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Biochar and herbicide application effect on weed dynamics and yield of dry direct-seeded rice

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ABSTRACT

Field experiment was conducted during rainy season *(Kharif)* 2018 to study the bio-efficacy of pre-emergence herbicides in dry direct-seeded rice. The treatments were weedy check, weed free, pendimethalin applied as pre-emergence at 1.0, 1.5 and 2.0 kg/ha *fb* post-emergence application of bispyribac-sodium at 0.025 kg/ha with amendment of biochar at 4.0 t/ha and without amendment of biochar. Total weed dry matter accumulation was maximum at 60 DAS. The highest grain yield was obtained in weed free treatment which was 7.38% higher than pendimethalin as pre-emergence at 1.5 kg/ha followed by bispyribac-sodium at 25 g/ha under biochar condition. Recommended dose of pendimethalin (1.0 kg/ha) along with biochar had 7.5% less yield compared to 1.0 kg/ha pendimethalin without biochar amendment. Higher dose of pendimethalin reduced grain, straw and biological yield, setback on yield was more pronounced in non-biochar amended soil. Addition of biochar decreased the B:C compared to without biochar treatments.

Direct-seeding saves irrigation water, labour and production costs, giving higher net profit (Mishra *et al.* 2016) and a reduction in methane gas emissions (Joshi *et al.* 2013) in rice. Despite these advantages, yields have been inconsistent in some regions, especially in case of dry direct-seeded condition due to uneven and unsatisfactory crop stand, poor weed control, crop lodging, and faulty management of water and nutrient (Kumar and Ladha 2011). Gharde *et al.* (2018) reported that economic losses due to weeds alone, was the highest in rice amounting to 4420 million dollar annually. Weeds grow much faster than crop plants and thus utilize available soil nutrient earlier, resulting in lack of nutrients for growth and development of rice plant (Angiras and Attri 2002). Sequential spray of pre-emergence application of pendimethalin 1.0 kg/ha followed by post-emergence application of bispyribac-sodium 30 g/ha at 15-25 days after sowing was found the best for the control of weeds in DSR (Mahajan *et al.* 2009). Management of rice residues after combine harvest is becoming a major issue in rice-wheat system; and most farmers in the Indo-Gangetic Plains are burning these crop residues to clean the field for the next crop, and thereby increasing environmental pollution (Mishra *et al.* 2020). Among various approaches of crop residue management, thermo-chemical conversion of residue into biochar has been found as a potential strategy (Haefele *et al.* 2011). It has been recommended as a promising soil amendment because of its potential to improve soil physical, chemical and biological properties (Lehmann and Joseph 2009). However studies are lacking with respect to weed occurrence, herbicide efficacy and weed management in high herbicide dependent management system like direct-seeded rice. Hence, an experiment was undertaken to optimize the dose of pre-emergence herbicide for direct-seeded rice under biochar amended soil and to find out the density and dry matter accumulation of major weed species and to calculate weed control efficiency at different crop growth stages.

Field experiment was carried out during *Kharif* season of 2018 at G.B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand). Soil type at the experimental site was clay loam in texture, almost neutral in reaction (pH- 6.7) and medium in organic carbon (0.72%). Available N, P and K content in soil was 282.4, 25.2 and 184.5 kg/ha, respectively. Rice variety '*Pant Dhan-18*' was sown on 14th June, 2018 at a row spacing of 20 cm and harvested on 15th October, 2018. Crop was fertilized with 120: 60:40 kg/ha of N, P and K, respectively. Biochar was applied in the field during the last tillage operation at 4 t/ha. Pendimethalin at 1.0, 1.5 and 2.0 kg/ha were applied on the next day of sowing and bispyribac-

sodium at 25 g/ha at 20 DAS using 500 litres volume of water by knapsack sprayer fitted with flat-fan nozzle. In weed free plot, weeds were removed by hand weeding as and when desired. Data on weed population and dry matter, crop growth and yield were recorded. Weed control efficiency and benefit: cost ratio was calculated. Weed data were square-root transformed before statistical analysis.

