The Pharma Innovation Journal 2020; 9(4): 79-83

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2020; 9(4): 79-83

www.thepharmajournal.com
Received: 22-02-2020
Accepted: 24-03-2020

V Ekka
Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

N Tiwari
Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

S Kujur
Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

D Nayak
Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Madan Kumar Jha
Department of Vegetable science, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Corresponding Author:
V Ekka
Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Effect of quinchlorac herbicide on weed indices on yield attributes and yields of transplanted rice

V Ekka, N Tiwari, S Kujur, D Nayak and Madan Kumar Jha

Abstract
The Field experiment was conducted during Kharif season 2015 at Research Cum Instructional farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur C.G. to evaluate the quinchlorac herbicide against weeds in transplanted rice. Ten weed control treatments were laid out in randomized block design with three replications. The result revealed that the major weed species in experimental site were Cyperus iria L, Cyanotis axillaris L, Alternanthera triandra L, Echinochloa colona L, Ischaemum rugosum Salisbury, and Caesulia axillaris Roxb. The significantly maximum panicle length and panicle weight was recorded under quinchlorac 250g/l SC @ 250 g ha-1 + bispyribac sodium (10% SC) @ 20 g ha-1 (T_5), which was significantly superior over T_1, T_2, T_3, T_7 and T_{10}, but, it was at par with hand weeding twice at 20 and 40 DAT (T_9), quinchlorac 250 g/l SC @ 250 g ha-1+ ethoxysulfuron (15% WP) @ 15 g. ha-1 (T_4), penoxsulam 21.7% SC @ 20 g ha-1 (T_8), quinchlorac 250 g/l SC @ 312.5 g ha-1 (T_6) and quinchlorac 250 g/l SC @ 250 g ha-1 (T_3). The maximum number of total grains panicle-1 was recorded under quinchlorac 250g/l SC @ 250 g ha-1 + bispyribac sodium (10% SC) @ 20 g ha-1 (134.64), which was significantly superior over T_1, T_2, T_3, T_7 and T_{10}. Quinchlorac 250g/l SC @ 250 g ha-1 + bispyribac sodium (10% SC) @ 20 g ha-1 recorded maximum number of filled and minimum number of unfilled grains panicle-1. As regards to filled and unfilled grains panicle-1 the best performing treatment quinchlorac 250g/l SC @ 250 g ha-1 + bispyribac sodium (10% SC) @ 20 g ha-1was at par to hand weeding twice at 20 and 40 DAT (T_9), quinchlorac 250 g/l SC + ethoxysulfuron (15% WP) @ 250 + 15 g ha-1 (T_4), penoxsulam 21.7% SC @ 20 g ha-1 (T8), and quinchlorac 250 g/l SC @ 312.5 g ha-1 (T_6). The lowest number of filled grains panicle-1 was noted in control (T10), whereas this treatment also recorded the highest number of unfilled grains panicle-1. Among different treatments, quinchlorac 250g/l SC @ 250 g ha-1 + bispyribac sodium (10% SC) @ 20 g ha-1 registered significantly lowest sterility percentage, however, it was at par to penoxsulam 21.7% SC @ 20 g *a.i* ha-1 (T_8), quinchlorac 250 g/l SC @ 312.5 g ha-1 (T_6), hand weeding twice 20 and 40 DAT (T_9), quinchlorac 250 g/l SC + ethoxysulfuron (15%WP) @ 250 + 15 g ha-1 (T4). The highest sterility percentage was recorded under control (T_{10}). The highest grain (5.37 t ha-1) and straw yield (6.61 t ha-1) were obtained under quinchlorac 250g/l SC @ 250 g ha-1 + bispyribac sodium (10% SC) @ 20 g ha-1 (T_5), which were significantly superior over over T_1, T_2, T_3, T_7 and T_{10}. However, it was at par to hand weeding twice at 20 and 40 DAT (5.18 t ha-1 and 6.42 t ha-1), quinchlorac 250 g/l SC @ 250 g ha-1+ ethoxysulfuron (15% WP) @ 15 g ha-1 (5.08 t ha-1 and 6.40 t ha-1), penoxsulam 21.7% SC @ 20 g ha-1 (4.89 t ha-1 and 6.28 t ha-1), quinchlorac 250 g/l SC @ 312.5 g ha-1 (4.79 t ha-1 and 6.26 t ha-1) and quinchlorac 250 g/l SC @ 250 g ha-1 (4.70 t ha-1 and 6.19 t ha-1), respectively.

