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Sumit
Department of Agronomy, IGKV, Raipur, Chhattisgarh, India

KL Nandeha
Department of Agronomy, IGKV, Raipur, Chhattisgarh, India

Sunil Kumar
Department of Agronomy, IGKV, Raipur, Chhattisgarh, India

Amit Mahilang
(M.Sc.), Department of Plant Pathology, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Mahanand Sahu
Department of Agronomy, IGKV, Raipur, Chhattisgarh, India

Mayuri Thakur
Department of Agronomy, IGKV, Raipur, Chhattisgarh, India

Corresponding Author:
Sumit
Department of Agronomy, IGKV, Raipur, Chhattisgarh, India

Effect of chemical weed management practices on yield and economics of direct-seeded rice (*Oryza sativa* L.) in Vertisoil of Chhattisgarh plans

Sumit, KL Nandeha, Sunil Kumar, Amit Mahilang, Mahanand Sahu and Mayuri Thakur

Abstract
A field experiment was conducted during *kharif* season 2018 at Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). To study Effect of weed management on yield and economics of direct seeded rice (*Oryza sativa* L.)**.** The treatments consisted of oxyfluorfen 20 DF in five rates of applications (160g, 200g, 240g, 480g and 720g/ ha^{-1}). Pre-emergence application of oxyfluorfen 20 DF @ 240 g ha^{-1} registered significantly highest values of growth parameters like plant height, number of effective tillers, number of grains panicle^{-1}, test weight and maximum grain (49.51 q ha^{-1}) and straw yield (64.52 q ha^{-1}) with maximum net return (Rs. 54618.24 ha^{-1}) and benefit cost ratio (2.41) followed by oxyfluorfen 20 DF@ 480 g *a.i.* ha^{-1} (Rs. 47092.24 ha^{-1}) and (2.17) in direct-seededrice.

Keywords: Oxyfluorfen, direct-seeded rice, grain yield, benefit cost ratio, net return

Introduction
Rice (*Oryza sativa* L.) is one of the important cereal crops which plays a vital role in food security. More than 90 per cent of total rice production in the world is consumed by Asian countries, where it is a popular food for a majority of the population (Mohanty, 2013) [12]. During 2016-17, India had record production of rice to the tune of 168 million tonnes (Anonymous, 2016) [4] but considering the present growth rate of population as well as per capita income, the demand for rice has been projected as 189 million tonnes by 2030 (Anonymous, 2016) [4].
Chhattisgarh state is totally dependent on monsoon and annual rainfall of state is 120-160 cm. Rice occupies an area of 3.68 m ha with productivity of 20.20 q ha^{-1}. In Chhattisgarh, rice is mainly grown under kharif season, which covers around 74, 97 and 95 per cent cropped area of total area of Chhattisgarh plain, Bastar plateau and Northern hill zone of Chhattisgarh, 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 of state is very poor (Anonymous, 2017) [5]. Rice is cultivated as rainfed crop under medium and lowland ecosystems during rainy (kharif) season. Huge labour cost is incurred in the nursery raising, puddling and transplanting operations. The technology of direct-seeded. rice is constantly finding favour with the farmers, when this method saves irrigation water and decrease the production costs. Direct seeded rice requires only 34% of total labour requirement and save 29% of the total cost involve in transplanted crop (Ho and Romli, 2000) [9]. Direct seeding offers certain advantages i.e. saves labour, faster, easier, timely sowing, less drudgery, early crop maturity by 7–10 days, less water requirements, higher tolerance to water deficit, often higher yield, low production cost, more profit, better soil physical conditions for crop (Akbar *et al*., 2011) [2]. Uncontrolled weeds cause up to 80% reduction in grain yield and sometime also results in complete failure of crop (Gopinath and Kundu, 2008) [8]. A weed-free period for the first 25-45 DAS is required to avoid any loss in yield in dry direct-seeded rice (Chauhan and Johnson 2011, Singh *et al*. 2012) [6, 17]. Chemical weed control in direct-seeded.rice has emerged as promising solution of weed problem and expanded manifold as it is easy, quick, economical and feasible. Several pre-emergence herbicides applied either alone or supplemented with hand weeding have been reported to provide fairly adequate weed suppression in direct-seeded. Rice (Pellerin and Webster, 2004) [13]. On this content the following studies was made conducted.