Weed population and dry matter

Echinichloa crus-galli and *E. colona* were the two dominant grasses in the experimental field contributing 17.02% and 43.77% at 60 DAS. *Trianthema portulacastrum, Cyperus rotundus* and *C. iria* were the predominant weed species during initial stages (40 DAS) contributing 17.25, 25.57 and 11.76%, respectively to the total weed population. Pendimethalin as pre-emergence (PE) at 2.0 kg/ha followed by bispyribac-sodium as post-emergence (PoE) at 25 g/ha caused highest weed reduction after weed free which was statistically at par with pendimethalin as PE at 1.5 kg/ha followed by bispyribac-sodium as PoE at 25 g/ha and pendimethalin as PE at 2.0 kg/ha followed by bispyribac-sodium as PoE at 25 g/ha under biochar condition and had significant effect over rest of the treatments at 60 DAS. At 40 DAS, pendimethalin as PE at 2.0 kg/ha followed by bispyribac-sodium as PoE at 25 g/ha caused significant reduction in total weed density compared to other treatments. Among the biochar amended treatments, pendimethalin as PE at 1.0 kg/ha followed by bispyribac-sodium as PoE at 25 g/ha under biochar condition resulted in significant higher weed density over pendimethalin as PE at 1.5 kg/ha followed by bispyribac-sodium as PoE at 25 g/ha under biochar condition and pendimethalin as PE at 2.0 kg/ha followed by bispyribac-sodium as PoE at 25 g/ha under biochar condition throughout every stages of crop growth. In biochar amended plots, the density of the weeds was more compared to no biochar amended plots as the pendimethalin got adsorbed to the larger surface area of biochar and reduced its bioavailability to the weeds ultimately affecting density. Soni *et al.* (2015) observed similar results. At all the stages of crop growth, increasing the dose of pendimethalin from 1.0 kg/ha to 2.0 kg/ha as PE *fb* bispyribac-sodium as PoE at 25 g/ha reduced the weed density and dry matter. This is due to the fact that with increasing the dose of pendimethalin there was more active ingredient and more herbicide molecules in the same area of application as of lower dose (Singh *et al.* 2005). Application of biochar resulted in higher total weed dry matter accumulation compared to no biochar at all the stages. This could be ascribed to the fact that adsorption of pendimethalin to biochar limits its activity and thus effects weed density as well as weed dry matter.

Crop growth and yield

Shoot count varied according to weed densities across the treatments. At low dose of pendimethalin *i.e.* 1.0 kg/ha as PE *fb* bispyribac-sodium as PoE at 25 g/ha crop growth was lower in biochar amended soil compared to without biochar. However, application of pendimethalin at 1.5 kg/ha as pre-emergence *fb* bispyribac-sodium as PoE at 25 g/ha led to better shoot count due to reduction in weed pressure and beneficial effect of biochar.

Biochar amended weed control treatments resulted in higher plant height, number of shoots and crop dry matter accumulation per unit area compared to no biochar treatments as application of biochar improved soil physical characteristics (*i.e.* bulk density, water holding capacity, permeability), soil chemical characteristics (*i.e.* nutrient retention, nutrient availability) and soil biological properties which resulted in better plant growth attributes. The highest grain yield was observed in weed free treatment (5.42 t/ha). This might be due to frequent hand weeding which resulted in elimination of weeds as and when required. This produced a favourable microclimate by reducing the weed competition particularly at most rapid tillering stage of rice. At the dose 1.5 kg/ha of pendimethalin as pre-emergence *fb* bispyribac-sodium as PoE at 25 g/ha, grain yield was

Table 1. Effect of different treatments on density and dry matter accumulation of total weeds at different crop growth stages