Keywords: Transplanted Rice, Herbicide, Test weight and Harvest Index

Introduction
Rice is the most important staple food crop of millions of mankind from down of civilization (Chakravarti *et al.* 2012) [5]. Among the cereal crops, it serves as the principal source of nourishment for over half of the global population (Davla *et al.* 2013) [6]. In world, rice is the second most widely consumed cereal next to wheat and it has occupied an area of 160.60 million hectares, with a total production of 738.20 million tonnes and productivity 3424.41kg ha^{-1} (Anonymous, a2015) [1]. 80 per cent of the world rice production mainly comes from Asian countries and Brazil. Among these countries, China is the largest producer of rice with a production of 197.3 million tonne and occupying an area of 29.9 million ha with a productivity of 6.59 tonne ha^{-1}. India is the second largest rice producer after China and has an area of over 44.1 million hectare with a production of 105.48 million tonnes with a productivity of 3020 kg ha^{-1} (Anonymous b, 2015) [2] contributing 26.0 per cent of world rice production. Chhattisgarh state is popularly known as "Rice bowl" because of maximum area covered during *kharif* under rice contributing major share in national rice production. Rice occupies an area of 3.64 million hectare with the production of 7.65 million tonnes and productivity of 1517 kg ha^{-1}

(Anonymous c, 2015) [3]. The productivity of rice per unit area is poor, despite of suitable environmental conditions. One of major problem in rice cultivation for low productivity is weed infestation. Manna (1991) [8] reported a yield reduction of 25 per cent in transplanted rice, 32 per cent in puddle broadcast rice and 52 per cent in direct- sown upland rice due to weeds. Yield reduction in transplanted rice due to unchecked weed growth is 47 per cent (Mukharjee and Singh, 2004) [13]. Weeds not only cause quantitative but they also hamper the quality of produce due to competition for nutrient, moisture, light and to some extent for space. Weed problem is generally of lower magnitude in transplanted system if puddling and proper water management is followed. In transplanted rice, weeds germinate few days after transplanting of seedling. Hand weeding is the most common and effective method of weed control in rice but it is being difficult and uneconomical day-by-day due to high wages and non-availability of labours at peak period of farm operation. Herbicide is the most effective and economic means of weed control, but inappropriate or wrong application may not only increase production cost and yield penalty but also may cause development of herbicide resistant weeds and environmental hazard (Karim *et al.* 2004) [12].

Herbicidal weed control methods offer an advantage to save man power and money, as a result, regarded as cost effective method of weed control (Ahmed *et al.* 2000) [11]. Therefore, timely weed control is imperative for realizing optimum level of productivity. In Chhattisgarh state, application of new herbicides (molecules) is very limited. A new formulation named Quinchlorac has been identified as early post emergence herbicide for controlling annual grassy weeds especially *Echinochloa* sp. The relevant information on the use of new herbicide to control the post emergence weeds of transplanted rice is not available, especially under the agro-climatic conditions of Chhattisgarh plains.

Materials and Methods

1 Number of effective tillers hill^{-1}

The observations on number of panicle bearing tillers were made at harvest. Panicle bearing tillers were counted randomly from five hills and then average was worked out.

2 Panicle weight (g)

The panicles selected for measuring length were weighed on an electrical weighing balance and then mean was worked out.

3 Panicle lengths (cm)

The length of panicle was taken from ten panicles selected randomly from harvested produce. It was measured from the neck-node to the tip of the apical grains. After this, average length of panicle was determined.

4 Number of total, filled and unfilled grains panicle^{-1}

The panicles collected for measurement of length were used to count number of total, filled and unfilled grains and then average was calculated.

