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Weed management in finger millet (*Eleusine coracana* L.) under system of crop intensification

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Abstract
A field experiment was conducted to find out the bio-efficacy of botanical & chemical herbicides in finger millet (*Elusine coracona* L) under SCI,at INS Farm-II of Faculty of Agricultural Sciences (Institute of Agricultural Sciences), SOADU, BBSR with 8 different weed management treatment viz. W_1=Weedy check, W_2=Hand weeding at 18 & 35 DAT, W_3=Mechanical weeding at 18 & 35 DAT, W_4=Pendimethalin @750 g a.i. ha^{-1} at 2 DAT+ MW at 35 DAT, W_5=Oxyflurofen 23.5 EC @ 80 ga.i.ha^{-1}DAT+MW at 35 DAT, W_6=*Calotropis gigantea* extract @ 5% at 2 DAT + MW at 35 DAT, W_7=*Parthenium hysterophorous* extract @ 5% at 2 DAT + MW at 35 DAT and W_8=*Parthenium hysterophorous* + *Calotropis gigantea each* @ 5% at 2 DAT +MW at 35 DAT. The experiment was laid out in RBD, replicated thrice during *kharif*, 2018.Weed density, biomass showed a significant difference among different weed management treatments at both 20 and 40 DAT. Under the treatment two Hand weeding (W_2), the weed density was found least. The highest weed density was recorded with weedy check (W_1). Similar trends observed in weed biomass. The plant character varied significantly among different weed management practices. The highest plant height, no of tillers m^{-2}, LAI and dry matter production was recorded highest in Hand weeding at 18 & 35 DAT , and the lowest were found under weedy check. Similar trends observed on Yield attributes and grain & straw yield varied significantly. Yield attributes like no of ear/plant, no of finger /ear and grains /finger shows highest values under Under the treatment two HW (W_2) and least under weedy plot. The maximum (28.56 q/ha) grain yield was recorded with Hand weeding at 18 & 35 DAT (28.56q/ha).

Keywords: Finger millet, oxyflurofen, pendimethalin, *calotropis gigantea* extract, *Parthenium*

Introduction
Indian agriculture is predominantly subsistence type (Reddy and Reddy). Finger millets constitute to be a part of subsistence agriculture. These are high in folic acid, minerals, iron and fibre, and have higher vitamin levels than rice. Finger millet or ragi has the pride of place in having the highest productivity among small millets. It is the main food grain for many people, especially in dry areas of India and Sri Lanka. In Odisha ragi production is 28000ton & in India the production is 1793 thousand ton in year 2015-16. Area of ragi in Odisha 46000 ha & in India 1259 thousand ha (Anonymous, 2017).

The production and productivity of finger millet is low because of heavy weed infestation, incidence of blast disease etc. Among these, weed infestation is a serious threat to its production. Uncontrolled weed growth during crop period has significantly reduced the grain yield ranging from 34 to 61 per cent (Ramachandra Prasad *et al.*, 1991) [3]. The critical period for crop-weed competition is initial five weeks period from planting (Sundaresh *et.al.*, 1975 and Nanjappa, 1980) [4, 5]. System of crop intensification (SCI) is an agricultural production strategy that seeks to increase and optimize the benefits that can be derived from making better use of available resources: soil, water, seeds, nutrients, solar radiation, and air. There is always need to consider agricultural options in context, taking full account of the factors and interactions of time and space so that field operations are conducted in a timely way, with land area optimally occupied by crops, and not just by a single crop. It is also important that ecosystem services be considered (Garbach *et al.*, 2017) [6]. SCI principles and practices build upon the productive potentials that derive from plants having larger, more efficient, longer-lived root systems and from their symbiotic relationships with a more abundant, diverse, and active soil biota. The critical period of crop – weed competition for the crops varies from 25-45 days after sowing (Lall and Yadav, 1982) [2]. Weed control during early stages of crop growth period assumes important as revealed from the significant decrease in yield due to

delay in weeding. The costly and laborious nature of manual weeding has made chemical weed control popular among farmers. To reduce the cost of finger millet production, intensive applications of weed control methods should be optimized. Therefore, determining appropriate weed management practices is important for production to ensure optimum grain yield.

