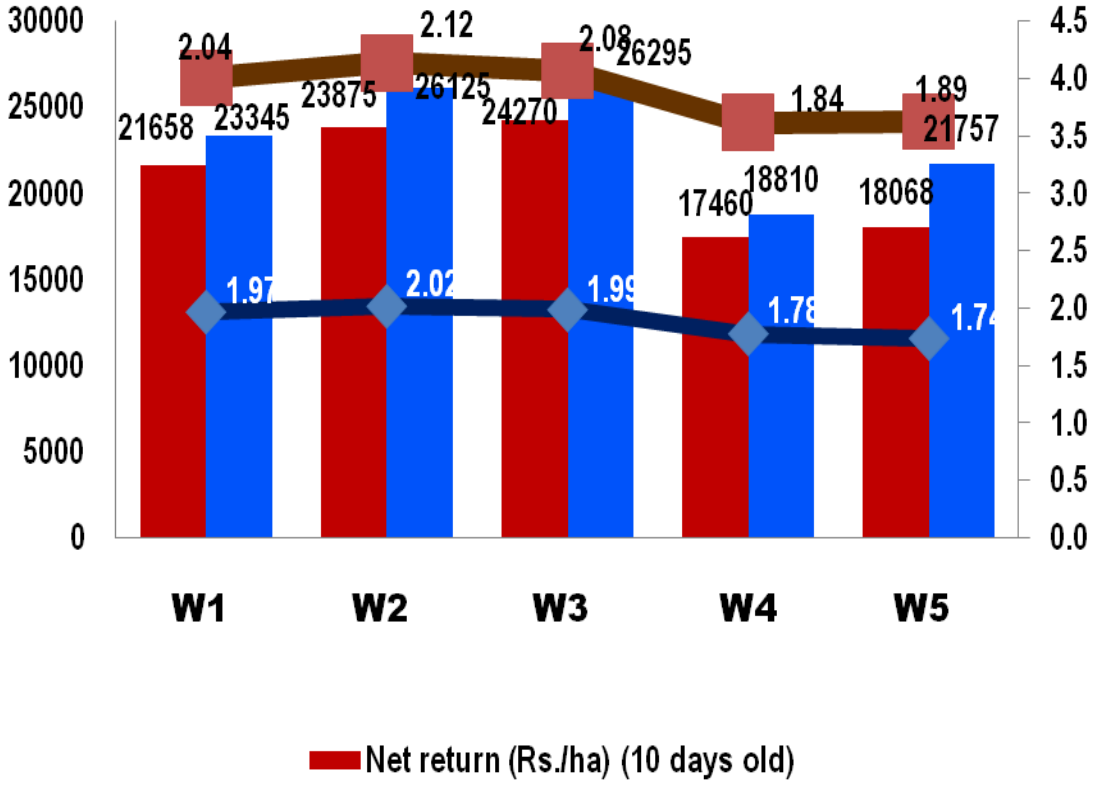


Fig. 3. Economics for Rabi 2010-11
30000
25000
20000
15000
10000
5000
0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
19948
19980
23003
25910
13690
15088
22783
23238
16108
16968
1.89
2.06
1.65
1.99
1.69
1.88
1.94
1.59
1.97
1.65
W1
W2
W3
W4
W5
Net return (Rs./ha) (10 days old)
Net return (Rs./ha) (15 days old)

**Fig. 4. Economics for Kharif 2011**




**Treatment Details: 2 factors**

| | |
|---|---|
| **Factors 1** | **Age of seedlings – 2** |
| | **A1** – 10 days old |
| | **A2** – 15 days old |
| **Factors 2** | **Weed management practices - 5** |
| **W1** | 2 times cono weeder at 10 and 20 DAT |
| **W2** | 3 times cono-weeder at 10, 20, 30 DAT |
| **W3** | 4 times cono weeder at 10, 20, 30 and 40 DAT |
| **W4** | Herbicides pre emergence Butachlor @ 1.50 a.i/ha at 5 DAT followed by one hand weeding |
| **W5** | Location specific |

All the weed management practices exerted similar effect when they practiced in 10 days old seedlings.

The increased growth parameters in 15 days old seedlings plus cono weeding four times might be due to lesser competition from weeds, vigour of seedlings, wider spacing, presence of thin film of water, improved respiration of roots, root development, absence of mutual shading and increased uptake of nutrients (Uphoff, 2001; Thiyagarajan *et al.*, 2002; Natesan *et al.*, 2008).

The findings of two seasons, use of 15 days old seedlings with four times cono weeding was performed excellent by registering higher yield attributes and grain yield of 5360 and 4020 kg $ha^{-1}$ during Rabi 2010-11 and Kharif 2011 respectively (Table 1–7 and Fig. 1–4). It may be concluded that in SRI, transplanting of 15 days old seedlings coupled with cono weeding four times at 10, 20, 30 and 40 DAT favourably increased the growth parameter which ultimately reflected in higher yield.

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