Effect of different doses of herbicides and mechanical weeding on yield attributes and grain yield of direct seeded rice (Oryza sativa L.) varieties under Inseptisols of Chhattisgarh plain

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Abstract
The experiment was conducted at Research cum Instructional Farm, IGKV, Raipur (Chhattisgarh) during Kharif season 2015-2016. The soil of experimental field was sandy loam in texture (Inceptisols) known as Matasi. The Experiment was laid out in Factorial Randomized Block Design (FRBD) with three replications. The treatment consisted of three varieties viz. MTU-1010 (V1), Indira barani dhan (V2) and IR-64 (V3) and four weed management practices viz. Rinskor @ 37.5 ml a.i. ha⁻¹ at 20 DAS (H₁), H₂ - Rinskor @ 75 ml a.i. ha⁻¹ at 20 DAS, Mechanical weeding at 20 and 40 DAS (H₃) and Control (H₄). The results of experiment indicated that variety MTU-1010 (V1) registered significantly highest values of growth characters of rice like leaf area, plant population, dry matter accumulation and number of tillers. It was at par to variety IR-64 (V₃) for above parameters. Among weed management practices, Mechanical weeding at 20 and 40 DAS (H₃) registered significantly highest values of growth parameters of rice like plant population, leaf area, dry matter accumulation and number of tillers, but it was comparable to Rinskor @ 37.5 ml a.i. ha⁻¹ at 20 DAS (H₁). Among the varieties, higher grain yield and B:C ratio was recorded under MTU-1010 (V₁) as regards to weed management practices maximum grain yield and B:C ratio were obtained under Mechanical weeding at 20 and 40 DAS (H₃).

Keywords: Herbicide, Different doses, Direct-seeded rice, yield attribute, Grain yield, Chhattisgarh plain

Introduction
Rice is the most consumed cereal grain in the world, constituting the dietary staple food for more than half of the planet's human population. In world, rice is the second most widely consumed cereal next to wheat and it has occupied an area of 163.20 million hectares, with a total production of 719.70 million tonnes (Anonymous, 2014a) [3]. Rice provides about two-thirds of the calorie intake for more than two billion people in Asia and a third of the calorie intake of nearly one billion people in Africa and Latin America (Shastry et al., 2000) [19]. Hence there is a need to increase the productivity of rice.

India the second largest producer after China has an area of over 43.95 million hectare under rice with production of 106.18 million tonnes of rice (Anonymous, 2014b) [4]. The rice plays a very vital role in the national food security. In India, rice is grown under three major ecosystems: rainfed uplands (16%), irrigated lands (45%) and rainfed low lands (39%), with a productivity of 0.87, 2.24 and 1.55 t ha⁻¹, respectively (Anonymous, 2011a) [1]. The country's population of more than a billion is growing at 1.8 per year, outpacing the 1.4 per cent annual growth rate of rice production. To maintain self-sufficiency, annual production needs to increase by 2 million tonnes every year.

Chhattisgarh state is popularly known as “Rice bowl of India” occupies an area around 3.88 million hectares with the production of 8.20 million tonnes and productivity of 2112.82 kg per hectares (Anonymous, 2015). In Chhattisgarh, rice is mainly grown under rainfed ecosystem, which covers about 74, 97 and 95 per cent cropped area of Chhattisgarh plain, Bastar plateau and Northern hill zones, respectively. Chhattisgarh state contributes 5.26 per cent of the total rice production of the country. However, the production and productivity of rice per unit area is very low (Anonymous, 2011b) [5].
The rice culture system in the country mainly depends on the onset and distribution of monsoonal rains. Erratic distribution of rainfall and unavailability of irrigation during this period compel the farmers to choose alternative for transplanting. Direct seeding of rice has been receiving increased attention recently in view of increased labour costs, scarcity of water and increased availability of herbicides for weed management and is an economical alternative to transplanted rice. The average productivity of rice is very low due to several constraints. Among these, in direct seeded rice, weeds are one of the major constraints for low productivity of rice because both rice and weed germinate almost simultaneously. Weed problem persists because of their ability to cope with their reproductive capacity and massive recycling. Aerobic soil conditions and dry-tillage practices, besides alternate wetting and drying conditions are conducive for germination and growth of highly competitive weeds, which makes that weeds becoming a serious problem in direct seeded drilled rice ecosystems. Rice is grown under conducive condition to profuse weed growth. As such during the early stages of crop growth, severe crop-weed competition is big constraint for improving rice productivity. In the rice ecosystem of this region, weeds play a dominant role by competing for nutrients, water and space with the rice crop. Weeds usually absorb mineral nutrients faster than crop plants and accumulate them relatively in larger amounts. Rice grain production in India suffers a yearly loss of 15 million tonnes due to weed competition. A weed free period for the first 30-45 DAS is required to avoid any loss in yield because the dry weight of weeds increases greatly from 30 DAS in direct-seeded drilled rice. Banerjee et al. (2008) observed that the predominant weed flora associated with the rice crop was grasses (Echinochloa crusgalli, Cynodon dactylon, Leersia hexandra), sedges (Cyperus rotundus, Cyperus difformis, Fimbristylis littoralis) and broad leaves (Ludwigia octovalvis, Monochoria vaginalis, Marsilea minuta).

