International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(2): 1360-1362

Received: 09-01-2018
Accepted: 12-02-2018

Ajay Kumar
College of Forestry, V.C.S.G. Uttarakhand University of Horticulture and Forestry, Ranichauri, Tehri Garhwal, Uttarakhand, India

Arunima Paliwal
College of Forestry, V.C.S.G. Uttarakhand University of Horticulture and Forestry, Ranichauri, Tehri Garhwal, Uttarakhand, India

Laxmi Rawat
College of Forestry, V.C.S.G. Uttarakhand University of Horticulture and Forestry, Ranichauri, Tehri Garhwal, Uttarakhand, India

Pankaj Kumar
College of Forestry, V.C.S.G. Uttarakhand University of Horticulture and Forestry, Ranichauri, Tehri Garhwal, Uttarakhand, India

Ajay Paliwal
College of Forestry, V.C.S.G. Uttarakhand University of Horticulture and Forestry, Ranichauri, Tehri Garhwal, Uttarakhand, India

Sumit Chaudhary
College of Forestry, V.C.S.G. Uttarakhand University of Horticulture and Forestry, Ranichauri, Tehri Garhwal, Uttarakhand, India

Correspondence
Ajay Kumar
College of Forestry, V.C.S.G. Uttarakhand University of Horticulture and Forestry, Ranichauri, Tehri Garhwal, Uttarakhand, India

Barnyard millet (*Echinochloa frumentacea*) productivity enhancement through establishment methods and weed management practices under hilly rainfed conditions

Ajay Kumar, Arunima Paliwal, Laxmi Rawat, Pankaj Kumar, Ajay Paliwal and Sumit Chaudhary

Abstract
The field experiments were conducted during *Kharif* season of 2015, 2016, and 2017 at Gaja Research and Extension Centre, College of Forestry, V.C.S.G. Uttarakhand University of Horticulture and Forestry, Ranichauri, Uttarakhand, India to find out effective establishment and weed management method for the maximizing the productivity of barnyard millet crop. Four establishment methods and four weed management practices were tested in split plot design with three replications. Major weeds found in the plots were *Galinsoga parviflora, Persicaria capitatum, Paspalum dilatatum, Digitaria ciliaris, Oxalis latifolia, Setaria glauca Cyperus defformis* and *Cyperus iria*. Among the establishment methods higher seed rate of 15 kg per hectare recorded significantly lower density and biomass of weeds in turn resulted in higher grain and straw yield of barnyard millet. Among the weed management treatments one inter-culture at 20 DAS and one hand weeding at 40 DAS registered significantly higher grain yield than pre-emergence spray of isoproturon 0.5 kg a.i./ha+ one inter-culture at 40 DAS, the straw yield was statistically at par with each other. Highest benefit: cost ratio was recorded in pre-emergence spray of isoproturon 0.5 kg a.i./ha+ one inter-culture at 40 DAS (2.61) followed by one inter-culture at 20 DAS and one hand weeding at 40 DAS (2.59). Therefore on the basis of pooled data of three year experiments, it can be concluded that higher seed rate of 15 kg per hectare of barnyard millet and integrated approach of isoproturon 0.5 kg a.i./ha and one inter culture at 40 DAS are effective in managing weed problems of barnyard millet.

Keywords: Barnyard millet, establishment methods, isoproturon, weed management

Introduction
Barnyard millet is one of the important *Kharif* crop of Uttarakhand hills. It is grown for grain and fodder which is used in winter season when fodder scares. Uttarakhand occupies 55.4 thousand hectare area and produce 78.5 thousand tonns of barnyard grain with 1416 kg/ha productivity (Anon. 2016-17) [2]. Uttarakhand stands first in area and production among barnyard producing states in India. Being a *Kharif* crop, it is severely infested with diverse weed flora. Uttarakhand farmers are hardly using herbicides to control weeds as of result, they lose the yield severely. Slow initial growth of barnyard millet and favourable conditions for weed multiplication cause a serious threat to optimum yield of barnyard millet. Weeds caused an appreciable reduction in density, dry weight and depletion of nutrients of crop plants, if not controlled in time and appropriate stage of crop growth. The early crop weed competition can be escaped by selecting proper establishment method *viz.* early or delay sowing, higher seed rate and change in spacing and weed management practices.
The proper establishment method helps in ensuring good crop stand and early vigour while good weed management practice provides minimum crop weed competition at early stage of crop growth. Hence this study entitled "Barnyard millet (*Echinochloa frumentacea*) productivity enhancement through establishment methods and weed management practices under hilly rainfed conditions" was carried out to evaluate establishment and weed control methods for the improvement of barnyard millet yield under rainfed condition of Uttarakhand.

