

Original Research Article

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Effect of Forchlorfenuron on growth and yield of Rice (*Oryza sativa* L.) during *Kharif* season of Central India

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ABSTRACT

The field experiment on the Effect of Forchlorfenuron on growth and yield of rice (*Oryza sativa* L.) during *Kharif* season of Central India was conducted at Krishi Nagar Farm, Department of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (Madhya Pradesh) during *Kharif* 2018. The treatments comprising of forchlorfenuron at different doses were applied at panicle initiation (PI) stage through foliar spray @ 520, 1040, 1560, 2080, 2600, 3120, 3640 g ha⁻¹ and untreated control (No foliar spray) in randomized block design with three replications. Among all the treatments growth parameters of rice (*viz.*, plant height, number of tillers hill⁻¹, dry matter accumulation) and yield attributes (*viz.*, effective tillers hill⁻¹, panicle length, panicle weight and sound grains panicle⁻¹) were significantly maximum in plots receiving foliar spray of forchlorfenuron @ 3640 g ha⁻¹. While the test weight of rice was not influenced significantly due to different treatments of forchlorfenuron. The foliar spray of forchlorfenuron @ 3640 g ha⁻¹ gave highest grain and straw yield (4745 and 7290 kg ha⁻¹) over untreated control (3080 and 5460 kg ha⁻¹).

Keywords

Forchlorfenuron, Rice (*Oryza sativa* L.), Growth and yield

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Introduction

Rice (*Oryza sativa* L.) is the monocot plant belonging to the genus *Oryza* under tribe Oryzeae in grass family Gramineae. (Kumhar *et al.*, 2016a, Kumhar *et al.*, 2016b and Kumhar *et al.*, 2018). It provides half of total dietary carbohydrate, especially in Asian

countries and it is suitable diet for more than three billion people that supplied 50-80% of their daily calorie intake (Khush, 2005 and Choudhary *et al.*, 2011). Globally rice is grown in over 160 mha producing about 478 MT of grains annually (Anonymous, 2016). Rice is an important staple food crop of India and grown on nearly 43.19 mha area with the

production of 109.70 MT and triggering productivity of 2550 kg ha⁻¹. (Agriculture Statistics at a glance, 2017).

Use of the plant growth regulators in rice has been one of the most potential tools for increasing crop production. Growth regulators like GA₃, NAA and chemicals like KH₂PO₄ along with boron as foliar spray found to improve panicle emergence, seed set percent and seed yield in hybrid rice seed production (Zhu *et al.*, 1998). The introduction of chemical growth regulators has added a new dimension to the possibility for improving the growth and yield of rice crop. In principle, the availability of exogenous bio-regulators to modify plant growth offers great opportunity.

Plant growth regulators generate metabolic and physiological responses in plants by affecting their growth and development (Hayat *et al.*, 2010). Similarly, Choi *et al.*, (2010) stated that application of PGR increased paddy yield. Whereas, Reddy *et al.*, (2009) reported that application of NAA increased yield components and yield of rice.

N-(2-chloro-4-pyridyl)-N'-phenylurea) or forchlorfenuron (CPPU) is a synthetic cytokinin-active phenylurea with a physiologic activity exceeding that of zeatin (Mok and Mok 2001).

It induces callus formation, promotes shoot regeneration, provokes seed germination, promotes fruit expansion, retards leaf senescence, etc. CPPU activity exceeds those of other adenine-type cytokinins (Singh and Syamal 2001). CPPU and its derivatives are also known as cytokinin oxidase/dehydrogenase inhibitors (Kopečný *et al.*, 2010). Such an ability to substitute for active adenine-type cytokinins has been demonstrated in various callus culture bioassays (Mok *et al.*, 1982).

Materials and Methods

The experiment was conducted at the Krishi Nagar Farm, Department of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidyalyaya, Jabalpur during *kharif* 2018, to study Effect of Forchlorfenuron on growth and yield of rice (*Oryza sativa* L.) during *Kharif* season of Central India. The soil of the experimental field was sandy clay loam in texture, medium in organic carbon and available nitrogen, phosphorus and potassium content and neutral in soil reaction. The experiment was laid out in randomized block design with eight treatments and three replications. The treatments were foliar spray of forchlorfenuron @ 520, 1040, 1560, 2080, 2600, 3120, 3640 g ha⁻¹ and untreated control (No foliar spray) at per treatment was done on 2nd October 2018.

Seedlings of rice variety "Kranti" were raised in nursery on 18 June 2018 and 30 days old seedling transplanted in main field manually on 18 July 2018 after its thorough puddling and leveling. Healthy seedling (two seedling hill⁻¹) was transplanted at the planting geometry of 20 cm x 20 cm in all the plots and recommended nutrient dose of 120:60:40 N, P₂O₅, K₂O kg ha⁻¹ were applied through urea, single super phosphate and muriate of potash, respectively. Out of this, half of N and entire dose of P₂O₅ and K₂O were applied at the time of transplanting and the remaining quantity of N was applied in two equal splits, one at tillering and another at panicle initiation (PI) stage. Total amount of 1092.10 mm rainfall was received in 45 rainy days. Observations were recorded on plant growth parameters (*viz.*, plant height, number of tillers hill⁻¹, dry matter accumulation) and yield attributing traits (*viz.*, effective tillers hill⁻¹, panicle length, panicle weight and sound grains panicle⁻¹) were recorded at maturity on five randomly selected hills in each treatment. All data were subjected to analysis of variance

according to the experimental design used in this study and critical difference (CD) was utilized to compare the different means of treatment.