The botanical herbicides are safer to soil health in comparison to synthetic chemical herbicides. Mixture of botanical extracts with other botanicals or chemical herbicides need to be studied for further exploitation of these natural plant allelochemicals in various ecosystem.

Material and Methods

The present investigation was carried out in Instructional Farm-II of Faculty of Agricultural Sciences (Institute of Agricultural Sciences),Siksha O Anusandhan (Deemed to be University), Nuagaon, Bhubaneswar, Odisha during the *kharif* season of 2018, with 8 different weed management treatment viz. W_1=Weedy check, W_2=Hand weeding at 18 & 35 DAT, W_3=Mechanical weeding at 18 & 35 DAT, W_4=Pendimethalin @750 g a.i. ha^{-1} at 2 DAT+ MW at 35 DAT, W_5=Oxyflurofen 23.5 EC @ 80 ga.i.ha^{-1}DAT+MW at 35 DAT, W_6=*Calotropis gigantea* extract @ 5% at 2 DAT + MW at 35 DAT, W_7=*Parthenium hysterophorous* extract @ 5% at 2 DAT + MW at 35 DAT and W_8=*Parthenium hysterophorous + Calotropis gigantea each* @ 5% at 2 DAT +MW at 35 DAT. The experiment was laid out in RBD, replicated thrice during *kharif*, 2018. Data on weed density, dry weight, from each plot were recorded by marking 1mx1m area from three locations of each plot. Weedicides were applied at 2 days after planting. Hand weeding was also done. All other agronomic practices were performed uniformly.

Results and Discussion

Finger millet was infested with 10 weed species out of which 3 were grasses, 5 broadleaved and two sedge. An experimental result revealed that at 20 and 40 DAT, mechanical weeding at 18 and 35 DAT registered significantly lower density and biomass of grass, broad leaved, sedge and total weed and was at per with oxyflurofen 23.5 EC@80 g a.i. ha^{-1}. Among botanical herbicides *Parthenium hysterophorous + Calotropis gigantea each* @ 5% at 2 DAT +MW at 35 DAT control total weeds density and biomass and it was at per with chemical herbicide Pendimethalin @750 g a.i. ha^{-1} at 2 DAT+ MW at 35 DAT. Similar trends follow in growth and yield attributes(table 4).All weed control treatments recorded significantly higher plant height, number of tillers m-2 than weedy check. . Hand weeding treatment registered significantly the highest grain yield (28.56 q/ha) of finger millet (table 4).Among the others weed management treatments, Mechanical weeding at 18 and 35 DAT recorded highest grain yield(26.46 q/ ha^{-1}) over other treatments and it was at per with oxyflurofen 23.5 EC@80 g a.i. ha^{-1} (26.32q/ ha^{-1}).

In terms of economic, analysis results revealed that the highest benefit cost ratio (1.75) were observed in the plots treated with oxyflurofen 23.5 EC@80 g a.i. ha^{-1} followed by the treatment received twice hand wedding at 18 and 35 DAT (1.74) . The Least value was observed in weedy check plot (1.16).

Table 1: Weed Density at 20 DAT as affected by different weed management practices

Treatments	Grass	Sedges	BLW	Total
W_1=Weedy check	5.24(27.00)	3.29(10.67)	4.74(22.33)	7.76(60.00)
W_2=Hand weeding at 18 & 35 DAT	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)
W_3=Mechanical weeding at 18 & 35 DAT	2.32(5.00)	0.71(0.00)	1.77(2.67)	2.85(7.67)
W_4=Pendimethalin @750 g a.i. ha^{-1} at 2 DAT+ MW at 35 DAT	3.02(8.67)	0.71(0.00)	3.03(8.67)	4.22(17.33)
W_5=Oxyflurofen 23.5 EC @ 80 ga.i.ha^{-1}DAT+MW at 35 DAT	2.54(6.00)	0.71(0.00)	2.47(5.67)	3.48(11.67)
W_6=*Calotropis gigantea* extract @ 5% at 2 DAT + MW at 35 DAT	4.67(21.33)	2.12(4.00)	3.62(12.67)	6.20(38.00)
W_7=*Parthenium hysterophorous* extract @ 5% at 2 DAT + MW at 35 DAT	4.30(18.00)	1.58(2.00)	3.29(10.33)	5.55(30.33)
W_8=*Parthenium hysterophorous + Calotropis gigantea each* @ 5% at 2 DAT +MW at 35 DAT	3.07(9.00)	1.87(3.00)	2.81(7.67)	4.47(19.67)
SEm(±)	0.14	0.14	0.23	0.21
CD (P=0.05)	0.43	0.42	0.71	0.63