Materials and Methods
Field studies were conducted during *Kharif* season of 2015, 2016 and 2017 at Gaja Research

and Extension Centre, College of Forestry, V.C.S.G. University of Horticulture and Forestry, Ranichauri, Uttarakhand, India. The soil was silty clay loam of medium depth with acidic pH (5.7) having 0.71 % organic carbon, 219 kg/ha available N, 16 kg/ha available P and 390 kg/ ha available K. The experiment was laid out in split plot design with three replications. The main plot treatments comprised of four establishment method *viz.* M1: using high seed rate 15 kg/ha, M2: providing wider row spacing 45 cm and plant spacing 7.5 cm for barnyard millet and introduced sunhamp in between of barnyard millet row and harvested 40 DAS and used as mulch, M3: delay sowing 8-10 days after normal time of sowing and M4: recommended package of practices (sowing at right time i.e. first week of June, seed rate 10 kg/ha and row to row spacing 25 cm). Sub plots comprised of four weed management treatments *viz.*, W1: Control (weedy), W2: One inter cultivation at 20 DAS+ One hand weeding at 40 DAS, W3: Pre-emergence spray of isoproturon 0.5 kg a.i./ha and W4: One pre-emergence spray of isoproturon 0.5 kg a.i./ha followed by one inter-culture at 40 DAS. The barnyard millet variety '*PRJ-1*' was sown. Seed rate and row to row spacing were as per treatment. Pre-emergence application of isoproturon was sprayed by knapsack sprayer fitted with flat fan nozzle using a spray volume of 500 L/ha. Climate of College of Forestry is humid and temperate type with chilled winter. The total precipitation during the crop season was recorded 747.9 mm in 2015, 844.9 mm in 2016 and 1186.9 mm in 2017, whereas the maximum temperature varied between 18.1 to 25.8°C in 2015, 21.5 to 24.6°C in 2016 and 22.2 to 24.6°C in 2017 during cropping season. Similarly minimum temperature varied between 6.8 to 16.3°C in 2015, 11.5 and 17.8°C in 2016 and 11.2 and 16.8°C in 2017.

Weedy plots remained infested with native population of weeds till harvest. The data on density and biomass of weed was subjected to square root transformation $\sqrt{(x+1)}$ to normalize their distribution. The data of three year experiments was pooled and analyzed through STPR-2 software of G.B.P.U.A. & T. Pantnagar.

Results and Discussion

Weed Studies

During the three years study, population of broad leaf weeds dominated over grassey weeds. Among grasses *Paspalum dilatatum, Digitaria ciliaris, Setaria glauca* were the most dominated weed, among broad leaf weeds *Galinsoga parviflora, Persicaria capitatum, Oxalis latifolia,* and among sedges *Cyperus defformis* and *Cyperus iria* were dominant. Broad leaf weeds contributed maximum per cent to total weed density during three years.

The establishment method treatments exerted significant influence on density and biomass of weeds (Table 1). Among the establishment methods, higher seed rate of barnyard millet 15 kg/ha recorded significantly lower density and biomass of weeds. It might be due to higher population of crop plant which provides competition to the weed flora. Similar finding was reported by Ahmed *et al.*, 2014 [1] in direct seeded rice from Bangladesh. The highest weed density and dry biomass production to total weeds were recorded under M3 (delay sowing 8-10 days after normal time of sowing) at 60 DAS (Table 1). Among the weed management treatments, one inter-culture at 20 DAS and one hand weeding at 40DAS registered significantly lower population and dry biomass of weeds in comparison to other treatments. Integrated approach of weed management, pre emergence spray of isoproturon 0.5 kg a.i./ha and one inter-culture 40 DAS reduced the weed density and dry biomass significantly. This may be due to less germination of weeds at early stage of the crop growth by pre-emergence spray and later on one inter-culture operation at 40 DAS take care of the left over weeds. Similar finding have been reported by Pradhan *et al.*, 2012 [8] in finger millet.

Weed control efficiency (WCE) was highest in higher seed rate 15 kg/ha treatment followed by recommended practices *viz.*, June first week sowing, seed rate 10 kg/ha and row to row spacing 25 cm of barnyrard millet. Because, at high seeding rates of aerobic rice, the crop had a competitive advantage over weeds and closed canopy earlier, thus, reducing weed growth (Anwar *et al*. 2011) [3]. However, one inter-culture at 20 DAS and one hand weeding at 40DAS recorded highest weed control efficiency followed by pre-emergence spray of isoproturon 0.5 kg a.i./ha+ one inter-culture at 40 DAS among different weed management treatments. Ashok *et al.* (2003) [4] also found that isoproturon + one hand weeding was more effective against grassy and broad leaved weeds.