5 Sterility percentages

The number of filled and unfilled spikelets per panicle was counted from five panicles selected randomly for measurement of panicle length and sterility percentage was computed with the following formula:

$$\text{Sterility percentage} = \frac{\text{Number of unfilled spikelets panicle}^{-1}}{\text{Total number of grains panicle}^{-1}} \times 100$$

6 Test weight (g)

A random grain samples were taken from the produce of each net plot. Out of the samples, 1000 grains were counted from each net plot and same were dried in oven at 60°C to constant weight, thereafter, weight so obtained was noted as 1000-grain weight (test weight).

7 Grain and straw yield (t ha^{-1})

After proper sun-drying, the produce of the net plot was tied in bundles and weighed to determine the dry matter produce (grain + straw). The clean grain obtained after threshing and winnowing from each net plot was weighed. The results were expressed on 14 percent moisture basis. The straw yield was obtained by subtracting weight of the grain yield from the total weight of the bundle.

8 Harvest index (%)

Harvest index (HI) was calculated by the following formula:

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield (grain + straw)}} \text{x} 100$$

Results and Discussion

1. Number of effective tillers hill^{-1}

Grain yield of cereals is highly dependent upon the number of effective tillers produced by each plant (Power and Alessi, 1978). According to the data presented in Table 1 indicate that, almost all the treatments recorded significantly higher number of tillers hill^{-1} over control (T_{10}). The treatment quinchlorac 250g/l SC @ 250 g ha^{-1} + bispyribac sodium (10% SC) @ 20 g ha^{-1} (T_5) registered highest number of effective tillers which was significantly superior over quinchlorac 250 g/l SC @ 125 g ha^{-1} (T_1), quinchlorac 250 g/l SC @ 187.5 g ha^{-1} (T_2), cyhalofop butyl 10% EC @ 100 g ha^{-1} (T_7) and Control (T_{10}). Expect, hand weeding twice at 20 and 40 DAT (T_9), quinchlorac 250 g/l SC @ 250 g ha^{-1} + ethoxysulfuron (15% WP) @ 15 g ha^{-1} (T_4), penoxsulam 21.7% SC @ 20 g ha^{-1} (T_8) and quinchlorac 250 g/l SC @ 312.5 g ha^{-1} (T_6), recorded at par effective tillers hill^{-1}. The lowest number of effective tillers hill^{-1} was noted under control (T_{10}).

Higher number of effective tillers in above treatments were due to the fact that there was more space to the crop to show their potential due to lower weed competition in terms of dry matter of weeds as well as good source sink relationship which allow crop to absorb required amount of nutrient, water and sunlight for its growth and tillering behavior. These results are accordance with the findings of Hasazzaman and Karim (2007) [10] and Gowda *et al.* (2009) [9].

2 Panicle length (cm)

It is obvious from the Table 1 that significant difference in panicle length of rice was recorded due to different post emergence herbicides. The maximum length of panicle was recorded under quinchlorac 250g/l SC @ 250 g ha^{-1} + bispyribac sodium (10% SC) @ 20 g ha^{-1} (21.13 cm) which was significantly superior over quinchlorac 250 g/l SC @ 125 g ha^{-1} (T_1), cyhalofop butyl 10% EC @ 100 g ha^{-1} (T_7) and Control (T_{10}). Except, hand weeding twice at 20 and 40 DAT (20.27 cm), quinchlorac 250 g/l SC @ 250 g ha^{-1} + ethoxysulfuron (15% WP) @ 15 g ha^{-1} (20.10 cm), penoxsulam 21.7% SC @ 20 g ha^{-1} (20.03 cm), quinchlorac

250 g/l SC @ 312.5 g ha^{-1} (19.77 cm), quinchlorac 250 g/l SC @ 250 g ha^{-1} (19.67 cm) and quinchlorac 250 g/l SC @ 187.5 g ha^{-1} (18.60 cm), which were comparable with quinchlorac 250g/l SC @ 250 g ha^{-1} + bispyribac sodium (10% SC) @ 20 g ha^{-1} (T_5). The shortest panicle was recorded under control (T_{10}).