Based on research findings it was estimated that extent of yield reduction in rice due to weeds alone is about 15-20 per cent for transplanted rice, 30-35 per cent for direct seeded puddled rice and 50-95 per cent or even more in direct seeded rice under severe weed infestation (Choubey et al., 2001) [7]. The similar results were supported by Elliot et al., (1984) [8] and Gogai et al., (1996) [9]. However, if the weed population could effectively be controlled, direct seeded rice cultivation may offer a unique advantage of raising yields at par with transplanted rice. The types of weed flora obtainable under direct seeded condition is so variable that it may not be possible to manage them by one method alone. Not only this, flushes of weeds come up at different stages.

In Chhattisgarh plain, about 85 per cent of the rice crop is transplanted. Manual weeding in rice is not only costly and difficult but time consuming also due to morphological similarity of grass type weeds and rice crop. The physical methods are very costly, labour consuming and the advantage of manual weeding could only be achieved when it is performed timely. Chemical weed control is regarded to be better than weed due to drudgery of weeding and meagre availability for pre and post emergence application in direct seeded rice but, they have their own limitation. Most of the herbicides are narrow spectrum and control some species, while some remain unaffected. Second flush emerged after application of early post emergence herbicides. In order to manage the second flush or subsequent flush of weeds, sequential application of post emergence herbicides may prove promising. In Chhattisgarh state, consumption of new herbicide is very meagre. Therefore, there is a need to evaluate the suitability of new herbicides under agro-climatic condition of Chhattisgarh plain.

**Material and Method**

Field experiment was conducted during kharif season of 2015 at the Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, geographically, Raipur situated in mid–eastern part of Chhattisgarh state and lies at 21° 16' North Latitude and 81° 36' East Longitude with an altitude of 314.15 m above the mean sea level. Climatologically, Raipur comes under the Chhattisgarh plains agro climatic sub zone which having sub humid climatic condition. The region receives an average of 1104 mm annual rainfall, out of which about 87 per cent received during the rainy season (June to September) and the rest of 13 per cent during the winter season (October to February). The soil was neutral (pH 7.3) in reaction with medium in fertility having 0.67% soil organic carbon, low nitrogen (211.4 kg ha⁻¹), medium phosphorus (18.4 kg ha⁻¹) and high potassium (325 kg ha⁻¹) content. The experiment was laid out in Factorial Randomized Block Design (FRBD) with replicated time three. The treatments comprised of twelve treatments. Three varieties MTU-1010 (V₁), Indira Barani Dhan (V₂) and IR-64 (V₃) and four herbicide doses were consisting in experiment Rinskor 2.5% EC @ 37.5 ml a.i. ha⁻¹ at 20 DAS (H₁), Rinskor 2.5% EC @ 75 ml a.i. ha⁻¹ at 20 DAS (H₂), Mechanical weeding at 20 and 40 DAS (H₃) and Control (H₄). Rice varieties was sown in rows 20 cm apart during the fourth week of June.

**Results and Discussion**

All the yield attribute of direct seeded rice significantly influenced by varieties and weed management practices.

**Effective tillers (No. m⁻²)**

Number of effective tillers m⁻² as influenced by varieties and weed management practices are give Table 1. Among the varieties, cv. MTU-1010 (V₁) recorded significantly higher number effective tillers m⁻² than cv. Indira Barani dhan (V₂), but it was comparable to cv. IR-64 (V₃). Pathak et al. (2001) [15] also reported that the butachlor significantly increased the number of effective tillers than the weedy control. Applying butachlor increased yield by 23% compared to the weedy check. Regarding weed management practices, Mechanical weeding at 20 and 40 DAS (H₃) registered significantly higher number of effective tillers m⁻² than others, but it was statistically similar to Rinskor @ 37.5 ml a.i. ha⁻¹ at 20 DAS (H₁). This is quite possible because these combinations of weed management might have been very effective to reduce the mixed weeds density and their growth resulting better and congenial environment favoured the rice plant to utilize nutrients, light, space luxuriantly and grew well to produce more number of fertile tillers. Similar finding was reported by Tiwari (2002) [22] revealed that significantly higher effective tillers was obtained under the treatment of hand weeding twice.