Treatment	Dose (g/ha)	Total weed density (no./m^2)			Total weed dry matter (g/m^2)		
		40 DAS	60 DAS	80 DAS	40 DAS	60 DAS	80 DAS
Biochar + pendimethalin (PE) *fb* bispyribac-sodium (PoE)	1000+25	6.5(42.6)	6.7(44.7)	6.3(39.0)	4.2(16.8)	6.8(45.6)	5.4(29.1)
Biochar + pendimethalin (PE) *fb* bispyribac-sodium (PoE)	1500+25	4.8(22.8)	5.3(28.7)	4.8(23.3)	3.1(8.9)	5.7(31.8)	3.8(14.0)
Biochar + pendimethalin (PE) *fb* bispyribac-sodium (PoE)	2000+25	3.5(12.0)	3.7(13.3)	3.4(11.3)	2.2(4.2)	4.1(15.9)	1.5(1.5)
Pendimethalin (PE) *fb* bispyribac-sodium (PoE)	1000+25	5.1(26.0)	5.4(28.7)	4.9(23.3)	3.2(9.7)	5.6(31.4)	3.9(14.8)
Pendimethalin (PE) *fb* bispyribac-sodium (PoE)	1500+25	3.4(11.6)	3.8(14.0)	3.2(9.3)	2.1(3.6)	3.9(14.3)	2.5(5.7)
Pendimethalin (PE) *fb* bispyribac-sodium (PoE)	2000+25	2.4(5.3)	3.3(10.0)	2.6(6.0)	1.6(1.7)	2.8(7.9)	1.5(1.4)
Weedy check		9.2(85.0)	10.4(109.7)	9.7(94.7)	6.3(39.2)	11.0(121.0)	8.4(70.2)
Weed free		1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)
LSD (p=0.05)		0.9	0.8	0.7	0.44	0.69	0.40

PE- Pre-emergence; PoE- Post-emergence; Original values are given in parentheses; DAS - Days after sowing

Table 2. Effect of different treatments on crop growth, yield attributes, yield and economics of direct-seeded rice

Treatment	Dose (g/ha)	Plant height (cm)	Number of shoots (no./m²)	Crop biomass accumulation (g/m²)	Panicles (no./ m²)	Filled grains /panicle	Grain yield (t/ha)	B:C ratio
Biochar + pendimethalin (PE) *fb* bispyribac-sodium (PoE)	1000 + 25	97	368	1270	175	115	4.03	1.23
Biochar + pendimethalin (PE) *fb* bispyribac-sodium (PoE)	1500 + 25	100	385	1312	223	128	5.02	1.83
Biochar + pendimethalin (PE) *fb* bispyribac-sodium (PoE)	2000 + 25	100	380	1308	218	123	4.80	1.64
Pendimethalin (PE) *fb* bispyribac-sodium (PoE)	1000 + 25	100	350	1310	197	119	4.36	1.90
Pendimethalin (PE) *fb* bispyribac-sodium (PoE)	1500 + 25	99	370	1306	200	123	4.80	2.00
Pendimethalin (PE) *fb* bispyribac-sodium (PoE)	2000 + 25	93	343	1263	178	107	4.07	1.56
Weedy check		88	225	245	87	89	1.00	-0.22
Weed free		103	401	1308	225	129	5.42	1.81
LSD (p=0.05)		3	47	68	21	14	0.36	

significantly higher in biochar amended treatment (5.02 t/ha) compared to no biochar treatment at the same dose (4.80 t/ha). Grain yield was more due to synergistic effect of biochar and applied nitrogen which increased the nitrogen availability and also improved soil physical properties. This result was in compliance with the findings of Asai *et al.* (2009).