Longer panicle under these treatments might be due to minimum crop weed competition which allowed more growth of rice because of more availability of light, moisture, nutrients and space lead to production of larger size of panicle. Similar findings have been also reported by Narwal *et al.* 2002 [14] and Singh *et al.* 2005.

3. Panicle weight (g)

The data on panicle weight as affected by various treatments are presented in Table 1. All the herbicidal treatments showed significant impact on panicle weight as compared to control (T_{10}). Maximum panicle weight was recorded under quinchlorac 250g/l SC @ 250 g ha^{-1} + bispyribac sodium (10% SC) @ 20 g ha^{-1} (3.12 g). Hand weeding twice at 20 and 40 DAT (3.00 g), quinchlorac 250 g/l SC @ 250 g ha^{-1} + ethoxysulfuron (15% WP) @ 15 g ha^{-1} (2.74 g), penoxsulam 21.7% SC @ 20 g ha^{-1} (2.72 g), quinchlorac 250 g/l SC @ 312.5 g ha^{-1} (2.70 g), and quinchlorac 250 g/l SC @ 250 g ha^{-1} (T_3) were also found at par to quinchlorac 250g/l SC @ 250 g ha^{-1} + bispyribac sodium (10% SC) @ 20 g ha^{-1} (T_5).

Higher panicle length of the above treatment could be responsible for higher panicle weight; this might be due to post emergence herbicides during panicle initiation stage which facilitate the better transfer of photosynthetic to the sink which contributes more to increase the weight of panicles. These findings are accordance with those of Narwal *et al*. (2002) [14], Subramanyam *et al*. (2007) [19] and Tiwari (2002) [21].

4. Total number of grains panicle^{-1}

The data on total number of grains panicle^{-1} as affected by various treatments are presented in Table 1.The data showed that Quinchlorac 250g/l SC @ 250 g ha^{-1}+ bispyribac sodium (10% SC) @ 20 g ha^{-1} (T_5) recorded maximum number of total grains panicle^{-1}. However, it was at par to hand weeding twice at 20 and 40 DAT (T_9), quinchlorac 250 g/l SC @ 250 g ha^{-1} + ethoxysulfuron (15% WP) @ 15 g ha^{-1} (T_4), penoxsulam 21.7% SC @ 20 g ha^{-1} (T_8) and quinchlorac 250 g/l SC @ 312.5 g ha^{-1} (T_6).The lowest total number of grains panicle^{-1} was noted in control (T_{10}).

5. Filled and unfilled grains panicle^{-1}

The data on filled and unfilled grains panicle^{-1} as affected by various treatments are presented in Table 1. The data indicated that Quinchlorac 250g/l SC @ 250 g ha^{-1}+ bispyribac sodium (10% SC) @ 20 g ha^{-1} (T_5) recorded maximum number of filled and minimum number of unfilled grains panicle^{-1}. As regards to filled grains panicle^{-1} the best performing treatment quinchlorac 250g/l SC @ 250 g ha^{-1} + bispyribac sodium (10% SC) @ 20 g ha^{-1} (T_5) was at par to hand weeding twice at 20 and 40 DAT (T_9), quinchlorac 250 g/l SC @ 250 g ha^{-1} + ethoxysulfuron (15% WP) @ 15 g ha^{-1} (T_4), penoxsulam 21.7% SC @ 20 g ha^{-1} (T_8) and quinchlorac 250 g/l SC @ 312.5 g ha^{-1} (T_6) whereas, for unfilled grains panicle^{-1} it was at par to hand weeding twice at 20 and 40 DAT (T_9), quinchlorac 250 g/l SC @ 250 g ha^{-1} + ethoxysulfuron (15% WP) @ 15 g ha^{-1} (T_4), penoxsulam 21.7% SC @ 20 g ha^{-1} (T_8), quinchlorac 250 g/l SC @ 312.5 g ha^{-1} (T_6) and quinchlorac 250 g/l SC @ 250 g ha^{-1} (T_3). The lowest number of filled grains panicle^{-1} was noted in control (T_{10}), whereas this treatment also recorded the highest number of unfilled grains panicle^{-1}.