Material and Methods
Field experiment was conducted during kharif season of 2018 at Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, geographically, Raipur situated in mid–eastern part of Chhattisgarh state and lies at 210 16′ North Latitude and 810 36' East Longitude

with an altitude of 314.15 m above the mean sea level. 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 7.1) in reaction with medium in fertility having 0.46% soil organic carbon, low nitrogen (214 kg ha^{-1}), medium phosphorus (17.5 kg ha^{-1}) and high potassium (301 kg ha^{-1}) content. The experiment was laid out in Randomized Block Design (RBD) with three replication. The treatments comprised of eleven treatments *viz.* Oxyflourfen 20 DF @160 g a.i. ha^{-1} Oxyflourfen 20 DF @ 200 g a.i. ha^{-1} Oxyflourfen 20 DF @ 240 g a.i. ha-1 Oxyflourfen 20 DF @ 480 g a.i. ha^{-1} Oxyflourfen 20 DF @ 720 g a.i. ha^{-1} Oxyflourfen 23.5 EC @ 105.75 g a.i. ha^{-1} Pretilachlor 30.7 EC @ 187.27 g a.i. ha^{-1} Pendimethaline 30 EC @ 187.27 g a.i. ha^{-1} were used in the experiment. Application of herbicide at 2 days after sowing. Rice was sown in rows 20 cm apart during the fourth week of June and harvesting is done in October last week.

Results and Discussion

Effect of yield

Plant height

Data with respect to the plant height are presented in Table-1 and Fig-1 Significantly highest plant height was recorded under weed free treatment which was statistically superior over all other treatments. However, it was at par to treatment two hand weeding at 15 and 30 DAS and oxyflourfen 20 DF@ 240 g a.i. ha^{-1}. Among the different doses of oxyflourfen 20 DF, the lowest plant height (88.9 cm) was recorded with 160 g a.i. ha^{-1}. The logic for variation in plant height of all the treatment may be due to the lower competition between weeds and crop for light, nutrients and space along with availability of water which allowed the crop to grow to their potential [Yadav *et al*. (2009) [19], Saha and Rao (2010)] [15].

Effective tillers

Grain yield of cereals is completely dependent upon the number of productive tillers produced by each plant. The data on effective tillers are presented in Table-1 and Fig-2. Data indicate that, weed free treatment showed maximum number of effective tillers (389.33 m-2) which was significantly superior over all treatments, except in hand weeding. Among the all herbicides treatments Pre-emergence application of oxyflourfen 20 DF@ 240 g a.i.. ha^{-1} did produce highest number of tillers (349.33 m-2).

Number of grains panicle-1

The data on total number of grains panicle^{-1} as affected by different treatments are presented in Table-1 and Fig-3. Among all the treatments, the highest number of grains panicle^{-1} (142.33) was observed in treatment weed free which was significantly superior over all treatments but was found at par to two hand weeding at 15 and 30 DAS (140.67), oxyflourfen 20 DF @ 240 g a.i. ha^{-1} (136.33) and oxyflourfen 20 DF@ 480 g a.i. ha^{-1} (133.67). The minimum number of grains panicle^{-1} (79.33) was recorded under unweeded check. The higher number of grains panicle^{-1} recorded in these treatments which might be due to the lower weed competition in terms of dry matter of weeds which created overall congenial environment for growth and development of rice which resulted more availability of light, moisture, nutrients and space for rice plant which led to produce more number of sound grains panicle^{-1}. The results of investigation confirm the findings of Saini *et al*. (2001) [16] and Kiran *et al* (2010) [11].

1000-grain weight (g)

The weight of thousand grains is also an important attributes to yield and data are presented in Table-1 and Fig-4. The highest weight of 1000-grain (24.39 g) was found in weed free treatment which was statistically superior over all treatments except two hand weeding at 15 and 30 DAS and oxyflourfen 20 DF @ 240 g a.i. ha^{-1}. The lowest weight of 1000-grain (22.02 g) was found in unweeded check. These results are similar to the findings of Ganeshwor and Gadadhar (2000) [7], Khan and Tarique (2011) [10] and Popy *et al*. (2017) [14].