**Panicle length (cm)**

Panicle length as influenced by varieties and weed management practices (Table 1). Among the varieties, cv. MTU-1010 (V₁) recorded the longest panicle. However, it was at par to cv. IR-64 (V₃). This result was confirmed by the finding of Tiwari (2000) revealed that significantly higher panicle length were obtained under the treatment of hand weeding twice. As regard to weed management practices,
Mechanical weeding at 20 and 40 DAS (H2) gave significantly longer panicles than others, but it was comparable to Rinskor @ 37.5 ml a.i. ha\(^{-1}\) at 20 DAS (H1). Similar result was obtained by Saini (2005) [18].

Table 1 shows data related to the panicle weight as influenced by varieties and weed management practices. In case of varieties, cv. MTU-1010 (V1) gave significantly heaviest panicle weight with application of cyhalofop butyl 120 g ha\(^{-1}\) (15 DAS) fb 2, 4-D 1.0 kg ha\(^{-1}\) (20 DAS), 2, 4-D 1.0 kg ha\(^{-1}\) (15 DAS) fb. Cyhalofop butyl 120 g ha\(^{-1}\) (20 DAS) and hand weeding being at par with each other resulted in significantly higher panicle length which ultimately resulted in significantly higher rice yield over all other treatments.

**Panicle weight (g)**
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**Number of filled grains panicle\(^{-1}\)**
Data regarding number of filled grains panicle\(^{-1}\) as influenced by varieties and weed management practices are given in (Table 1). Among the varieties, cv. Indira barani dhan (V2) recorded significantly higher number of filled grains panicle\(^{-1}\) as compared to others, but it was statistically similar to Rinskor @ 37.5 ml a.i. ha\(^{-1}\) at 20 DAS (H1). Roy et al. (2009) [17] also reported that the effect of different kinds of herbicide was obtained to be significant. The highest number of total filled grains panicle\(^{-1}\) (91.58) was observed from Machete 5G herbicide applied in the rice field and the highest 1000 grain weight (30.94 g) was found from direct seeding.

**Grain yield (q ha\(^{-1}\))**
Data regarding 1000-grain weight (g) as influenced by varieties and weed management practices are given in (Table 1). Among the varieties, cv. Indira barani dhan (V2) registered significantly higher 1000-grain weight (g) than cv. Indira barani dhan (V2), but it was at par to cv. IR-64 (V3). Similar result was noted by Saini (2005) [18].

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Effective tillers (No. m(^{-2}))</th>
<th>Panicle length (cm)</th>
<th>Filled grains panicle(^{-1}) (No.)</th>
<th>Sterility (%)</th>
<th>1000 grain weight (g)</th>
<th>Grain yield (q ha(^{-1}))</th>
<th>Straw yield (q ha(^{-1}))</th>
<th>Harvest index (%)</th>
<th>Weed index (%)</th>
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<td><strong>Varieties</strong></td>
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<tr>
<td>V1</td>
<td>MTU 1010</td>
<td>221.72</td>
<td>22.53</td>
<td>76.24</td>
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<td>14.36</td>
<td>27.03</td>
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<td>Indira barani dhan</td>
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<td>21.82</td>
<td>70.57</td>
<td>19.08</td>
<td>20.72</td>
<td>23.08</td>
<td>26.51</td>
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<td>V3</td>
<td>IR 64</td>
<td>189.72</td>
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<td>74.72</td>
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<td>26.43</td>
<td>43.16</td>
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<td></td>
<td>SEM±</td>
<td>14.57</td>
<td>0.16</td>
<td>1.58</td>
<td>1.69</td>
<td>1.61</td>
<td>0.26</td>
<td>1.13</td>
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<td></td>
<td>CD(P=0.05)</td>
<td>42.47</td>
<td>0.47</td>
<td>4.64</td>
<td>4.97</td>
<td>4.73</td>
<td>0.77</td>
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<tr>
<td>H1</td>
<td>Rinskor @ 37.5 ml a.i. ha(^{-1}) at 20 DAS</td>
<td>214.82</td>
<td>22.86</td>
<td>75.98</td>
<td>12.89</td>
<td>14.40</td>
<td>25.88</td>
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<td>H2</td>
<td>Rinskor @ 75 ml a.i. ha(^{-1}) at 20 DAS</td>
<td>187.30</td>
<td>22.17</td>
<td>73.09</td>
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<td>H3</td>
<td>Mechanical weeding at 20 &amp; 40 DAS</td>
<td>241.90</td>
<td>22.99</td>
<td>79.37</td>
<td>15.33</td>
<td>16.02</td>
<td>26.41</td>
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<td>H4</td>
<td>Control</td>
<td>116.01</td>
<td>20.89</td>
<td>66.93</td>
<td>20.60</td>
<td>23.41</td>
<td>24.47</td>
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<tr>
<td></td>
<td>SEM±</td>
<td>16.83</td>
<td>0.19</td>
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<td></td>
<td>CD(P=0.05)</td>
<td>49.36</td>
<td>0.54</td>
<td>5.36</td>
<td>5.73</td>
<td>5.46</td>
<td>0.89</td>
<td>3.83</td>
<td>6.58</td>
</tr>
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</table>