The lowest number of unfilled grains panicle^{-1} in above treatments might be due to the lower weed competition in terms of dry matter of weeds which create overall agreeable environment for growth and development of rice resulted more availability of light moisture, nutrients and space for rice plant leads to produce more number of sound grains panicle^{-1}. Another possible reason to obtain maximum number of filled grains panicle^{-1} might be due to effective weed control and highest weed control efficiency in herbicidal treated plot. Similar results were also reported by Hasazzaman and Karim (2007) [10] and Gowda *et al*. (2009) [9].

6. Sterility Percentage (%)

The data on sterility percentage as affected by various treatments are presented in Table 1. Among different treatments, Quinchlorac 250g/l SC @ 250 g ha^{-1} + bispyribac sodium (10% SC) @ 20 g ha^{-1} (T_5) registered significantly lowest sterility percentage which was at par to penoxsulam 21.7% SC @ 20 g ha^{-1} (T_8), quinchlorac 250 g/l SC @ 312.5 g ha^{-1} (T_6), hand weeding twice 20 and 40 DAT (T_9), quinchlorac 250 g/l SC @ 250 g ha^{-1} + ethoxysulfuron (15% WP) @ 15 g ha^{-1} (T_4). The highest sterility percentage was observed under control (T_{10}).

It is the established fact that there were severe crop-weed competition under the above treatments for the nutrients, space, light and moisture. The higher weed competition under control arrested the nutrients and moisture available to rice crop. This, in turn, reduced the translocation of food material to sink resulted in higher sterility. As we know that weeds leads to imbalance uptake of nutrients, moisture, utilization of light and space, consequently affecting filling of grain adversely. Crop subject with higher competition for moisture, nutrients, light and space would definitely show high rate of sterility percentage owing to restricted transformation and translocation of food materials (Singh *et al.* 2006 and Yadav *et al.* 2007) [18, 22].

7. Test weight (g)

The weight of thousand grains is also an important attributes to yield and data are presented in Table 1. Among the treatments, 1000 grain weights were not statistically different. The findings are supported by the observations of Matsushima (1980) who stated that the weight of 1,000 grains always shows the least variation under any cultural season and practices, compared to other components. The test weight is a varietal character because the grain size is rigidly controlled by the size of the hull (Yoshida, 1981) [23]. Rao and Moody (1992) [15] mentioned that weed competition did not affect seed weight of the rice. This finding coincides with Razia (2000) [16] who found the similar non-significant effects of weed competition on 1000 grain weight. The present findings are in conformity with the results of Iqbal *et al*. (2008) [11] who reported that 1000 grain weight is a genetic character widely used in yield estimation and varietal selection in rice, and environmental factors have minimum influence on it.

Table 1: Yield attributing characters of transplanted rice as affected by weed management practices.

Treatments		Dose (g ha^{-1})	Time of application DAT	Effective tillers hill^{-1} (No.)	Panicle length (cm)	Panicle weight (g)	Total number of grain panicle^{-1}	Filled grains panicle^{-1} (No.)	Unfilled grains panicle^{-1} (No.)	Sterility percent (%)	Test weight (g)
T_1	Quinchlorac 250 g/l SC	125	15	6.33	18.27	2.36	105.91	95.57	10.33	9.82	26.82
T_2	Quinchlorac 250 g/l SC	187.5	15	6.67	18.60	2.48	109.31	99.31	10.00	9.13	26.83
T_3	Quinchlorac 250 g/l SC	250	15	8.00	19.67	2.69	110.13	100.80	9.33	8.50	26.87
T_4	Quinchlorac 250 g/l SC + Ethoxysulfuron (15% WP)	250 + 15	15	8.67	20.10	2.74	130.08	122.08	8.00	6.22	27.02
T_5	Quinchlorac 250g/l SC + Bispyribac sodium (10% SC)	250 + 20	15	9.33	21.13	3.12	134.64	127.31	7.33	5.44	27.08
T_6	Quinchlorac 250 g/l SC	312.5	15	8.33	19.77	2.70	120.25	111.25	9.00	7.50	26.94
T_7	Cyhalofop butyl 10% EC	100	15	5.33	17.73	2.28	97.99	86.99	11.00	11.17	26.77
T_8	Penoxsulam 21.7% SC	20	15	8.62	20.03	2.72	124.07	115.73	8.33	6.74	26.98
T_9	Hand weeding twice	-	20 & 40	9.00	20.27	3.00	133.69	124.69	7.67	5.79	27.03
T_{10}	Control	-		4.67	16.27	1.92	93.33	77.67	15.67	16.83	25.95
SEm±				0.40	0.91	0.16	6.28	6.20	0.77	0.72	1.72
CD(P=0.05)				1.19	2.69	0.48	18.67	18.43	2.28	2.14	NS