Grain yield (q ha^{-1})

On perusal of data given in table-1 reveal that the highest grain yield (54.75 q ha^{-1}) was recorded under weed free treatment which was significantly superior over all treatments, followed by two hand weeding at 15 and 30 DAS (53.91 q ha-1) and oxyflourfen 20 DF @ 240 g a.i. ha^{-1}. The minimum grain yield (5.83 q ha^{-1}) was recorded under unweeded check. So for as the different doses of oxyflourfen 20 DF is concerned, pre- emergence application of it @ 240 g a.i. ha^{-1} did produce higher grain yield (49.51 q ha^{-1}) which has been significantly higher over its lower dose of 160 g a.i. ha^{-1} whereas, it was at par with its 200, 480 and 720 g a.i. ha^{-1}. Higher grain yield is due to better control of weeds at critical stages and thus, providing favourable environment for better growth and development leading to enhanced yield and yield attributes. In rice, productivity is mainly decided by the weed control efficiency of weed management methods as earlier observed by Abraham *et al*. (2010) [1]. This corroborates the result of Singh *et al*. (2007) [18].

Straw yield (q ha^{-1})

The data on straw yield under different treatments have been presented in table-1. The straw yield was significantly affected by different treatments. The highest straw yield 67.93 q ha^{-1}) was recorded under treatment weed free which was significantly superior over all treatments but was found at par with hand weeding (67.06 q ha^{-1}). The minimum straw yield (13.80 q ha^{-1}) was recorded under unweeded check. Pre-emergence application of oxyflourfen @ 240 g a.i. ha^{-1} did produce (64.52 q ha^{-1}) straw yield which was statistically higher over its two lower doses (160 and 200 g a.i. ha^{-1}), however it was at par with its doses 480 and 720 g a.i. ha^{-1}. This may be because of better weed control which reduce the competition with crop and thus, better crop growth and thus, yield.