Results and Discussion

Growth Parameters

The plant height differed significantly due to treatments with forchlorfenuron (Table 1). The foliar spray of forchlorfenuron at panicle initiation (PI) stage increased the plant height significantly over control. The treatment of forchlorfenuron @ 3640 g ha⁻¹ recorded tallest plant (105.67 cm) and shortest plant were noted in untreated control (100.13 cm). Similar results were reported by Watanabe and Saigusa (2004), who reported that plant height was significantly increased by the application of 50 ppm ethephon, 100 ppm GA3 alone or in combination over that of control.

The increase in the plant height is due to applying of plant growth regulators and hormones was promoted vegetative growth by active cell division, cell enlargement and cell elongation and these helped in improving growth traits and also facilitated reproductive growth (Pareek *et al.*, 2000) and these findings were in strict agreement with results of Tiwari *et al.*, 2011, Viramani *et al.*, 2007 and Bakhsh *et al.*, 2012.

The significant variation was recorded in number of tillers hill⁻¹ and maximum number of tillers hill⁻¹ were recorded (10.20) with spraying of forchlorfenuron @ 3640 g ha⁻¹ at par with forchlorfenuron 3120 g ha⁻¹ (10.09) whereas untreated control was recorded lowest number of tillers (8.86). Similarly, Yin *et al.*, 2012 found that the CPPU-treated wheat seedlings had about four tillers on average, whereas the control seedlings did not initiate tillering at 25 days after sowing. Phytohormones are the key factors that control

tillering (Michael and Beringer 1980). Dry matter accumulation was noticed maximum (81.04 g hill⁻¹) under treatment of forchlorfenuron @ 3640 g ha⁻¹ at par with forchlorfenuron @ 3120 g ha⁻¹ resulted in dry matter production (79.32 g hill⁻¹) at harvest which is a beneficial trait from yield point of view. Untreated control plots registered the minimum production of assimilates in the assimilatory apparatus (73.20 g hill⁻¹) at harvest (Table 1). Similarly, Jayachandran *et al.*, (2000) studied the effect of mepiquat chloride @ 150 ppm and paclobutrazol @ 120 ppm, on rice and observed that both these treatments sprayed at flowering stage and recorded maximum dry matter of 13.5 t ha⁻¹ and 12.6 t ha⁻¹ respectively over control.

Yield attributes and yield

The number of effective tillers hill⁻¹ as believed to be closely associated with grain yield hill⁻¹ resulting high productivity. The number of effective tillers varied significantly due to different treatments. Maximum number of effective tillers hill⁻¹ were recorded (10.11) with foliar spray of forchlorfenuron @ 3640 g ha⁻¹ at par with forchlorfenuron @ 3120 g ha⁻¹ (9.96) and it was very low in untreated control (No foliar spray) (8.45) (Table 1).

This result was supported by Rahman *et al.*, 2017 who revealed that the number of effective tillers hill⁻¹ of rice was significantly increased with the concentrations of 100 ppm NAA and 2 t ha⁻¹ residual limes. Similar trend was reported through Miyodo application by Islam, 2007. Significant variation in panicle length were observed (Table 2), it was lengthy in forchlorfenuron @ 3640 g ha⁻¹ (25.22 cm) at par with forchlorfenuron @ 3140 g ha⁻¹ (25.03 cm) and over control (22.17 cm) because of more cell division, cell enlargement and cell elongation occurred in the presence of forchlorfenuron which increased panicle length.

Table.1 Influence of different doses of forchlorfenuron on growth parameters of rice

Treatments	Plant height (cm)	Tillers hill ⁻¹	Effective tillers hill ⁻¹	Dry matter accumulation (g hill ⁻¹)
T ₁ - Untreated control	100.13	8.86	8.45	73.20
T ₂ - Forchlorfenuron 520 g ha ⁻¹ at PI stage	101.20	8.90	8.76	75.59
T ₃ - Forchlorfenuron 1040 g ha ⁻¹ at PI stage	102.13	9.04	8.86	76.13
T ₄ - Forchlorfenuron 1560 g ha ⁻¹ at PI stage	102.40	9.58	9.45	76.98
T ₅ - Forchlorfenuron 2080 g ha ⁻¹ at PI stage	103.27	9.68	9.59	76.53
T ₆ - Forchlorfenuron 2600 g ha ⁻¹ at PI stage	103.40	9.95	9.72	77.22
T ₇ - Forchlorfenuron 3120 g ha ⁻¹ at PI stage	104.33	10.09	9.96	79.32
T ₈ - Forchlorfenuron 3640 g ha ⁻¹ at PI stage	105.67	10.20	10.11	81.04
SEm±	0.68	0.33	0.27	0.86
CD(P=0.05)	2.06	0.99	0.82	2.61