8. Grain yield (t ha^{-1})

The data pertaining to grain yield of rice as influenced by weed management practices have been present in Table 2. Results revealed that treatment, quinchlorac 250g/l SC @ 250 g ha^{-1}+ bispyribac sodium (10% SC) @ 20 g ha^{-1} (T_5) registered significantly highest grain yield (5.37 t ha^{-1}), however, it was found at par with the application of quinchlorac 250 g/l SC + ethoxysulfuron (15% WP) @ 250 + 15 g ha^{-1} (5.08 t ha^{-1}), quinchlorac 250 g/l SC @ 312.5 g ha^{-1}, (4.79 t ha^{-1}), penoxsulam 21.7% SC @ 20 g ha^{-1} (4.89 t ha^{-1}), quinchlorac 250 g/l SC @ 250 g ha^{-1} (4.70 t ha-^{1}) and hand weeding twice at 20 and 40 DAT (5.18 t ha^{-1}). The minimum seed yield was recorded under control (1.57 t ha^{-1}).

A similar result was also reported by Jason *et al*. (2007), Narwal *et al*. (2002) [14] and Yadav *et al*. (2009) [22]. Grain production, which is the final product of growth and development, is controlled by dry matter accumulation during the ripening phase (De Datta, 1981). All the herbicidal treatments significantly influenced grain yields compared with control. These results agreed on the findings of IRRI (1990) which reported that yields of weeded plots were consistently higher than those of un weeded. The occurrence of weeds has become a serious problem and they limit the yield and quality of crops. It is often stated that some weeds cause total crop failure and that weeding practices are absolutely essential. Unchecked weed compete with rice plants for light, nutrients and moisture resulting reduction of grain yield upto 80% (De Datta and Haque, 1982) [7]. Contrarily, the poor growth of plants as well as development of yield attributing characters in control might be due to less moisture, nutrient, space and light available at the time of flowering and grain development adversely influenced the grain yield. The lower grain yield under control may be due to the high weed interference and less number of effective tillers (Behera and Jha, 1992) [4].

9. Straw yield (t ha^{-1})

The data on straw yield under different treatments have been presented in Table 2. The straw yield was significantly influenced by different treatments. Quinchlorac 250g/l SC @ 250 g ha^{-1}+ bispyribac sodium (10% SC) @ 20 g ha^{-1} (6.61 t ha^{-1}) produced the highest straw yield and it was significantly superior over quinchlorac 250 g/l SC @ 125 g ha^{-1} (T_1), quinchlorac 250 g/l SC @ 187.5 g ha^{-1} (T_2), cyhalofop butyl 10% EC @ 100 g ha^{-1} (T_7) and Control (T_{10}), but it was at par to application of quinchlorac 250 g/l SC @ 250 g ha^{-1} (6.19 t ha^{-1}), quinchlorac 250 g/l SC @ 250 g ha^{-1} + ethoxysulfuron (15% WP) @ 15 g ha^{-1} (6.40 t ha^{-1}), quinchlorac 250 g/l SC @ 312.5 g ha^{-1} (6.26 t ha^{-1}), T_8 penoxsulam 21.7% SC @ 20 g ha^{-1} (6.28 t ha^{-1}), and hand weeding twice 20 and 40 DAT (6.42 t ha^{-1}). The minimum straw yield (2.78 t ha^{-1}) was noted under control (T_{10}). It can be inferred that treatments T_3, T_4, T_6, T_8, and T_9 checked the weeds in comparison to other treatments leading to higher grain yield and straw yield. While, in control (T_{10}) reverse trend was observed and therefore, the lowest straw yield was noted under this treatment. Similar findings were also reported by Jason *et al.* 2007, Yadav *et al.* 2009 [22].