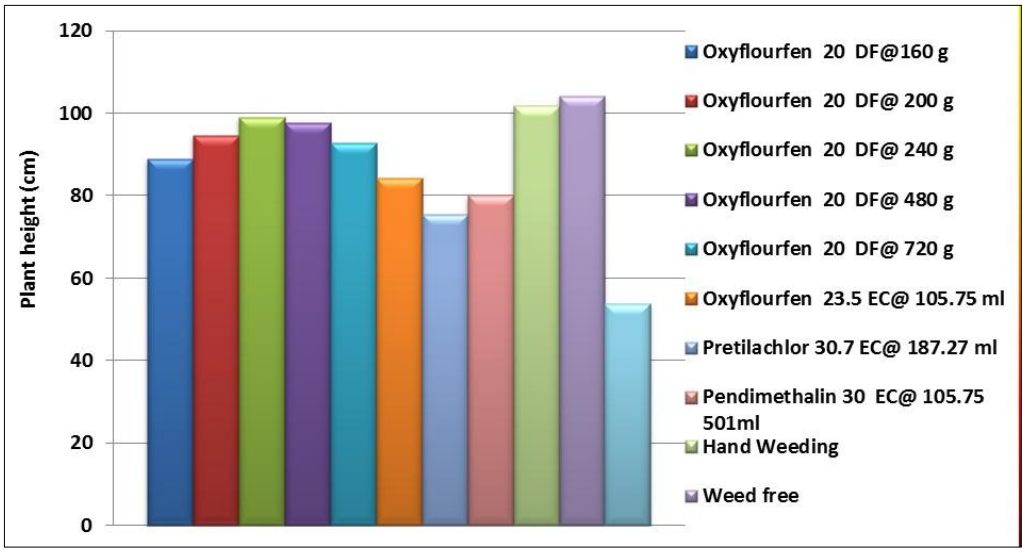

Fig 1: Effect of weed management practices on plant height of direct-seeded rice

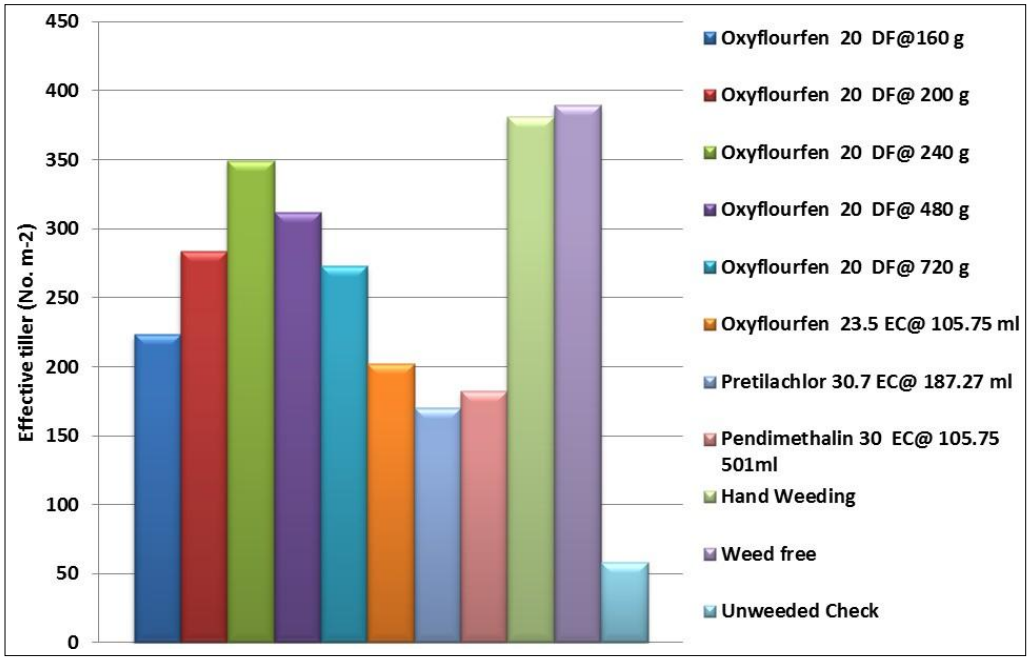

Fig 2: Effect of weed management practices on effective tiller No. m^{-2} of direct-seeded rice

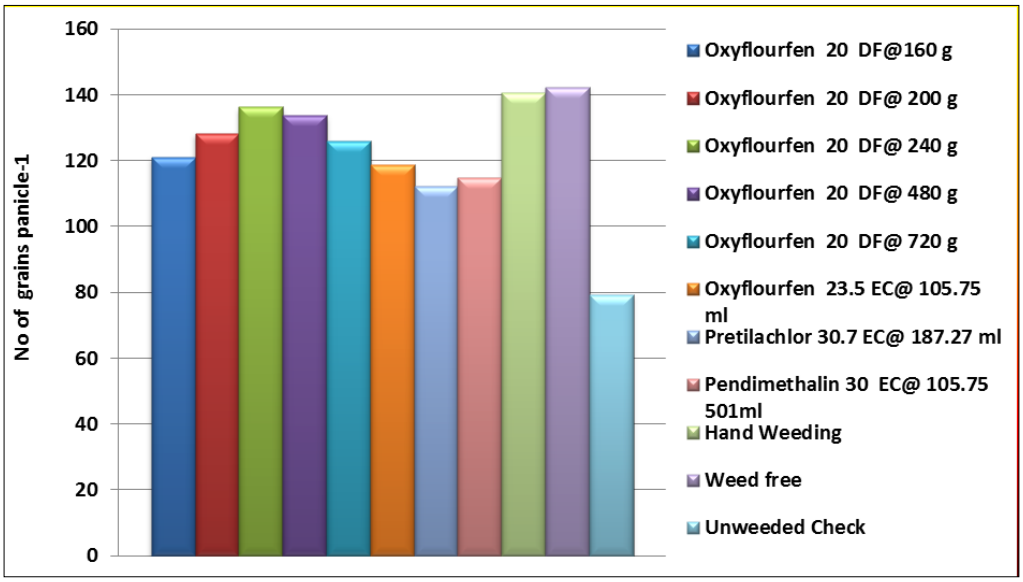

Fig 3: Effect of weed management practices on No of grains $panicle^{-1}$ of direct-seeded rice