Table 2: Weed Density at 40 DAT as affected by different weed management practices

Treatments	Grass	Sedges	BLW	Total
W_1=Weedy check	4.67(21.33)	3.43(11.33)	3.95(15.33)	6.96(48.00)
W_2=Hand weeding at 18 & 35 DAT	1.08(0.67)	0.71(0.00)	1.27(1.11)	1.51(1.78)
W_3=Mechanical weeding at 18 & 35 DAT	1.76(2.67)	0.71(0.00)	1.58(2.00)	2.26(4.67)
W_4=Pendimethalin @750 g a.i. ha^{-1} at 2 DAT+ MW at 35 DAT	2.12(4.00)	0.71(0.00)	2.41(5.18)	2.77(7.18)
W_5=Oxyflurofen 23.5 EC @ 80 g a. i. ha^{-1} DAT+MW at 35 DAT	2.04(3.67)	0.71(0.00)	1.77(2.67)	2.61(6.33)
W_6=*Calotropis gigantea* extract @ 5% at 2 DAT + MW at 35 DAT	4.22(17.33)	2.12(4.00)	2.78(7.33)	5.40(28.67)
W_7=*Parthenium hysterophorous* extract @ 5% at 2 DAT + MW at 35 DAT	3.97(15.33)	1.58(2.00)	2.54 (6.00)	4.88(23.33)
W_8=*Parthenium hysterophorous +Calotropis gigantea each* @ 5% at 2 DAT + MW at 35 DAT	2.67(6.67)	0.71(0.00)	2.19(4.33)	2.97(8.33)
SEm (±)	0.13	0.07	0.20	0.14
CD (P=0.05)	0.39	0.23	0.60	0.42

Table 3: Weed Biomass (g m^{-2}) as affected by different weed management practices 20 & 40 DAT

Treatments	Weed Biomass (g m^{-2})	
	20 DAT	40 DAT
W_1=Weedy check	79.45	92.11
W_2=Hand weeding at 18 & 35 DAT	0.0	2.38
W_3=Mechanical weeding at 18 & 35 DAT	1.94	4.60
W_4=Pendimethalin @750 g a.i. ha^{-1} at 2 DAT+ MW at 35 DAT	16.51	13.26
W_5=Oxyflurofen 23.5 EC @ 80 g a. i. ha^{-1} DAT+MW at 35 DAT	3.60	8.77
W_6=*Calotropis gigantea* extract @ 5% at 2 DAT + MW at 35 DAT	36.50	54.16
W_7=*Parthenium hysterophorous* extract @ 5% at 2 DAT + MW at 35 DAT	32.92	48.92
W_8=*Parthenium hysterophorous* + *Calotropis gigantea each* @ 5% at 2 DAT + MW at 35 DAT	18.03	17.25
SEm (±)	1.48	2.27
CD (P=0.05)	4.49	6.88

Table 4: Yield attributing characters of finger millet as affected by weed management practices

Treatments	No of ear/plant	No of fingers/Ear	No of Grains/ Finger	Weight of ear(g)	Test weight (g)
W	2.77	3.35	1489.67	6.19	2.84
W_2	4.80	6.30	2481.67	9.33	3.07
W_3	4.50	5.95	2388.67	8.70	3.04
W_4	3.70	5.22	2279.00	8.02	2.98
W_5	4.37	5.52	2473.67	8.51	3.01
W_6	3.13	4.38	2045.33	7.52	2.89
W_7	3.27	4.45	2085.00	7.72	2.91
W_8	3.63	4.83	2173.00	8.35	2.97
SEm (±)	0.35	0.27	36.01	0.28	0.07
CD (P=0.05)	1.07	0.81	109.11	0.86	NS

Conclusion

Application of two HW at 18 and 35 DAT was found to be superior in respect to growth, yield attributing character and yield of ragi under System of crop intensification but in in terms of cost effectiveness pre emergence application of oxyflurofen and one HW is the best.

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