10. Harvest Index (%)

The data on harvest index as influenced by different treatments have been presented in Table 2. Different post emergence herbicides influenced harvest index (%) significantly. Quinchlorac 250g/l SC @ 250 g ha^{-1} + bispyribac sodium (10% SC) @ 20 g ha^{-1} (T_5) recorded significantly highest (44.81%) harvest index, but it was found at par to quinchlorac 250 g/l SC @ 250 g ha^{-1} (T_3), quinchlorac 250 g/l SC @ 250 g ha^{-1} + ethoxysulfuron (15% WP) @ 15 g ha^{-1} (T_4), quinchlorac 250 g/l SC @ 312.5 g ha^{-1} (T_6), penoxsulam 21.7% SC @ 20 g ha^{-1} (T_8), hand weeding twice 20 and 40 DAT (T_9), and quinchlorac 250 g/l SC @ 187.5 g ha^{-1} (T_3). The lowest harvest index (36.10%) was obtained under control (T_{10}). The highest harvest index in above treatments (T_2, T_3, T_4, T_6, T_8 and T_9) was due to higher economic yield i.e. grain yield in proportion to straw yield because of low crop-weed competition. While, the lowest harvest index was observed in control (T_{10}) due to more crop-weed competition. The possible reason of lower harvest index may be due to the more competition during the critical periods which results in lower number of tillers, leaves, less number of grains and lower translocation of photosynthetic towards the reproductive parts of the crop plant and act as a barrier for lower economic as well as biological yield. Deberman and Fairhurst (2000) [8] reported that estimation of yield losses caused by competition from weeds ranges from 30-100%. This indicates that heavy weed infestation has caused a substantial reduction in the yield of rice. Yield losses from weeds in rice varies with the type of culture, method of planting, time of weed infestation, soil fertility and cultivar (De Datta *et al.* 1969) [7].

Table 2: Grain yield, straw yield, harvest index and weed index of transplanted rice as affected by weed management practices.

	Treatments	Dose (g ha^{-1})	Time of application DAT	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)	Weed index (%)
T_1	Quinchlorac 250 g/l SC	125	15	3.93	5.47	41.84	26.81
T_2	Quinchlorac 250 g/l SC	187.5	15	4.12	5.57	42.47	23.27
T_3	Quinchlorac 250 g/l SC	250	15	4.63	6.19	42.80	13.78
T_4	Quinchlorac 250 g/l SC + Ethoxysulfuron (15% WP)	250 + 15	15	5.08	6.40	44.25	5.40
T_5	Quinchlorac 250g/l SC + Bispyribac sodium (10% SC)	250 + 20	15	5.37	6.61	44.81	-
T_6	Quinchlorac 250 g/l SC	312.5	15	4.79	6.26	43.36	10.80
T_7	Cyhalofop butyl 10% EC	100	15	2.97	4.72	38.61	44.69
T_8	Penoxsulam 21.7% SC	20	15	4.89	6.28	43.76	8.93
T_9	Hand weeding twice	-	20 & 40	5.18	6.42	44.64	3.53
T_{10}	Control	-		1.57	2.78	36.10	70.76
SEm±				0.25	0.33	1.71	
CD(P=0.05)				0.75	0.98	5.08	

11. Weed index (%)

Data on weed index are presented in Table 2. Weed index was remarkably influenced by post emergence herbicides. The highest weed index was observed under control (T_{10}). The yield reduction due to weed were 70.7%. Similar finding have been found by Thura 2010.