Weed index is used to evaluate the superiority or inferiority of weed control treatments. It is a measure of yield loss caused due to varying degree of weed competition compared to the relatively weed free condition throughout the crop period leading to higher productivity (Vinothini and Arthanar, 2017) [11]. Weed index was registered lowest in recommended package of practices (sowing at right time i.e. first week of June, seed rate 10 kg/ha and row to row spacing 25 cm) followed by using high seed rate 15 kg/ha on the basis of three year pooled data. Among the weed management treatments, lowest weed index was recorded in one inter-culture at 20 DAS and one hand weeding at 40DAS followed by pre-emergence spray of isoproturon 0.5 kg a.i./ha and pre-emergence spray of isoproturon 0.5 kg a.i./ha followed by one inter-culture at 40 DAS. Vinothini and Arthanari, 2017[11] also recorded lowest yield reduction (7.06 per cent) under hand weeding at 20 and 40 DAS.

Crop Studies

Plant height of barnyard millet was recorded significantly highest in establishment method with higher seed rate 15 kg/ha due to more completion for light among barnyard plant. Rahman and Hossain, 2011 [10] also reported similar finding in soybean crop. The increase in plant height at higher density is probably caused through stem elongation (Pendersen and Lauer, 2003 [7]) and increase of number of nodes/plant due to mutual shading. Among the weed management treatments, one inter cultivation at 20 DAS+ one hand weeding at 40 DAS recorded significantly higher plant height of barnyard millet which was statistically at par with one pre-emergence spray of isoproturon 0.5 kg a.i./ha followed by one inter-culture at 40 DAS. Lowest plant height was recorded under pre-emergence spray of isoproturon 0.5 kg a.i./ha.

Grain and straw yield were the maximum in higher seed rate 15 kg/ha followed by recommended practices (June first week sowing, seed rate 10 kg/ha and row to row spacing 25 cm). High seeding rates improve the ability of crops to suppress weeds and can reduce yield loss under partially-weedy conditions. Similar results have been reported for barley (O'Donovan, *et al.*, 2001 [5]) and wheat (Olsen *et al.* 2005 [6]). Barnyard millet grown under wider row spacing 45 cm and introduced sunhamp in between of barnyard millet row and harvested 40 DAS and used as mulch registered lowest grain and straw yield.

Among establishment methods, higher seed rate 15 kg/ha registered 14.08 and 7.1 per cent higher grain and straw yield,

respectively. However, among the weed management treatments, one inter-culture at 20 DAS and one hand weeding at 40DAS registered significantly higher grain yield than pre-emergence spray of isoproturon 0.5 kg a.i./ha+ one inter-culture at 40 DAS. While straw yield, was statistically at par with each other. Prajapati *et al.*, 2007 [9] also reported similar result in kodo millet. Pre-emergence spray of isoproturon 0.5 kg a.i./ha was recorded significantly lower grain and straw yield in comparison to one inter-culture at 20 DAS and one hand weeding at 40DAS and pre-emergence spray of isoproturon 0.5 kg a.i./ha+ one inter-culture at 40 DAS. Highest harvest index was estimated under higher seed rate 15 kg/ha and one inter-culture at 20 DAS and one hand weeding at 40DAS and lowest in delay sowing 8-10 days after normal time of sowing and weedy condition of barnyard millet.

Economic Studies

Higher seed rate 15 kg gave higher net return (Rs 43082/ha) and benefit: cost ratio (2.95). This was because the less increase in cost of cultivation and higher increase of grain and straw yield in comparison to recommended practices. While in case of weed management treatments, one inter-culture at 20 DAS and one hand weeding at 40DAS recorded highest net return (Rs 39999/ha) followed by One pre-emergence spray of isoproturon 0.5 kg a.i./ha followed by one inter-culture at 40 DAS (Rs 39111/ha). Highest benefit: cost ratio was recorded in one pre-emergence spray of isoproturon 0.5 kg a.i./ha followed by one inter-culture at 40 DAS (2.61) followed by one inter cultivation at 20 DAS+ one hand weeding at 40 DAS (2.59). It is due to higher cost of cultivation (Rs15457/ha) in one inter cultivation at 20 DAS+ One hand weeding at 40 DAS than one pre-emergence spray of isoproturon 0.5 kg a.i./ha followed by one inter-culture at 40 DAS (Rs 14957) and less difference in net return (Table 1). Un-weeded control recorded a loss of Rs.14492/ha due to 43.5 and 27.0 per cent decrease in grain and straw yield in comparison to one inter cultivation at 20 DAS+ one hand weeding at 40 DAS.