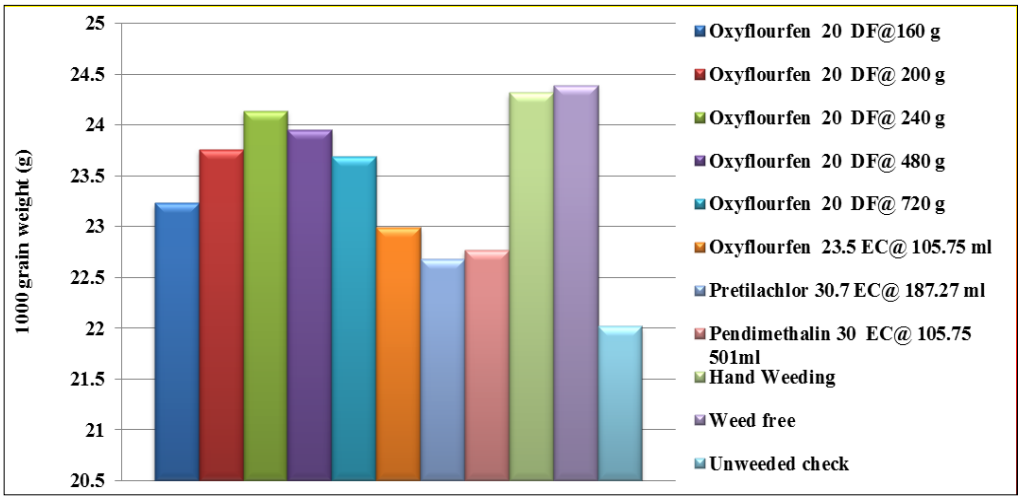

Fig 4: Effect of weed management practices on 1000 grain weight (g) of direct-seeded rice

Table1: Effect of weed management on growth, yield attributes and yield of direct-seeded-rice

Treatment	Plant height (cm) at harvest	Effective Tillers (No.m^{-2})	No of Grains panicle^{-1}	1000 grain weight (g)	Grain Yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)
Oxyflourfen 20 DF@160 g *a.i.* ha^{-1}	88.97	223.33	121.17	23.23	35.15	50.47	41.11
Oxyflourfen 20 DF@ 200 g *a.i.* ha^{-1}	94.71	284.00	128.33	23.76	42.33	58.70	42.09
Oxyflourfen 20 DF@ 240 g *a.i.* ha^{-1}	99.03	349.33	136.33	24.14	49.51	64.52	43.36
Oxyflourfen 20 DF@ 480 g *a.i.* ha^{-1}	97.70	311.67	133.67	23.95	46.23	61.54	42.79
Oxyflourfen 20 DF@ 720 g *a.i.* ha^{-1}	92.86	273.33	126.00	23.69	41.41	57.22	42.00
Oxyflourfen 23.5 EC@ 105.75 ml ha^{-1}	84.30	202.33	118.67	22.99	30.75	45.37	40.52
Pretilachlor 30.7 EC@ 187.27 ml ha^{-1}	75.41	170.33	112.33	22.68	22.50	33.56	40.03
Pendimethalin 30 EC@ 105.75 501ml ha^{-1}	80.09	182.33	114.67	22.77	26.58	39.17	40.27
Hand Weeding	101.77	381.00	140.67	24.32	53.91	67.06	44.58
Weed free	104.20	389.33	142.33	24.39	54.75	67.93	44.64
Unweeded Check	53.88	58.33	79.33	22.02	5.83	13.80	29.71
Sem±	2.74	5.17	3.63	0.10	2.86	3.26	1.82
CD (P=0.05)	6.83	15.26	10.72	0.29	8.43	9.62	5.37

EC - Emulsifiable concentrate, DF- Dry flowable a.i.= Active ingredient, DAS- Days after sowing

Harvest index

The data on harvest index for different treatments have been presented in table-1. The highest harvest index (44.64%) was found in weed free treatment which was statistically superior over all treatments; however, it was at par to treatment two hand weeding at 15 and 30 DAS (44.58%) and oxyflourfen 20 DF@ 240 g a.i ha-1. The lowest harvest index was found in unweeded check (29.71%).