Pendimethalin as PE at 2.0 kg/ha followed by bispyribac-sodium as PoE at 25 g/ha resulted lower grain yield (4.07 t/ha) compared to lower doses of application of pendimethalin (1.0 and 1.5 kg/ha) followed by bispyribac-sodium as PoE at 25 g/ha (4.36 and 4.80 t/ha, respectively). This could be ascribed to the fact that high dose of pendimethalin resulted in lesser number of shoots per unit area which led to lesser panicles per unit area and ultimately reduced number of grains per unit area. Singh *et al.* (2005) also reported that with increase in dose of pendimethalin from 1.0 kg/ha to 2.0 kg/ha as PE *fb* bispyribac-sodium as PoE at 25 g/ha, there was reduction in number of panicles per unit area which ultimately reduced the yield. B: C ratio (2.00) was higher when pendimethalin was applied at 1.5 kg/ha as PE *fb* bispyribac-sodium as PoE at 25 g/ha in without biochar herbicidal treatment compared to the same dose in biochar amended soil in spite of lower yield (1.83). Lower B:C ratio in biochar amended weed control treatments is attributed to increased cost of cultivation due to biochar. Weedy check reported negative B: C ratio due to significantly lower yield compared to other treatments.

Pendimethalin as PE at 1.5 kg/ha followed by bispyribac-sodium at 25 g/ha under biochar condition was proved best treatment both for weed control and yield obtained.

REFERENCES

Angiras NN and Attri SP. 2002. Efficacy of herbicide mixture in direct seeded puddle rice. *Indian Journal of Weed Science* **34**(1&2): 42–45.

Asai H, Samson BK, Stephan HM, Songyikhangsuthor K, Homma K, Kiyono Y, Inoue Y, Shiraiwa T and Horie T. 2009. Biochar amendment techniques for upland rice production in Northern Laos 1. Soil physical properties, leaf SPAD and grain yield. *Field Crops Research* **111**: 81–84.

Gharde Y, Singh PK, Dubey RP and Gupta PK. 2018. Assessment of yield and economic losses in agriculture due to weeds in India. *Crop Protection* **107**: 12–18.

Haefele SM, Konboon Y, Wong boon W, Amarante S, Maarifat AA and Pfeiffer EM. 2011. Effects and fate of biochar from rice residues in rice-based systems.*Field Crop Research* **121**: 430–440.

Joshi E, Kumar D, Lal B, Nepalia V, Gautam P and Vyas AK. 2013. Management of direct seeded rice for enhanced resource-use efficiency. *Plant Knowledge Journal* **2**(3): 119.

Kumar V and Ladha JK. 2011. Direct seeding of rice. Recent developments and Future Research needs. *Advances in Agronomy* **111**: 297–413.

Lehmann CJ and Joseph S. 2009.Biochar systems. pp. 207-222. In: *Biochar for Environmental Management: Science and Technology*. (Eds. Lehmann CJ and Joseph S), *Earthscan. London*.

Mahajan G, Chauhan BS and Johnson DE. 2009. Weed management in aerobic rice in north Western Indo-Gangetic plains. *Journal of Crop Improvement* **23**: 366–382.

Mishra AK, Khanal AR and Pede V. 2016. Economic and resource conservation perspectives of direct-seeded rice planting methods: Evidence from India *Proceedings of Agricultural and Applied Economics Association's 2017 AAEA Annual Meeting,* Chicago, IL, July 30-August 2, 2016.

Mishra JS, Bhatt BP, Arunachalam A and Jat ML. 2020. *Conservation Agriculture for Sustainable Intensification in Eastern India*. Policy Brief, 8p. Indian Council of Agricultural Research and National Academy of Agricultural Sciences, New Delhi.

Singh VP and Singh G. 2001. Weed control studies in spring rice under rainfed low land situation of Uttaranchal. *Indian Journal of Weed Science* **33** (1&2): 52–55.

Singh VP, Singh G, Singh RK, Singh SP, Kumar A, Dhyani VC, Kumar M and Sharma G. 2005. Effects of herbicides alone and in combination on direct seeded rice. *Indian Journal of Weed Science* **37**(3&4):197–201.

Soni N, Leon RG, Erickson JE, Ferrell JA and Silveira ML. 2015. Biochar decreases atrazine and pendimethalin pre-emergence herbicidal activity. *Weed Technology* **29**(3): 359–366.