Table 1: Effect of establishment and weed management methods on weeds, yield and economics of barnyard millet.

Treatment	Plant Height (cm)	Weed Density (m^2)	Weed Dry Biomass (g)	Weed Control efficiency (%)	Weed Index (%)	Grain Yield (kg/ha)	Straw Yield (kg/ha)	Harvest Index (%)	Cost of Cultivation (Rs/ha)	Gross Return (Rs/ha)	Net Return (Rs/ha)	B:C Ratio
M1	161.4	19.7(394)	11.4(156)	45.2	10.2	2312	5731	28.7	14620	57702	43082	2.95
M2	130.6	20.7(435)	15.2(248)	28.2	22.9	1844	4845	27.6	15166	46570	31404	2.07
M3	111.5	22.1(498)	15.9(265)	30.3	13.9	1595	4378	26.7	14720	40656	25936	1.76
M4	151.3	20.7(424)	13.5(198)	39.6	7.6	2013	5348	27.3	14480	50956	36476	2.52
S.Em±	1.75	0.220	0.275			130	266					
CD (5 %)	5.04	0.635	0.790			374	766					
W1	135	23.6(557)	19.1(365)	00.0	30.0	1546	4352	26.2	14117	39624	25507	1.81
W2	144	17.9(321)	8.3(77)	69.0	00.0	2220	5528	28.7	15457	55456	39999	2.59
W3	134	22.8(524)	15.2(238)	31.0	17.0	1841	4968	27.0	14457	46756	32299	2.23
W4	142	18.6(349)	13.5(188)	43.0	17.0	2158	5454	28.3	14957	54068	39111	2.61
S.Em±	0.96	0.159	0.278			55	101					
CD (5 %)	2.69	0.445	0.780			154	282					

*: Original values are in parenthesis

Acknowledgment

We would like to thank ICAR AICRP-Small Millet for funding the research and College of Forestry, V.C.S.G. Uttarakhand University of Horticulture and Forestry, Ranichauri, Tehri Garhwal, Uttarakhand for providing institutional support for smooth execution of the research.

References

1. Ahmed S, Salim M, Chauhan BS. Effect of Weed Management and Seed Rate on Crop Growth under Direct Dry Seeded Rice Systems in Bangladesh. PLoS ONE. 2014; 9(7):e101919. doi:10.1371/journal.pone.0101919
2. Anonymous. Uttarakhand Agriculture Statistics Data, *Kharif*, 2016-17. http://agriculture.uk.gov.in/files/Booklet_Kharif_Production_2016-17_(page_no_20_to108).pdf
3. Anwar MP, Juraimi AS, Puteh A, Selamat A, Man A *et al*. Seeding method and rate influence on weed suppression in aerobic rice. Afr J Biotechnol. 2011; 10(68):15259-15271.
4. Ashok EG, Chandrappa M, Kadalli GG, Kiran Kumar, Mahad V, Krishne Gowda. Integrated weed control in drill sown rainfed finger millet (*Eleusine coracana* L). Indian Journal of Agronomy. 2003; 48(4):290-293.
5. O'Donovan JT, Harker KN, Newman JC, Hall LM. Barley seeding rate influences the effects of variable herbicide rates on wild oat. Weed Science. 2001; 49(6):746-754.
6. Olsen JM, Kristensen L, Weiner J, Griepentrog HW. Increased density and spatial uniformity increases weed suppression by spring wheat (*Triticum aestivum* L.). Weed Research. 2005; 45(4):316-321.
7. Pendersen P, Lauer JG. Corn and soybean response to rotation sequence, row spacing and tillage system. Agronomy Journal. 2003; 95:965-997.
8. Pradhan A, Rajput AS, Thakur A. Effect of weed management practices on finger millet under rainfed conditions. Indian Journal of Weed Science. 2012; 44(2):115-117.
9. Prajapati BL, Upadhyaya VB, Singh RP. Integrated weed management in rainfed Kodo millet (*Paspalum scrobiculatum*). Indian Journal of Agronomy. 2007; 52(1):67-69.
10. Rahman MM, Hossain MM. Plant density effects on growth, yield and yield components of two soybean varieties under equidistant planting arrangement. Asian Journal of Plant Sciences. 2011; 10:278-286.
11. Vinothini G, Arthanari PM. Pre emergence herbicide application and hand weeding for effective weed management in irrigated kodo millet (*Paspalum scrobiculat*um L.) International Journal of Chemical Studies. 2017; 5(3):366-369.