Table 2: Economics of cultivation assessment

Treatment	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
Oxyflourfen 20 DF@160 g *a.i.* ha^{-1}	37980.26	66559.5	28579.24	1.75
Oxyflourfen 20 DF@ 200 g *a.i.* ha^{-1}	38228.26	79947.5	41719.24	2.09
Oxyflourfen 20 DF@ 240 g *a.i.* ha^{-1}	38476.26	93094.5	54618.24	2.41
Oxyflourfen 20 DF@ 480 g *a.i.* ha^{-1}	39964.26	87056.5	47092.24	2.17
Oxyflourfen 20 DF@ 720 g *a.i.* ha^{-1}	41452.26	78189.5	36737.24	1.88
Oxyflourfen 23.5 EC@ 105.75 ml ha^{-1}	38188.26	58349.5	20161.24	1.52
Pretilachlor 30.7 EC@ 187.27 ml ha^{-1}	37828.26	42731	4902.74	1.12
Pendimethalin 30 EC@ 105.75 501ml ha^{-1}	38588.26	50432.5	11843.74	1.30
Hand Weeding twice 15 & 30 DAS	47905.66	101048.5	53142.84	2.10
Weed free	59397.66	102605.5	43207.84	1.72
Unweeded Check	36413.66	11582.5	-24831.2	0.31

Effect on economics of direct-seeded rice

The data on cost of cultivation, gross return, net return and benefit cost ratio from direct-seeded rice as affected by different treatments are presented in table-2. The highest cost of cultivation (Rs. 59397.66 ha^{-1}) was noted under weed free treatment followed by two hand weeding at 15 and 30 DAS (Rs.47905.66 ha^{-1}), and oxyflourfen 20 DF @ 720 g a.i. ha^{-1} (Rs. 41452.26 ha^{-1}). The minimum cost was involved under untreated check (Rs 36413.66 ha^{-1}). The highest gross return (Rs. 102605.5 ha-1) was noted under weed free treatment, followed by two hand weeding at 15 and 30 DAS (Rs 101048.5 ha^{-1}) and oxyflourfen 20 DF @ 240 g a.i. ha^{-1} (Rs. 93094.5 ha^{-1}). Minimum gross return was noted under untreated check (Rs. 11582.5 ha^{-1}). The highest net return (Rs. 54618.24 ha^{-1}) was noted with pre-emergence application of oxyflourfen 20 DF @ 240 g a.i. ha^{-1}, followed by two hand weeding at 15 and 30 DAS (Rs 53142.84 ha^{-1}) and oxyflourfen 20 DF @ 480 g a.i. ha^{-1} (Rs. 47092.24 ha^{-1}).

Negative net return was noted under unweeded check (Rs. -24831.16 ha^{-1}). The highest B:C ratio was recorded under oxyflourfen 20 DF @ 240 a.i. ha^{-1} (2.41), followed by oxyflourfen 20 DF @ 480 g a.i. ha^{-1} (2.17) and two hand weeding at 15 and 30 DAS (2.10). This has been because of more gross returns and less cost involvement in these treatments as compared to others. The least B:C ratio (0.31) in unweeded check was owing to marginal yield obtained because of heavy crop-weed competation.

Conclusion

The research findings of direct seeded rice clearly visualized that pre-emergence application of Oxyflourfen 20% DF@ 240 g a.i. ha^{-1} recorded significantly highest yield attributes, grain and straw yield. However the highest economics fesibilies was recorded under treatment Oxyflourfen 20% DF@ 240 g a.i. ha^{-1} followed by Oxyflourfen 20% DF@ 480 g a.i. ha^{-1}.

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