1000-grain weight (g)
Data regarding 1000-grain weight (g) as influenced by varieties and weed management practices are given (Table 1). Among the varieties, cv. MTU-1010 (V1) registered significantly higher 1000-grain weight (g) than cv. Indira barani dhan (V2), but it was at par to cv. IR-64 (V3). Similar result was observed by Roy et al. (2009) [17]. Weed management practices, Mechanical weeding at 20 and 40 DAS (H1) recorded significantly higher 1000-grain weight (g) as compared to others, but it was statistically similar to Rinskor @ 37.5 ml a.i. ha\(^{-1}\) at 20 DAS (H1).

**Grain yield (q ha\(^{-1}\))**
Grain yields as influenced by varieties and weed management practices are given in (Table 1). The grain yield influenced...
significantly due to different varieties. The maximum grain yield (30.00 q ha⁻¹) was recorded under cv. MTU-1010 (V₁) which was significantly superior over cv. Indira barani dhan (V₂), but at par to cv. IR-64 (V₃). Jadhav (2013) [13] and Behera et al. (1996) reported the grain yield (4.69 t ha⁻¹) were highest with manual weeding. The grain yield influenced significantly due to different weed management practices. The maximum grain yield (37.87 q ha⁻¹) was recorded with Mechanical weeding at 20 and 40 DAS (Hₛ). It was significantly superior over other treatments but at par to Rinskor @ 37.5 ml a.i. ha⁻¹ at 20 DAS (H₁). Timely and effective control of weeds with integrated use of post-emergence herbicides and mechanical weeding resulted in increased yield components, which ultimately reflect on grain yield. Gogai and Kalita (1990) [10] similar result noticed that the highest grain yield (1.47 t ha⁻¹) was associated with hand weeding at 15, 30 and 45 DAE.

### Harvest index (%)

Harvest index as influenced by varieties and weed management practices (Table 1). The harvest index influenced significantly due to different varieties. The maximum harvest index (47.17% q ha⁻¹) was recorded with cv. MTU-1010 (V₁) which was significantly superior over cv. Indira barani dhan (V₂), however, it was at par to cv. IR-64 (V₃). Similar finding was also reported by Mutnal et al. (1998) [13]. The maximum harvest yield (53.67% q ha⁻¹) was recorded with Mechanical weeding at 20 and 40 DAS (Hₛ). It was significantly superior over others, but at par to Rinskor @ 37.5 ml a.i. ha⁻¹ at 20 DAS (H₁). The minimum harvest yield (20.94% q ha⁻¹) was recorded with Control plot (Hₐ). Similar finding was reported by Choubey et al. (1998) observed that the different weed control treatments produced significantly higher harvest yield over unweeded check. The highest being obtained in hand weeding, followed by chemical weed control/chemical + chemical weed control and mechanical weeding treatments.

### Weed index (%)

Weed index as influenced by varieties and weed management practices are given in (Table 1). Among varieties, the highest weed index (28.88%) was noted with cv. Indira barani dhan (V₂) and the lowest was found under cv. MTU-1010 (V₁). In case of weed management practices, the weed index was recorded maximum under Control plot (Hₐ) and minimum was observed under Mechanical weeding at 20 and 40 DAS (Hₛ). Similar findings were also noted by Nayak et al. (2014) [14] and Prameela et al. (2014) [16].

### Conclusion

The findings of direct seeded rice under Inseptisols of Chhattisgarh plains, clearly visualized that variety MTU-1010 (V₁) recorded significantly highest yield attributes, grain yield, straw yield and harvest index as well as weed index although it was comparable to variety IR-64 (V₃). Among weed management practices, Mechanical weeding at 20 and 40 DAS (Hₛ) registered significantly highest values of yield attributes, grain yield, straw yield, harvest index and weed index but it was comparable to Rinskor @ 37.5 a.i. ml ha⁻¹ at 20 DAS (H₁).

### Reference