Table.2 Influence of different doses of forchlorfenuron on different yield attributes and yield of rice

Treatments	Panicle length (cm)	Panicle weight (g)	Sound Grains panicle ⁻¹	Test weight (g)	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)
T ₁ - Untreated control	22.17	5.18	141.44	24.78	3080	5460
T ₂ - Forchlorfenuron 520 g ha ⁻¹ at PI stage	23.61	5.56	145.44	24.83	3590	6083
T ₃ - Forchlorfenuron 1040 g ha ⁻¹ at PI stage	24.04	5.70	150.22	24.91	3631	6140
T ₄ - Forchlorfenuron 1560 g ha ⁻¹ at PI stage	24.17	5.81	157.44	25.04	3909	6241
T ₅ - Forchlorfenuron 2080 g ha ⁻¹ at PI stage	24.41	5.95	162.33	25.12	4040	6293
T ₆ - Forchlorfenuron 2600 g ha ⁻¹ at PI stage	24.84	6.37	168.89	25.23	4343	6743
T ₇ - Forchlorfenuron 3120 g ha ⁻¹ at PI stage	25.03	6.75	173.78	25.31	4553	7140
T ₈ - Forchlorfenuron 3640 g ha ⁻¹ at PI stage	25.22	6.81	177.89	25.43	4745	7290
SEm±	0.32	0.28	4.83	0.24	90	79
CD(P=0.05)	0.98	0.85	14.62	NS	274	240

Similarly, Pandey *et al.*, (2017) reported that the application of GA₃ at 60, 90 and 120 g ha⁻¹ significantly increases the panicle length of rice 21.08, 22.56 and 23 cm respectively over control (19.66 cm).

The panicle weight was increased markedly with corresponding increase in the doses of forchlorfenuron from 520 to 3640 g ha⁻¹ (5.56 to 6.81 g respectively). Significantly heaviest panicle weight (6.81 g) were noted under forchlorfenuron@ 3640 g ha⁻¹ over its remaining treatments (Table 2). This result was supported by Pandey *et al.*, (2001) who reported that the treatments of cytokinin soil application (40 ppm) + triacanol foliar application (10 ppm) at 25 and 50 DAT increased the panicle weight as compared to control.

The sound grains panicle⁻¹ increased in all the treatment over control. Number of sound grains panicle⁻¹ were more in forchlorfenuron@ 3640 g ha⁻¹ at par with forchlorfenuron@ 3120 g ha⁻¹ and lowest was recorded in untreated control (Table 2). The total sound grains panicle⁻¹ was increased with forchlorfenuron as it obtained higher yield attributing characters. This result was supported with the work of Thuc *et al.*, (2016) who revealed that the application of paclobutrazol at 50 mg L⁻¹ significantly increases the number of filled grains panicle⁻¹ of rice over control.

The test weight did not shows any significant variation among different treatments (Table 2) and these results were in conformity with results of Elankavi *et al.*, 2009 and Nataraj *et al.*, 2016. The possible reason for a non-significant difference in test weight under the treatments was due to varietal characters i.e. similarity in size and shape of individual grains. These results are in collaboration with the findings of Chauhan *et al.*, 2013. The grain yield is very complex trait, it is multiplicative

end product of several basic components of yield such as panicle length, panicle excretion and productive tillers. The significantly maximum grain and straw yield were recorded with forchlorfenuron@ 3640 g ha⁻¹ (4745 and 7290 kg ha⁻¹) and it was at par with forchlorfenuron@ 3120 g ha⁻¹ (4553 and 7140 kg ha⁻¹) and minimum in untreated control (3080 and 5460 kg ha⁻¹) (Table 2). The increase in grain yield with application of plant growth regulators due to active translocation of photosynthesis and mobilization of reserve food materials in plant and to the developing sink by the increasing development of hydrolyzing and oxidizing enzyme activities and leads to increase grain yield (Elankavi *et al.*, 2009). Gurmani, *et al.*, (2006) reported an increased paddy yield with application of plant growth regulator, while comparing different plant growth regulators (ABA, BA and CCC) and their effects on yield and yield attributing characters. The enhanced yield with growth regulator may be due to increase in panicle length, and number of panicles. The finding is also similar with Pandey *et al.*, 2001, whom reported that IAA @ 50 ppm produced significantly maximum grain yield hill⁻¹, 1000-grain weight and yield kg ha⁻¹. Many other researchers studied that, the application of plant growth regulators supplied by exogenously and was observed that increase grain yield due to undergo several metabolic processes in the soil resulting in loss of their activity and reduced availability to plants and these type of behavior were only seen with application of IAA and gibberellic acid. These results were in conformity Zahir *et al.*, 2007, Yogeesha *et al.*, 2000 and Shi-Hua *et al.*, 2006.

From the present experiment it is concluded that application of forchlorfenuron @ 3640 g ha⁻¹ at panicle initiation stage significant enhanced growth, yield attributing characters and yield of rice. The increase grain yield was 35.09% higher over control treatment.

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