References

1. Anonymous (a), FAO. Rice Market Monitor and market division Food and Agriculture Organisation of United Nations, 2015.
2. Anonymous (b). Agricultural Statistics Division, Department of Economics and Statistics, Department of agriculture and Cooperation. New Delhi, India, 2015.
3. Anonymous (c). State Level Agricultural Statistics, Directorate of Agriculture Raipur, Chhattisgarh2015.
4. Behera AK, Jena SN. Weed management in direct seeded rice under puddle condition, Oryza. 1997; 34(4):337-340.
5. Chakrawarti SK, Kumar H, Lal JP, Vishwakarma MK. Induced mutation in traditional aromatic rice-frequency and spectrum of viable mutations and characterizations of economic values. The Bioscan. 2012; 7(4):739-742.
6. Davla D, Sasidharan N, Macwana S, Chakraborty S, Trivedi R, Ravikiran R *et al*. Molecular characterization of rice (*Oryza sativa* L.) genotypes for salt tolerance using microsatellite markers. The Bioscan. 2013; 8(2):498-502.
7. De Datta SK. Principle and Practices of rice production. John Wiley and Sons, New York, USA, 1981, 618.
8. Dobermann A, Fairhurst T. Rice nutrient disorders and nutrient management. International Rice Research Institute, Manila, Philippines, 2000.
9. Gowda PT, Shankaraiah C, Jnanesh AC, Govindappa M, Murthy KN. Studies on chemical weed control in aerobic rice (*Oryza sativa* L.). Journal of Crop and Weed. 2009; 5(1):321-324.
10. Hasanuzzaman KNM, d Karim MR. Effectiveness of different weed control methods on the performance of transplanted rice. Pakistan Journal of Weed Science Research. 2007; 13(1-2):17-25.
11. Iqbal S, Ahmad A, Hussain A, Ali MA, Khaliq T, Wajid SA. Influence of transplanting date and nitrogen management on productivity of paddy cultivars under variable environments. International Journal of Agricultural Biology. 2008; 10:288-292.
12. Karim SMR, Azmi BM, Ismail BS. Weed problems and their management in rice fields of Malaysia: an overview. Weed Biology Management. 2004; 4:177-186.
13. Mukharjee D, Singh RP. Efficiency of low dose herbicides on divergent weed flora in transplanted rice. Oryza. 2004; 41:20-23.
14. Narwal S, Singh S, Panwar KS, Malik RK. Performance of acetachlor and anilofos + ethoxysulfuron for weed control in transplanted rice (*Oryza sativa* L.). Indian Journal of Agronomy. 2002; 47(1):67-71.
15. Rao AS, Ratnam M. Evaluation of post emergence herbicides on weed control in rice nursery. Pakistan Journal of Weed Science Research. 2010; 16(4):387-392.
16. Razia S. Competitive ability of three grass weeds grown in upland direct seeded aus rice in Bangladesh. Pakistan Journal of Agricultural Research. 2000; 16:24-26.
17. Singh VP, Singh G, Singh SP, Kumar A, Singh Y. Effect of rice-wheat establishment methods and wheat management in the irrigated rice–wheatproduction system. In: Workshop on Direct Seeded Rice in the Rice–Wheat System of the Indo-Gangetic Plains held in Pantnagar, Uttaranchal, India, 1–2 February 2005. G.B. Pant University of Agriculture and Technology, 2005, 12.
18. Singh P, Singh SS. Effect of establishment method, fertility level and weed management practices on aromatic rice. Indian Journal of Agronomy. 2006; 51(4):288-292.
19. Subramanyam D, Reddy CR, Reddy DS. Influence of puddling intensity and water-management practices on weed dynamics and yield of transplanted rice. Indian Journal of Agronomy. 2007; 52(3):225-230.
20. Thapa CB, Jha PK. Paddy crop-weed competition in Pokhara, Nepal. Geobios. 2002; 29(1):51-54.
21. Tiwari N. Effect of herbicide on performance of direct seeded rice, weed dynamic and soil microflora M.Sc. (Ag.) Agronomy Thesis Indira Gandhi Krishi Vishwavidyalaya Raipur, (C.G.), 2002.
22. Yadav DB, Yadav A, Punia SS. Evaluation of bispyribac-sodium for weed control in transplanted rice. Indian Journal of Weed Science. 2009; 41(1-2):23-27.
23. Yoshida S. Fundamental of rice crop science. The International Rice Research Institute, Los Banos, Laguna, Philippines, 1981, 269.